# *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 $k_i$, $\gamma_i$
- 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 $k$, $\gamma$
- 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, $\eta$ are the elasticities of demand ($v$) and supply c, respectively. $s_i$ and $\sigma_i$ 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 $\eta \to 0$ 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 $\alpha$
- Selling cost $k_i\, w(q_i/k_i)$, elasticity $\beta$
- Production cost $\gamma_i\, c(x_i/\gamma_i)$, elasticity $\eta$
- $\theta = p/r$
- $A = 1/\alpha$; $B = (1-\theta)/\beta$; $C = \theta/\eta$

# 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.
- $A \rightarrow \infty$:

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

# 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

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

- 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 | $\sigma_i$ | $s_i$ |
|---|---|---|
| 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 $\alpha=1/3$, $\beta=5$, $\eta=1/2$.

# 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, $\theta$
  - Elasticity of retail demand, $\alpha$
  - Elasticity of retailing costs, $\beta$
  - Elasticity of production cost, $\eta$
  - Upstream $\sigma_i$ 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