A Theory of Bilateral Oligopoly with Applications to Vertical Mergers

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- 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 \( \varepsilon \) 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:

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

• $\alpha, \eta$ 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,*

\[ v_i' = c_i' \]

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.

• $A \to \infty$:

\[
MHI = \sum_{i} \left( 1 - \theta \right) \frac{S_i^2}{\beta (1 - s_i)} + \theta \frac{\sigma_i^2}{\eta (1 - \sigma_i)}
\]
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

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

• 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

<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>
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<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 $\alpha = \frac{1}{3}$, $\beta = 5$, $\eta = \frac{1}{2}$. 
The Exxon Mobil Merger Results

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