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Technological diversification, core-technology competence, and firm growth☆

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ABSTRACT

This paper investigates, using a unique panel dataset of Korean manufacturing firms, the relationship between technological diversification and firm growth and the conditioning role of firm-specific core-technology competence in the relationship. First, the relationship is inverted U-shaped regardless of the type of technological diversification, implying that both insufficient and excessive technological diversifications are harmful for firm growth. Second, the level of competence in the field of core technology conditions the relationship by attenuating the harmful effect of excessive technological diversification. Furthermore, in case of unrelated technological diversification, the inverted U-shaped relationship weakens substantially for firms with high core-technology competence. These results suggest that sufficient core-technology competence is needed for firms to effectively manage and utilize technological diversification, particularly unrelated one, for their growth.

1. Introduction

Technological diversification has received substantial attention from studies in strategic management and technological innovation, as many firms have increasingly diversified their technological resources (Cantwell et al., 2004; Granstrand et al., 1997). Two strands of research have been most popular: One examines the patterns and determinants of technological diversification (e.g., Breschi et al., 2003; Granstrand et al., 1997; Patel and Pavitt, 1997), and the other investigates the effect of technological diversification on firm performance, as measured by, for example, either technological innovation (e.g., Garcia-Vega, 2006; Quintana-Garcia and Benavides-Velasco, 2008), firm profitability, or firm market value (e.g., Kim et al., 2009; Miller, 2006).[1]

Despite the prevalence of technological diversification as a driving force of firm growth, the relationship between technological diversification and firm growth and the factors influencing the relationship have remained largely unexplored (Granstrand, 1998; Granstrand et al., 1997). This paper aims to contribute to the literature by addressing the lacuna. In doing so, following Lee (2010),[2] we focus our attention on the potential conditioning role of firm-specific technological competence in the field of core technology, which has been unexplored in the literature on the relationship between technological diversification and firm growth.[3] In addition, unlike most previous studies, we decompose overall technological diversification into related and unrelated ones and

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[1] On the contrary, the effect of business (or product) diversification on firm profitability has also been heavily studied in the fields of industrial organization and strategic management. For a summary of empirical findings, see Montgomery (1994), Palich et al. (2000), and Wan et al. (2011).

[2] Lee (2010) shows that firm-specific technological competence (especially learning capability) determines the patterns (or trajectories) of firm growth.

[3] A firm's core technological field is defined in this paper as a technological field in which the firm shows the highest value of the multiplication of the number of its patents in the field (i.e., absolute advantage) and the revealed technology advantage (RTA) index (i.e., comparative advantage over the other fields of technology).

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examine the differential effects of the two types of technological diversification on firm growth.[4] This is largely because the driving forces and underlying strategic purposes of technological diversification differ depending on its type.

The conditioning role of core-technology competence in the relationship between technological diversification and firm growth is based on the dual role or characteristics of core-technology competence: competence in (core) domain knowledge as well as architectural knowledge on R&D and the management of innovation. The former increases either the likelihood of market or commercial success or the combined value of new knowledge generated from technological diversification, or both. The latter, architectural competence in R&D and innovation management, refers to a facility for doing and managing R&D, which enables to explore better and integrate more efficiently new (component) knowledge. Specifically, it includes firm-specific R&D and management capabilities to identify, assimilate, and utilize technological opportunities emanating from diverse fields of technology and to efficiently allocate and coordinate resources over diverse R&D projects.[5] Hence, firms with low core-technology competence are more likely to face difficulties in effectively managing technological diversification, particularly into remote and unrelated technological fields with greater technological uncertainty, and to suffer precipitously diminishing marginal returns to technological diversification. In contrast, firms with high core-technology competence are better positioned to harness technological and commercial opportunities for growth emanating from diverse fields of technology, particularly due to their high architectural competence in R&D.[6] It seems, therefore, reasonable to presume that the level of firm-specific core-technology competence influences the technological and commercial returns to technological diversification.[7]

This paper, using a unique panel dataset of Korean manufacturing firms during the period of 1991–2005, finds that the relationship between technological diversification and firm growth differs depending on the level of firm-specific competence in the field of core technology as well as on the type of technological diversification. First, we observed an inverted U-shaped relationship regardless of the type of technological diversification, which implies that both insufficient and excessive technological diversifications are harmful for firm growth. Second, the level of firm-specific core-technology competence moderates the relationship by attenuating or even offsetting the harmful growth effect of excessive technological diversification. Third, in case of unrelated technological diversification, the inverted U-shaped relationship weakens substantially for firms with sufficiently high core-technology competence.

The rest of the paper is organized as follows. Section 2 reviews the literature on the causes of technological diversification and its effects on firm performance. Section 3 sets up a theoretical framework from which to draw hypotheses on the relationship between technological diversification and firm growth. Section 4 describes the data, variables, and empirical specifications to be employed to test the hypotheses. Section 5 presents the empirical results, and Section 6 concludes the paper with some strategic implications.

2. Literature review

2.1. Reasons for technological diversification

Various explanations were offered for the key drivers of technological diversification. First, firms diversify their technological bases to exploit economies of scope in R&D and technological knowledge, thereby using their technological resources efficiently and leading to synergy among diverse knowledge across multiple product lines (Miller, 2006; Panzar and Willig, 1981; Teece, 1982). Often technological resources and know-how can be shared across a wide range of R&D projects and complementarities exist among different fields of technology (Besanko et al., 2010; Granstrand, 1998; Grant, 1996). The explanation is analogous to the one, based on the resource-based view of the firm (Montgomery, 1994; Penrose, 1959; Peteraf, 1993), for business diversification, in which firm-specific resources can create additional market value when shared across other areas within a firm (Markides and Williamson, 1994; Robins and Wiersema, 1995).

Second, firms engage in technological diversification in order to enhance their absorptive capacity and thus technological competence. Tapping into diversified technological areas helps them enhance firm-specific capability to assimilate extramural knowledge (Cohen and Levinthal, 1989, 1990; Garcia-Vega, 2006; Quintana-Garcia and Benavides-Velasco, 2008). Technological diversification can also strengthen firms' technological competence or R&D productivity particularly in the fields of their core technology and help offset, at least partially, diminishing marginal returns to scale in R&D associated with the accumulation of R&D along a certain technological trajectory (Henderson and Cockburn, 1996; Klette, 1996; Klette and Kortum, 2004).

Third, technological diversification allows firms to reduce the risk involved in R&D and to enhance adaptability to the fast-changing technological environment. As technological innovation is risky by nature, firms seek to lower the variance associated with the returns from R&D investment by spreading their resources across different technologies (Garcia-Vega, 2006), which also enables firms to develop more versatile technologies by expanding their technological scope. A rise in technological diversity due primarily to system complexity and technological fusion becomes an increasing and prevailing trend in many high-tech industries including electronics, telecommunications, chemicals, and automobiles (e.g., Gambardella and Torrisi, 1998; Granstrand et al., 1997; Suzuki and Kodama, 2004).

Finally, the accumulation of technological capabilities across various fields of technology through technological diversification helps firms to extract greater rents in the market for core

[4] It is intrinsically hard to delineate the boundary between "related" and "unrelated" technological diversification, as technological diversification cannot be easily defined dichotomously but rather than as a continuous degree of scale. Hence, although the dichotomous distinction has been used for convenience, the terms "related" and "unrelated" technological diversification better be understood respectively as "focused" or "specialized" technological diversification or, simply, technological deepening and "broad" or "dispersed" technological diversification or, simply, technological widening.

[5] The notions of domain-knowledge and architectural-knowledge competences are similar to those of component and architectural competences (Henderson and Clark, 1990; Henderson and Cockburn, 1994) and functional and organizational capability (Grant, 1996; Prahalad and Hamel, 1990).

[6] There are some examples of the importance of core-technology competence in the technological and commercial success of technological diversification. For example, based on strong core-technology competence in fine optics and precision mechanics Canon diversified into the areas of microelectronics and semiconductor equipment technologies (e.g., mask aligners and steppers), and Fujifilm utilized its core-technology competence in photographic film to diversify its technological base into, among others, imaging and document solution technologies and applied chemical and health care technologies (used in cosmetics and pharmaceuticals). An old and similar example can be found in Klepper and Simons (2000), which show the importance of core-technology competence in a prior industry (i.e., radio) in the probabilities of entry and survival and post-entry performance in a newly emerging industry (i.e., TV receiver). It is worth noting that the link between core-technology competence and the technological and commercial success of (unrelated) technological diversification tends to be weak in a highly discrete and drastic technological environment, in which the usefulness or effectiveness of core-technology competence in technological diversification would rather be limited.

[7] A similar reasoning can be found in some studies for business diversification (e.g., Hitt and Ireland, 1986; Markides and Williamson, 1994; Ng, 2007; Wan et al., 2011), which emphasize the role of core competence or dynamic capability in business diversification.