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Research article

Architectural innovation and the emergence of a dominant design: The effects of strategic sourcing on performance

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ABSTRACT

This study investigates four different sourcing strategies employed by firms in order to successfully deal with a new architectural innovation hitting the market. The four sourcing approaches reflect the varying degrees of internalization of component design and manufacturing: *make*, *in-house design*, *long-term supplier*, and *new supplier*, where *make* implies the highest and *new supplier* the lowest degree of internalization of the firm's component sourcing in a spectrum. Comparing and contrasting the innovation performance of the four sourcing approaches in the pre- and post-dominant design eras, we suggest theoretical implications for the critical path of strategic sourcing decisions over time for a new architectural innovation. By doing so, we suggest an integrated framework of stage-contingent sourcing strategies and provide the associated empirical results that demonstrate normative strategic guidance for managers.

1. Introduction

In many industries, the competitive advantage of a firm depends on its ability to manage new innovations and resulting market and technological changes. The ways in which a firm organizes its product development, sourcing, and production processes across a new innovation's life cycle can affect firm performance. One important stream of the technology management literature discusses the performance impact of the make-buy sourcing choice (with respect to upstream components) across a new innovation's life cycle (Fine, 1998; Baldwin and Clark, 2000; Christensen et al., 2002; Argyres and Bigelow 2007; Qian et al., 2012).

This literature deals with the specific industry context where a radical technological innovation broadly hits the market, and the firm's subsequent component sourcing decision is a dichotomous choice between make or buy. It also assumes that the eventual emergence of a dominant design following the innovation's market introduction immediately leads to product standardization. More specifically, this literature argues that a make component sourcing decision yields better performance for firms before the emergence of a dominant design (in the pre-dominant design era), while a buy component sourcing decision yields better performance after the dominant design's emergence (in the post-dominant design era) (Fine, 1998; Baldwin and Clark, 2000; Christensen et al., 2002; Argyres and Bigelow 2007; Qian et al., 2012).

This previous literature, however, also poses some important concerns that require further elaboration and development. First, not all technological innovations are radical in nature. For example, architectural (or modular) innovations are abundant and the varying sourcing decisions for these innovations have been observed across real industries. Accordingly, we may need to characterize distinctive innovation types to address their specific contexts of component sourcing. Second, complementing the dichotomous "make" vs. "buy" sourcing decision based on transaction cost economics (TCE) and the knowledge-based view (KBV), we may need to develop a more diverse scheme of component sourcing approaches as readily seen in practice. Third, the emergence of a dominant design does not always instantly lead to product standardization (Gallagher, 2007); in such cases, there exists a period of time that firms need to develop new firm- or model-specific knowledge to obtain competitive advantages from the innovation (Lau and Yam 2005; Agrawal, 2009). Reflecting these research requirements, recent studies point out that such existing views of innovation sourcing need to be re-visited and further examined to explain more nuanced component sourcing decisions along the innovation life cycle (Wolter and Veloso 2008; Cabigiosu and Camuffo, 2012).

In order to address the set of concerns of previous research, our study focuses on the context where a new architectural innovation

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Table 1
Four Sourcing Approaches.

Sourcing Option:	Make Strategy	In-house Design Strategy	Long-term Supplier Strategy	New Supplier Strategy
Manufacturing:	Insourced	Outsourced	Outsourced	Outsourced
Design:	Insourced	Insourced	Shared	Shared
Degree of Internalization	+ + + +	+ + +	+ +	+

invades the market, experiences the emergence of its dominant design, and then undergoes product standardization at some later point in time. To enrich the dichotomous make versus buy component-sourcing decision (Williamson, 1985), we introduce four sourcing approaches that reflect the varying degrees of internalization of component design and manufacturing: the *make* strategy, the *in-house design* strategy, the *long-term supplier* strategy, and the *new supplier* strategy, where *make* implies the highest and *new supplier* the lowest degree of internalization of the firm's component sourcing in a spectrum. The four strategic sourcing approaches that reflect the varying degrees of component-sourcing internalization are summarized in Table 1. We then examine whether each of these sourcing approaches performs better for one particular period over the other – i.e., the "before dominant design" period over the "after dominant design" period – along the evolution of a new architectural innovation. We also provide a synthesized model that compares these four sourcing approaches in terms of relative innovation performance for the before and after dominant design periods, respectively.

In the context of the four component sourcing approaches, our study contributes to the extant literature in the following manner. First, we suggest a theoretical base for employing the four different sourcing approaches, each of which provides relative performance advantages for the different stages of a new architectural innovation. We also introduce the concepts of *hierarchy hazards* and *exchange hazards* and discuss the desirable characteristics of component sourcing approaches to reduce these hazards, using the logic of Nickerson and Zenger (2004) and Balakrishnan and Wernerfelt (1986).

In the early period of a new architectural innovation, i.e., before the emergence of a dominant design, understanding the new innovation and acquiring new knowledge to manage it is the key success factor for performance advantage. However, firms' existing processes and routines developed from previous innovation contexts in the past can easily be outdated, making it difficult for firms to tackle the new innovation and the associated new knowledge surrounding it, i.e., causing firms to suffer from *hierarchy hazards*. Hierarchy hazards indicate the hazards of inertia a firm's "organizational hierarchy" encounters when its internally established solution search and learning routines restrict the firm from the acquisition of new knowledge required for a new innovation (Balakrishnan and Wernerfelt, 1986). Therefore, in this period, efficiently reducing hierarchy hazards and developing new problem-solving processes and new learning routines are a key to achieving better innovation performance.

Contrastingly, after the emergence of a dominant design (but before the emergence of a *de facto* standard), the key basis of competition revolves around acquiring firm- or model-specific knowledge. The component suppliers' opportunism based on the dominant design specification hampers the manufacturing firm's efforts to secure its firm-specific innovation knowledge, rendering *exchange hazards* a major problem to solve. Normally, exchange hazards occur when a firm's supplying partner engages in opportunistic behaviors and exploits the firm's reliance on the outsourced knowledge (Nickerson and Zenger, 2004). Thus, in this period, the reduction of exchange hazards for efficient acquisition of firm-specific innovation knowledge is the key to maintaining competitive advantage.

Second, given a theoretical basis of two distinctive hazards in terms of innovation and component knowledge requirements, our overarching arguments reflect that before the emergence of a dominant design, the firms that internalize less of the design and manufacturing of components are likely to be in a better position to efficiently reduce hierarchy hazards. In contrast, after a dominant design emerges, the firms that internalize more of the component design and manufacturing are likely to be in a better position to efficiently reduce exchange hazards. These arguments suggest that our four different sourcing approaches and their varying degrees of internalization will provide different levels of performance advantage depending on whether they are employed before vs. after the emergence of a dominant design. Furthermore, we compare and rank these four strategic sourcing approaches in terms of their impact on innovation performance as each of them provides the firm with different levels of capabilities that help to solve hierarchy and exchange hazards. Our hypotheses and performance-rank comparison are summarized in Table 2.

To develop and test our arguments, we explore the U.S. road bicycle gear-shifting market from 1985 to 1995. Before 1985, product architectures for road bicycle gear-shifting components were modular and standardized. And as suggested by the 'mirroring hypothesis'[2] (Colfer and Baldwin 2016), most derailleur firms pursued a buy strategy regarding the sourcing of freewheel components. However, in 1985, the bicycle gear shifting market saw the advent of index shifting technology, a new architectural innovation that changed and more tightly integrated the linkage between the derailleur and freewheel components. Holding to the 'mirroring hypothesis,' firms should have switched to making the freewheel components in-house. However, firms exhibited heterogeneous sourcing approaches regarding the freewheel component during this period. This technological and market context provides a suitable arena to examine how the organizational sourcing differences lead to performance heterogeneity across an architectural innovation's life cycle.

In sum, when comparing and contrasting the innovation performance of the four sourcing approaches in the pre- and post-dominant design eras, we first suggest theoretical implications for the critical path of strategic sourcing decisions over time for a new architectural innovation. By doing so, we suggest an integrated framework of stage-contingent sourcing strategies and provide the associated empirical results that demonstrate normative strategic guidance for managers.

2. Sourcing approaches and performance advantages before and after an architectural innovation's dominant design

2.1. Background

Firms need to take into account (at least) two hazards when dealing with a new innovation – hierarchy hazards and exchange hazards. These two hazards stem from the two distinctive knowledge management activities that firms should perform in the face of a new innovation (Zahra and George, 2002). The first activity is firms' knowledge identification, which identifies, understands, and acquires externally-generated new knowledge that is critical to a new innovation. The second activity is knowledge integration, which adds, removes, combines, and integrates the existing knowledge and the newly acquired knowledge.

We note that the reduction of *hierarchy hazards* becomes a key issue to achieving better innovation performance as it improves the firm's knowledge identification (i.e., activity of identifying, understanding and acquiring new external knowledge) (Harrigan, 1985; Balakrishnan and Wernerfelt, 1986). Hierarchy hazards occur when a firm's solution

[2] The mirroring hypothesis suggests that organizational structure is likely to correspond to the interdependence of components in a product's architecture (Colfer and Baldwin, 2016).