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# Is technological learning a firm core competence, when, how and why? A longitudinal, multi-industry study of firm technological learning and market performance

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## Abstract

This paper proposes the conceptual outline for a general theory of higher order technological learning within and across firms and attempts to empirically test the power of correlation between technological learning and market performance in select multi-industry firm clusters over multi-year periods. After reviewing relevant extant literature, this paper constructs an integrated, multi-dimensional framework for the analysis of technological learning activities and their associated impact on firm market performance. Using a subset of the concepts in this framework, a pilot study was conducted to test the relationship between technological learning effort and firm market performance. The analysis combines traditional quantitative indicators of learning with a qualitative index constructed through inductive examination of corporate annual reports. The empirical analysis shows some strength in the relationship between technological learning and market performance, but this relationship is dependent upon temporal, non-linear, firm-specific factors. The results of the study are discussed in the context of expanding research to integrate all aspects and levels of technological learning, especially differentiating between higher order (strategic and tactical) and basic (operational) learning. © 2002 Elsevier Science Ltd. All rights reserved.

*Keywords:* Technological learning; Optimal bandwidth of technological learning; Higher order technological learning; Qualitative methods; Quantitative methods; Market performance

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## 1. Introduction

Existing concepts in the theory of the firm, especially those focused on strategic issues, tend to be constrained along two dimensions. First, past theory development has been static, analyzing the nature of a firm and its competitive position at a given point in time. Second, past analyses have emphasized homogeneity, so that firms are perceived to function in the same way, with variations in performance attributed to subtle differences in conceptual constructs not readily apparent (such as organizational culture, managerial talent, “core competencies” and knowledge, as well as technological learning processes).

Further extensions to the theory of the firm need to

challenge the static, homogeneous approach, and move towards the creation of a theory of the firm that accommodates the dynamic and heterogeneous nature of firms. Some recent works include a greater focus on dynamism and differences in firms as key determinants of competitive advantage (Porter, 1991). Examples include the development of the “dynamic capabilities” theory (Teece et al. 1992, 1997), attempts to identify the differences among firms with greatest strategic significance (Nelson, 1991). Also of relevance is how the particular nature and environment of firms, especially in high-technology fields, leads to a new basis of competition and competitive advantage in those firms (Granstand, 1998).

A promising path towards a new theory of the firm is to focus on the role of organizational learning in competitive advantage (Edmondson and Moingeon, 1996). This research focus is supported by the recent examination of the nature of knowledge, and how the acquisition and integration of knowledge leads to the development of new competencies through organizational

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transformation (Nonaka and Takeuchi, 1995; Spender, 1996). These processes of knowledge-based transformation are organizational learning activities. The result of improved organizational learning is enhanced “strategic flexibility” (Sanchez, 1993), meaning that the firm faces a greater range of potential options for action which can then be leveraged to achieve a better fit to its competitive environment. Such a view of organizational learning is analogous to the general concept of learning advanced by Huber (1991): “An entity learns if, through its processing of information, the range of its potential behaviors is increased” (p. 89). Thus, a learning-based theory of the firm would advance our understanding of the dynamic construction of competitive advantage by

...focusing on the ways that organizations and the people therein generate, process, and alter their explicit knowledge and tacit skills, as well as the paths of change that such styles of organizational cognition can follow...and [thereby] create questions and motives for further research on the dynamics of the creation and evolution of firm core competencies (Carayannis, 1994).

In this paper, we address a specific area of organizational learning, which we term *technological learning*: “Technological learning (TL) is defined as the process by which a technology-driven firm creates, renews, and upgrades its latent and enacted capabilities based on its stock of explicit and tacit resources (Aaker, 1989; Amit and Shoemaker, 1993; Bahrami and Evans, 1989; Barney, 1991; Carayannis 1993, 1994; Carayannis et al., 1994; Morone, 1989). It combines both technical and administrative learning processes (Jelinek, 1979)” (Carayannis, 1994).

The management of technological capabilities produces increasing economic returns as they focus more narrowly on knowledge assets and processes that are non-substitutable, imperfectly imitable, rare, and valuable (Carayannis, 1994). As the cone in Fig. 1 indicates, the highest value is derived from the strategic management of technological learning, as these processes enable the renewal of critical capabilities and assets and the generation of new sources of competitive advantage (Carayannis, 1994).

To probe the relationship between technological learning, strategic management, and firm performance, we developed a framework describing specific dimensions of technological learning at various levels of competitive significance. We then operationalized these concepts through quantitative and qualitative indicators of technological learning activity, as shown in Fig. 2. These concepts are applied in an empirical investigation into a subset of the framework, represented by the shaded region in Fig. 2. This sub-cube encompasses only two out of the three levels (operational and tactical) and two out of

the four dimensions (content and process) of technological learning. In this process, we will construct a lexicon of learning concepts through the inductive examination of corporate annual reports, as well as through deductive analysis of the literature on technological learning. The learning lexicon will be converted into a qualitative indicator of technological learning effort, and integrated with quantitative indicators of technological learning to produce a total technological learning index. Finally, we explore the implications of these results on the prospects for future, broader research into the various aspects of technological learning.

## 2. Literature review and conceptual foundations

This research integrates three streams of literature relating to organizational learning, strategic management, and technology management, to create an empirical model for detecting and measuring organizational learning activities and connecting them to changes in firm performance. This model should suggest how learning can lead to new insight about a theory of the technology-based firm (Granstand, 1998).

### 2.1. Organizational learning literature and strategic advantage

Early research on organizational learning in the context of organization theory focused most substantially on attempting to describe learning processes in organizational settings, without necessarily assigning a normative value to learning (cf. March and Simon, 1958; Cyert and March, 1963; Nelson and Winter, 1982; Levitt and March, 1988). Learning as an organizational activity is perceived as an integration of individual efforts and group interactions. Thus, organizational learning becomes a process embedded in relationships among individuals; some authors argue that organizational culture is the outcome of shared learning experiences. Some authors use descriptive accounts of “learning organizations” to identify paths to the improvement of organizational performance (Senge, 1990; Ciborra and Schneider, 1992), under the presumption that firms which are better at organizational learning will perform better than others in the market.

Other authors point out that learning can decrease organizational performance. Huber (1991) notes, “Entities can incorrectly learn, and they can correctly learn that which is incorrect”. Ineffective or inappropriate learning processes can erode firm competitive advantage if they reinforce incorrect linkages between managerial activities and firm performance (Levitt and March, 1988). Even effective learning processes can be undermined by changes in market and environmental conditions which render them irrelevant, or worse, damag-

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