Entry

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Entry

- Firm's decisions whether (and where) to enter determines market structure

✓ Entry decisions determine:
  - Industry concentration
  - Product differentiation – where to enter in product space
  - Social efficiency

- Traditional thought on factors influencing entry
  - Technological and economies of scale (Bain)
  - Sunk costs (Sutton)

- Additional factors
  - Market size
  - Entry barriers

NEIO Approach to Entry

- Entry is determined by strategic interactions amongst firms
  - ✓ Should model number of firms together with industry outcomes
- Initiated by Bresnahan and Reiss (1989, 1990) [self study]
  - ✓ Market expansion with number of firms is indicative of conduct
  - Key Assumption: Homogeneous firms
- Recent papers following Berry (1992) adopt revealed preference approach
  - Firms expect positive profits on entry
  - Not entering indicates negative profits

Basic Framework: Two-Period Models

- Work-horse model defined with the following game
  1. Potential entrants decide whether and where to enter
  2. Competition in prices/quantities

✓ Subgame perfect equilibrium

  2. Solve period 2 game first given market configuration
  1. Find Nash Equilbria of entry stage

- Challenges/Issues
  - Difficult to determine number of potential entrants
  - Inherenty dynamic phenomenon – literature based on cross-sectional data
  - Focus on the impact of entry differences on price-cost margins
  - Existence and multiplicity of equilibria
    - ✓ Issues for estimation and counterfactual analysis

Outline

Berry (ECMA 1992)

- Study entry by airlines in city-pairs, motivated by deregulation of the airline industry in late 70's
  - CAB (former FAA) controlled entry and licenses, favored weaker carriers
  - Entry was essentially prohibited
  - Service was point-to-point and prices were high
- Following deregulation, hub and spoke systems became important – economies of scale
  - ✓ What is the importance of airport presence?
- Data from the O&D Survey of Air Passenger Traffic
  - First and third quarter of 1980 – after effective deregulation
  - 10% random sample of all passenger tickets issues by US airlines
  - Use only the 50 largest US cities – 1225 possible city-pair combinations
  - Do not know flights, just the O&D – require at least 90 passengers in survey

Revealed Preference Approach

- Econometric issues
  - Simultaneity in profits and market structure
  - Heterogeneity in potential entrants

- Nash equilibrium of entry game is a vector $s^* \in \{0,1\}^K$ such that

$$s_k^* \pi_{ik}(s^*) \geq 0 \text{ and } (1 - s_k^*)\pi_{ik}(s^{*+k}) \leq 0$$

  where i indexed market and s^{*+k} is equal to s^* except that $s_k^{*+k} = 1$

✓ Entry (non-entry) reveals that profits are positive (negative)

- Discussion
  - Multiplicity of equilibria complicates analysis:
  - ✓ Could be that AA enters and DL stays, out or vice-versa
  - Entry at city-pairs modelled as independent decisions

Entry Model with Heterogeneous Profitability

- Reduced form profit function with

$$\pi_{ik}(s) = v_i(N(s)) + \phi_{ik}$$

  which orders firms by profitability $\phi_{i1} > \ldots > \phi_{iK_i}$

  1. Retains a degree of heterogeneity
  2. Results in a unique number of equilibrium firms,

$$N_i^* = \max_{0 \leq n \leq K_i} \{n : v_i(n) + \phi_{in} \geq 0\}$$

✓ Second point – allows simulation based estimation using equalities
  - Non-uniqueness of equilibrium is a general issue
  - Estimation based on a condition satisfied across equilibria is a solution

- Alternative work-around: assume order of entry $\Longrightarrow$ unique SPNE

- Ideal model would fully derive profit function with heterogeneous firms
  - Difficulty with determining (multiple) market equilibria
  - Likely requires data on quantities and prices
- Reduced-form profit function:

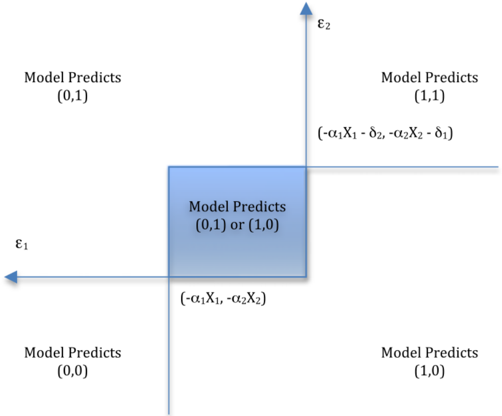
$$\pi_{ik}(N) = X_i\beta - \delta \ln(N) + Z_{ik}\alpha + \rho u_{io} + \sqrt{1-\rho^2}u_{ik}$$

with $u_{io} \sim N(0,1)$ and $u_{ik} \sim N(0,1)$

- Identification of effect of number of firms and market size vs. heterogeneous firms needs stance on potential entrants:
  - No heterogeneity implies no effect of number of potential entrants
  - More potential entrants related to more firms under heterogeneity
  - ✓ No u_{ik} heterogeneity can be rejected since k enters and j does not imply

$$Z_k\alpha - Z_j\alpha > \delta(\ln(N^*) - \ln(N^*+1))$$

Regions of Integration



(Ciliberto and Tamer notation)

- Region of integration is not straightforward though N_i^* is unique

✓ Simulate number of firms

Estimation

- Simulation based estimation based on prediction error on number of firms

$$v_{io}(N_i^*, W_i, \theta) = N_i^* - E[N^*|W_i, \theta]$$

where W_i contains exogeneous market and firm characteristics

- Use moment condition

$$E[v_{io}(N_i^*, W_i, \theta)|W_i, \theta_0] = 0$$

  - Compute $E[N^*|W_i, \theta]$ by simulating:

$$\hat{N}(W_i, \theta, u_i) = \frac{1}{T}\sum \hat{n}(W_i, \theta, u_i^t)$$

where $u_i = (u_i^1, \ldots, u_i^T)$ and $\hat{n}(W_i, \theta, u_i^t) = \max\{n : \#\{k : \hat{\pi}_{ik}(n, u_i^t) \geq 0\} \geq n\}$

✓ Prediction error in simulation is linear in moments. Important!

Descriptive

- Lots of entry and exit, indicative of heterogeneity
  - Entry occurs in 20% of the markets and exit occurs in 14% of the markets
  - Both entry and exit occurs in 3% of the markets $\implies$ heterogeneity

TABLE I

THE JOINT FREQUENCY DISTRIBUTION OF ENTRY AND EXIT, IN PERCENT OF TOTAL MARKETS SERVED

		Number of Exits, as % of Total Markets in the Sample: 0	1	2	3 +	Total
Number	0	68.50	10.01	1.07	0.00	79.57
of	1	15.09	2.63	0.41	0.00	18.13
Entrants	2	1.96	0.25	0.00	0.00	2.05
(as %)	3 +	0.16	0.08	0.00	0.00	0.24
	Total	85.56	12.96	1.48	0.00	100.00

TABLE II

NUMBER AND PERCENTAGE OF MARKETS ENTERED AND EXITED IN THE LARGE CITY SAMPLE, BY AIRLINE

	Airline	# of Markets Served	# of Markets Entered	# of Markets Exited	% of Markets Entered	% of Markets Exited
1	Delta	281	43	28	15.3	10.0
2	Eastern	257	33	36	12.8	14.0
3	United	231	36	10	15.6	4.3
4	American	207	22	12	10.6	5.8
5	USAir	201	20	17	10.0	8.5

Potential Entrants

TABLE III

NUMBER OF POTENTIAL ENTRANTS, BY NUMBER OF CITIES SERVED WITHIN A CITY PAIR, WITH NUMBER AND PERCENTAGE ENTERING

Number of Cities Served	Total # of Potential Entrants	# Entering	% Entering
0	47600	4	0.01%
1	12650	45	0.36
2	3590	232	6.46

- Analysis defines potential entrants as those with presence in either city

TABLE VI

Maximum Likelihood Results[a]

Variable	No Heterogeneity	Only Observed Heterogeneity	No Correlation
Constant	1.00	−0.973	−1.54
	(0.056)	(0.485)	(0.815)
Population	4.33	4.16	4.32
	(0.102)	(0.180)	(0.059)
Dist	−0.184	−0.841	−0.903
	(0.034)	(0.070)	(0.112)
City2	—	1.68	1.43
		(0.479)	(0.524)
City share	—	1.20	−2.94
		(0.118)	(0.070)
δ	1.81	1.66	0.252
	(0.050)	(0.470)	(1.92)
−2 log-likelihood:	3715	3619	1732

[a] Observations are 1219 markets. Standard errors are in parentheses.

TABLE VII

SIMULATION ESTIMATES[a]

Variable	Most Profitable Move First	Incumbents Move First
Constant	−5.32	−3.20
	(0.354)	(0.258)
Population	1.36	5.28
	(0.239)	(0.343)
Dist	1.72	−1.45
	(0.265)	(0.401)
City2	4.89	5.91
	(0.295)	(0.149)
City Share	4.73	5.41
	(0.449)	(0.206)
δ	0.527	4.90
	(0.119)	(0.206)
ρ	0.802	0.050
	(0.105)	(0.048)
Value of the objective fn:	33.3	26.2

[a]Observations are 1219 markets. Standard errors are in parentheses.

TABLE VIII

Predictions from the Models
Actual Mean Number of Firms: 1.629

		Probit	No Heterogeneity (Ordered Probit)	Full Model
		Predicted Mean Number of Firms		
1.	Actual exog. data	1.326	1.887	1.699
2.	.5 Mil. popl. increase	10.78	2.308	1.809
3.	500 extra miles dist.	0.6710	1.770	1.406
4.	All entrants "Well-Qual"	2.724	—	2.045
5.	All firms "Well-Qual"	6.334	—	2.080
6.	10% incr. in City Shr	2.178	—	1.697
		% Correctly Predicted Entrants		
7.		90.29	—	92.75
		Mean Squared Error in the Prediction of N:		
8.		1.257	2.072	1.299

Conclusion

- Entry games bring up some issues
  - Multiplicity of equilibria
  - Simultaneous determination of conduct and structure
  - Who are the potential entrants?

- Revealed preference approach is one solution
  - Number of firms is endogeneous
  - What about heterogeneous effects?

Outline

Mazzeo (2002)

- In addition to operating, firms also decide product type
- Study motel quality choice at 492 interstate exit locations
  - Data from directories – code motel quality using AAA rating
  - Multiple-agent qualitative response model, similar to Berry (1992)
  - Payoff function:

    $$\pi_{Tm} = X_m\beta_T + g(\theta_T; \vec{N}) + \varepsilon_{Tm}$$

    where $T \in \{H, L\}$ is quality type and m is market
- Two-period model with investment (entry) stage and competition stage

✓ Alternative assumptions on investment stage

1. Stackelberg game – sequential choice
2. Sequential entry sub-stage, followed by product type substage

Empirical Strategy

- Mazzeo shows that equilibrium configuration of number of each type, (L, H), is unique if g is such that $\pi_T(L, H)$ is:
  1. Decreasing in both arguments, L and H
  2. Exhibits larger loss from entry of same type

     $$\pi_L(L, H) - \pi_L(L + 1, H) > \pi_L(L, H) - \pi_L(L, H + 1)$$

     and analogously for π_H

✓ Still challenging to estimate model
  - Restricts to three firms and two types in main analysis
  - ✓ Total of 15 market configurations

- Simulated maximum likelihood using probabilities

$$L(\theta) = \prod_{m=1}^{292} P\{(L, H)|\theta\}$$

  - Not terrible since the number of outcomes is small

TABLE 5 **Summary Statistics of X Variables**

		Mean	Standard Deviation	Minimum	Maximum
***X* variables in the payoff function**					
PLACEPOP	Population of town closest to the market	5,802.3	6,408.8	100	38,705
TRAFFIC	Average annual daily traffic on interstate at market exit	16,506.6	8,754.4	2,040	68,103
SPACING	Sum of miles from market exit to adjacent markets along highway	53.1	29.9	10	224
WEST	Dummy variable; equals one if market is in west region	.18	.39	0	1

***X* variable transformation**

$$X_m^* = \ln\left[\frac{X_m}{\frac{1}{492}\sum_{m=1}^{492} X_m}\right]$$

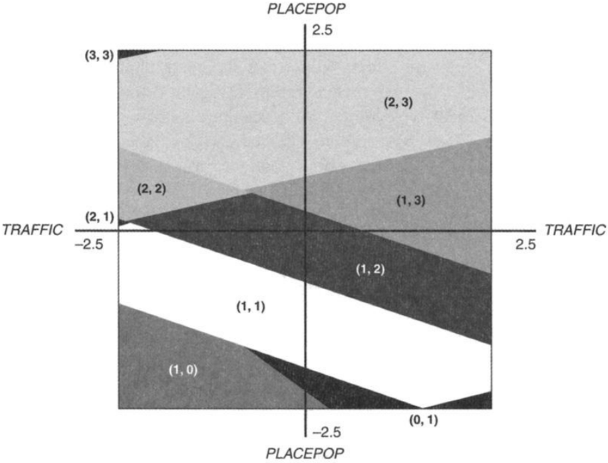
X_m	X_m^*
Sample mean	0
Half the sample mean	$\ln(.5) = -.693$
Twice the sample mean	$\ln(2) = .693$

TABLE 6 Estimated Parameters: Two-Product-Type Models

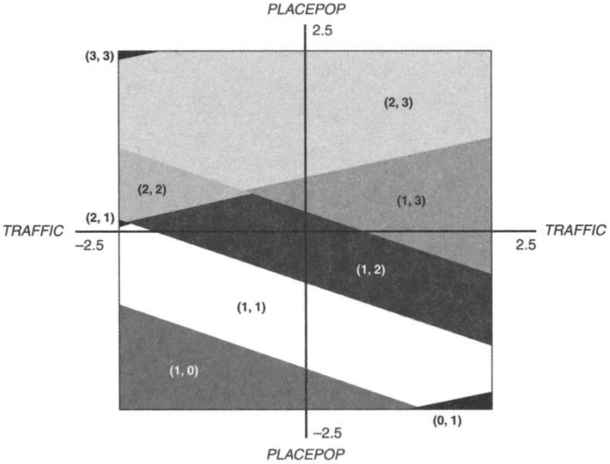
Parameter		Two-Substage Version		Stackelberg Version	
		Estimate	Standard Error	Estimate	Standard Error
Effect on low-type payoffs					
Constant	C_L	1.6254	.9450	1.5420	.9192
Low competitor #1	θ_{LL1}	−1.7744	.9229	−1.6954	.8931
Low competitor #2	θ_{LL2}	−.6497	.0927	−.6460	.0922
High competitor #1 (0 lows)	θ_{L0H1}	−.8552	.9449	−.7975	.9258
Additional high competitors (0 lows)	θ_{L0HA}	−.1247	.0982	−.1023	.0857
Number of high competitors (1 low)	θ_{L1H}	−.0122	.1407	−.0154	.0444
Number of high competitors (2 lows)	θ_{L2H}	−.0000	.0000	−1.12E-6	.0001
PLACEPOP	β_{L-P}	.2711	.0550	.2688	.0554
TRAFFIC	β_{L-T}	−.0616	.1070	−.0621	.1069
SPACING	β_{L-S}	.3724	.1271	.3700	.1271
WEST	β_{L-W}	.5281	.1515	.5246	.1511

Effect on high-type payoffs					
Constant	C_H	2.5252	.9395	2.5303	.8925
High competitor #1	θ_{HH1}	−2.0270	.9280	−2.0346	.8810
High competitor #2	θ_{HH2}	−.6841	.0627	−.6841	.0627
Low competitor #1 (0 highs)	θ_{H0L1}	−1.2261	.9314	−1.2176	.8841
Additional low competitors (0 highs)	θ_{H0LA}	−5.25E-6	.0006	−.0000	.0000
Number of low competitors (1 high)	θ_{H1L}	−2.82E-7	.0001	.0000	.0001
Number of low competitors (2 high)	θ_{H2L}	−.0000	.0000	−5.34E-6	.0003
PLACEPOP	β_{H-P}	.6768	.0551	.6801	.0570
TRAFFIC	β_{H-T}	.2419	.1137	.2419	.1142
SPACING	β_{H-S}	.5157	.1332	.5159	.1328
WEST	β_{H-W}	.2562	.1585	.2588	.1592
Log-likelihood		−1143.01		−1143.12	

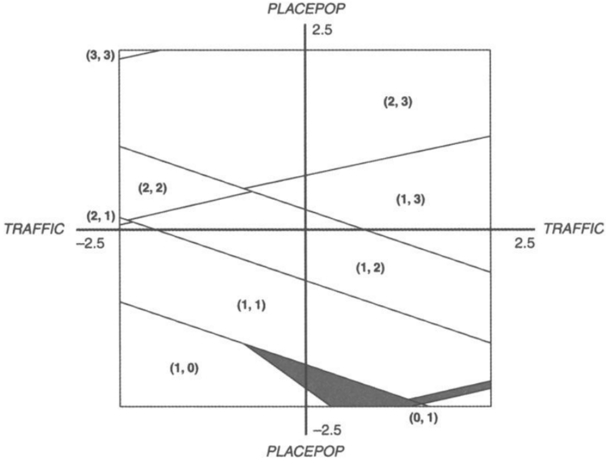
Two-substage version



Stackelberg version



Difference



PLACEPOP
2.5
(3, 3)
(2, 3)
(2, 2)
(1, 3)
(2, 1)
TRAFFIC
TRAFFIC
–2.5
2.5
(1, 2)
(1, 1)
(1, 0)
(0, 1)
–2.5
PLACEPOP

Discussion

- Empirical results
  - Market size incentive for operating higher quality motels
  - Estimates in the two games don't look very different
- Technical issues
  - Difficulty using many configurations in MLE
  - Game form and payoffs chosen to deliver unique equilbria

Outline

Incomplete Information: Seim (2006)

- Firm-location profits

$$\Pi_{fl}^m = X_l^m \beta + \xi^m + h(\Gamma_{\cdot,l}, n^m) + \varepsilon_{fl}^m$$

where Γ parametrizes competitive effects, representing the intensity of competition between locations

  - Competitive effects based on distance bands, $h(\cdot) = \sum_b \gamma_b n_{bl}^m$

- Asymmetric information with ε is private information

- Equilibrium

$$\begin{aligned} E[\Pi_{fl}] &= \xi + X_l \beta + \sum_b E[N_{bl}] + \varepsilon_{fl} \\ &= E[\bar{\Pi}_{fl}] + \varepsilon_{fl} \end{aligned}$$

and entry based on symmetric perceptions

$$p_{gl} = \frac{\exp(E[\bar{\Pi}_{gl}])}{\sum_k \exp(E[\bar{\Pi}_{gk}])}$$

Outline

Binary Game Example: Tamer (2003)

	$y_2 = 0$	$y_2 = 1$
$y_1 = 0$	$0, 0$	$0, x_2\beta_2 - u_2$
$y_1 = 1$	$x_1\beta_1 - u_1, 0$	$x_1\beta_1 + \Delta_1 - u_1, x_2\beta_2 + \Delta_2 - u_2$

✓ This is a two-player entry game

- Easy to span game types with different equilibria
  - Co-ordination case (both $(0, 0)$ and $(1, 1)$ as equil.)
  - Anti-cordination (both $(0, 1)$ and $(1, 0)$ as equil.)
  - Dominant strategy to play 0 or 1

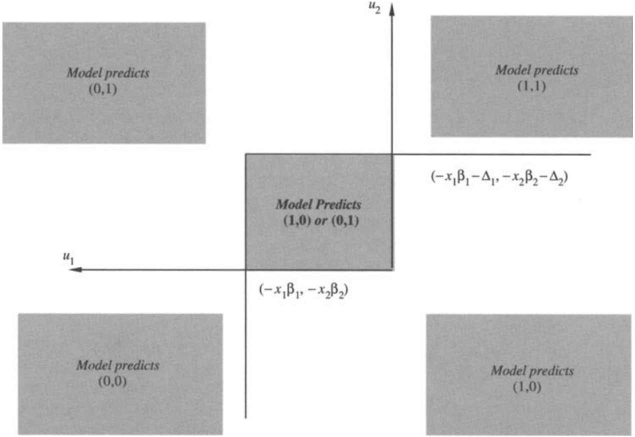


FIGURE 1
Incomplete model with multiple equilibria

$$\sum_{(y_1,y_2)\in Y^*} Pr((y_1,y_2)|x) > 1$$

- An incoherent econometric model predicts multiple values of the endogeneous variable as a feasible outcome of econometric error

$$Y \in \Gamma(X, \xi)$$

where

$$\Gamma : \chi \times \Xi \rightrightarrows \Upsilon$$

- Examples of incomplete models
  - A game that results in multiple equilibria
  - Agent randomly picks undominated strategy
  - Agent actions are not uniquely determined by structural errors
  - Mixed strategy equilibria where Y is a realization
- True likelihood depends on the selection rule, λ

$$L(\theta|Y) = \sum_{\lambda} P(Y|\theta, \lambda)P(\lambda)$$

  - May be in trouble without specifying selection rule
  - Since it is possible for

$$\sum_{Y} \int P(Y \in \Gamma(X, \varepsilon)|\theta) dF_{\varepsilon} > 1$$

Empirical Issues with Coherency

- MLE is inconsistent using (all outcomes in) an incoherent model
  - Typically also problematic for moments based estimation

- Typical Solutions
  - Restrict model to have unique equilibrium – Mazzeo (2002)
  - Pick an equilibrium selection rule
  - Find an empirical restriction true in all equilibria – Berry (1992)

- Incoherent models also create identification issues
  - Are often not point identified even with parametric restrictions
  - Tamer (2003) identifies using outcomes $(0, 0)$ and $(1, 1)$, which are unique when predicted
    - ✓ Effectively throwing away data
  - Galichon and Henry (2011) have partial identification results

- Additional problems in counterfactuals
  - ✓ Model does not have a unique prediction

Outline

Ciliberto and Tamer (2009)

- Study effect of repealing the Wright Ammendment on Airline entry
  - Wright Ammendment restricts airlines flying from Dallas Love to neighboring states
  - American Airlines consolidated share in DFW
  - Southwest sued for rights to fly elsewhere
  - Repealed in 2014
  - ✓ Simulate the effect of taking out the 93 markets affected by the wright ammendment
- Dataset is similar to Berry (1992), follow their decisions

Revisitng Restrictions in Berry (1992)

- Berry (1992) estimated model with symmetric competitive effects

$$\pi_{ik}(N) = X_i\beta - \delta \ln(N) + Z_{ik}\alpha + \rho u_{io} + \sqrt{1-\rho^2}u_{ik}$$

  - Effect of large carrier and low-cost carrier is the same
  - Market presence of the competitor does not matter
  - Additional entrant always lowers profits (perhaps reasonable unless goods are complements)

✓ Without these restrictions, number of firms may not be identical

Model: Ciliberto and Tamer (2009)

- Ciliberto and Tamer (2009) posit the ambitious model:

$$\pi_{im} = S'_m \alpha_i + Z'_{im} \beta_i + W'_{im} \gamma_i + \sum_{j \neq i} \delta^i_j y_{jm} + \sum_{j \neq i} Z'_{jm} \phi^i_j y_{jm} + \varepsilon_{im}$$

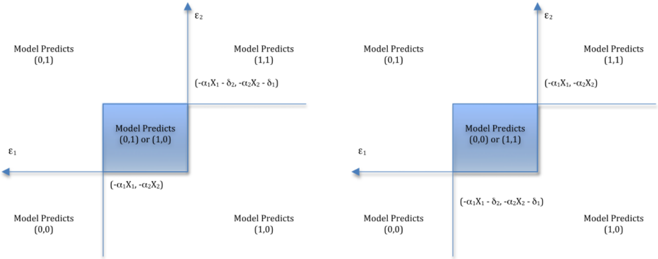
where m is market, i is firm.

  - S_m is a market characteristic
  - Z_{im} enters the profits of all firms
  - W_{im} only enters the profit of the firm itself
  - δ^i_j and ϕ^i_j allow for heterogeneous competitor effects

✓ Allows for

  - Aggressive vs non-aggressive effects of certain competitors
  - Interactions of firm presence with market characteristics

Idea of Inequalities Estimator



- Bound the probabilities of observed outcomes

$$\pi_{im} = \alpha_i X_{im} + \delta_{-i} y_{-im} + \varepsilon_{im}$$

then,

$$P(\varepsilon \in R_1) \leq P((1,0)) \leq P(\varepsilon \in R_1) + P(\varepsilon \in R_2)$$

where

  - $\varepsilon \in R_1$ implies only $(1,0)$ is an equilibrium
  - $\varepsilon \in R_2$ implies $(1,0)$ and $(0,1)$ are equilibria (blue region in left fig)

- In general, for each ε, we can determine if observed outcome Y is
  1. Unique equilibrium $\Longrightarrow \varepsilon \in R_1$
  2. An equilibrium $\Longrightarrow \varepsilon \in R_1 \cup R_2$
  3. Not an equilibrium $\Longrightarrow \varepsilon \in (R_1 \cup R_2)^c$

  ✓ Simply check inequalities

- Construct inequalities

$$H_1(\theta, X; Y) = \int_{R_1(\theta,X)} \mathrm{d}F \leq P(Y|X) \leq \int_{R_1(\theta,X)} \mathrm{d}F + \int_{R_2(\theta,X)} \mathrm{d}F = H_2(\theta, X; Y)$$

where $P(Y|X)$ is the probabilities in the true model

- Allows for arbitrary equilibrium selection rule
- Still a complete information game
- Mixed strategies are zero probability if ε has a density
- No conceptual restrictions on π

Identified Set and Estimator

- Incomplete models typically allow only for set identification

$$\Theta_I = \{\theta \in \Theta : H_1(\theta, X; Y) \le P(Y|X) \le H_2(\theta, X; Y) \text{ a.s. in } X, Y\}$$

  - Based only on necessary equilibrium conditions
  - ✓ Cost of model flexibility – you could have selected an equilibrium
- Estimation using Chernozhukov, Hong and Tamer (2007)
  - Criterion function:

$$Q(\theta) = \int \|H_1(\theta, X) - P(X)\|_+ + \|H_2(\theta, X) - P(X)\|_- \mathrm{d}F_X$$

    where $P(X)$ and $H_\cdot(\theta, X)$ stack the discrete Y outcomes
  - Estimator

$$\hat{\Theta}_I = \{\theta \in \Theta | Q_n(\theta) \le o(1)\}$$

    where Q_n is simulated sample analog
    - ✓ To compute H_1 and H_2, simulate ε and check equilibrium conditions to determine whether it belongs to R_1 or R_2
  - See CHT for consistency and asymptotic theory

Empirical Application

- Market is trip between two airports

✓ Split airlines into
  - Low-cost Carriers (LCC): Southwest (WN), lump others into one
  - Medium Airlines (MA): lump into one
  - Legacy Airlines (LAR): American, Delta, United

- Selected set of 2742 markets using 100 largest MSAs
- Variables
  - Airport presence ratio of markets served out of airport to total markets served out of airport by all carriers
  - Cost measured as ratio of flight via hub to direct flight
- General error structure

$$\varepsilon_{im} = u_{im} + u_m + u_m^o + u_m^d$$

where u_{im} is market-firm specific, u_m is market-specific, u_m^o is origin airport-specifi and u_m^d is destination airport-specific

✓ All are iid normal

TABLE I

SUMMARY STATISTICS

%	AA	DL	UA	MA	LCC	W
Airline (%)	0.426 (0.494)	0.551 (0.497)	0.275 (0.447)	0.548 (0.498)	0.162 (0.369)	0.247 (
Airport presence (%)	0.422 (0.167)	0.540 (0.180)	0.265 (0.153)	0.376 (0.135)	0.098 (0.077)	0.242 (
Cost (%)	0.736 (1.609)	0.420 (1.322)	0.784 (1.476)	0.229 (0.615)	0.043 (0.174)	0.302 (
Market level variables						
Wright amendment (0/1)			0.029 (0.169)			
Dallas airport (0/1)			0.070 (0.255)			
Market size (population)			2,258,760 (1,846,149)			
Per capita income ($)			32,402.29 (3911.667)			
Income growth rate ($\% * 100$)			5.195 (0.566)			
Market distance (miles)			1084.532 (624.289)			
Closest airport (miles)			34.623 (20.502)			
U.S. center distance (miles)			1570.614 (593.798)			
Number of markets			2742			

TABLE II

DISTRIBUTION OF THE NUMBER OF CARRIERS BY MARKET SIZE[a]

Number of Firms	Large	Medium	Small	Total
0	7.07	7.31	7.73	7.29
1	41.51	22.86	20.91	30.63
2	29.03	24.30	22.14	25.93
3	12.23	19.67	16.34	15.72
4	8.07	15.14	14.59	11.93
5	1.66	9.58	16.17	7.48
6	0.42	1.13	2.11	1.02
Number	1202	971	569	2742

[a]Cross-tabulation of the percentage of firms serving a market by the market size, which is here measured by the geometric mean of the populations at the market endpoints.

TABLE III

EMPIRICAL RESULTS[a]

	Berry (1992)	Heterogeneous Interaction	Heterogeneous Control	Firm-to-Firm Interaction
Competitive fixed effect	[−14.151, −10.581]			
AA		[−10.914, −8.822]	[−9.510, −8.460]	
DL		[−10.037, −8.631]	[−9.138, −8.279]	
UA		[−10.101, −4.938]	[−9.951, −5.285]	
MA		[−11.489, −9.414]	[−9.539, −8.713]	
LCC		[−19.623, −14.578]	[−19.385, −13.833]	
WN		[−12.912, −10.969]	[−10.751, −9.29]	
LAR on LAR				
LAR: AA, DL, UA, MA				[−9.086, −8.389]
LAR on LCC				[−20.929, −14.321]
LAR on WN				[−10.294, −9.025]
LCC on LAR				[−22.842, −9.547]
WN on LAR				[−9.093, −7.887]
LCC on WN				[−13.738, −7.848]
WN on LCC				[−15.950, −11.608]
Airport presence	[3.052, 5.087]	[11.262, 14.296]	[10.925, 12.541]	[9.215, 10.436]
Cost	[−0.714, 0.024]	[−1.197, −0.333]	[−1.036, −0.373]	[−1.060, −0.508]
Wright	[−20.526, −8.612]	[−14.738, −12.556]	[−12.211, −10.503]	[−12.092, −10.602]
Dallas	[−6.890, −1.087]	[−1.186, 0.421]	[−1.014, 0.324]	[−0.975, 0.224]
Market size	[0.972, 2.247]	[0.532, 1.245]	[0.372, 0.960]	[0.044, 0.310]
WN			[0.358, 0.958]	
LCC			[0.215, 1.509]	

✓ 95% CI

TABLE III—*Continued*

	Berry (1992)	Heterogeneous Interaction	Heterogeneous Control	Firm-to-Firm Interaction
Market distance	[4.356, 7.046]	[0.106, 1.002]	[0.062, 0.627]	[−0.057, 0.486]
WN			[−2.441, −1.121]	
LCC			[−0.714, 1.858]	
Close airport	[4.022, 9.831]	[−0.769, 2.070]	[−0.289, 1.363]	[−1.399,−0.196]
WN			[1.751, 3.897]	
LCC			[0.392, 5.351]	
U.S. center distance	[1.452, 3.330]	[−0.932, −0.062]	[−0.275, 0.356]	[−0.606, 0.242]
WN			[−0.357, 0.860]	
LCC			[−1.022, 0.673]	
Per capita income	[0.568, 2.623]	[−0.080, 1.010]	[0.286, 0.829]	[0.272, 1.073]
Income growth rate	[0.370, 1.003]	[0.078, 0.360]	[0.086, 0.331]	[0.094, 0.342]
Constant	[−13.840, −7.796]	[−1.362, 2.431]	[−1.067, −0.191]	[0.381, 2.712]
MA			[−0.016, 0.852]	
LCC			[−2.967, −0.352]	
WN			[−0.448, 1.073]	
Function value	1756.2	1644.1	1627	1658.3
Multiple in identity	0.837	0.951	0.943	0.969
Multiple in number	0	0.523	0.532	0.536
Correctly predicted	0.328	0.326	0.325	0.308

TABLE IV

VARIABLE COMPETITIVE EFFECTS

	Independent Unobs	Variance–Covariance	Only Costs
Fixed effect			
AA	[−9.433, −8.485]	[−8.817, −8.212]	[−11.351, −9.686]
DL	[−10.216, −9.255]	[−9.056, −8.643]	[−12.472, −11.085]
UA	[−6.349, −3.723]	[−4.580, −3.813]	[−10.671, −8.386]
MA	[−9.998, −8.770]	[−7.476, −6.922]	[−11.906, −10.423]
LCC	[−28.911, −20.255]	[−14.952, −14.232]	[−11.466, −8.917]
WN	[−9.351, −7.876]	[−6.570, −5.970]	[−12.484, −10.614]
Variable effect			
AA	[−5.792, −4.545]	[−4.675, −3.854]	
DL	[−3.812, −2.757]	[−3.628, −3.030]	
UA	[−10.726, −5.645]	[−8.219, −7.932]	
MA	[−6.861, −4.898]	[−7.639, −6.557]	
LCC	[−9.214, 13.344]		
WN	[−10.319, −8.256]	[−11.345, −10.566]	
Airport presence	[14.578, 16.145]	[10.665, 11.260]	
Cost	[−1.249, −0.501]	[−0.387, −0.119]	
AA			[−0.791, 0.024]
DL			[−1.236, 0.069]
UA			[−1.396, −0.117]
MA			[−1.712, 0.072]
LCC			[−17.786, 1.045]
WN			[−0.802, 0.169]

- Restricts $\phi^i_j = \phi_j$ for simplicity

Wright	[−17.800, −16.346]	[−16.781, −15.357]	[−14.284, −10.479]
Dallas	[0.368, 1.323]	[0.839, 1.132]	[−5.517, −2.095]
Market size	[0.230, 0.535]	[0.953, 1.159]	[1.946, 2.435]
WN	[0.260, 0.612]	[0.823, 1.068]	
LCC	[−0.432, 0.507]		
Market distance	[0.009, 0.645]	[0.316, 0.724]	[−0.039, 1.406]
WN	[−3.091, −1.819]	[−2.036, −1.395]	
LCC	[−1.363, 1.926]		
Close airport	[−0.373, 0.422]	[0.400, 1.433]	[3.224, 6.717]
WN	[1.164, 3.387]	[2.078, 2.450]	
LCC	[1.059, 3.108]	[1.875, 2.243]	
U.S. center distance	[−9.271, 0.506]	[0.015, 0.696]	[2.346, 3.339]
WN	[0.276, 1.008]	[0.668, 1.097]	
LCC	[−0.930, 0.367]		
Per capita income	[0.929, 1.287]	[0.824, 1.052]	[1.416, 2.307]
Income growth rate	[0.136, 0.331]	[0.151, 0.316]	[1.435, 2.092]
Constant	[−0.522, 0.163]	[−0.827, −0.523]	[−12.404, −10.116]
MA_m	[0.664, 1.448]	[0.279, 0.747]	
LCC	[−1.528, −0.180]	[−0.233, 0.454]	
WN	[1.405, 2.215]	[1.401, 1.659]	
Function value	1616	1575	1679
Multiple in identity	0.9538	0.9223	0.9606
Multiple in number	0.6527	0.3473	0.0728
Correctly predicted	0.3461	0.3375	0.3011

TABLE VII

PREDICTED PROBABILITIES FOR POLICY ANALYSIS: MARKETS OUT OF DALLAS LOVE

Airline	Variance–Covariance	Independent Obs	Only Costs
No firms	[−0.6514, −0.6384, −0.6215]	[−0.7362, −0.6862, −0.6741]	[−0.6281, −0.6162, −0.5713]
AA	[0.4448, 0.4634, 0.4711]	[0.2067, 0.3013, 0.3280]	[0.3129, 0.3782, 0.4095]
DL	[[0.4768, 0.4988, 0.5056]	0.2733, 0.3774, 0.4033]	[0.3843, 0.4315, 0.4499]
UA	[0.1377, 0.1467, 0.1519]	[0.1061, 0.1218, 0.2095]	[0.2537, 0.3315, 0.3753]
MA	[0.4768, 0.4988, 0.5056]	[0.2733, 0.3774, 0.4033]	[0.3656, 0.4143, 0.4342]
LCC	[0.3590, 0.3848, 0.4156]	[0.8369, 0.8453, 0.8700]	[0.2839, 0.3771, 0.3933]
WN	[0.4480, 0.4744, 0.4847]	[0.2482, 0.2697, 0.3367]	[0.3726, 0.4228, 0.4431]

- Multiplicity complicates reporting of counterfactual outcomes
  - Compute the maximum/minimum change from taking 93 markets out of Dallas Love and putting it back in across estimated parameter set
  - Middle number reports the outcome using parameter for which the objective function is minimized (what about mult. eq.?)

✓ Wright ammendment protected AA since WN could serve most markets that lose service from Love

Outline

Self-preferencing and Antitrust

- Recent concerns about large tech firms exerting market power
- Self-preferencing by platforms is a key channel
  - Amazon favoring its own offerings
  - Apply favoring its apps
  - Google promoting Google reviews, Google flights
  - ✓ Potential "gate-keeper" role
- But, platforms do not want to provide a low quality product either
  - Two-sided market → Need to attract both consumers and sellers

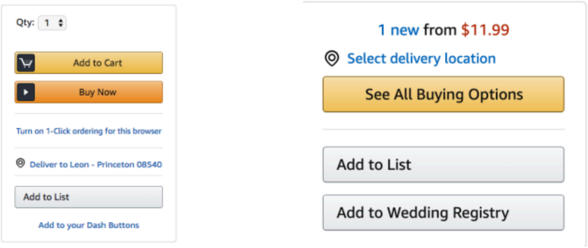
Lee and Musolff (2021)

- What is the effect of Amazon self-preferencing its offerings on the "buy box" on consumer and producer surplus?
- Key contribution/approach:
  - Self-preferencing can induce exit by firms
  - Also affects price competition
  - Holds consumer participation on the platform fixed

✓ Builds on prior literature showing trade-off for platform between inducing price competition and guiding consumers to preferred products

Amazon Buy Box

- Focus on “fashion” items and competition across sellers for the buy box
  - Homogenizes the product quality, abstracts away from product search
  - Perhaps search across products is a more important dimension



(a) *Occupied Buybox.* **(b)** *Canceled Buybox.*

Figure 1: *The Buybox.*

- Data
  - High-frequency data on prices, recommendations, and sales for 1,000 sellers and 200,000 products from a "repricing" service
  - ✓ Does not observe recommended product every single time, imputes market shares

	Fraction of Observations		
	Overall	FBA	Amazon
Amazon Offer Exists	11.28%	11.34%	100.00%
FBA Offer Exists	99.44%	100.00%	99.98%
Winner Is ...			
Lowest Priced	51.24%	51.20%	45.43%
Second Lowest Priced	28.31%	28.32%	31.84%
Highest Feedback Count	17.23%	17.14%	8.32%
Highest Feedback Rating	18.13%	18.11%	15.02%
Fastest Shipping	19.61%	19.60%	23.45%
Lowest Priced FBA	63.47%	63.84%	63.26%
FBA	96.46%	97.01%	98.07%
Amazon	4.95%	4.98%	43.85%
Lowest Fastest Shipping	64.59%	64.76%	64.11%

Table 2: *Determinants of Recommendation Status.*

Model Sketch: Demand Side

- Consumer preferences follow logit

$$v_{ijt} = x_{jt}\beta - \alpha_t p_{jt} + \xi_{jt} + \varepsilon_{ijt}$$

- Notes:
  - Naive consumers simply pick from the buybox or nothing, fraction $1 - \rho$
  - Sophisticates look at all product offerings
  - Estimates that roughly 75% of consumers are sophisticated
  - ✓ Consideration set model of Goeree (2008)
- Recommendation algorithm follows nested logit

$$v^r_{jt} = x_{jt}\beta^r - \alpha^r_t p_{jt} + \xi^r_{jt} + \zeta^r_{gt} + (1 - \lambda)\varepsilon^r_{jt}$$

  - Yields recommendation probability r_{jt}
- And market shares

$$s_{jt} = \rho \times \frac{\exp(\delta_{jt})}{1 + \sum_k \exp(\delta_{kt})} + (1 - \rho) \times r_{jt} \frac{\exp(\delta_{jt}}{1 + \exp(\delta_{jt})}$$

Model Sketch: Supply Side

- Profits

$$\pi_j(\omega, \xi, p) = \sum_t \chi_{jt}[\phi p_{jt} - C_t(s_{jt}(\omega, p), \omega_j) s_{jt}(\omega, p) - F_t)$$

  where
  - ω_j is a firm type drawn from $G(\cdot)$
  - χ denotes entry decisions
  - F_t is fixed costs
- Assumptions on entry/pricing game
  1. Separable markets
  2. Constant marginal cost c_j
  3. Two stage, entry followed by pricing
  4. Equilibrium with lowest cost offer attains highest recommendation share
  5. Firms only know costs when entering (not ξ)
  6. Type-symmetric entry strategy $\xi_j(c, F) = \xi_k(c, F)$
- Prop 1: Unique symmetric equilibrium in cutoff strategies that solves $E_{q,c_{-j}}[\pi_j(c^*, \cdot))] = F$
  - Simplifies solving for the counterfactual
  - Uses MLE to estimate fixed costs from log-normal model

✓ Simple, but effective model

Main result

- Recommendation algorithm is very price elastic, consumers like Amazon
- Counterfactual without self-preferencing

Δ Outcome/Counterfactual	Short-Run	Medium-Run	Long-Run
Δ Platform Fees	-$47,669	-$42,009	-$41,295
Δ Total Consumer Surplus	$312,407	$386,787	$398,131
Δ Consumer Surplus (Naive)	$312,407	$465,147	$452,484
Δ Consumer Surplus (Soph.)	$0	-$78,359	-$54,353
Δ Producer Surplus	-$45,292	$17,271	$1,896
Δ Welfare	$267,115	$404,059	$400,028
Δ Mean (Price/MSRP)	0.00%	0.50%	0.53%
Δ Mean # Entrants	0.00	0.00	-0.01

Table 8: *A Preference for the Platform's Own Offers Slightly Raises Welfare.*

Conclusions

- Entry by firms is indicative of profitability
  - Entry affects efficiency
- Analysis complicated by multiple equilbria. Solutions:
  - Set estimation
  - Equilibrium selection
  - Clever restrictions on payoffs
- Further topics:
  - Entry deterence vs predation motives
  - Effects on firm behavior
  - Endogenous product choice