Endogenous R&D Investment and Market Structure:
A Case Study of the Agricultural Biotechnology Sector

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Motivation

• Why agricultural biotechnology?
  – Young (dynamic) industry
  – Property rights
  – Increasing importance in global agriculture

• Why an endogenous fixed cost (EFC) model?
  – Product quality and sunk investments in R&D
  – Levels of industry concentration bounded away from perfect competition
Research Questions

• Is the agricultural biotechnology industry, specifically the GM corn seed industry, characterized by an EFC-type model?

• How is this analysis relevant to:
  – Past consolidation activity
  – Current discussions on anticompetitive actions
  – Implications on future sector growth
The Agricultural Biotechnology Sector

• The seed industry before biotechnology
  – Innovation, IPRs, and patenting
  – Mendelian genetics and hybridization

• Consolidation and concentration: the first generation of commercialized GM crops

• Subsequent generations and renewed concerns of concentration
Data

• R&D Concentration
  – APHIS Field Trial Data on applications (6697) for the release of GM crops (1990-2010)
  – Dates, phenotypes/genotypes, states
  – Petitions for deregulation (heterogeneity)

• Market Size
  – NASS Acreage Reports (1996-2010)
Market Definition

• Share of total corn acres planted
• Share of corn acres planted to total cropland
• Herbicide Use
  – % of corn acres treated
  – Intensity of application (lb/acre)
• Pesticide Use
  – % of corn acres treated
  – Intensity of application (lb/acre)
Market Definition

Figure 3: Core and Fringe Regions of the US Corn Belt
(Regional Share of Total Corn Acres Planted)

Legend

Source: Authors’ calculations from NASS 2010 Acreage Report.
Empirical Model


• Theoretical prediction: \( C_1 \geq \frac{a_0}{k_0} \cdot \beta^* \cdot h \)

• Empirical model: \( (\tilde{C}_n/h)_i = \beta_0 + \frac{\beta_1}{\ln(S/F_0)} + \varepsilon_i \),
  – where \( F(\varepsilon) = 1 - \exp\left\{-\left[\frac{\varepsilon-\mu}{\delta}\right]^\varphi\right\}, \quad \varphi, \delta > 0 \).
Concluding Remarks

• Supportive evidence for agricultural biotechnology being characterized by EFC

• Going forward:
  – Refining markets
  – Estimating model accounting for specific product traits
  – Comparison with other GM seed industry markets (soybeans/cotton)