Market Structure and Competition in Airline Markets

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Product Selection: Review

Eizenberg made the point that estimating demand typically involves conditioning on the product set.

In his notation

$$E[\xi_j \cdot z_j \mid q_j = 1] = 0$$

where q_j is a selection indicator function.

He estimates fixed costs (in a separate stage) using necessary conditions for SPNE.

Two Issues with Eizenberg's Solution

1. Selection on unobservables.

Eizenberg treats selection on a fixed cost unobservable seriously: $E[\nu_j|A^1] \neq 0$

But what if there is correlation between fixed cost unobservable and demand or marginal cost unobservables? $E[\xi \mid X, F] = 0$, where F includes ν.

2. Counterfactuals

His counterfactuals are of the form "What if product X stayed in the market?"

But what about solving for new equilibrium configurations after a change in the market?

Our Solution

The authors present a solution that handles both of these issues.

But the solution comes with some costs.

They propose *solving* for equilibrium.

- Fully parametric model.
- Computationally demanding (simulation-based algorithm).
- Curse of dimensionality in the number of players.

The Econometric Problem

- Consider the workhorse model of discrete choice demand for differentiated products.
- Consumer utility: $u_{ijt} = X_{jt}\beta - \alpha p_{jt} + \xi_{jt} + \epsilon_{ijt}$
  - product (j); market (t); consumer (i)
- Typically, estimation proceeds by making use of some a distributional assumption on unobserved product quality, $\{\xi\}$, to identify model:

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- Typically, estimation proceeds by making use of some a distributional assumption on unobserved product quality, $\{\xi\}$, to identify model:

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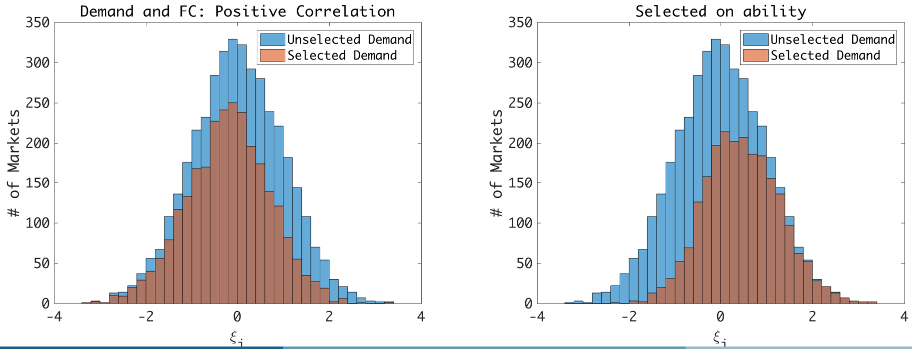
- Issue: Set of observed products set is not random.
- Consider firm entry decision: $y_{jt} = 1$ if enter and $y_{jt} = 0$ if not entered. If firms face a meaningful selection problem (non-zero fixed/sunk costs)

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

- More generally, entry and post-entry actions might be correlated: $E[\xi \mid F] \neq 0$, where F determines threshold for y.

Motivating Numerical Example

- 4 potential entrants, 1000 markets, simultaneous entry and pricing game.
- $\pi_j = (p_j - exp(\nu_j))s_j(p;\xi) - exp(-3 + \eta_j)$
- $(\xi_j, \nu_j, \eta_j) \sim N(0, \Sigma)$



Motivation: Why Mergers?

> *As part of their full assessment of competitive effects, the Agencies consider entry into the relevant market. The prospect of entry into the relevant market will alleviate concerns about adverse competitive effects only if such entry will deter or counteract any competitive effects of concern so the merger will not substantially harm customers.*

Source: 2010 Horizontal Merger Guidelines

Plan of Talk

1. Methodological Example
    - Discuss estimation.
2. Model of Airline competition.
3. Data and Identification
4. Estimation Specifics and Results
5. AA - US Merger

Methodological Example

Simple Model with Two Firms

- Two firms simultaneously make a participation (entry) decision and, if active, realize some outcome (demand/profit/revenue).
- Complete information environment.
- Researcher has data on both the participation and the outcome.
- Outcome equation has endogenous variable (separate from entry decision).
- Researcher interested in primitives of participation and outcome equation.

Simple Model: Entry with Two Firms

- The following system of equations describes the model:

$$\begin{cases} y_1 = 1\left[\delta_2 y_2 + \gamma Z_1 + \nu_1 \geq 0\right], \\ y_2 = 1\left[\delta_1 y_1 + \gamma Z_2 + \nu_2 \geq 0\right], \\ S_1 = y_1(X_1\beta + \alpha_1 P_1 + \xi_1), \\ S_2 = y_2(X_2\beta + \alpha_2 P_2 + \xi_2). \end{cases}$$

- $y_j = 1$ if firm j decides to enter a market, and $y_j = 0$ otherwise.
- Consider Pure Strategy Nash solution.
- Endogenous variables: $(y_1, y_2, S_1, S_2, P_1, P_2)$. We observe $(S_1, P_1$ only if $y_1 = 1$ and (S_2, P_2) if $y_2 = 1$.
- The variables $\mathbf{Z} \equiv (Z_1, Z_2)$ and $\mathbf{X} \equiv (X_1, X_2)$ are exogenous.
- Unobservables have a joint normal distribution,

$$(\nu_1, \nu_2, \xi_1, \xi_2) \sim N(0, \Sigma),$$

"Standard" Estimation Procedure

- Strategic interaction in the participation equation induced by $\delta_i y_i$.

$$\begin{cases} y_1 = 1\left[\delta_2 y_2 + \gamma Z_1 + \nu_1 \geq 0\right], \\ y_2 = 1\left[\delta_1 y_1 + \gamma Z_2 + \nu_2 \geq 0\right], \\ S_1 = y_1(X_1\beta + \alpha_1 P_1 + \xi_1), \\ S_2 = y_2(X_2\beta + \alpha_2 P_2 + \xi_2). \end{cases}$$

- Let's forget about that for a moment: $\delta_1 = \delta_2 = 0$.

- How would we estimate the parameters of the "outcome" equation?

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- Let’s forget about that for a moment: $\delta_1 = \delta_2 = 0$.
- How would we estimate the parameters of the “outcome” equation?
  - Estimate a first stage probit.
  - Compute Inverse Mills Ratio.
  - Do IV with IMR for the outcome equation.
- Reiss and Spiller (1989) find positive correlation between demand/prices and entry.

Challenges to Estimation

Strategic nature of the entry decision is problematic.

$$\begin{cases} y_1 = 1\left[\delta_2 y_2 + \gamma Z_1 + \nu_1 \geq 0\right], \\ y_2 = 1\left[\delta_1 y_1 + \gamma Z_2 + \nu_2 \geq 0\right], \\ S_1 = y_1(X_1\beta + \alpha_1 P_1 + \xi_1), \\ S_2 = y_2(X_2\beta + \alpha_2 P_2 + \xi_2). \end{cases}$$

1. A multi-agent version of the classic Heckman Selection problem.
   - Multiple equilibrium in the entry equation.
   - The selection region of the unobservables is a potentially complicated area that depends on the full equilibrium map.
   - The selection equation is incomplete – cannot use some well defined Inverse Mill Ratio.

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   - Multiple equilibrium in the entry equation.
   - The selection region of the unobservables is a potentially complicated area that depends on the full equilibrium map.
   - The selection equation is incomplete – cannot use some well defined Inverse Mill Ratio.
2. The "outcome" equation has an additional endogenous process.

Our Solution

$$\begin{cases} y_1 = 1\left[\delta_2 y_2 + \gamma Z_1 + \nu_1 \geq 0\right], \\ y_2 = 1\left[\delta_1 y_1 + \gamma Z_2 + \nu_2 \geq 0\right], \\ S_1 = y_1(X_1\beta + \alpha_1 P_1 + \xi_1), \\ S_2 = y_2(X_2\beta + \alpha_2 P_2 + \xi_2). \end{cases}$$

- Directly simulate the equilibrium selection region of the unobservables.
  - Simulate all possible equilibria for many draws of the joint dist. of the errors.
  - Assume $(\xi_1, \nu_1) \sim N(0, \Sigma)$ where
$$\Sigma = \begin{pmatrix} \sigma_\xi & \sigma_{\xi,\nu} \\ \sigma_{\xi,\nu} & \sigma_\nu \end{pmatrix}$$
- Compare the **simulated selection region** of ξ to the joint density of the residuals $(\hat{\xi})$ estimated from the data.

Estimating the Distribution of the Unobservables

Case where $(y_1 = 1, y_2 = 0)$:

- For a given (α_1, β), the data identifies

$$Pr(S_1 - \alpha_1 P_1 - X_1\beta \leq t_1;\, y_1 = 1, y_2 = 0, X, Z)$$

  where t_1 arbitrary random variable independent of all variables in the model with the same support as S_1.

- CDF for residuals evaluated at t_1 and where we condition on *all exogenous variables* in the model.

Model Implied Distribution of Unobservables with Multiple Equilibria

We do not assume a eqm selection rule.

$$\begin{cases} y_1 = 1\left[\delta_2 y_2 + \gamma Z_1 + \nu_1 \geq 0\right], \\ y_2 = 1\left[\delta_1 y_1 + \gamma Z_2 + \nu_2 \geq 0\right], \\ S_1 = y_1(X_1\beta + \alpha_1 P_1 + \xi_1), \\ S_2 = y_2(X_2\beta + \alpha_2 P_2 + \xi_2). \end{cases}$$

- $\left(\xi_1 \leq t_1;\, (\nu_1, \nu_2) \in A^U_{(1,0)}\right)$ be the set of ξ_1 that are less than t_1 when the unobservables (ν_1, ν_2) belong to the set $A^U_{(1,0)}$.
  - $A^U_{(1,0)}$: set where $(1,0)$ unique Nash equilibrium outcome.
- $\left(\xi_1 \leq t_1;\, (\nu_1, \nu_2) \in A^M_{(1,0)}, d_{(1,0)} = 1\right)$ be the set of ξ_1 less than t_1 when unobservables (ν_1, ν_2) belong to set $A^M_{(1,0)}$.
  - $A^M_{(1,0)}$: set where $(1,0)$ one among multiple equilibria outcomes.
  - $d_{(1,0)} = 1$ indicate that $(1,0)$ was selected.

Recap

- We find the distribution of residuals for the outcome equation implied by the **data**:

$$Pr(S_1 - \alpha_1 P_1 - X_1\beta \leq t_1;\, y_1 = 1, y_2 = 0, X, Z).$$

- For the same parameters, we simulate the model and derive the distribution of unobservables, accounting for multiple equilibria:

$$Pr\left(\xi_1 \leq t_1;\, (\nu_1, \nu_2) \in A^U_{(1,0)}\right)$$
$$Pr\left(\xi_1 \leq t_1;\, (\nu_1, \nu_2) \in A^M_{(1,0)}, d_{(1,0)} = 1\right)$$

Bounds of the Distribution of Residuals

- "Match" distribution of residuals (at a given parameter value) from data with its counterpart predicted by the selection model.

- By the law of total probability:

$$
\begin{aligned}
Pr(\xi_1 \leq t_1;\, y_1 = 1, y_2 = 0, \mathbf{X}, \mathbf{Z}) \quad &= \quad Pr\left(\xi_1 \leq t_1;\, (\nu_1, \nu_2) \in A^U_{(1,0)}, \mathbf{X}, \mathbf{Z}\right) \\
&+ \quad Pr(d_{(1,0)} = 1 \mid \xi_1 \leq t_1;\, (\nu_1, \nu_2) \in A^M_{(1,0)}, \mathbf{X}, \mathbf{Z}) \\
&\quad\quad Pr\left(\xi_1 \leq t_1; (\nu_1, \nu_2) \in A^M_{(1,0)}, \mathbf{X}, \mathbf{Z}\right)
\end{aligned}
$$

- $Pr(d_{1,0} = 1 \mid \xi_1 \leq t_1;\, (\nu_1, \nu_2) \in A^M_{(1,0)})$ unknown and represents the equilibrium selection function.

- Conduct inference using natural upper and lower bounds on this unknown function:

$$
\begin{aligned}
& Pr\left(\xi_1 \leq t_1;\, (\nu_1, \nu_2) \in A^U_{(1,0)}\right) \\
\leq \quad & Pr(S_1 - \alpha_1 P_1 - X_1\beta \leq t_1;\, y_1 = 1, y_2 = 0) \\
\leq \quad & Pr\left(\xi_1 \leq t_1;\, (\nu_1, \nu_2) \in A^U_{(1,0)}\right) + Pr\left(\xi_1 \leq t_1; (\nu_1, \nu_2) \in A^M_{(1,0)}\right)
\end{aligned}
$$

Moment Inequality Condition

- The middle part can be consistently estimated from the data given a value for (α_1, β, t_1):

$$Pr(S_1 - \alpha_1 P_1 - X_1\beta \leq t_1;\ y_1 = 1; y_2 = 0)$$

- We simulate the upper and lower bound on the distribution of unobservables implied by the selection model for a given value of the parameter vector:

$$Pr\left(\xi_1 \leq t_1;\ (\nu_1, \nu_2) \in A^U_{(1,0)}\right),\ Pr\left(\xi_1 \leq t_1; (\nu_1, \nu_2) \in A^M_{(1,0)}\right)$$

- Conditional moment inequality model where at the truth, the moment inequalities above hold for all $\mathbf{X}, \mathbf{Z}, t_1$.

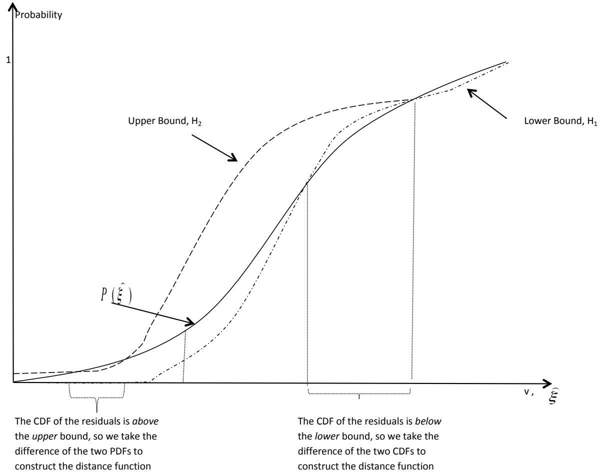
- Use standard moment inequality methods to conduct set inference.

$$E[\mathbf{G}(\theta, S_1y_1, S_2y_2, P_1y_1, P_2y_2, y_1, y_2; t_1, t_2)|\mathbf{Z}, X] \leq 0$$

Estimation – Moment Conditions

- Construct moments using the following inequality:

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



A Model of Airline Entry and Pricing

Model: Demand and Supply

- Market (m) is a unidirectional airport pair with k potential entrants.
- Firms simultaneously decide entry and prices.

Demand

- Nested Logit, inside/outside nesting structure:

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

Supply

- Simultaneous Nash Bertrand pricing with constant marginal cost (Berry, 1994):

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

Model: Entry

- **Entry** equation:

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

- $3 \times J$ equations plus selection rule describes the equilibria.

- **Structural Errors**:

- Demand, MC, FC Errors, $(\xi_{jm}, \eta_{jm}, \nu_{jm})$ are joint normal with mean zero and covariance:

$$\Sigma_{1m} = \begin{pmatrix} \sigma_\xi^2 & \sigma_{\xi\eta} & \sigma_{\xi\nu} \\ \sigma_{\xi\eta} & \sigma_\eta^2 & \sigma_{\nu\eta} \\ \sigma_{\xi\nu} & \sigma_{\nu\eta} & \sigma_\nu^2 \end{pmatrix} \tag{4}$$

How is this different than the simple model?

1. Added nonlinearities.

2. Need to *solve for the equilibrium of the full model*, which has six (rather than just four) endogenous variables (**prices!**).

3. There are *three* unobservables for each firm over which to integrate (marginal cost, demand, fixed cost).

A look back at the literature

- If we were to estimate the demand and supply conditions, then we have Berry 94, BLP etc.
  - Set of products/airline taken as exogenous.
  - Cannot estimate features of fixed costs distribution.
- If we were to estimate a reduced form version of the entry conditions, we have Bresnahan and Reiss (many), Berry 92, etc.
  - Difficult to make inferences on primitives like market power, welfare, etc.
- For sure, traction has been made on estimating these "jointly":
  - Berry/Waldgoel (1999) Berry/Waldfogel/Eizenberg (wp)
  - Eizenberg (2014)
- Our solution allows for meaningful selection on unobservables, in the sense of Heckman 76/79.

Empirical Setting

- Domestic commercial airline industry:
  - Considerable price differences across markets and market structure.
  - Considerable variation in market structure, with many recent mergers.
- 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

	Number of Entrants					
	1	2	3	4	5	6
Fraction of markets	0.08	1.11	5.16	18.11	42.87	32.68

Endogenous Variables

- Entry: y_{jm}
- Prices: p_{jm}
- Shares/Demand: s_{jm}
- p_{jm} and s_{jm} are only observed if $y_{jm} = 1$

Exogenous Variables – Demand

- *Nonstop Origin*: number of non-stop routes that an airline serves out of the origin airport.
  - Proxy of frequent flyer programs: the larger the share of nonstop markets that an airline serves out of an airport, the easier is for a traveler to accumulate points, and the more attractive flying on that airline is.
- *Distance* between the origin and destination airports is also a determinant of demand.

Exogenous Variables – Flight/Pass. Costs (MC)

- *Origin Presence*: the *ratio* of markets served by an airline out of an airport over the total number of markets served out of that airport by at least one carrier.
- We think of this as the opportunity cost for not using a particular plane (seats/personnel/etc) for another flight. The more opportunities there are to use a particular plane, the higher the opportunity costs.

Exogenous Variables – Airport Costs (FC)

- Airport/fixed costs do not change with an additional passenger flown on an aircraft, or the use of the that plane for some other reason at that airport.
- Airlines must lease gates and hire personnel to enplane and deplane aircrafts at the two endpoints.
- *Nonstop Origin*: # of nonstop routes from origin.
- *Nonstop Destination*: the number of non-stop routes that an airline serves out of the destination airport.

Descriptive Statistics

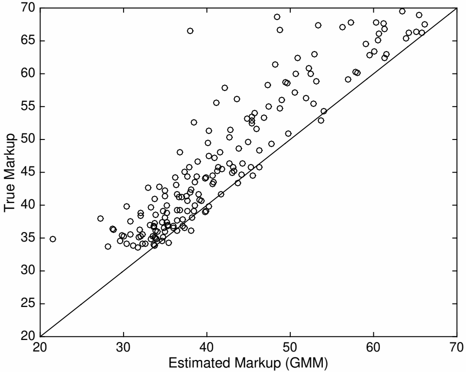
Table: *Summary Statistics*

	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

Estimation and Results

Numerical Exercise: Evidence of Selection

- We claimed that there is a selection problem in demand/supply estimation.
- Generate data using model with different sets of parameters.
- We estimate market power using standard GMM framework of Berry (1994).
- In all cases, $corr(\xi, \nu) > 0$.



Estimation Algorithm

- Guess parameters $(\beta^0, \alpha^0, \sigma^0, \phi^0, \gamma^0, \Sigma^0)$.
- Using Σ^0, draw from the unselected distribution of errors.
- Solve all equilibria of of the model and construct an upper and lower envelope for the cdf of selection region.

$$\{Pr^L(\{\xi*, \eta*\} < \boldsymbol{t}|\boldsymbol{\Omega}), Pr^U(\{\xi*, \eta*\} < \boldsymbol{t}|\boldsymbol{\Omega})\},\ \Omega = (X, W, Z, y) \tag{5}$$

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- Also, construct the data identified distribution of "selected" residuals

$$\begin{aligned} Pr(ln(s_{jt}) - ln(s_{j0}) - (X_{jm}\beta^0 + \alpha^0 p_{jm} + \sigma^0 ln(s_{j|g})) < t|\boldsymbol{\Omega}, \boldsymbol{y}) \\ = Pr(\hat{\xi}_{jm} < t|\boldsymbol{\Omega}, \boldsymbol{y}) \end{aligned} \tag{6}$$

- In practice, construct moments from matching bin counts of the cdfs, conditional on a market type.
- Use sub-sampling routine suggested by CHT for inference.

Computational Challenges

- Solve for all possible equilibria
    - Typical type of mult eq in entry games.
    - Assume a unique pricing equilibrium given a market structure (nested logit).
- Probably a very funny looking objective function, so simulation bias could be a serious issue.
- Both issues imply non-trivial computational costs.

Parameter Estimates

TABLE 4
PARAMETER ESTIMATES

	GMM (1)	Exogenous Entry (2)	Endogenous Entry (3)
	A. Demand		
Price ($100)	[−2.385, −2.185]	[−2.315, −2.282]	[−1.557, −1.488]
λ	[.320, .519]	[.294, .366]	[.186, .206]
Distance	[.308, .364]	[.394, .461]	[.724, .793]
Origin presence	[.291, .339]	[.102, .169]	[1.688, 1.752]
LCC	[−.333, −.143]	[−1.078, −.486]	[.080, .273]
WN	[.216, .335]	[−.077, .206]	[−.029, .128]
Constant	[−2.299, −1.817]	[−2.961, −2.851]	[−4.683, −4.587]
	B. Marginal Cost		
Distance	[.118, .124]	[.112, .130]	[.083, .094]
LCC	[−.313, −.287]	[−.419, −.288]	[−.027, .054]
WN	[−.144, −.127]	[−.247, −.080]	[−.079, −.017]
Constant	[5.343, 5.351]	[5.339, 5.348]	[5.132, 5.179]
	C. Fixed Cost		
Nonstop origin			[−.387, −.327]
Nonstop destination			[−1.538, −1.473]
Constant			[1.227, 1.315]
	D. Variance-Covariance		
Variance demand	1.514	[2.354, 3.425]	[1.736, 1.876]
Variance marginal cost	.059	[.072, .132]	[.330, .353]
Variance fixed cost			[14.640, 15.636]
Demand–marginal cost covariance	.184	[.278, .504]	[.470, .512]
Demand–fixed cost covariance			[.674, .829]
Marginal cost–fixed cost covariance			[−.709, −.659]
	E. Market Power		
Median elasticity	[−8.163, −8.091]	[−7.281, −7.063]	[−4.105, −4.007]
Median markup	[28.146, 28.274]	[30.366, 31.564]	[53.617, 56.051]

Takeaways from Estimation Results

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

Merger with Endogenous Repositioning

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

Increased 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 or drive down prices.

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.

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]

Post Merger Entry/Exit in Concentrated Markets

- Many markets that DL is potential entrant. Now enters as duopoly.

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.]

Market Structure and Price Transitions

Table: Post-merger Entry of AA in New Markets

	(1)	(2)		(3)		(4)		(5)
Monopoly			Duopoly		3-opoly		4-opoly	
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]				

Market Structure and Price Transitions

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	[-0.009,0.001]		
		LCC	[-0.04,-0.02]				
		WN	[-0.05,-0.02]				
		UA	[-0.04,-0.03]				
		WN	[-0.02,-0.02]				

Conclusions

- Estimate 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.

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]