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Enhancing effects of manufacturing flexibility through operational absorptive capacity and operational ambidexterity

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ABSTRACT

A large body of research investigates how manufacturing flexibility in uncertain environments leads to firm performance, with mixed results. The mixed findings could be due to differences across firms in terms of the capabilities to acquire, assimilate, and transform knowledge and to simultaneously pursue both the exploitation of existing operational capabilities and the exploration for new operational capabilities. Building on the literature that suggests that manufacturing flexibility mediates the relationship between environmental uncertainty and firm performance, we explore the applicability of two organizational learning contingencies to the operations environment: operational absorptive capability and operational ambidexterity. Absorptive capacity enables the recognition and assimilation of new knowledge. Ambidexterity determines whether this knowledge will be applied for both exploration and exploitation. Using a sample of 852 manufacturing firms, we find that environmental uncertainty affects firm performance directly and indirectly through manufacturing flexibility. Furthermore, both operational absorptive capacity and operational ambidexterity moderate the relationship between environmental uncertainty and manufacturing flexibility and the relationship between manufacturing flexibility and firm performance. Theoretical and practical implications are discussed.

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1. Introduction

Faced with complex and unpredictable task environments, "manufacturing flexibility permits a manufacturing firm to cope" (Swamidass and Newell, 1987, p. 515). Manufacturing flexibility is "the ability to change or react with little penalty in time, effort, cost or performance" (Upton, 1994, p. 73). Environmental uncertainty describes the rate and unpredictability of change in a firm's external environment (Dess and Beard, 1984) related to, for example, demand, technology, and competition. Despite the proposed benefits of manufacturing flexibility, prior research documents mixed findings for the effects of manufacturing flexibility on performance in uncertain environments. Swamidass and Newell's seminal study (1987) reported that environmental uncertainty influenced manufacturing flexibility that, in turn, enhanced performance. Some subsequent replications reported consistent findings (e.g., Anand and Ward, 2004; Chang et al., 2002, 2003; Narasimhan and Das, 1999), while others did not find support. For example, Pagell and Krause (1999) challenged the assumption that the environment influences the extent of manufacturing flexibility, and found that firms with higher performance had greater manufacturing flexibility regardless of environmental uncertainty. Introducing the contingent role of competitive strategy, Ward and Duray (2000) found that competitive strategy mediates both the relationship between environmental uncertainty and the manufacturing strategy and the relationship between manufacturing strategy and performance.

The inconclusive nature of previous studies may result from how firms develop, deploy, and leverage manufacturing flexibility differently. Upton (1995a, pp. 76–77) cautioned that firms must identify the right type of flexibility, reporting that 40% of flexibility-improvement efforts are unsuccessful and "the cause could be traced to a failure to identify precisely what kind of manufacturing flexibility was needed, how to measure it, or which factors most affected it." This suggests that capabilities might explain why some firms are more likely to realize higher performance from increased manufacturing flexibility while others are not. Scholars have called for further empirical examination of the environmental uncertainty–manufacturing flexibility–firm performance relationship, especially research that examines mediators and employs rigorous measures (Anand and Ward, 2004; Pagell and Krause, 2004). Ketokivi (2006, p. 226) proposed a contingency-based approach:

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"in addition to the classical contingencies, we must incorporate the strategic and technological contingencies into our examination, otherwise our understanding of the phenomenon remains incomplete."

The present study responds to these calls and adopts a contingency perspective by investigating: "*Why are some firms able to develop more effective responses to environmental uncertainty using manufacturing flexibility?*" We explore two firm learning capabilities that may moderate the environmental uncertainty–manufacturing flexibility–performance relationship: *operational absorptive capability* and *operational ambidexterity*. Operational absorptive capacity is the ability of a firm's operational units to acquire, assimilate, transform, and exploit knowledge from the operations environment. Operational ambidexterity refers to an operational unit's simultaneous pursuit of exploration and exploitation. As the concepts of absorptive capacity and ambidexterity originate in the strategy literature, no a priori assumption should be made about their suitability and value to operations management research. Following suggestions on theory borrowing across contexts (e.g., Whetten et al., 2009), we create an operationalization to the operations management context and examine the strategy concepts' appropriateness and value using a sample of 852 manufacturing firms.

Our study offers contributions to both the operations management and the strategic management literature. First, to the large literature describing manufacturing flexibility as an effective response to environmental threats, we find that operational absorptive capacity and operational ambidexterity are moderators, strengthening the relationships between environmental uncertainty and manufacturing flexibility and between manufacturing flexibility and firm performance. Second, we examine the transferability of these strategy concepts to the functional level context of operations management – specifically, the horizontal theory borrowing of absorptive capacity and vertical borrowing of ambidexterity. Thus, we extend seminal work by Swamidass and Newell (1987) and inform mixed findings by exploring the effects of operations related learning. Extant operations management literature focused on manifestations of learning such as increased efficiency or increased flexibility. Operational absorptive capacity and operational ambidexterity may explain how operational routines and capabilities are renewed and realigned to meet environmental contingencies. Third, we contribute to the absorptive capacity literature by offering theoretical reasoning and empirical evidence of its importance in the operations management context. The empirical evidence is also valuable as extant literature typically discusses the possible impacts of absorptive capacity on firm learning and performance, but offers limited empirical analysis (Lane et al., 2006; Tu et al., 2006). Fourth, we answer calls for exploring ambidexterity in an operations context (Adler et al., 2009; Andriopoulos and Lewis, 2009), especially the complex relationship between ambidexterity, environment (Gibson and Birkinshaw, 2004; He and Wong, 2004), and performance (Raisch and Birkinshaw, 2008).

The paper is structured as follows: Section 2 introduces the theoretical background of the model, including the theory borrowing of our moderators, and hypotheses based on the literatures associated with manufacturing flexibility, environmental uncertainty, operational absorptive capacity, and operational ambidexterity. The research sample and methodology are presented in Section 3, with the results provided in Section 4. Section 5 discusses the contributions to the literatures of operations management and strategic management, managerial implications, limitations, and future research opportunities.

2. Theoretical development and hypotheses

A persistent theme in the study of organizations is the fit between a firm's strategy and its environment. A large body of research focuses on manufacturing flexibility as a key element of an organization's response to environmental uncertainty (Upton, 1994, 1995b, 1997). Flexibility initiatives differ substantially, depending on how organizations scan, interpret, and learn from their environments (Daft and Weick, 1984; De Treville et al., 2007). Scholars have highlighted the need for further investigation of the operational routines and learning processes related to manufacturing flexibility that could explain why some firms respond to the environment more successfully than others (Patel, 2011; Sawhney, 2006).

2.1. Borrowing of learning concepts from the strategy literature

Following calls by to explore the possible contribution of strategic management theories and constructs in an operations context (Ketchen and Guinipero, 2004; Ketchen and Hult, 2007) and the caveat of theory borrowing across contexts posited by Whetten et al. (2009), we examine the appropriateness and value of these strategy concepts to the context of operations management. We outline two broad theoretical borrowing approaches suggested by Whetten et al. (2009). Horizontal borrowing is cross-context and concerns theories *in* organizations the use of "concepts that were developed for the study of phenomena in other types of social contexts" (Whetten et al., 2009, p. 538). Vertical borrowing is cross-level and concerns theories *of* organizations and the borrowing of concepts that were originally developed for a different level of analysis. Table 1 depicts vertical and horizontal borrowing for operational absorptive capacity and operational ambidexterity.

Absorptive capacity refers to a firm's ability to "recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990, p. 129). Initially labeled by Kedia and Bhagat (1988) in research on international technology transfer, the major groundwork for absorptive capacity was Cohen and Levinthal's (1990) examination of how organization's R&D units need prior knowledge in order to assimilate new knowledge. Cohen and Levinthal (1990) acknowledged early work by Abernathy (1978) and Rosenberg (1982) on the benefits of direct involvement in manufacturing as helping to recognize and exploit new information about product markets. A recent review (Volberda et al., 2010) indicates that most absorptive capacity research is based on R&D units.

There is little examination of absorptive capacity in the operations management literature (Tu et al., 2006). We use the term "operational absorptive capacity" to refer to the ability of a firm's operational units to acquire, assimilate, transform, and exploit knowledge from the operations environment. As such, operational absorptive capacity is a characteristic of the operational unit, and its examination represents a shift in context to the functional operational unit from the R&D unit. Absorptive capacity is a theory *in* organizations and is measured by individuals' learning, whether these individuals are working on their own or in a team in one of many firm units. As Cohen and Levinthal (1990, p. 131) put it, "the development of an organization's absorptive capacity will build on prior investment in the development of its constituent, individual absorptive capacities, and, like individuals' absorptive capacities, organizational absorptive capacity will tend to develop cumulatively." Taken together, this suggests that the absorptive capacity concept will function similarly when transferred horizontally to the operations context.

Ambidexterity refers to a firm's ability to balance between exploration and exploitation (e.g., Duncan, 1976; March, 1991). Exploration entails search for increasing variation, risk taking, and

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