



Survival and the introduction of new technology: A patent analysis in the integrated circuit industry

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Abstract

Utilizing a database containing all US patents issued to integrated circuit (IC) manufacturers from 1975 to 1994 we analyze a firm's decision to pursue a technology across varying levels of technological turbulence. We examine the effects of the value of a firm's technological advancement, the newness of its technology, and industry turbulence on the probability of failure. We find during periods of low technological turbulence, firms utilizing new technologies to create significant technological advances, face a higher probability of failure. During periods of high technological turbulence, firms using older technology to develop significant technological advancements face lower probabilities of failure.

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1. Introduction

The effects of technological change on firm performance have long intrigued economic and management scholars and, consequently, precipitated rich streams of theoretical and empirical analysis (Schumpeter, 1947; Schmookler, 1966; Perrow, 1967; Thompson, 1967; Abernathy and Utterback, 1978; Nelson and Winter, 1982; Abernathy and Clark, 1985; Tushman and Anderson, 1986; Henderson, 1993; Freeman, 1994). Indeed, since the pioneering work of Solow (1957), mainstream economists generally accept the notion that technology is endogenous to models of firm activity and, as a consequence, that firms can differ along performance dimensions

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(Rosenberg, 1982; Scherer and Ross, 1990). More “fringe” economic theory suggests firms that are first to discover and exploit new technologies can accrue performance awards that exceed competitive market levels (Penrose, 1959; Kirzner, 1979; Dosi, 1982, 1988). Still other economic research has sought explanations as to why firms may successfully utilize and market sub-optimal technologies even though buyers are provided with technologically superior choices (David, 1985; Arthur, 1988).

Management research has responded by suggesting that economic factors are but one of a multitude of factors that determine the trajectory of technological change with respect to the firm. Societal needs, government regulation (Scherer and Ross, 1990), constituent (e.g. suppliers, buyers) demands (Tushman and Rosenkopf, 1992; Henderson, 1993; Christensen and Bower, 1996; Tripsas, 1997) as well as firm idiosyncrasies (Nelson and Winter, 1982; Levitt and March, 1988; Kogut and Zander, 1992; Leonard-Barton, 1992; Kogut and Zander, 1996; Teece et al., 1997) are thought to play an equally if not more important role in a firm’s ability to successfully develop and adopt new technology. To be sure, the results of management research in this area suggest that economic value, a central focus in more traditional economic models (e.g. Scherer and Ross, 1990) may assume a secondary role to these other considerations (Tushman and Rosenkopf, 1992).

These rich and varied research streams have progressed our understanding of a firm’s use of technology beyond Rosenberg (1982) amorphous “black box” and have informed us of the intricacies of firm behavior. However, this situation has also presented scholars with a host of new issues that remain to be reconciled. For instance, when can managers base their decisions to pursue/use a technology on that technology’s estimated future technological value? In instances where managers cannot base their decisions on this value yardstick, on what can they base their decision? Furthermore, researchers have suggested that over the long term, firms that repeatedly introduce valuable technological advances to the industry tend to outperform their less innovative counterparts (Penrose, 1959; Kogut and Zander, 1992; Henderson and Cockburn, 1994; Bierly and Chakrabarti, 1996; Kogut and Zander, 1996; Teece et al., 1997; Cockburn and Henderson, 1998). In the shorter term, however, when is it advisable for firms to withhold innovations so as not to challenge the status quo? Conversely, when are challenges to the status quo necessary for survival? In short, research to date has not adequately uncovered the environmental conditions under which firm can “safely” pursue the development of valuable technologies without concern for other factors, and when these same firms should delay or postpone such efforts. We try to enhance research in this area by examining how exogenous environmental forces and endogenous firm decisions simultaneously effect innovative firms’ survival.

By utilizing a database that contains all US patents issued to integrated circuit merchant manufacturers between 1975 and 1994, we attempt to shed light on these questions. Specifically, we analyze a firm’s decision to pursue a technology across varying levels of technological turbulence. Turbulence in this paper is defined as the rate at which new knowledge is being introduced into the market and is a gauge of the external environment’s willingness to accept technological change. A high rate of change in turbulence, for example, suggests fertile ground for newly introduced ideas as well as inventors’ willingness to test ideas, and thus an increasing likelihood that old industry routines will be challenged. A low rate of change in turbulence suggests a less accepting environment. We examine the effects of valuable technology development by the firm, the newness of its technology, and the effects of industry turbulence on the probability of firm failure. Our findings indicate that the impact of the newness of technology on the probability of firm survival depends on the level of turbulence within the industry and the value of the innovations.

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