

Effects of Industry Structure on Technology Innovation (Primary Investigators: Rajshree Agarwal, Charles Williams)

Goals: This research project will explore three different ways that industry structure and firm strategy shape innovations that stem from basic science and research. We are interested in exploring business as the interface between science and society, and its integral role in shaping innovation. Our first question relates to how firms, scientists, and policymakers should manage the role of business in the process of scientific discovery. Since firms and industry environments shape the information that guides investment in science, we need a much more explicit understanding of the mechanisms by which business influences innovation. Our second goal is to integrate one research stream on how industries evolve in tandem with technology with a separate research stream on how firms evolve and adapt in rapidly changing environments. We propose to examine how firm structure and strategies co-evolve with the industry, and address the tension between organizational endowments and inertia when firms undertake change and innovation. In particular, since firm capabilities at the time of entry may facilitate or constrain future innovations, it is not clear whether initial performance advantages necessarily translate into a sustained advantage over time.

Finally, this study will also allow us to tackle an important question in the field of strategic management: Do diversifying entrants or entrepreneurial start-ups represent key sources of innovation and does their role in introducing key innovation change as the industry evolves? We propose to shed further light on this issue by systematically examining firm evolution in the context of industry evolution, and the resulting implications for firm performance.

Procedures: To explore the differences in strategic development among the three types of firms – established players in the focal industry, diversifying entrants, and entrepreneurial start-ups – we plan a multi-method comparison of four industries: agricultural biotechnology, nanotechnology, information technology (personal computers), and telecommunications (wireless and fixed services). Our first step will be the conceptual development for the project. Industries evolve over time from the first introduction of an innovation in distinct phases before they reach maturity (Abernathy & Utterback, 1978; Gort & Klepper, 1982). The temporal effects of continued product and process innovation have been documented extensively in literature streams on industry evolution (Agarwal, Sarkar, & Echambadi, 2002; Gort & Klepper, 1982) and firm evolution (Nelson & Winter, 1982; Williams & Mitchell, 2004). We expect that industries evolve because of decisions that individual firms make and that changes in industries will influence the evolution of firms, but existing theory gives little guidance as to the nature of this co-evolution. In particular, innovations are at the root of the shifts from early industry development to the takeoff (accelerated growth) phase. While some firms are responsible for *creating* industry change, others have to *respond* to these changes once they occur. We expect that established firms will bring capabilities that enable them to shift course, but entrepreneurial firms will benefit from flexibility gained from low levels of inertia.

The two principal investigators have developed lines of research in the separate streams of industry evolution and firm evolution, and the goal of our conceptual development is to develop a fruitful interaction of these two related areas. This conceptual development will lead to specific hypotheses for testing in later stages. Next, we propose to carry out four comparative industry histories to develop practical insight into the major sources of innovation and evolution for each of the industries. We will construct these histories through secondary sources and interviews with participants active in different stages of industry evolution. During this stage we will also

gather (and possibly purchase from databases) available archival data on the agricultural biotech and nanotechnology industries to complement the extensive databases we have already built over many studies on the telecommunications and IT industries.

Once our conceptual development and understanding of each industry is in place, we will test the hypotheses we develop using a survey of organizations in each industry. The survey will ask firms to report on their strategies and innovative activities early in industry evolution and at the current time. The survey will allow us to measure difficult to observe aspects of strategy and innovation such as the structure of knowledge-sharing in the firm and the firm's innovative goals. The goal of the survey will be to measure the endowments of each firm, their strategies for building new capabilities, and the technical outcomes for the firms. We will develop and execute the survey working jointly with the University of Illinois Survey Research Laboratory.

Timelines: *Year 1:* Conceptual development and industry histories through interviews and archival studies. *Year 2:* Survey planning and execution. *Year 3:* Developing and sharing research findings through journal articles, conference submissions, and reports.

Impact of studies about: Effects of Industry Structure on Technology Innovation: Because firms act as the interface between science and society, the strategies adopted by individual firms and the aggregate composition of the industry influence the direction of technology development. Industry and firm structure acts as a feedback system that influences the direction, speed, and extent of technological and scientific advance. Industries vary in the extent to which they change through innovations promoted by existing firms, by diversifying entrants from other industries, or by entrepreneurial start-ups. We propose to conduct a comparative study of four technology-based industries to examine the role of these different firms in shaping the development of the scientific field upon which the industry is based. The study will compare two industries where the principal investigators have conducted multiple studies of firm and industry evolution – telecommunications and information technology – with two rapidly emerging sectors– agricultural biotechnology and nanotechnology.

In conducting the comparative study across industries that entail significant innovation, we hope to contribute to a better understanding of how agricultural biotechnology has evolved to its current industry structure. This will also enable us to understand how firm strategies and structure interface with innovation and society in agricultural bio-technology, and the implications of these for the future development of the industry.

Co-investigators in Dr. Agarwal's team have well-developed research streams in the management of innovation, both from the industry and firm perspective. Dr. Agarwal has worked on the evolution of new product innovations. Her research interests focus on innovation, entrepreneurship, and technological change. Her recent projects examine knowledge transfer through employee entrepreneurship, experience-based advantages in new product markets, and the influence of dynamic knowledge-based capabilities on firm performance. Dr. Williams has worked on the evolution of organizations. His research focuses on how firms build competitive advantage in fast-paced, technologically intensive markets from a perspective which combines evolutionary and information-processing approaches to organizations. His recent work explores the impact of structure on the evolution of firms within the telecommunication industry.