



Proactive R&D management and firm growth: A punctuated equilibrium model

Ram Mudambi^a, Tim Swift^{b,*}

^a Department of Strategic Management, Fox School of Business, Speakman Hall (006-00), Temple University, Philadelphia, PA 19122, USA

^b Management Department, Mandeville 380, Haub School of Business, St. Joseph's University, 5600 City Avenue, Philadelphia, PA 19131, USA

ARTICLE INFO

Article history:

Received 29 July 2009

Received in revised form

29 September 2010

Accepted 15 October 2010

Keywords:

Exploration and exploitation

Punctuated equilibrium

R&D expenditure volatility

Firm growth

Innovation

ABSTRACT

The external environment is characterized by periods of relative stability interspersed with periods of extreme change, implying that high performing firms must practice exploration and exploitation in order to survive and thrive. In this paper, we posit that R&D expenditure volatility indicates the presence of proactive R&D management, and is evidence of a firm moving from exploitation to exploration over time. This is consistent with a punctuated equilibrium model of R&D investment where shocks are induced by reactions to external turbulence. Using an unbalanced panel of almost 11,000 firm-years from 1997 to 2006, we show that greater fluctuations in the firm's R&D expenditure over time are associated with higher firm growth. Developing a contextual view of the relationship between R&D expenditure volatility and firm growth, we find that this relationship is weaker among firms with higher levels of corporate diversification and negative among smaller firms and those in slow clockspeed industries.

© 2010 Elsevier B.V. All rights reserved.

1. Introduction

Exploration and exploitation are two paths to creating and appropriating firm value (March, 1991). Extant research defines exploitation activities as those in which the firm leverages its existing knowledge base (Rosenkopf and Nerkar, 2001; Benner and Tushman, 2003), while exploration involves the search for new knowledge in domains that are relatively distant from the firm's core base of knowledge (Baum et al., 2000; Rosenkopf and Nerkar, 2001; Benner and Tushman, 2003; He and Wong, 2004).

One strand of the literature has argued that the best performing firms undertake exploration and exploitation simultaneously. Such firms have been called "ambidextrous" (Tushman and O'Reilly, 1996). They concurrently devote resources to discovering the next great opportunity while maintaining their ability to maximize the value of their existing assets and capabilities (Benner and Tushman, 2003; He and Wong, 2004).

Some theorists have criticized the literature on organizational ambidexterity. They argue that the skills required to undertake exploration or exploitation are fundamentally incompatible, and cannot be practiced by one firm at the same time (March, 1991, 1996, 2006; He and Wong, 2004). This literature suggests that the co-existence of exploration and exploitation processes within the firm is best understood within the context of the "punctuated equi-

librium" framework, wherein long periods of industry stability are interspersed with challenging periods of extreme change (Miller and Friesen, 1980, 1984; Tushman and Romanelli, 1985; Romanelli and Tushman, 1994; Loch and Huberman, 1999).

In this paper, we use the concept of punctuated equilibrium as a lens to study the performance of organizations in changing external environments. The specific relationship we examine is the link between intertemporal firm-level R&D expenditure patterns and firm growth. Proactive management of the firm's R&D function requires not only exploiting current knowledge-based competencies, but also exploring new opportunities once those competencies lose their competitive edge. Technological discontinuities that cause major, promising R&D opportunities arise infrequently (Kuhn, 1962). This gives rise to (often long) periods of stability, during which firms exploit existing competencies. These stable periods are punctuated by periods of disruption and turbulence, during which firms must discover ways of dealing with new conditions. The punctuated equilibrium framework implies that surviving firms move from exploitation during periods of stability to exploration during periods of disruption and change. These firms are moving between periods of low R&D activity and periods of high R&D activity. This is consistent with extant evidence that expenditure rises, peaks and then falls as an R&D project is initiated, achieves success and moves past maturity (Di Masi et al., 2003).

We posit that high-performing firms have the ability to leverage existing competencies, constantly renewing them during periods of exploitation. Further, these firms proactively explore for new innovations during periods of technological uncertainty, and fund new projects once new promising project results have been observed.

* Corresponding author. Tel.: +1 215 499 7973; fax: +1 610 660 1229.

E-mail addresses: ram.mudambi@temple.edu (R. Mudambi), tim.swift@sju.edu (T. Swift).

This ability to move from exploitation to exploration is manifested in a highly volatile R&D spending profile over time.

Further, we predict that this proactive R&D management (and the associated volatility in R&D spending) may not always benefit the firm. Successful firms that compete in fast clockspeed industries, in which the rates of product, process, capital equipment and organizational design obsolescence are relatively high (Fines, 1998) make rapid executive decisions in order to keep pace with the fast pace of opportunities confronting the firm (Davis et al., 2009). However, high-performing firms in slow clockspeed firms place greater emphasis on efficient operations, and less on strategic flexibility (Pisano, 1994; Rivkin and Siggelkow, 2003). Further, smaller firms may lack the resources required to practice both exploration and exploitation (Beckman, 2006). Therefore, we develop a contingency-based view of R&D expenditure volatility, and identify circumstances where stable R&D spending may be more suitable than proactive R&D management.

In analysis shown below, we will note that R&D expenditure volatility is quite weakly correlated with R&D intensity, suggesting that these two measures capture very different dimensions of firm performance. While R&D intensity has been used as a measure of firm-level dedication to knowledge creation (Hall et al., 2005), we posit that R&D expenditure volatility is an observable proxy for the firm's ability to proactively invest in R&D spending while existing competencies remain valuable, and to move into exploratory research as existing competencies begin to wane in value.

The purpose of this paper is to evaluate the relationship between R&D expenditure volatility and firm growth. Using financial data from an unbalanced panel of almost 11,000 manufacturing firm-year observations from 1997 to 2006, analysis provided in this paper indicates that, in general, higher firm-level R&D spending volatility is associated with higher firm growth. This relationship decreases as corporate diversification increases. In addition, we find that the relationship between R&D expenditure volatility and firm growth is negative in smaller firms, and among firms in slow clockspeed industries (Fines, 1998). These findings suggest that firms that proactively manage their R&D function, moving between periods of exploration and exploitation, generate higher levels firm growth than firms that do not make these transitions.

In order to transition successfully between periods of exploration and exploitation, firms must have the domain expertise and knowledge management processes that enable them to move in the right direction, at the right time. These intangible assets are deeply embedded within the firm. Penrose (1959) argued that firms with highly specialized, valuable assets (or resources) have the incentive to expand, because these assets that form the basis of the firm's competitive capabilities are not divisible, and cannot be employed as profitably outside the firm (Teece, 1982, 1986; Wernerfelt, 1984; Montgomery, 1994). In this view, successful proactive management of R&D expenditure is most likely to express itself in the form of a higher rate of firm growth (Penrose, 1959; Marris, 1964; Mahoney and Pandian, 1992). Indeed, recent research uses sales growth as a measure of firm performance (He and Wong, 2004), because firm growth has found to be a reliable indicator of multiple forms of firm performance such as firm survival and long-term profitability (Timmons, 1999; Henderson and Cockburn, 1994).

In general, these results are consistent with the position that R&D expenditure volatility indicates the presence of proactive R&D management. More importantly, they point to firms and circumstances where such capabilities are most valuable. Firms must attain critical mass and maintain a focused corporate structure in order to transition effectively between periods of exploration and exploitation over time. Firms that must transition frequently, as when their environment is fast-paced, have much to gain from keeping close tabs on their R&D spending. Conversely, aggressively adjusting the firm's level of R&D expenditure over time is less valu-

able and perhaps even detrimental to firm growth under conditions of extreme environmental stability.

2. R&D management in the firm: research hypotheses

It has been suggested that exploration skills and exploitation skills are fundamentally different (Gupta et al., 2006). As such, under conditions of punctuated equilibrium, the firm's R&D function is challenged to move between exploration and exploitation modes. Moving from a phase of exploitation, wherein the firm leverages an existing competency to create value, to a phase of exploration, wherein the firm emphasizes the discovery of new resources that can be used to renew the firm's competitive position, is a form of extreme organizational change (McGrath, 2001; Burgelman, 2002; Katila and Ahuja, 2002; Lee et al., 2003; Benner and Tushman, 2003; Holmqvist, 2004; Gupta et al., 2006). Firm exploration involves experimentation or varied processes (Baum et al., 2000), or efforts to shift to a different technological trajectory (Benner and Tushman, 2003; He and Wong, 2004). In contrast, firm exploitation involves re-using existing knowledge (Rosenkopf and Nerkar, 2001; Benner and Tushman, 2003) or refining and improving existing product-market domains or competencies (He and Wong, 2004).

Modifying the firm's R&D activities to move between exploration and exploitation is particularly challenging because of the high level of information asymmetry that exists between executive managers and R&D project managers within the firm (Bernardo et al., 2001; Stein, 2003). R&D projects are relatively opaque to executive managers because the discovery of valuable innovations is a stochastic process; it is difficult, if not impossible, to predict when they will be discovered (Anderson and Tushman, 1990). In the drug industry, which relies on patents to protect valuable new knowledge, R&D projects can endure for 10–12 years without producing a rent-generating patent (Bernardo et al., 2001, p. 333). Because progress in R&D is difficult to observe, managers are often unable to compel R&D project managers to truly disclose the prospects for long-run projects. Management rarely has currently available data that can be used to evaluate or refute project manager claims (Stein, 2003).

Extant research has shown in a broad variety of contexts that the best firms are able to meet the challenges of achieving these conflicting goals (Ancona et al., 2001; Benner and Tushman, 2003; Dougherty, 1992; Eisenhardt and Martin, 2000; Feinberg and Gupta, 2004; Levinthal and March, 1993; March, 1991, 1996, 2006; Gupta et al., 2006). The remainder of this paper develops a new perspective on how firms strike such a balance between exploration and exploitation.

2.1. R&D expenditure volatility and proactive firm management

Relatively few scholars have evaluated changes in R&D expenditure over time. Greve (2003) finds that firms increase R&D spending when low performance causes "problemistic search" or when excess resources cause "slack search" (685). Kor and Mahoney (2005) posit that the benefits of R&D erode quickly, and that firms must frequently renew these benefits by increasing R&D investments over time. Recently, Cuervo-Cazurra and Un (2010) note that a surprising percentage of firms never invest in formal R&D. These authors show that firms that have only internal sources of knowledge must always invest in R&D in order to sustain the flow of new knowledge, while firms with both internal and external sources of knowledge vary R&D spending over time.

In this paper, we make a new contribution to this nascent literature on R&D expenditure volatility. We utilize prior research showing that ambidextrous firms are superior innovators, having

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات