Conduct

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Grad IO

Conduct Overview

- A second set of important questions in IO is being able to use data to decide whether firms are competing or colluding.
- Absent additional restrictions, we cannot generally look at data on (P, Q) and decide whether or not collusion is taking place.
- We can make progress in two ways: (1) parametric restrictions on marginal costs; (2) exclusion restrictions on supply.
  - Most of the literature focuses on (1) by assuming something like: $\ln mc_{jt} = x_{jt}\gamma_1 + w_{jt}\gamma_2 + \omega_{jt}$.
  - In principle (2) is possible if we have instruments that shift demand for products but not supply. (These are much easier to come up with than "supply shifters").

A famous plot (Bresnahan 87)

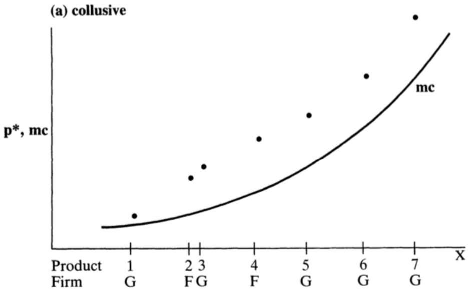

Figure 2(a)

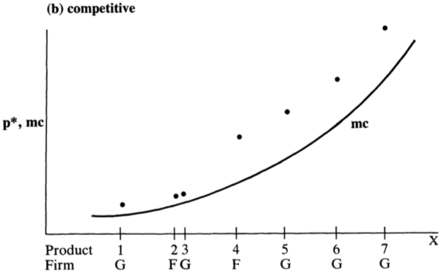

Figure 2(b)

Testing For Conduct: Challenges

- Recall the Δ matrix which we can write as $\Delta = \tilde{\Delta} \odot A$, where $\odot$ is the element-wise or Hadamard product of two matrices.
    - $\tilde{\Delta}$ is the matrix of demand derivatives with $\Delta(j,k) = \frac{\partial q_j}{\partial p_k}$ for all elements.
    - $A_{(j,k)} = 1$ if (j,k) have the same owner and 0 otherwise.
- Mergers are about changing 0's to 1's in the A matrix.
- Matrix form of FOC: $q(\mathbf{p}) = \Omega(\mathbf{p}) \cdot (\mathbf{p} - \mathbf{mc})$

Testing For Collusion: Challenges

We derived those conditions from multi-product Bertrand FOCs:

$$
\begin{aligned}
\arg\max_{p \in \mathcal{J}_f} \pi_f(\mathbf{p}) &= \sum_{j \in \mathcal{J}_f} (p_j - c_j) \cdot q_j(\mathbf{p}) + \kappa_{fg} \sum_{j \in \mathcal{J}_g} (p_j - c_j) \cdot q_j(\mathbf{p}) \\
\rightarrow 0 &= q_j(\mathbf{p}) + \sum_{k \in (\mathcal{J}_f, \mathcal{J}_g)} \kappa_{fg} \cdot (p_k - c_k) \frac{\partial q_k}{\partial p_j}(\mathbf{p})
\end{aligned}
$$

- Now we have generalized the $A(\kappa)$ matrix.
- Instead of 0's and 1's we now have $\kappa_{fg} \in [0, 1]$ representing how much firm f cares about the profits of g.
  - If f and g merge (or fully colluded) then $\kappa_{fg} = 1$
  - Often in the real world firms cannot reach fully collusive profits and $\kappa_{fg} \in (0, 1)$.
  - Evidence that $\kappa_{fg} > 0$ is not necessarily evidence of malfeasance, just a deviation from static Bertrand pricing.

Reasons for Deviations from Static Bertrand

Biased estimates of own and cross price derivatives: For anything to work, you have correct estimates of $\tilde{\Omega}$. My prior is most papers underestimate cross price elasticites.

Vertical Relationships: Who sets supermarket prices? Just the retailer? Just the manufacturer? Some combination of both? Retailers tend to soften downstream price competition.

Faulty Timing Assumptions: Bertrand is a simultaneous move pricing game. Lots of alternatives (Stackelberg leader-follower, Edgeworth cycles, etc.).

Dynamics and Dynamic Pricing: Forward looking firms or consumers might not set static Nash prices. [e.g. Temporary Sales, Switching Costs, Network Effects, etc.]

Unmodeled Supergame: Maybe firms are legally tacitly colluding, higher prices might be about what firms believe will happen in a price war.

Algorithm #1: Bertrand Deviations

- Recover $\tilde{\Omega}$ from demand alone.
- Recover marginal costs $\widehat{\mathbf{mc}} = \mathbf{p} + (O.*\tilde{\Omega}(\mathbf{p}))^{-1} q(\mathbf{p})$.

Challenges:

- Given $[\mathbf{q}, \mathbf{p}, \tilde{\Omega}, O]$ I can always produce a vector of marginal costs $\mathbf{c}$ that rationalizes what we observe. [ie: J equations J unknowns].
- Maybe some vectors of $\mathbf{c}$ look less "reasonable" than others.
  - ie: I have a parametric model of MC in mind.
  - Can test that model with GMM objective of c_{jt} on regressors.
  - Maybe marginal costs cannot deviate too much within product from period to period.
  - Marginal costs ≤ 0 seem problematic. [Might just be that your estimates for demand are too inelastic...]

Algorithm #2: Simultaneous Supply and Demand

- Recover $\tilde{\Omega}$ from demand and parametric assumption on supply (GMM with both sets of moments).
- I can impose $c > 0$ by using $\ln mc_{jt} = x_{jt}\gamma_1 + w_{jt}\gamma_2 + \omega_{jt}$.
- The fit of my supply side will also inform my demand parameters, particularly α the price coefficient. [BLP 95 used this for additional power with lots of random coefficients and potentially weak instruments].

Challenges:

- Am I testing conduct? Or am I testing the linear functional form for my supply model?
- Will a missing z_{jt} change whether or not I believe firms are colluding?

Algorithm #3: Exclusion Restrictions

- We provide a formal test for four alternative models of conduct based on the exclusion restriction test in Berry and Haile (2014)

$$\begin{aligned}
\widehat{mc_{jt}}(\kappa, \hat{\theta}) &= \lambda_j + \gamma_1 x_{jt} + \gamma_2 w_{jt} + \omega_{jt} \\
\omega_{jt} &= \widehat{mc_{jt}}(\kappa, \hat{\theta}) - \lambda_j - \gamma_1 x_{jt} - \gamma_2 w_{jt} \\
0 &= E[\omega_{jt} | \lambda_j, x_{jt}, w_{jt}, z^s_{jt}]
\end{aligned}$$

- w_{jt}: cost shifters (price of corn for Corn Flakes, price of rice for Rice Krispies).
- z^s_{jt}: should not shift marginal costs under the true model of conduct but could potentially shift marginal costs under the alternative. A good choice is markup shifters.
  - BLP instruments
  - Cost shifters for other products (Price of Rice for Corn Flakes, Price of Corn for Rice Krispies).
  - κ parameters or κ weighted diversion.

Start with BLP(95/99) / Nevo (2001)

Utility of consumer i for product j and store-week t as:

$$u_{ijt} = \delta_{jt} + \mu_{ijt} + \epsilon_{ijt}$$

Market shares are given by:

$$s_{jt}(\delta_{\cdot t}, \theta_2) = \int \frac{\exp[\delta_{jt} + \mu_{ijt}]}{\sum_{k \in J_t} \exp[\delta_{kt} + \mu_{ikt}]} f(\mu_{it} \mid \widetilde{\theta}_2)\, d\mu_{it}.$$

BH2014 show that one can invert the vector of observed market shares $\mathcal{S}_t$ to solve for $\delta_t = D_t^{-1}(\mathcal{S}_t, \theta_2)$.

Supply Side

Consider the multi-product Bertrand FOCs:

$$
\begin{aligned}
\arg\max_{p \in \mathcal{J}_f} \pi_f(\mathbf{p}) &= \sum_{j \in \mathcal{J}_f} (p_j - c_j) \cdot s_j(\mathbf{p}) + \kappa_{fg} \sum_{k \in \mathcal{J}_g} (p_k - c_k) \cdot s_k(\mathbf{p}) \\
0 &= s_j(\mathbf{p}) + \sum_{k \in \mathcal{J}_f} (p_k - c_k) \frac{\partial s_k}{\partial p_j}(\mathbf{p}) + \sum_g \kappa_{fg} \sum_{l \in \mathcal{J}_g} (p_l - c_l) \frac{\partial s_l}{\partial p_j}(\mathbf{p})
\end{aligned}
$$

It is helpful to define the matrix $\Omega_{(j,k)}(\mathbf{p}) = -\frac{\partial s_j}{\partial p_k}(\mathbf{p})$:

$$
A(\kappa)_{(j,k)} = \left\{ \begin{array}{lr} 1 & \text{for } j \in \mathcal{J}_f \\ \kappa_{fg} & \text{for } j \in \mathcal{J}_f, k \in \mathcal{J}_g \\ 0 & \text{o.w} \end{array} \right\}
$$

We can re-write the FOC in matrix form:

$$
\begin{aligned}
s(\mathbf{p}) &= (A(\kappa) \odot \Omega(\mathbf{p})) \cdot (\mathbf{p} - \mathbf{mc}), \\
\mathbf{mc} &= \mathbf{p} - \underbrace{(A(\kappa) \odot \Omega(\mathbf{p}))^{-1} s(\mathbf{p})}_{\eta(\mathbf{p}, \mathbf{s}, \theta_2, \kappa)}.
\end{aligned}
$$

Simultaneous Problem

Assume additivity, and write in terms of structural errors:

$$\xi_{jt} = \delta_{jt}(\mathcal{S}_t, \widetilde{\theta}_2) - \theta_1[x_{jt}, v_{jt}] - \alpha p_{jt}$$
$$\omega_{jt} = f\left(p_{jt} - \eta_{jt}(\mathbf{p}, \mathbf{s}, \theta_2, \kappa)\right) - h(x_{jt}, w_{jt}, \theta_3)$$

We've highlighted the two exclusion restrictions:

- Cost shifters w_{jt}
- Demand shifters v_{jt}

To simplify slides we let $f(x) = x$ (often $f(x) = \log(x)$).

Simultaneous Problem: Menu Approach

Assume two models of conduct (correct: κ_0) (incorrect: κ_1)

$$f(p_{jt} - \eta_{jt}(\kappa_0)) = h(x_{jt}, w_{jt}; \theta_3^0) + \omega_{jt}^0,$$
$$f(p_{jt} - \eta_{jt}(\kappa_1)) = h(x_{jt}, w_{jt}; \theta_3^1) + \omega_{jt}^1.$$

Write things in terms of the markup difference:

$$p_{jt} - \eta_{jt}(\kappa_1) = h(x_{jt}, w_{jt}; \theta_3) + \overbrace{\lambda \cdot \Delta\eta_{jt}(\mathbf{p}, \mathbf{s}, \theta, \kappa_0, \kappa_1) + \omega_{jt}}^{\widetilde{\omega_{jt}}}$$

Tempting idea: run the above regression and test if $\lambda = 0$.

- True model $\lambda = 0$, alternate model $\lambda \neq 0$.

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Tempting idea: run the above regression and test if $\lambda = 0$.

- True model $\lambda = 0$, alternate model $\lambda \neq 0$.
- η_{jt} is endogenous: it depends on everything including (ξ, ω).

An Old Problem

- Bresnahan (1980/1982) recognized this problem: we need "rotations of demand".
- Most of the literature followed Bresnahan (1987):
  - ω_{jt} is measurement error in price
  - Ex: Bonnet and Dubois (2010) $E[\ln(\omega_{jt})|x_{jt}, w_{jt}] = 0$:

$$\log(p_{jt} - \eta_{jt}(\kappa, \widehat{\theta}_2))) = h(x_{jt}, w_{jt}, \theta_3) + \ln \omega_{jt}$$

- Other idea: put markup back on RHS and test $\lambda = 1$

$$p_{jt} = h(x_{jt}, w_{jt}, \theta_3) + \lambda \cdot \eta_{jt}(\kappa, \widehat{\theta}_2) + \omega_{jt}$$

  - "Informal" test of Villas Boas (2007): $E[\omega_{jt}|x_{jt}, w_{jt}] = 0$.
  - Pakes (2017) uses Wollman (2018) data and BLP IV $E[\omega_{jt}|x_{jt}, w_{jt}, f(x_{-j})] = 0$.

A subtle solution

- Berry Haile 2014 tell us we need marginal revenue shifters to act as exclusion restrictions.
- We need an instrument for $\Delta\eta_{jt}(\mathbf{p}, \mathbf{s}, \theta, \kappa_0, \kappa_1)$
  - Maybe not so hard since it is basically a function of everything.
  - Cannot have a direct effect on mc_{jt} (exclusion restriction).
- Idea would be to use $E[\omega_{jt}|x_{jt}, w_{jt}, z_{jt}^S] = 0$:

$$p_{jt} - \eta_{jt}(\mathbf{p}, \mathbf{s}, \theta_2, \kappa) = h(x_{jt}, w_{jt}, \theta_3) + \omega_{jt}$$

Candidate Instruments for z^s_{jt}

1. The demand shifter v_{jt}: maybe easy to find??
    - We use product recalls; prices of complements don't work so well.
2. BLP instruments $f(x_{-j})$: not always strong
    - Amit and JF have a nice paper showing how to choose $f(x_{-j})$
3. Can use the same logic to construct v_{-jt} or w_{-jt}
    - ie: cost shifters (or demand shifters) of competing goods.
    - Price of rice for Corn Flakes; price of corn for Rice Krispies.
    - Will depend on closeness of substitutes ΔPPI or D_{jk}.
4. Observed Conduct Shifters: κ_{fg}
    - Usually conduct is unobserved if we are testing it!
    - Index Inclusion Events (Fiona, Kennedy et. al); BlackRock-BGI Acquisition (AST)
    - Miller Weinberg (2017) use (pre/post merger for cartel participants).

Things that don't work

- ξ_{jt} only makes sense if you believe $Cov(\xi_{jt}, \omega_{jt}) = 0$.
- $p_{j,t,-s}$ (Hausman instruments) same good in other markets: pick up cost shocks (but could pick up changes in conduct!).
- If it isn't in one of our equations: does it have anything to do with demand or supply?
- It turns out that 2SLS analog $E[\Delta\eta_{jt} | x_t, w_t, v_t, Z_{jt}^e] = \widehat{\Delta\eta_{jt}}$ doesn't add much:
    - Markups aren't a linear function of observables.
    - Coefficients are (probably) quite different across products.