Market Structure and Competition in Airilines Markets

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Outline

Introduction

- **Setup:** Two firms ($i = 1, 2$) across markets ($j = 1, \ldots, J$).
- Each firm chooses:
  - Entry decision $y_{ij} \in \{0, 1\}$
  - Price P_{ij} if $y_{ij} = 1$
- **Key issues:**
  1. Firms self-select into markets $\Rightarrow$ entry must be modeled.
  2. Ignoring this biases demand and cost estimates (contrast with BLP).
  3. Crucial for evaluating merger policy and welfare.

Literature Review

- **BLP (1995):** Demand and pricing in differentiated products, assumes exogenous market structure.
- **Ciliberto & Tamer (2009):** Entry games with multiple equilibria, partial identification.
- **This paper:** Combines BLP with endogenous entry à la CT (2009).

Simple Model

$$
\begin{aligned}
y_1 &= \mathbb{1}[\delta_2 y_2 + \gamma Z_1 + \nu_1 \geq 0] \\
y_2 &= \mathbb{1}[\delta_1 y_1 + \gamma Z_2 + \nu_2 \geq 0] \\
S_1 &= X_1\beta + \alpha_1 V_1 + \xi_1 \\
S_2 &= X_2\beta + \alpha_2 V_2 + \xi_2
\end{aligned}
$$

- Errors are jointly normal $\mathcal{N}(0, \Sigma)$.
- Off-diagonal entries of $\Sigma \neq 0 \implies$ **selection bias**.
- Issues: multiple equilibria and endogenous variables.

Inference: Setup

Observables: $(S_1 y_1, V_1 y_1, y_1,\ S_2 y_2, V_2 y_2, y_2)$.

Key Idea: Link the distribution of observables to the model's predictions.

For $(y_1, y_2) = (1, 0)$:

$$P(\xi_1 \leq t_1; y_1 = 1, y_2 = 0)$$

This probability can be decomposed into unique (A^u) and multiple (A^m) equilibrium regions.

$$\mathrm{P}(\xi_1 \leq t_1; (\nu_1, \nu_2) \in A^u_{(1,0)}) \ + \ P(d_{1,0} = 1 \mid \xi_1 \leq t_1, (\nu_1, \nu_2) \in A^{nu}_{(1,0)}) \cdot P(\xi_1 \leq t_1; (\nu_1, \nu_2) \in A^{nu}_{(1,0)})$$

Multiplicity regions

Here add the picture from CT 2009

Inference: Bounds

$$
\begin{aligned}
& P(\xi_1 \leq t_1; (\nu_1, \nu_2) \in A^u_{(1,0)}) \\
& \leq P(S_1 - \alpha_1 V_1 - X_1 \beta \leq t_1; y_1 = 1, y_2 = 0) \\
& \leq P(\xi_1 \leq t_1; (\nu_1, \nu_2) \in A^u_{(1,0)}) + P(\xi_1 \leq t_1; (\nu_1, \nu_2) \in A^m_{(1,0)})
\end{aligned}
$$

All Moment Conditions

Moment Inequalities:

- For $(y_1, y_2) = (1, 0)$:

$$ml_{(1,0)} \leq \mathbb{E}[\nVdash_{\{S_1 - \cdots \leq t_1, y_1 = 1, y_2 = 0\}}] \leq mu_{(1,0)}$$

- For $(y_1, y_2) = (0, 1)$:

$$ml_{(0,1)} \leq \mathbb{E}[\nVdash_{\{S_2 - \cdots \leq t_2, y_1 = 0, y_2 = 1\}}] \leq mu_{(0,1)}$$

Moment Equalities:

- For $(y_1, y_2) = (1, 1)$:

$$\mathbb{E}[\nVdash_{\{S_1 - \cdots \leq t_1, S_2 - \cdots \leq t_2, y_1 = 1, y_2 = 1\}}] = m_{(1,1)}$$

- For $(y_1, y_2) = (0, 0)$:

$$\mathbb{E}[\nVdash_{\{y_1 = 0, y_2 = 0\}}] = m_{(0,0)}$$

Overall Moment Conditions:

$$\mathbb{E}[G(\theta, S_1 y_1, S_2 y_2, V_1 y_1, V_2 y_2, y_1, y_2) | Z, X] \leq 0$$

The Structural Model

$$
\begin{cases}
y_1 = 1 \iff \pi_1 = (p_1 - c(W_1, \eta_1) M \cdot \tilde{s}_1(\mathbf{p}, \mathbf{X}, \mathbf{Y}, \xi) - F(Z_1, \upsilon_1)) \geq 0 \\
y_2 = 1 \iff \pi_2 = (p_2 - c(W_2, \eta_2) M \cdot \tilde{s}_2(\mathbf{p}, \mathbf{X}, \mathbf{Y}, \xi) - F(Z_2, \upsilon_2)) \geq 0 \\
S_1 = \tilde{s}_1(\mathbf{p}, \mathbf{X}, \mathbf{Y}, \xi) \\
S_2 = \tilde{s}_2(\mathbf{p}, \mathbf{X}, \mathbf{Y}, \xi) \\
(p_1 - c(W_1, \eta_1)) \frac{\partial \tilde{s}_1}{\partial p_1} + \tilde{s}_1(\mathbf{p}, \mathbf{X}, \mathbf{Y}, \xi) = 0 \\
(p_2 - c(W_2, \eta_2)) \frac{\partial \tilde{s}_2}{\partial p_2} + \tilde{s}_2(\mathbf{p}, \mathbf{X}, \mathbf{Y}, \xi) = 0
\end{cases}
\tag{1}
$$

Estimation Algorithm

- Find $\Theta = (\alpha, \beta, \varphi, \gamma, \Sigma)$ that minimizes distance between empirical and simulated distributions.
- Candidate parameter value: Θ_0

Step 1: Empirical CDF

- Compute residuals from data using Θ_0:

$$\hat{\xi}, \hat{\eta}$$

- Construct empirical CDFs:

$$\hat{P}(\hat{\xi} \leq t_D, \hat{\eta} \leq t_S | \mathbf{X}, \mathbf{W}, \mathbf{Z})$$

Step 2: Simulated CDFs (Bounds)

- Simulate (ν^r, ξ^r, η^r) from $\mathcal{N}(0, \Sigma_0)$.
- For each draw and each of the $2^K - 1$ potential market structures:
  - Solve the subsystem of demand and FOCs for equilibrium prices and shares, $(\bar{p}^r, \bar{s}^r)$.
  - Compute profits to determine equilibria.

Data

Demand	GMM	Ex.E	En.E
Price (100$)	[-2.385, -2.185]	[-2.315, -2.282]	[-1.557, -1.488]
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]