A Theory of Bilateral Oligopoly with Applications to Vertical Mergers

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Exxon Mobil Merger

- Refining is concentrated in CA
- Retail Sales are concentrated too
- How to assess the impact of the merger?
- How to think about captive consumption?

Other Applications

- Trade in spectrum licenses
- BP/ARCO
- IBM’s captive chip production
- Defense industry mergers

Questions

- How to treat captive consumption?
- What is the effect of vertical integration?
- With concentration upstream, can an increase in concentration downstream improve efficiency?
- How to generalize HHI to two-sided concentration?

Literature

- Old literature on “bilateral oligopoly”
- Many, many papers with special assumptions about upstream and downstream configuration
  - Foreclosure, raising rival’s costs, etc.
- Klemperer & Meyer
  - Invented solution concept
  - No applied results

Review of Cournot

- Profits are $\pi_i = p(\sum_j q_j)q_i - c_i(q_i)$
- Manipulating the first order conditions:

$$\sum_i \left(\frac{(p(Q) - c_i')q_i}{p(Q)Q} \right) = \frac{\sum_i s_i^2}{\varepsilon},$$

- Where s_i is the market share of firm i and å is the elasticity of demand.
- Thus, the HHI measures price cost margins.

Special Theory

- Ignore downstream competition
- Firms have capacities k_i, γ_i
- Capacities lead to payoffs from consumption q_i and production x_i of:

$$\pi_i = k_i v\left(q_i / k_i \right) - \gamma_i c\left(x_i / \gamma_i \right) - p(q_i - x_i).$$

Special Theory, Cont'd

- Formulation facilitates consideration of mergers
- Merger if *i* and *j* produces a firm with capacities $k_i + k_j$, $\gamma_i + \gamma_j$.
- Net purchase at identical market price *p*
- Value *v*, cost *c* exhibit CRS w.r.t. (q,k)

Solution Concept

- Firms can pretend to have other k, γ
- Restricted to acting like a possible type
- Market maps the pretend levels to the efficient outcome (p,q_i) given those levels
- Firm choice is full information equilibrium to the induced game
- Mirrors Cournot black box

Special Theory Solution

- å, η are the elasticities of demand (v) and supply c, respectively. s_i and σ_i are the shares of consumption and production.
- *Theorem* 1: *In any interior equilibrium,*

$$v_i' = c_i'$$

and

$$\frac{v_i' - p}{p} = \frac{c_i' - p}{p} = \frac{s_i - \sigma_i}{\varepsilon(1 - s_i) + \eta(1 - \sigma_i)}.$$

Special Theory Solution

- Generalizes to incorporate boundaries
- Yields Cournot as $\eta \rightarrow 0$ and buyers are dispersed
- More generally, value minus cost is:

$$\frac{1}{p}\left(\sum_{i=1}^{n} s_i v_i' - \sum_{i=1}^{n} \sigma_i c_i'\right) = \sum_{i=1}^{n} \left(\frac{(s_i - \sigma_i)^2}{\varepsilon(1 - s_i) + \eta(1 - \sigma_i)} \right).$$

Special Theory Conclusions

- Only net trades matter
- Captive consumption can be safely ignored
- HHI generalizes to this intermediate good case
- Similar information requirements
- Quantity, not capacity, shares are relevant (true in Cournot, too)

General Theory

- Add Cournot downstream
- Retail price r(Q), elasticity α
- Selling cost $k_i\, w(q_i/k_i)$, elasticity β
- Production cost $\gamma_i\, c(x_i/\gamma_i)$, elasticity η
- $\theta = p/r$
- $A = 1/\alpha$; $B = (1-\theta)/\beta$; $C = \theta/\eta$

General Theory

- Firms can pretend to have different capacities than they have
- Firms maximize given the behavior of others and the true capital levels
- Market prices, quantities are efficient given the pretend levels chosen by the firm.

Main Theorem

- The quantity weighted difference between price and marginal cost, or modified herfindahl, is:

$$MHI = \sum_{i=1}^{n}\left[\frac{BC(s_i-\sigma_i)^2 + ABs_i^2(1-\sigma_i) + AC\sigma_i^2(1-s_i)}{A(1-s_i)(1-\sigma_i) + B(1-\sigma_i) + C(1-s_i)}\right].$$

Special Cases

- A=0: perfectly elastic demand, yields special theory.
- $A\rightarrow\infty$:

$$MHI = \sum_i (1- \quad) \frac{s_i^2}{(1-s_i)} + \quad \frac{\sigma_i^2}{\eta(1-\sigma_i)}$$

Effect of Downstream

- The more elastic the downstream demand, the more only the HHI based on net trades matters.
- When downstream demand is very inelastic, MHI is a weighted sum of upstream and downstream HHIs, *with weights given by the intermediate to final good price ratio*.
  - Captive consumption matters 100%

Effect of Downstream

- Thus, paper helps resolve the debate about accounting for captive consumption
- Count captive consumption more the more inelastic is downstream demand
- Counts strongly in BP-Arco

Special Cases, Cont'd

- B=0 is a constant marginal cost of retailing
- Any retailer can expand easily

$$MHI\Big|_{B=0} = \sum_{i=1}^{n} \left[\frac{\sigma_i^2}{\eta(1-\sigma_i)+} \right]$$

- Only the upstream matters.

Exxon Mobil Merger

- In California, both gasoline refining and retailing are highly concentrated
- Seven firms account for 95% at each level
- Retail demand is very inelastic

The Exxon Mobil Merger

Company	σ_i	s_i
Chevron	26.4	19.2
Tosco	21.5	17.8
Equilon	16.6	16.0
Arco	13.8	20.4
Mobil	7.0	9.7
Exxon	7.0	8.9
Ultramar	5.4	6.8

The Exxon Mobil Merger

- Small inaccuracies arise from relying on public data sources
- $\theta = p/r$ is approximately 0.7
- Estimate α=1/3, β=5, η=1/2.

The Exxon Mobil Merger Results

	Pre-Merger	Post-merger	Refinery Sale	Retail Sale
% Markup	20.0	21.3	20.1	21.2
% Efficiency	94.6	94.3	94.6	94.3

The Exxon Mobil Merger Effects

- Small quantity effects
- Significant (1%) retail price effects
- Markup increase
- Virtually solved by refinery divestiture
- Retail divestiture has little effect
- Approach based on naïve market shares mimics exact approach

The Exxon Mobil Merger

- Sensible predictions:
- Relatively elastic retaining means retail merger is of little consequence
- Inelastic downstream demand magnifies effect of upstream concentration
- 20% price/cost margin in line with CA vs. gulf coast prices.

Conclusions

- Generalize Cournot theory to case of intermediate goods
- Similar informational requirements to calculate price/cost margins
- Readily evaluate effects of mergers
- Compute effects of divestitures

Conclusions, Continued

- The more elastic the retail demand, the smaller the effect of captive consumption
- The price/cost margin is a weighted average of:
  - HHI of the intermediate good market
  - Weighted (by price ratio) average of the upstream and downstream HHIs (captive production included)

Conclusions

- As the downstream production process gets more elastic, it figures less in price/cost margin
- Vanishing in the limit of perfectly elastic retailing costs.

Conclusions

- Modest information requirements
  - Intermediate to final good price, θ
  - Elasticity of retail demand, α
  - Elasticity of retailing costs, β
  - Elasticity of production cost, η
  - Upstream σ_i and downstream s_i market shares
- Straightforward computations with exact predictions
- Available on my website

Conclusions: Exxon-Mobil

- 20% price/cost margin, 95% efficient output
- Merger increases retail price by 1%
- Retailing concentration less important
- Refining concentration very important

Robustness

- Ignores
  - Entry
  - Collusion
  - Product differentiation
  - Dynamic considerations
- Static theory
- Added competitive fringe to computation