# Market Structure and Competition in Airline Markets

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# Introduction

- We expect firms to strategically self-select themselves into markets based on observable and *unobservable* characteristics.
    - Firms who are present in markets may match better with those markets than firms who are not present, analagous to the labor literature where we expect workers who accept wage offers to differ than the population of potential workers.
- After a merger, or other change in environment, we expect firms to adjust intensive margins (quantity, prices, etc) as well as entry or product mix decisions.
- However, canonical models of demand and supply rely on the assumption that the set of products observed is "exogenous."
- Two potential problems:
    - Biased estimates: demand elas., marginal costs, market power.
    - What to do with set of products for counterfactuals?

# Introduction

- Practically, there is a tension between the canonical static "outcome" models (demand/supply models of Berry, 1994; BLP) and the canonical selection models (Bresnahan and Reiss, multiple; Berry, 1992).
  - Demand models of product differentiation have rich heterogeneity to capture markups and costs.
  - Adding rich heterogeneity creates problems in entry models (multiplicity of equilibrium).

# What our paper is about...

- Propose methodology to estimate simultaneous, static, complete information games where economic agents make a discrete participation decision, and conditional on participation, make a continuous decision and receive a payoff.
  - Develop a multi-agent version of the classic selection model (Gronau, 1974 and Heckman, 1976/1979).
  - Use the insights of Tamer (2003) and Ciliberto and Tamer (2009) to deal with multiple equilibria.
- We use the methodology to study airline firms that strategically decide whether to enter into a market *and* the prices they charge if they enter.
- Simulate how prices and market structure change after a hypothetical merger between USAir and American.

# The Econometric Problem

- Workhorse model of demand/supply: Berry (1994) etc make use of some form of a distributional assumption on unobserved product quality and marginal costs, $\{\xi, \omega\}$, to identify model:

$$E[\xi|Z] = E[\omega|Z] = 0$$

- Where utility has some form like: $u_{ijt} = X_{jt}\beta - \alpha p_{jt} + \xi_{jt} + \epsilon_{ijt}$

- Consider firm entry decision: $y_{jt} = 1$ if enter and $y_{jt} = 0$ if not entered. If firms face a meaningful selection problem (non-zeros fixed/sunk costs)

$$E[\xi|Z, y = 1] = 0 \not\Rightarrow E[\xi|Z] = 0$$

- Using above distributional assumption will give biased results – high value $\xi$ firms should be more likely to enter.

- More generally, there may be correlation between unobserved demand, marginal costs, and entry costs, that contribute selection.

# Entry and Competition in the Literature

## Eizenberg (2014) – selection on observables

- Uses insights of Pakes, Porter, Ho, Ishii (2015) to estimate a model where PC manufacturers decide which computers to offer, then compete in prices.
- One assumption needed to identify model is that during the "entry" stage firms do not know $\xi$, only its distribution.
- This may be appropriate in some contexts, but inappropriate in others.

## Mergers, Prices, and Entry/Exit

- Gandhi et al (2008) and Seim, Mazzeo, and Varela (wp) both use simulated data to understand how prices are affected by product entry and repositioning after a merger.
- Li, Mazur, Sweeting and Roberts (wp) estimate similar model to ours, without mult. eq. and correlations between unobservables.

# Findings

Using 2012 DB1B Department of Transportation airline data:

- Price-cost markups about 30% higher than a model with no selection.
- Correlation between unobservables is important for selection.
- Simulate USAir-American merger:
  - Merged firm has strong incentive to enter new markets.
  - Post-merger entry mitigates price increases from merger.
  - Merged firm faces stronger entry threat from legacy carriers, as opposed to low cost carriers.
    - During actual merger, DOJ focused on protecting LCCs market access.

# Model and Estimation

# Model

- Firms simultaneously decide to enter market, and conditional on entry, simultaneously set prices.
- **Demand:** Nested Logit, inside/outside nesting structure:

$$
\begin{aligned}
u_{ijm} &= X_{jm}\beta + \alpha p_{jm} + \xi_{jm} + v_{igm} + (1-\sigma)\epsilon_{ijm} \\
\implies ln(s_{jt}) - ln(s_{j0}) &= X_{jm}\beta + \alpha p_{jm} + \sigma ln(s_{j|g}) + \xi_{jm} \qquad (1)
\end{aligned}
$$

- **Supply**, constant marginal cost Nash Bertrand (Berry, 1994):

$$
log(mc_{jm}) = log(p + \frac{1-\sigma}{\alpha(1-\sigma\bar{s}_{j|g} - (1-\sigma)s_j)}) = \phi W_{jm} + \eta_{jm} \qquad (2)
$$

- **Entry** equation:

$$
y_{jm} = 1 \iff \underbrace{(p_{jm} - mc_{jm})M_m s_{jm}}_{Var.Profits} - \underbrace{[\gamma Z_{jm} + \nu_{jm}]}_{FixedCosts} \geq 0 \qquad (3)
$$

- We have $3 \times J$ equations.

# Estimation – General Framework

- A multi-agent version of the classic Heckman Selection problem.
- Two concerns:
  1. Multiple equilibrium in the entry equation.
  2. The "outcome" equation has an additional endogenous process: pricing decision.
- Because of multiple equilibrium, the selection equation is incomplete.
- The model can only generate an upper and lower bounds for the cumulative distribution of selected demand errors.
- For example, no hope of constructing a correction using a well defined inverse Mills ratio.

# Estimation – General Framework

- Given a guess of the parameters $(\beta^0, \alpha^0, \sigma^0, \phi^0, \gamma^0)$, the data identifies the distribution of "selected" residuals

$$Pr(s_{jt} - s_{j0} - (X_{jm}\beta^0 + \alpha^0 p_{jm} + \sigma^0 ln(s_{j|g})) < t|X, Z, W, \boldsymbol{y})$$
$$= Pr(\hat{\xi_{jm}} < t|X, Z, W, \boldsymbol{y}) \quad (4)$$

- We can then fully solve the model given $(\beta^0, \alpha^0, \sigma^0, \phi^0, \gamma^0)$ by simulating the unselected distribution of demand, marg. cost, and fixed cost errors and recovering the model predicted distribution of selected errors, $\xi *$.

- There is multiple equilibrium in the entry equation, so we construct an lower and upper bound for the distribution of selected errors predicted by the model.

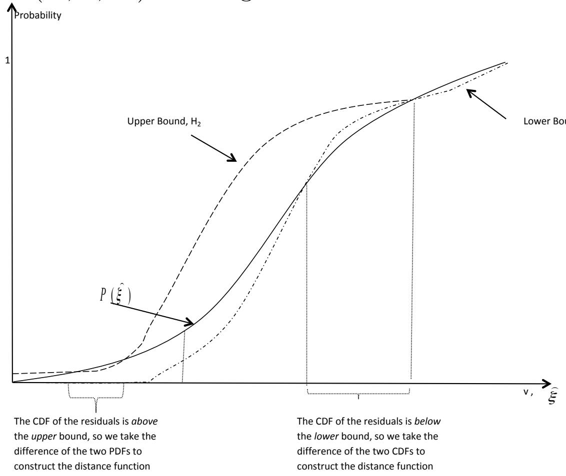
$$\{Pr^L(\xi * < t), Pr^L(\xi * < t)\} \quad (5)$$

# Estimation – Moment Conditions

- Construct moments using the following inequality:

$$Pr^L(\xi^* < t \mid Q) \leq Pr(\hat{\xi} < t \mid Q) \leq Pr^U(\xi^* < t \mid Q)$$

- where $Q = (X, Z, W)$ are exogenous shifters from the $3 \times J$ equations.



# Empirical Setting

- Domestic commercial airline industry
- Unit of observation: airline-market from DOT's DB1B and T-100 datasets in 2012.
- Market: unidirectional trip between two airports (6,322 markets, including 172 not served by any airline).
- Six airlines: American (AA), Delta (DL), United (UN), US Air (US), Southwest (WN), and a composite Other Low Cost Carrier (LCC)
- Number of potential entrants varies across markets, based on existing flights at endpoints.

# Descriptive Statistics – Entry

Table: Percent of Markets Served

| | Entry | Potential |
|---|---|---|
| AA | 0.48 | 0.90 |
| DL | 0.83 | 0.99 |
| LCC | 0.26 | 0.78 |
| UA | 0.66 | 0.99 |
| US | 0.64 | 0.95 |
| WN | 0.35 | 0.38 |

Table: Distribution of Number of Entrants

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Fraction | 0.08 | 1.11 | 5.16 | 18.11 | 42.87 | 32.68 |

# Variables

- Market distance – demand and MC.
- Demand: Nonstop Origin – captures affect of FFP.
- MC: Origin Presence – captures the opportunity cost of using those seats on another route.
- Entry: Nonstop Dest. – captures economies of density in using gates and gate staff to run multiple routes.

# Descriptive Statistics

Table: *Summary Statistics*

| | Mean | Std. Dev. | Min | Max | N | Equation |
|---|---|---|---|---|---|---|
| Price ($) | 243.21 | 54.20 | 139.5 | 385.5 | 20,470 | Entry, Utility, MC |
| **All Markets** | | | | | | |
| Origin Presence (%) | 0.44 | 0.27 | 0 | 1 | 37,932 | MC |
| Nonstop Origin | 6.42 | 12.37 | 0 | 127 | 37,932 | Entry, Utility |
| Nonstop Dest. | 6.57 | 12.71 | 0 | 127 | 37,932 | Entry |
| Distance (000) | 1.11 | 0.63 | 0.15 | 2.72 | 37,932 | Utility, MC |
| **Markets Served** | | | | | | |
| Origin Presence (%) | 0.58 | 0.19 | 0.00 | 1 | 20.470 | MC |
| Nonstop Origin | 8.50 | 14.75 | 1 | 127 | 20.470 | Entry, Utility |
| Nonstop Destin. | 8.53 | 14.70 | 1 | 127 | 20.470 | Entry |
| Distance (000) | 1.21 | 0.62 | 0.15 | 2.72 | 20,472 | Utility, MC |

# Parameter Estimates

Table: *Parameter Estimates: Exogenous vs Endogenous Market Structure*

| | Exog Mkt Structure | Endog Mkt Structure |
|---|---|---|
| **Demand** | Point Est. (s.e.) | CHT CI |
| Constant | -2.863 (0.225) | [-5.499, -5.467] |
| Distance | 0.319 (0.015) | [ 0.184, 0.191] |
| Nonstop Origin | 0.180 (0.008) | [ 0.125, 0.130] |
| LCC | -0.980 (0.053) | [-0.345, -0.333] |
| WN | 0.416 (0.038) | [ 0.222, 0.230] |
| Price($\alpha$) | -0.025 (0.001) | [-0.012, -0.011] |
| $\sigma$ | 0.080 (0.017) | [ 0.481, 0.499] |
| **Marginal Cost** | | |
| Constant | 5.338 (0.003) | [ 5.173, 5.221] |
| Distance | 0.064 (0.002) | [ 0.030, 0.031] |
| Origin Presence | -0.041 (0.003) | [-0.242, -0.233] |
| Cons LCC | -0.127 (0.007) | [-0.132, -0.127] |
| Cons WN | -0.282 (0.008) | [-0.088, -0.085] |
| **Fixed Cost** | | |
| Constant | – | [ 7.768, 8.066] |
| Nonstop Origin | – | [-0.142, -0.137] |
| Nonstop Dest. | – | [-0.333, -0.321] |
| LCC | – | [-0.003, -0.003] |
| WN | – | [-1.642, -1.583] |
| Median Elas. of Demand | -5.567 | [-2.43,-2.40] |
| Median Markup | 38.167 | [51.25,53.40] |

# Takeaways from Estimation Results

- Selection model price parameter / elasticity is half the size of exogenous model.
- Story: Firms who enter are "better" (unobservables) and therefore can exert more market power.
- Airline heterogeneity important in both demand and costs.

# Merger

# Merger Simulation

- Simulate merger between American and USAir (our data is pre-merger).
- Consider a "best case" scenario for the new AA/US merged firm.
- Details:
  - Eliminate US as a potential firm.
  - In each market, assign AA the "best" observable and unobservable characteristics between the pre-merged AA and US.
  - Implies AA will have weakly lower costs and weakly higher utility after the merger.

# Economics of Merger with Endogenous Entry

More Concentration (markets with US and AA pre-merger)

- Less competition $\implies$ higher prices [EX].
- New firm enters market – ?? prices.

AA/US lower marginal costs:

- Lower prices. [EX]
- Rivals might exit b/c fiercer price competition.
- AA/US might enter new markets.

AA/US lower fixed costs:

- Entry into new markets, could replace incumbents.

AA/US higher consumer utility:

- AA/US can raise price.[EX]
- AA/US enters new markets because charge higher prices and cover FC.
- AA/US steal consumers from rivals – rivals exit.

# Post Merger Entry/Exit in Concentrated Markets

- AA enters unserved markets. Also, high likelihood of monopolization.
- Many markets that DL is potential entrant. Now enters as duopoly.

Table: Market Structures in AA and US Monopoly and Duopoly Markets

| | Post-merger | |
|---|---|---|
| Pre-merger | No Firms | AA Monopoly |
| No Firms | [0.36,0.90] | [0.10,0.19] |
| AA & US Duopoly | [0.00,0.01] | [0.20,0.82] |

Table: Entry of Competitors in AA and US Duopoly Markets

| | Post-merger market structure | | | |
|---|---|---|---|---|
| Pre-merger | Duopoly AA/US & DL | Duopoly AA/US & LCC | Duopoly AA/US & UA | Duopoly AA/US & WN |
| Duopoly AA & US | [0.08,0.25] | [0.01,0.02] | [0.05,0.11] | [0.00,0.01] |

Table: AA/US Price Changes in Duopoly Markets

| | Post-merger market structure | | | |
|---|---|---|---|---|
| Change in the price of AA | Duopoly AA/US & DL | Duopoly AA/US & LCC | Duopoly AA/US & UA | Duopoly AA/US & WN |
| Duopoly AA & US | [-0.12,-0.01] | [-0.01,0.03] | [-0.06,0.00] | [0.00,0.04] |

# Markets Involving DCA

- DCA was an airport with a high presence by AA and US.
- Type of market that is particularly concerning for regulators.
- The DOJ approved the merger conditional on AA giving up slots to other competitors.

Table: Post-merger entry and pricing in pre-merger AA & US Duopoly markets, Reagan National Airport

| Prob mkt structure | Monopoly AA/US | Duopoly AA/US & DL | Duopoly AA/US & LCC | Duopoly AA/US & UA | Duopoly AA/US & WN |
|---|---|---|---|---|---|
| Mkt Struct. Transitions | [0.161, 0.710] | [ 0.136, 0.227] | [0.000, 0.047] | [0.059, 0.188] | [0.000, 0.000] |
| % Change in Prices | [0.019, 0.089] | [-0.095, 0.018] | [-0.073, 0.126] | [-0.114, 0.068] | [n.a.] |

# Conclusions

- Estimated a model of supply/demand with endogenous entry.
- Market power estimates differ substantially from exogenous market structure estimates.
- Potential upside of merger due to entry.
- Many possible changes to market structure and prices.

# Market Structure and Price Transitions

Table: Post-merger Entry of AA in New Markets

| Monopoly | (1) | (2) | Duopoly | (3) | 3-opoly | (4) | 4-opoly | (5) |
|---|---|---|---|---|---|---|---|---|
| Pre-merger Firms | AA Replacement | AA Entry | Pre-merger Firms | AA Entry | Pre-merger Firms | AA Entry | Pre-merger Firms | AA Entry |
| DL | [0.02,0.09] | [0.19,0.25] | DL,LCC | [0.09,0.27] | DL,LCC,UA | [0.21,0.35] | DL,LCC,UA,WN | [0.27,0.44] |
| LCC | [0.07,0.19] | [0.02,0.14] | DL,UA | [0.24,0.32] | DL,LCC,WN | [0.10,0.33] | | |
| UA | [0.04,0.12] | [0.10,0.21] | DL,WN | [0.16,0.27] | DL,UA,WN | [0.29,0.37] | | |
| WN | [0.01,0.04] | [0.10,0.19] | LCC,UA | [0.05,0.22] | LCC,UA,WN | [0.07,0.29] | | |
| | | | LCC,WN | [0.04,0.23] | | | | |
| | | | UA,WN | [0.11,0.26] | | | | |

Table: Post-Merger Price Changes After the Entry of AA in New Markets

| Monopoly | | Duopoly | | 3-opoly | | 4-opoly | |
|---|---|---|---|---|---|---|---|
| Pre-merger Firms | %ΔPrice | Pre-merger Firms | %ΔPrice | Pre-merger Firms | %ΔPrice | Pre-merger Firms | %ΔPrice |
| DL | [-0.12,-0.08] | DL | [-0.05,-0.03] | DL | [-0.03, -0.01] | DL | [-0.02, -0.01] |
| | | LCC | [-0.01,-0.01] | LCC | [-0.01,-0.00] | LCC | [-0.00,-0.00] |
| | | | | UA | [-0.015 -0.010] | UA | [-0.01,-0.01] |
| | | | | | | WN | [-0.01,-0.00] |
| LCC | [-0.10,-0.09] | DL | [-0.04,-0.02] | DL | [-0.028,-0.014] | | |
| | | UA | [-0.02,-0.02] | LCC | [-0.008,-0.004] | | |
| | | | | WN | [-0.012,-0.008] | | |
| UA | [-0.12,-0.09] | DL | [-0.05,-0.03] | DL | [-0.021,-0.013] | | |
| | | WN | [-0.02,-0.01] | UA | [-0.016,-0.010] | | |
| | | | | WN | [-0.008,-0.006] | | |
| WN | [-0.11,-0.08] | LCC | [-0.02,-0.01] | LCC | [-0.011,-0.005] | | |
| | | UA | [-0.04,-0.03] | UA | [-0.025,-0.015] | | |
| | | | | WN | [illegible] | | |

# Transitions with Exit

Table: Likelihood of Exit by Competitors after AA-US Merger

| Duopoly with AA | | 3-opoly with AA | |
|---|---|---|---|
| Pre-merger Firm | Exit | Pre-merger Firms | Exit |
| DL | [0.03,0.05] | DL | [0.05,0.15] |
| | | LCC | [0.01,0.01] |
| LCC | [0.09,0.16] | DL | [0.04,0.14] |
| | | UA | [0.01,0.05] |
| UA | [0.06,0.08] | DL | |
| | | WN | |

Table: Price Changes From Exit of Competitor After Merger

| Duopoly | | 3-opoly | | | |
|---|---|---|---|---|---|
| Pre-merger Firm | AA %ΔPrice | Pre-merger Firm | %ΔPrice | Pre-merger Firm | %ΔPrice |
| DL | [-0.02,0.04] | AA | [-0.07,-0.05] | DL | [-0.03,-0.00] |
| | | AA | [-0.01,0.06] | LCC | [-0.02,0.01] |
| LCC | [0.01,0.07] | AA | [-0.07,-0.04] | DL | [-0.03,0.03] |
| | | AA | [-0.02,-0.00] | UA | [-0.03,0.02] |
| UA | [0.01,0.08] | AA | [-0.05,-0.02] | DL | [-0.01,0.01] |
| | | AA | [-0.04,-0.01] | WN | [-0.02,0.03] |