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:

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

• Where \( s_i \) is the market share of firm \( i \) and \( \varepsilon \) 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:

\[
\pi_i = k_i \nu \left( \frac{q_i}{k_i} \right) - \gamma_i c \left( \frac{x_i}{\gamma_i} \right) - p(q_i - x_i).
\]
• 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

• $\alpha$, $\eta$ 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,

\begin{equation}
    v'_i = c'_i
\end{equation}

and

\begin{equation}
    \frac{v'_i - p}{p} = \frac{c'_i - p}{p} = \frac{s_i - \sigma_i}{\varepsilon (1 - s_i) + \eta (1 - \sigma_i)}.
\end{equation}
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 $\eta$
- $\theta = p/r$
- $A = 1/\alpha; \quad B = (1-\theta)/\beta; \quad C = \theta/\eta$
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.
- $A \to \infty$:

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

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

- 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

<table>
<thead>
<tr>
<th>Company</th>
<th>$\sigma_i$</th>
<th>$s_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chevron</td>
<td>26.4</td>
<td>19.2</td>
</tr>
<tr>
<td>Tosco</td>
<td>21.5</td>
<td>17.8</td>
</tr>
<tr>
<td>Equilon</td>
<td>16.6</td>
<td>16.0</td>
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<tr>
<td>Arco</td>
<td>13.8</td>
<td>20.4</td>
</tr>
<tr>
<td>Mobil</td>
<td>7.0</td>
<td>9.7</td>
</tr>
<tr>
<td>Exxon</td>
<td>7.0</td>
<td>8.9</td>
</tr>
<tr>
<td>Ultramar</td>
<td>5.4</td>
<td>6.8</td>
</tr>
</tbody>
</table>
The Exxon Mobil Merger

• Small inaccuracies arise from relying on public data sources
• $\theta = \frac{p}{r}$ is approximately 0.7
• Estimate $\alpha = 1/3$, $\beta = 5$, $\eta = 1/2$. 
The Exxon Mobil Merger Results

<table>
<thead>
<tr>
<th></th>
<th>Pre-Merger</th>
<th>Post-merger</th>
<th>Refinery Sale</th>
<th>Retail Sale</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Markup</td>
<td>20.0</td>
<td>21.3</td>
<td>20.1</td>
<td>21.2</td>
</tr>
<tr>
<td>% Efficiency</td>
<td>94.6</td>
<td>94.3</td>
<td>94.6</td>
<td>94.3</td>
</tr>
</tbody>
</table>
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 HHI (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