Discussion: Economies of Scale and Scope in Agricultural Biotechnology Research

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Evolution in science such as recent developments in agricultural biotechnology creates new challenges for patent regimes, leads to reforms in laws and regulations, and has led to the creation of property rights where none existed before. The new property rights in agriculture imply new and complex incentives for research, new avenues of rents for firms and the public sector in agriculture, and new types of strategic behavior in research and product markets between firms as well as between the public and the private sectors.

The present exponential growth in agricultural biotechnology research in both the public and private sectors is one of the byproducts of changes in intellectual property rights for living organisms. The literature in agricultural economics is just catching up to the agricultural biotechnology and intellectual property rights revolution in agricultural R&D. The seminal studies of the social returns to agricultural research and development essentially predated the mid 1990s take off in agricultural patenting. Much of the nascent literature on agricultural biotechnology R&D has been theoretical in orientation. These three papers represent part of the efforts underway to update that line of work to incorporate the expansion in both public and private research objectives to include patenting and other private sector interactions.

Perhaps foremost among the key issues in agricultural biotechnology is the optimal organization of research in an industry dominated by a few private firms (as is the case in the seed industry), devoted to securing intellectual property rights on its research, but at the same time facing an active public sector which also is actively engaged in research and patenting. The problem of understanding research organization and output is the theme underlying these three papers presented here today.

One of the key sub-issues for understanding industry and research organization in agriculture that is brought forth in the work by Schimmelpfennig, King, and Naseem and the work by Xia is the synergies that may or may not exist between multiple research outputs (i.e., basic research and applied research or product development) as well as between different types of research organizations, such as those dedicated to basic research (e.g., universities) and those working on product development (e.g., firms). This issue which can be investigated across firms as in Schimmelpfennig, King, and Naseem or between the public and private sectors as in Xia has elicited much work in the economics literature but has only recently become important in agriculture.

A second key issue in understanding the agricultural biotechnology research process which underlies the analysis of all three works is the difficulty of observing or inferring research effort from research outcomes. The economics of R&D are complicated within the firm by scientists' effort being difficult to observe and quantify and the seeming randomness of breakthroughs and patentable ideas. As has been amply pointed out elsewhere this makes the game played between a research unit and a research manager or investor a complex web of moral hazard and adverse selection that is not easily solved such that everyone's incentives line up optimally. Along with confounding the research manager's optimization problem, from an economist's point of view this low observability of effort and outcomes can make empirical research difficult to conduct, a problem the work by Graff addresses.

The work of Schimmelpfennig, King, and Naseem sets out a theory of mergers based on measurements of intellectual capital that is based on an idea of intellectual synergies that can be captured by firms through mergers. This presents an alternative view to the commonly expressed idea that the synergies driving

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mergers are technologically driven. Being a combined company with multiple products and research lines would be optimal if the research process of agricultural biotechnology exhibits increasing returns to scale and/or economies of scope. The idea of this work is that the economies of scale and scope driving mergers are based on intellectual capital that can be allocated across multiple outputs. Work on the determinants of mergers in the evolving agricultural biotechnology industry can lead us closer to understanding whether these large companies are optimal both from an investor's point of view and that of society.

As the big chemical/pharmaceutical companies shed their agricultural divisions in the wake of the ag-biotech merger boom, however, one has to wonder whether this was ever an optimal strategy or whether it was actually a poorly thought out accountants dream. Schimmelpfennig, King, and Naseem make a start in measuring outcomes since their Q-theory includes an implicit measure of company value. I would hope that future work could delve further into measuring outcomes of mergers in terms of stock prices, returns to investors, and returns to society. Another useful avenue for this line of research on mergers would be to investigate scale and scope within this industry and perhaps in comparison to other related industries.

Within agricultural R&D, the interactions of the public and private sectors has become a key issue because the traditional divide of the public sector working on basic research and the private sector doing more applied commercial research has been blurred. The work of Xia sounds the call for a full structural model of the interaction between public and private research efforts that accounts for the endogeneity of both public and private sector R&D expenditures and outcomes. Such a model could lead us to a better understanding of the role of the public sector in an increasingly privatized agricultural world, although it is only in the creation of these models that one can really determine whether the assumptions necessary to make a tractable model leaves a model that is truly useful for understanding policy.

The work by Graff presents one method of understanding research effort through using technological trajectories as a means of accounting for the complex and cumulative nature of research. This provides a welcome technique that can be emulated by other researchers especially for understanding the potential synergies or tradeoffs in the production of different types of research outputs. The success of this technique in helping understand agricultural biotechnology research, however, will rest on its ability to distinguish the quality of research output from the mere quantity and to make distinctions among types of research (inbred line versus polypeptides) that are economically meaningful.

Together these three works show the strides being made in our understanding of the research process in agricultural biotechnology. The two key concepts driving the issues addressed in these papers, economies of scope between research outputs and the low observability of research effort, deserve further investigation within firms, within the public sector, between firms and the public sector, as well as inside the research lab. Understanding their effects can help policy makers line up the incentives for high quality research in both the public and private sectors.