



The moderating effects of knowledge characteristics of firms on the financial value of innovative technology products



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ABSTRACT

The development of innovative technology products is both costly and risky, and their economic value is highly uncertain. Based on a sample of 312 innovative technology products introduced between 1987 and 2006 in the U.S. and a long-horizon event study with control firms, we study the impact of innovative technology products on the long-term financial performance of a firm. In particular, we examine how the knowledge characteristics of the firm, which embrace its knowledge absorptive capacity, knowledge impact, and knowledge diversity, moderate such an impact. We find that on average an innovative technology product increases the firm's return on assets (ROA) (relative to control firms) by 2.18% in the second year after product introduction. However, the value of an innovative technology product varies with the knowledge characteristics of the firm that invented it. We find that the financial impact of technology products is stronger when firms have higher knowledge absorptive capacity, and more impactful and less diversified knowledge (as measured by patents). We classify firms into three categories based on their knowledge characteristics. We find that firms with a high knowledge fit increase their ROA by 4.55% after product introduction, while those with a low knowledge fit receive no benefit from the innovative technology products at all.

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1. Introduction

The successful launch of innovative technology products by manufacturers reflects a firm's ability in incorporating unique, advanced knowledge in developing new products. Generating and leveraging advanced knowledge in new product development and the subsequent creation of innovative technology products are considered to be critical competitive capabilities in the high-tech sector. In fact, the importance of knowledge sources, technological competence, and innovative capability is well recognized in business disciplines such as operations and technology management (Ettlie, 1998; Shane and Ulrich, 2004), strategic management (Roberts, 1999; Zahra and Nielsen, 2002), and financial economics (Chan et al., 2001; Eberhart et al., 2004). The launch of an innovative technology product is the result of a firm's research efforts, representing the unique, state-of-the-art technological knowledge that the firm has created. The development of an innovative technology product requires extensive knowledge sources and capabilities within the firm. However, an interesting question needs

addressing: To what extent and under what circumstances can these firms benefit financially from their innovative technology products?

The development of innovative technology products represents the fruitful result of a firm's marketing and technology research efforts. It is thus reasonable to assume that firms introducing innovative technology products have substantial differentiation advantage over their competitors. However, previous research suggests that technologically innovative firms do not necessarily outperform their rivals. Technological innovation requires substantial research and development (R&D) investments, and introducing innovative new products is highly risky (Cooper, 2000; Zahra and Nielsen, 2002). Innovators face the risk that other firms may imitate their actions, typically earning profits that are much greater than their initial investments (Chaney et al., 1991; Teece, 1986). As the financial benefits from innovative technology products are debated in the literature, researchers have explored a number of contingency factors that affect their impact on financial returns (Hendricks and Singhal, 1997; Langerak et al., 2004; Song and Parry, 1999; Sorescu et al., 2003). Previous studies have examined the contingency effects based on various marketing perspectives, focusing on such moderating factors as marketing proficiency, firm's market dominance, and customer knowledge (Joshi and Sharma, 2004). Recent research has taken a different perspective by focusing on the firm's own resources, behaviors, and capabilities. In particular,

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the knowledge possessed by the firm is considered an important contingent variable for the competitive outcome of its innovative technology products (Birkinshaw et al., 2002).

In this study we examine the impact of innovative technology products on a firm's value creation. Specifically, we focus on the knowledge characteristics of the firm, which embrace the firm's knowledge absorptive capacity, knowledge impact, and knowledge diversity, as contingent variables for the economic value of innovative technology products. Knowledge in this study refers to the result of any form of learning in technology, which reflects the amount of knowledge that the firm has accumulated over time and is embedded in the organization (DeCarolis and Deeds, 1999; Wu and Shanley, 2009). We argue that the firm's knowledge characteristics in new product development determine the products' attributes and thus their competitive outcomes. The development of innovative technology is likely to be associated with a greater appropriation of innovation rent (Langerak et al., 2004; Smith et al., 2005; Wang and Chen, 2010).

We conduct this study based on a sample of 312 technology products introduced in the U.S. between 1987 and 2006 that had won a major innovation award. Using return on assets (ROA) as the financial indicator, we carry out a long-horizon event study with control firms to detect long-term abnormal financial gains. We use R&D expenses and patent data from the National Bureau of Economic Research (NBER) to measure the firms' knowledge characteristics. We find that on average an innovative technology product increases a firm's ROA (relative to control firms) by 2.18% in the second year after product introduction, which is roughly US\$303 million. We estimate that the four-year total abnormal financial return is US\$767 million. However, the value of an innovative technology product varies with the knowledge characteristics of the firm that invented it. We find that the financial impact of technology products is stronger when firms have higher knowledge absorptive capacity, and more impactful and less diversified knowledge (measured by patents). We further classify firms into three categories based on their knowledge characteristics. We find that firms with a high knowledge fit increase their ROA by 4.55% after product introduction, while those with a low knowledge fit receive no benefit from their innovative technology products at all.

2. Literature review and hypotheses

2.1. Innovative technology products, value creation, and moderating factors

It is generally believed that innovative, highly differentiated products provide firms with sustainable competitive advantage (Calantone et al., 2010). Innovative technology products, which are putatively the most advanced in terms of technology and technical functionality, are likely to greatly increase customer benefits (Atuahene-Gima, 2003; Kleinschmidt and Cooper, 1991; Sorescu et al., 2003). After their introduction into the markets, such innovative products are likely to offer novel ways for solving problems and meeting customer demands.

The development of the knowledge-based view (KBV) over the past two decades provides a theoretical lens through which we understand the competitive advantage derivable from innovative technology products. The fundamental assumption is that firms possessing uncommon and idiosyncratic stocks of organizational knowledge stand a good chance of generating high value (Ranft and Lord, 2002). In particular, a firm's capability to develop new knowledge-based assets can create core competence and sustain competitive advantage (Kogut and Zander, 1992; Pemberton and Stonehouse, 2000). The development of innovative technology products embodies the creation, transfer, and application of

the firm's knowledge. This knowledge leading to innovative technologies is relatively inaccessible and difficult for rivals to imitate. Such firms have several technological advantage over their potential rivals in relevant fields. As the first mover in the technological race, these innovative firms can develop strong brand names and customer preferences (Min et al., 2006). Accordingly, despite the potential drawback of having to make large investments to develop highly innovative products, we hypothesize that firms with innovative technology products have substantial competitive advantage over rival firms as follows:

H1. The introduction of innovative technology products leads to higher firm financial performance.

The knowledge characteristics of a firm might influence the firm's development process of innovative technologies and subsequently its performance outcome in the market. Advanced knowledge of technology may enhance the novelty and inimitability of innovative products. The literature suggests that a firm's knowledge resources can act as a fence that deters the entrance of competition in the same product market. When a firm has high appropriability capability, rivals may have little incentive to invest heavily in similar products, or cannot easily develop a similar product or a substitute to compete with the original innovator. Consequently, some knowledge characteristics can maximize the value of market opportunities and inhibit competitive imitation after product introduction (Grant, 1991; Lieberman and Montgomery, 1988).

KBV also provides the theoretical background for us to hypothesize the moderating roles of a firm's knowledge characteristics. In general, KBV asserts that knowledge is a primary source of favorable organizational outcomes (Sullivan and Marvel, 2011). Various scholars have empirically demonstrated that knowledge development capacity and intellectual capital can serve as a strategic resource, leading to a competitive edge (Craighead et al., 2009; Patel et al., 2012). However, relatively little is known about the sustainability of knowledge-based advantages (McEvily and Chakravarthy, 2002) and the factors that lead firms to appropriate more value from their innovations (Wang and Chen, 2010). In particular, complex, profound, and firm-specific intellectual capital is considered an effective isolating mechanism preventing imitation by rival firms (Nag and Gioia, 2012; Wang and Chen, 2010). Building on this line of research (e.g., McEvily and Chakravarthy, 2002; Nag and Gioia, 2012; Wang and Chen, 2010), we investigate some knowledge characteristics of firms that help sustain the knowledge-based advantage, leading to higher rents from technological innovations. Specifically, we examine the knowledge characteristics that prevent distinctive technology advantages from diffusing to competitors, heightening the imitation barriers of innovative technology products, and generating rents better than competitors producing apparently similar innovative products.

2.1.1. Knowledge absorptive capacity

Knowledge absorptive capacity refers to the capacity of a firm to value, acquire, assimilate, transform, and exploit knowledge from external sources for commercial ends (Cohen and Levinthal, 1990; Todorova and Durisin, 2007; Tsai, 2009; Zahra and George, 2002). The knowledge absorptive capacity of a firm is greatly dependent on its current level of technological knowledge (Cohen and Levinthal, 1990; Kim, 2001, 1997), which is derived in turn from previous and current efforts in internal R&D (e.g., Stock et al., 2001; Veugelers, 1997). The efforts of a firm on R&D, and subsequently its knowledge absorptive capability, are related to the firm's ability in technology learning (Benner and Tushman, 2003; Cohen and Levinthal, 1990; Stock et al., 2001), particularly in assimilating knowledge from various external information sources (e.g., latest advances in science

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