Innovation and Market Structure: The Seed and Chemical Industry

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Consolidation and Concentration in Agrochemical and Seed Industries

Impact of Mid-2010s Mega-Mergers and Acquisitions

Figure 4: Global CR4 Seeds and Agrochemicals

Sources: Compiled from data in Fuglie 2011; ETC Group reports

Source: Clapp (2017)
Explanations for Observed Consolidation and Concentration

• Anticompetitive behavior
  – Raising prices
  – Bundling of seeds and agrochemicals
  – Reducing varieties and/or limiting farmers’ choices
Explanations for Observed Consolidation and Concentration

• Favorable regulatory/legal environment
  – Plant Protection Act (1930)
  – Plant Variety Protection Act (1970)
    • *Ex parte Hibberd* (1985)
    • *Bowman v. Monsanto* (2013)
Explanations for Observed Consolidation and Concentration

• Differential returns to or costs of R&D

Source: Bonny (2017) constructed using data from McDougall (2011) and McDougall (2016)
Explanations for Observed Consolidation and Concentration

• Economies of scale
• Economies of scope
• “Synergies”
  – Complementary products/markets
  – Complementary technologies
Innovation in Agrochemical and Seed Industries

Table 1.7

<table>
<thead>
<tr>
<th>Year</th>
<th>Herfindahl index</th>
<th>4-firm concentration ratio</th>
<th>8-firm concentration ratio</th>
<th>Industry R&amp;D intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Share of market (%)</td>
<td></td>
<td></td>
<td>R&amp;D/sales (%)</td>
</tr>
<tr>
<td>Crop protection chemicals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>398</td>
<td>28.5</td>
<td>50.1</td>
<td>7.0</td>
</tr>
<tr>
<td>2000</td>
<td>645</td>
<td>41.0</td>
<td>62.6</td>
<td>6.8</td>
</tr>
<tr>
<td>2009</td>
<td>937</td>
<td>53.0</td>
<td>74.8</td>
<td>6.4</td>
</tr>
<tr>
<td>Crop seed and traits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>171</td>
<td>21.1</td>
<td>29.0</td>
<td>11.0</td>
</tr>
<tr>
<td>2000</td>
<td>349</td>
<td>32.5</td>
<td>43.1</td>
<td>15.0</td>
</tr>
<tr>
<td>2009</td>
<td>991</td>
<td>53.9</td>
<td>63.4</td>
<td>10.5</td>
</tr>
</tbody>
</table>

n.a. = not available.
Source: USDA, Economic Research Service estimates based on firm-level sales and R&D expenditure data collected for this study. See specific chapters for details.

Source: Fuglie, et al. (2011)
## Table 1.9
### Company size and research and development (R&D) spending in agricultural input industries in 2006

<table>
<thead>
<tr>
<th>Sector</th>
<th>Companies</th>
<th>Average R&amp;D intensity</th>
<th>Global R&amp;D share</th>
<th>Global market share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop protection chemicals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large discovery companies (&gt; $2 billion sales)</td>
<td>5</td>
<td>9.0</td>
<td>74.1</td>
<td>57.4</td>
</tr>
<tr>
<td>Second-tier discovery companies (&lt; $2 billion sales)</td>
<td>17</td>
<td>7.3</td>
<td>19.6</td>
<td>18.7</td>
</tr>
<tr>
<td>Other manufacturers</td>
<td>23</td>
<td>2.3</td>
<td>7.7</td>
<td>23.9 est.</td>
</tr>
<tr>
<td>Crop seed and biotechnology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large seed companies (&gt; $600 million sales) + BASF</td>
<td>8</td>
<td>15.8</td>
<td>75.6</td>
<td>48.8</td>
</tr>
<tr>
<td>Midsize seed companies ($50-600 million sales)</td>
<td>29</td>
<td>7.3</td>
<td>13.7</td>
<td>19.2</td>
</tr>
<tr>
<td>Other seed companies</td>
<td>n.a.</td>
<td>2.0</td>
<td>3.1</td>
<td>16.0 est.</td>
</tr>
<tr>
<td>Agricultural biotechnology companies</td>
<td>58</td>
<td>42.1</td>
<td>7.6</td>
<td>1.8</td>
</tr>
</tbody>
</table>

est. = authors' estimate. n.a. = not available.
Source: USDA, Economic Research Service. See chapters for specific sources and methods.

Source: Fuglie, et al. (2011)
Innovation in Agrochemical and Seed Industries

- Brennan, et al. (2005)
- Magnier, et al. (2010)
- Charlot, et al. (2015)
- Deconinck (2018)
- Silva, et al. (2018)
- Régibeau and Rockett (2021)

Lower Bound to Concentration

Market Share

Market Size

- Exogenous Fixed Costs
- Viability ("Non-negative Profit")
- Stability ("No Arbitrage") Condition
- Sutton Lower Bound

Point A and B on the graph represent specific values that illustrate the relationship between market size and market share, highlighting the conditions for viability and stability in the market.
R&D Intensity Lower Bound

R&D Intensity

Market Size

Firm R&D/Profit

Exogenous Fixed Costs
Sutton Lower Bound
R&D Intensity
Lower Bound to R&D Concentration – Anderson and Sheldon (2017)

\[ R_{1m} \geq \alpha^2(\sigma, \beta)h^2_m - \alpha(\sigma, \beta)h_m \frac{F_0}{\Pi_m} \]

\[ R_{1m} = \frac{\hat{F}_m}{F_m} = \frac{F_0}{\Pi_m} \]
Lower Bounds to R&D Concentration
in GM Corn Seed
Lower Bounds to R&D Concentration in GM Cotton Seed: Accounting for Mergers and Acquisitions

Lower Bound to R&D Concentration in GM Cotton Seed: Accounting for Mergers and Acquisitions

- Cotton Submarkets (M&A-adjusted)
- M&A-adjusted Fitted Lower Bound
- Unadjusted Fitted Lower Bound
- M&A-adjusted 95% Confidence Interval
- Unadjusted 95% Confidence Interval
Lower Bound to R&D Concentration in GM Soybean Seed: Accounting for Mergers and Acquisitions
M&A Antitrust Enforcement and Innovation

• Régibeau and Rockett (2019)
  – Concentration alone is insufficient to show diminishing incentives to innovate
  – Divestment may be sufficient to address innovation effects in addition to price effects

• Whither recent mega-mergers/acquisitions?
  – Bayer-Monsanto
  – Dow-DuPont
  – ChemChina-Syngenta
Concluding Thoughts

• “Welfare effects” vs. “public policy effects”
  – Food security, biodiversity, and/or biased selection of potential research projects
  – Research foreclosure and control of IPR
  – Regulatory burden, fixed costs, and market and R&D concentration

• Hovencamp and Shapiro (2018)
Figure 1.a. Product market analytical structure.

Source: Régibeau and Rockett (2019)
Figure 1.b. Product market analytical structure: sources of efficiencies.

Source: Régibeau and Rockett (2019)