

## A Tale of Two Mergers: What We Can Learn from Agricultural Biotechnology Event Studies

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This study employs event study analysis to examine two mergers and acquisitions (M&A) of publicly traded firms. The stock price effect of these combinations in the agricultural biotechnology industry indicates a market expectation of their profitability. The paper also discusses the broader context of agricultural biotechnology M&A activity in the 1990s, focusing on innovation and competition.

**Key words:** Agricultural biotechnology, event study, industrial organization, mergers and acquisitions.

Modern biotechnology has introduced new and improved products to agriculture, utilizing genetic transformation techniques to confer beneficial agronomic characteristics to some crops. Seeking to capitalize on the opportunities afforded by new biotechnology techniques, firms have accelerated their research and development (R&D) programs, commercialized their discoveries, and developed new business models to profit from the results. But biotechnology has proven neither easy nor cheap, and firms have sought strategic alliances to better manage R&D and marketing costs. In addition, large companies with diversified agricultural operations have acquired research firms and seed companies to expand their ability both to develop and distribute genetically modified seed. As a result, industry merger and acquisition (M&A) activity rose sharply in the 1990s, peaking in 1996 (Figure 1); for instance, Monsanto alone formed thirty significant research alliances and initiated sixteen separate acquisitions (Figure 2).<sup>1</sup> A consequence of this M&A activity was consolidation and an increase in industry concentration, although somewhat offset by entry of new firms into the industry.

This article describes the use of an empirical tool called *event study analysis* to measure the response of financial markets to changes in the agricultural biotechnology industry resulting from M&A activity in the 1990s. Event study analysis uses data from daily stock price movements to determine whether an event—such as the announcement or conclusion of M&A activity—generates a statistically significant change in firm valuations. Under certain assumptions about how efficiently financial markets incorporate new information, this

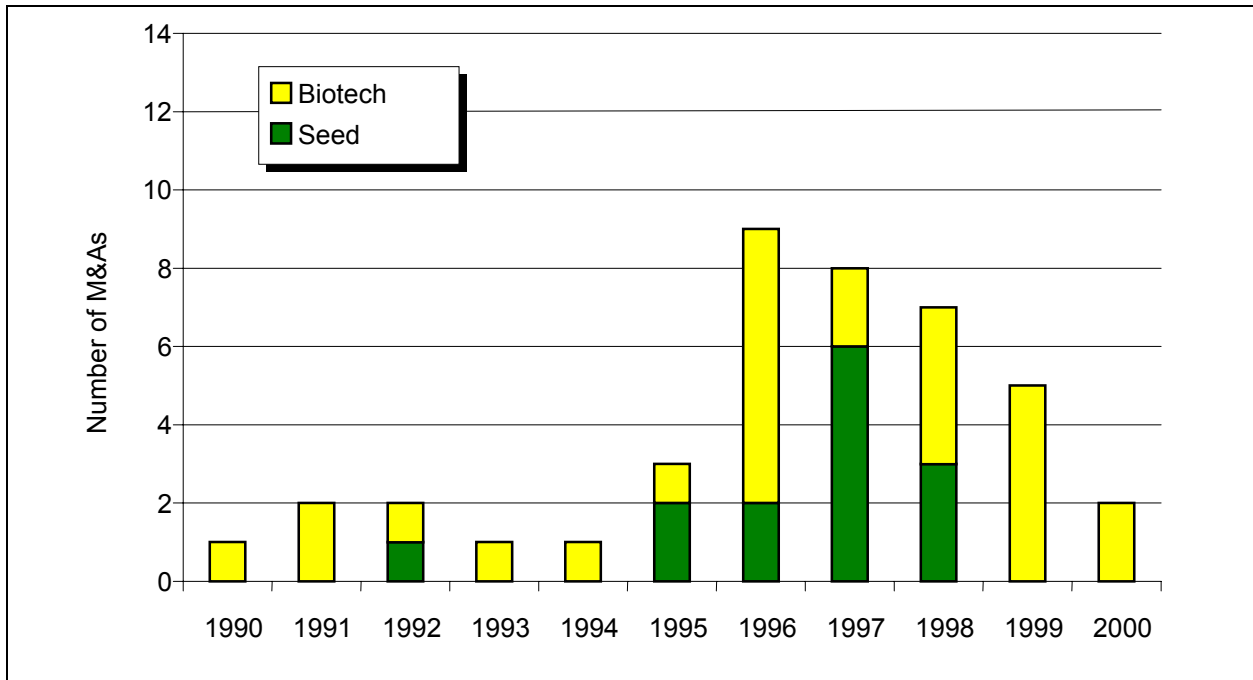
technique can be used to estimate the competitive effects of mergers and acquisitions on firms.<sup>2</sup>

This paper applies event study analysis to the announcement of two M&A events in the agricultural biotechnology industry: the acquisition (20 percent equity purchase) of Pioneer Hi-Bred by DuPont on August 8, 1997, and the merger of Astra with Zeneca on December 12, 1998. The DuPont-Pioneer acquisition combined firms with complementary businesses in natural fibers, agricultural chemicals, biotechnology, and seed; the AstraZeneca merger combined firms with substantial agriculture and biotechnology operations, but even more significant operations in pharmaceuticals. The events illustrate an important motivation behind 1990s M&A activity: an attempt to leverage new biotechnology techniques across numerous industry sectors.

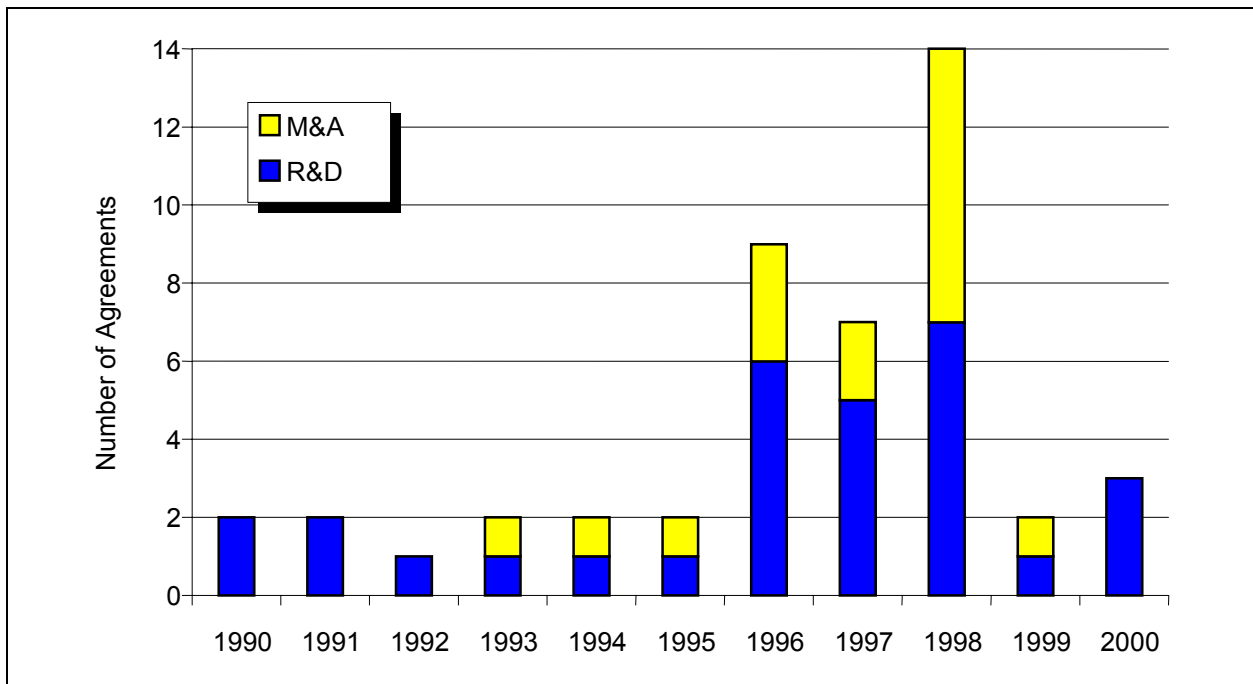
We also discuss the use of event study analysis as a potentially important way to assess the dynamic effects of mergers and acquisitions. Enforcers of antitrust regulations carefully scrutinize M&A activity to ensure that industries remain competitive despite the attendant increase in concentration. However, typical measures of concentration (CR4 ratios, the Herfindahl-Herschman index, and so on) are static in nature, indicating the degree of competition only at a particular point in time. Event study analysis utilizes financial market information, which is inherently forward looking. Static mea-

1. The sixteen M&As initiated by Monsanto also include the failed merger with American Home Products and the failed acquisition of Delta & Pine Land.

2. One branch of the empirical industrial organization literature has developed the event study method for investigating the competitiveness of M&As. The reader is referred to Eckbo (1983), McAfee and Williams (1988), McGuckin, Warren-Boulton, and Waldstein (1992), and Schumann (1993), *inter alia*. The event studies investigations of M&A activity is so well established that the US Department of Justice Antitrust Division routinely examines the stock returns of rival firms in merger investigations (Schumann, 1993).



**Figure 1. Biotechnology and seed company mergers and acquisitions by agricultural biotechnology companies, 1990-2000.**  
 Note. From "Structural Change in the Biotechnology and Seed Industrial Complex: Theory and Evidence" by N. Kalaitzandonakes and M. Hayenga with authors' updates, presented at the NE-165 conference "Transitions in Agbiotech: Economics of Strategy and Policy," Washington, DC, June 24-25, 1999.



**Figure 2. Merger and acquisition and research and development deals of Monsanto, 1990-2000.**  
 Note. From "Actions Database" CD-ROM, Institute for Biotechnology Information. Raleigh, NC: Lexis-Nexis, 1999.

tures of industry concentration are especially limiting in industries characterized by rapid technological transformation, such as the agricultural biotechnology industry in the 1990s. Firms in innovating industries compete not only to satisfy market demand today, but also to undertake R&D that will secure competitive advantages tomorrow. Furthermore, firms can protect the advantages gained through innovation with intellectual property rights, blocking rivals from direct competition until these legal instruments expire or until the tide of further innovation erodes their strategic value. Although our study concerns only two M&A events, the results suggest further exploration of industry structure with this technique.

### A Tale of Two Mergers

Event study analysis tracks the stock prices of firms for a period of time around a specific event, comparing behavior before an event with behavior during and after it. Under a weak version of the efficient market hypothesis, financial markets quickly incorporate new information into security prices. When an announcement or other event occurs, event study analysis measures the response of stock price performance against an estimate of expected (or “normal”) returns based on prior behavior.<sup>3</sup> Actual stock returns that deviate sharply from normal returns tend to support the hypothesis that the event in question affected stock price valuations (Armitage, 1995; MacKinlay, 1997; Peterson, 1989). When these deviations are statistically significant, variation is unlikely to result from “random walk” behavior of stock prices. For statistical tests, we assumed error terms to be normally distributed; although this assumption is strong, “in practice it generally does not lead to problems because the assumption is empirically reasonable and inferences... tend to be robust to deviations from the assumptions” (MacKinlay, 1997, p. 17).

To understand the importance of the M&As in our event study, it is important to review the context of industry activity in the 1990s. One motive for the wave of M&A activity in agribusiness during this period was the effort by companies such as Monsanto, Dow, Astra, and Zeneca to create “life science” firms capable of

exploiting biotechnology advances across agricultural, pharmaceutical, chemical and related research fields. Many of the firms leading the mergers and acquisitions were originally chemical or pharmaceutical firms with agricultural divisions. For instance, at the time of their merger in 1998, Astra had 15.8 percent of its sales in agricultural chemicals, while Zeneca had 25.2 percent of its sales from agribusiness operations (Cowell, 1998, p. C1). The firms hoped that their merger would generate synergies from their agricultural divisions and across their agricultural and pharmaceutical divisions. Acquisition of seed companies by life science firms also provided a means of controlling the distribution of seeds engineered with these value-added traits, in addition to ownership of their research assets complementary to existing R&D operations.

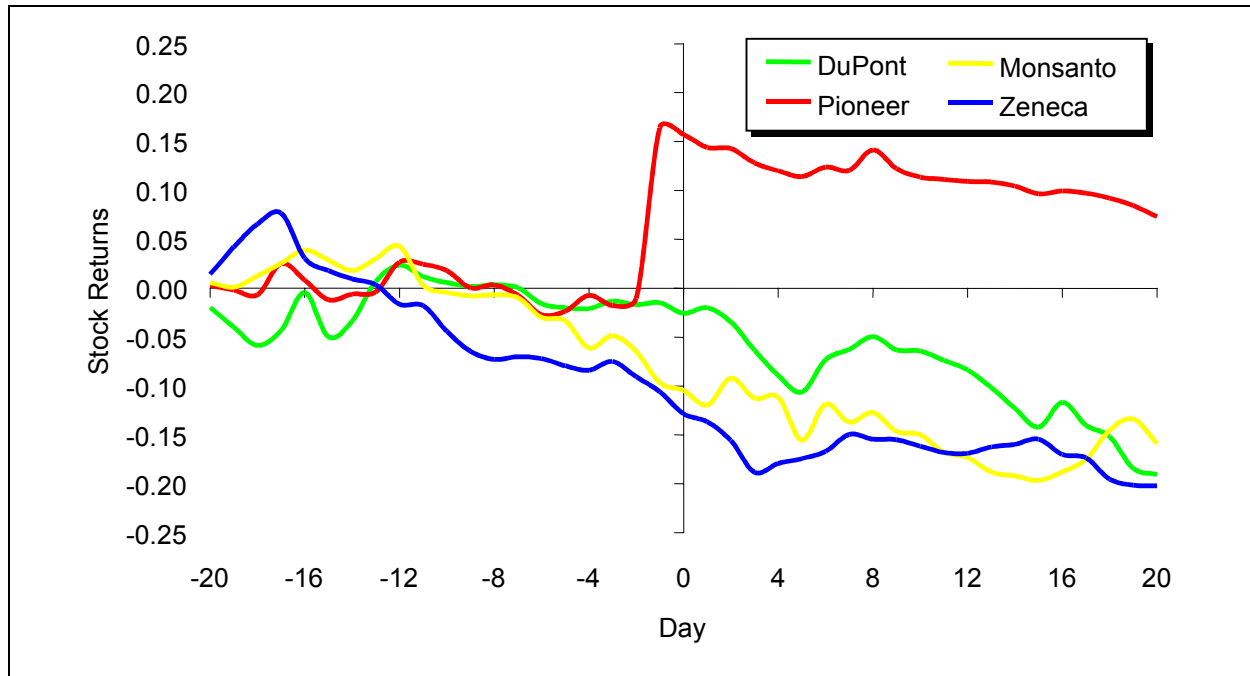
Figures 3 and 4 show the cumulative deviation of daily returns of a few agricultural biotechnology companies on the days immediately surrounding announcements. Cumulative deviations are the sum of daily deviations of actual stock returns from their normal returns for several days before and after the announcement, normalized to date “zero.”<sup>4</sup> These firms include those directly involved with the combination as well as close industry rivals for which stock price information was available.

When DuPont announced the acquisition of Pioneer Hi-Bred, the cumulative deviation of the stock return of Pioneer Hi-Bred increased significantly (Figure 3). Although the cumulative deviation of holding DuPont decreased, the decrease was smaller than the increase in the cumulative deviation of Pioneer shares. The decreased cumulative deviation might suggest that financial markets believed DuPont overpaid for its stake in Pioneer, perhaps parallel to the “winner’s curse” phenomenon, which explains why some auctions result in overbidding. However, the positive aggregate return for the companies suggests a prediction that the profitability of the combined firms would exceed that of the two firms operated separately—presumably the entire rationale for the acquisition.

In the AstraZeneca merger, the cumulative deviations of both firms increased significantly upon the

3. Estimates of normal returns are based not only on individual stock price movements, but also take into account movements of the broader market. For example, if an across-the-board stock market crash happened on the same day as a specific merger announcement, this adjustment would help separate the effect of the general decline in stock prices from the specific effect of the announcement.

4. Following standard event study methodology, we collect data on deviations from normal returns for a brief period before and after the event itself. Including deviations after the event date allows for the fact that financial markets might be slow to fully absorb new information; deviations before the event date allow for possibility that information leaked to financial markets before the official announcement.



**Figure 3. Announcement of the August 8, 1997 acquisition (20 percent equity purchase) of Pioneer Hi-Bred: cumulative deviations of daily stock returns of selected firms.**

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announcement of the merger. As in the DuPont-Pioneer acquisition, the actual increase in cumulative deviation commenced a day before the earliest public announcement of the merger, indicating that rumors of the announcement might have leaked. In contrast to the DuPont-Pioneer acquisition, which combined a leading chemical (agri-chemical) firm with a major seed supplier, the AstraZeneca merger combined two leading firms in pharmaceutical, agri-chemical, and crop development. The fact that cumulative deviations in both Astra and Zeneca increased might indicate a view that elements of their operations had more synergies or economies of scope and scale than the DuPont-Pioneer acquisition. Synergistic relationships between two firms are a common explanation for an increase in the value of a combined firm; Graff, Rausser and Small (in press) show that synergies are an important factor in agricultural biotechnology.

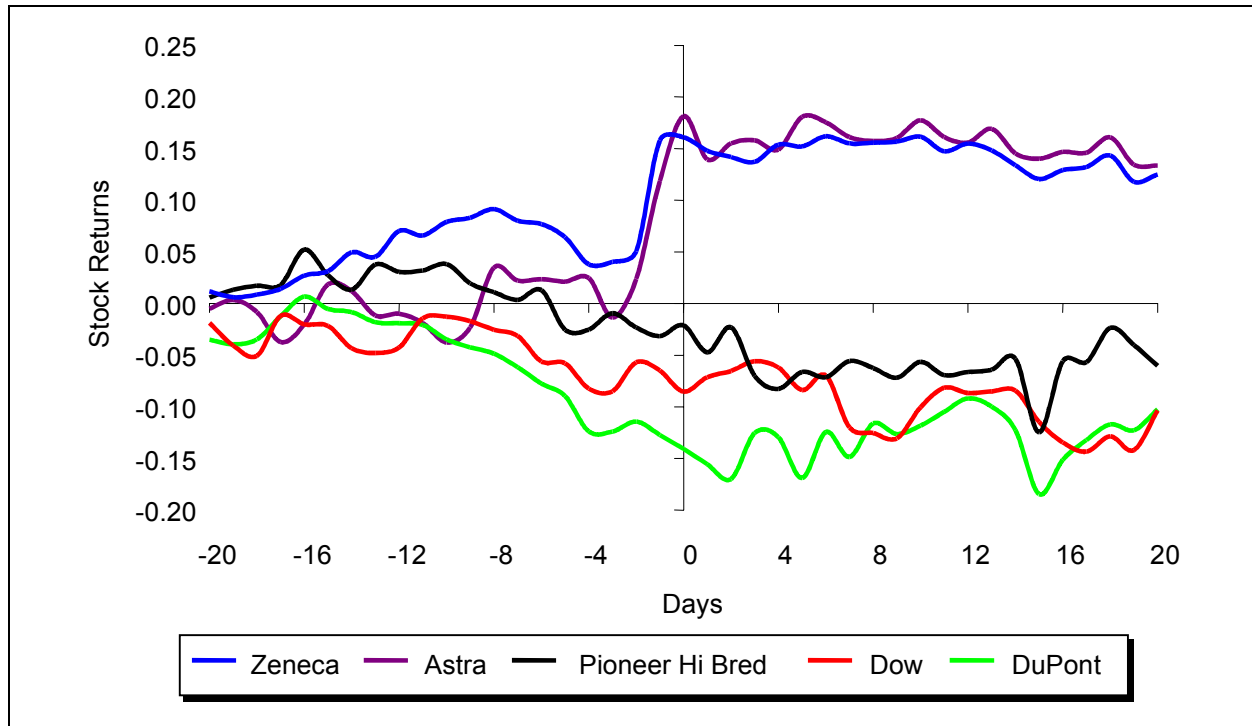
### Did Consolidation Mean Less Competition?

But how can we use event study analysis to assess whether these examples of M&A activity represented aggressive competition in a changing industry, or whether the chief result was to restrain competition and

increase market power? This empirical technique can provide an interesting (although not definitive) perspective on changes in industry structure by examining the effects of mergers and acquisitions on industry rivals.

Large sunk costs can constrain entry, so that horizontal combinations have anticompetitive effects. Investments in biotechnology R&D capacity could play this role, so that mergers and acquisitions create economic rents that are not dissipated by competition and entry (Werden & Froeb, 1998). These rents might accrue not just to the combining firms, but to industry rivals in newly less-competitive markets as well. In contrast, M&A activity in a competitive, contestable market should not be profitable for other firms. Firms that combine to realize competitive advantages (economies of scale and scope, internalization of transaction costs, and so on) do so in order to lower their costs or generate other efficiencies. These should create a positive effect on the aggregate profitability of the firms involved in the combination, but lower profits for rivals.

With regard to event study analysis, these two scenarios yield opposite predictions. In the former case, in which consolidation is primarily anticompetitive, other industry firms experience positive deviations in their stock prices as competitive pressures decrease (see Aus-



**Figure 4. Announcement of the December 12, 1998 merger of Astra and Zeneca: cumulative deviations of daily stock returns of selected firms.**

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tin, 2000; Barton & Sherman, 1984; Eckbo, 1983; McAfee & Williams, 1988). In the latter case, the creation of a more efficient rival causes other firms in the industry to experience negative deviations in their stock prices upon announcement of the combination. In either case, firms should only initiate a combination if they expect to increase the profitability of merged operations, so that cumulative deviations for the combined firms should be positive.

In both the DuPont-Pioneer acquisition and the AstraZeneca merger, the combining firms exhibited positive cumulative deviations. Moreover, the effect on rival firms in the industry was negative—although the deviations of stock returns of rival firms were not all significantly different from zero after adjusting for movements in the broader stock market, Figures 3 and 4 show that the response of rival firms was mildly negative. Of the two hypotheses introduced above, these data provide more evidence for efficiency-enhancing mergers, and evidence against the hypothesis that the M&A activity was anticompetitive.

Some caveats apply. First, conclusions based on financial data depend ultimately on the views of financial markets and rely on an assumption of market effi-

ciency. However, stock markets can be notoriously fickle. Event study analysis adjusts for movements in the broad market, and care was taken to ensure that other M&A events did not interfere with the events in this study. Second, stock price is an aggregate measure of firm value and might capture influences on profitability other than R&D capabilities and M&A effects. This problem might be exacerbated when the companies in question operate across several industry sectors, but would seem to be accounted for by the focus on a specific event in time. Third, the negative effects on industry rivals were not significantly different from zero. One might expect that the competitive effects of M&A activity would be concentrated in the combining firms and more broadly dispersed among the industry rivals, leading to a difference in the statistical power of the hypothesis tests. Finally, a merger in a noncontestable market (like that described by Werden and Froeb, 1998) could be profitable for the merging firms without benefiting competitors, so the observed negative effects on rivals are not mutually exclusive of anticompetitive effects.

## Conclusions

We analyzed the stock price movements of agricultural biotechnology firms participating in M&A activity in the 1990s. The announcement of M&A activity had a statistically significant effect on cumulative deviation of stock returns of combining firms. In the AstraZeneca merger announcement, stock prices of both merging firms increased. In contrast, the cumulative deviation of DuPont stock prices fell when it acquired Pioneer, while the cumulative deviation of Pioneer stock increased. The increase in Pioneer stock price was greater than the corresponding DuPont decline, indicating that financial markets viewed the performance of the combined firms positively. A view that the combinations might provide the firms with valuable synergies is one explanation, although event study analysis does not provide a direct test of that hypothesis.

Evidence from the event study is consistent with industry competition despite consolidation, but not conclusively so. In the two examples presented here, financial markets favorably regarded firms directly involved with M&As during the recent bout of industry consolidation. Rivals fared less well, which is more consistent with a model of competition and contestable markets than a model in which sunk costs impose barriers to entry and limit competition. Because the financial information on which these tentative conclusions are based is forward looking, the data suggest to us that markets did not view these M&A events to substantially inhibit dynamic competition.

Possible extensions of this research might apply the same event study analysis to more M&A events in the same period and attempt to use the larger sample size to determine which specific factors (synergies, complementary R&D assets and intellectual property, market power, and so on) might have the most influence on industry competitiveness.

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