

Architectural innovation essay sample

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Acs and Audretsch, (1988)), but this research has either not distinguished between minor and major innovations or has used aggregated data and a limited set of variables to explore the impact of firm specific effects on productivity. This failure to integrate theories of firm capability into empirical studies of the impact of technological innovation may result from the fact that these types of explanations yield qualitatively similar predications to the class of explanations that focuses on investment behavior.

Both suggest that established firms will be more likely than entrants to introduce incremental innovations, since established firms will not only invest more in incremental innovation in an attempt to extend monopoly power but will also have more effective research and development efforts since they have the benefit of historical experience with the technology. Similarly the two classes of explanation suggest that established firms will be less successful in the face of radical innovation both because in some circumstances they will invest less for fear of cannibalizing their existing revenues, and because their research and development efforts will be less effective than those of entrants. However recent work by Henderson and Clark (1990) suggests that it is increasingly important to explicitly distinguish between the two effects and to understand the interactions between them. They suggest that a significant number of innovations are “ architectural.”

Architectural innovations are incremental in the economic sense in that they do not provide dramatically different or improved benefits to their customers, and they continue to actively compete with existing products, but they are radical in the organizational sense in that established firms find them extremely difficult to develop. Architectural innovations are likely to be

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the focus of complex competitive dynamics since the strategic incentives to invest in them that flow from market position run counter to the incentives that flow from the relative research efficiency of actual and potential players in the industry, and they cannot be easily understood through the lens of the currently available theoretical and empirical results.

This paper addresses this gap in the literature through the exploration of the failure of established firms to survive architectural innovation in the semiconductor photolithographic alignment equipment industry. The author obtained research and development costs, sales, and organizational and technical information for every product development project initiated by every firm in the semiconductor photolithographic equipment industry for the period between the foundation of the industry in the early 1960s and 1986. Four waves of architectural innovation shook the industry during this time, each of which saw the replacement of the industry leader with a new firm. Thus the data set affords a unique opportunity to explore the dramatic competitive effects of technological change.

I differentiate between the decision to invest in a particular research program and the effectiveness with which the research was carried out, and show that established firms failed to successfully exploit architectural innovation in the industry because although they consistently invested an equivalent amount in innovation, their research was consistently less effective. Not only were established firms less successful in their attempts to introduce technically successful new products, but they were also less able to successfully commercialize the products that they did develop. I show that this failure is consistent with the hypothesis that established firms

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develops specialized organizational capability during the course of their historical experience with incremental innovation that handicaps their attempts to respond to more radical change. The paper is unique in explicitly incorporating both explanations based upon investment behavior and explanations based on the concept of firm heterogeneity into its analysis of the problem of established firm failure in the face of radical innovation, and in the detail and comprehensiveness of the data set upon which it is based.

My results are exciting and suggest that we cannot assume that innovation that is radical or incremental in the economic sense is also radical or incremental in the organizational sense, and that the competitive implications of technological innovation cannot be understood without an appreciation of the qualitatively different capabilities of entrants and incumbents in the face of different types of innovation. They have broad implications for theories of industry and firm evolution. The next section describes the data upon which the study was based, and Section 3 describes the empirical model and the results. The paper closes with a discussion of the implications of this research for further work.

n The Data

The data for this study were collected during an eighteen month, field based study of the photolithographic alignment equipment industry conducted from the spring of 1987 to the summer of 1988.

Photolithographic aligners are pieces of capital equipment used in the manufacture of semiconductors. ^ Improvements in photolithographic alignment capability have been critical to the dramatic improvements in performance and reductions in cost that have characterized semiconductors

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over the last twenty years, and the industry has shared in the rapid growth of the semiconductor industry.

Alignment equipment is technically very sophisticated, and technical change in the industry has been very rapid. The first aligners were introduced in the early sixties. They were built by teams of two or three designers and cost less than five thousand dollars. A modern aligner can cost