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Ambidexterity in Technology Sourcing: The Moderating Role of Absorptive Capacity

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A firm's organizational and technological boundaries are two important demarcation lines when sourcing for technology. Based on this theoretical lens, four possible combinations of exploration and exploitation emerge. Applying an ambidexterity perspective to a firm's technology sourcing strategy, we hypothesize that a curvilinear relationship exists between a firm's technology sourcing mix and its performance. We further introduce a contingency element by proposing that a firm's absorptive capacity exerts a positive moderating effect on this relationship. We empirically test these hypotheses on a random, multi-industry sample of U.S. manufacturing companies. We find support for the notion that the relationship between technology sourcing mix and firm performance is an inverted U-shape. Moreover, higher levels of absorptive capacity allow a firm to more fully capture the benefits resulting from ambidexterity in technology sourcing.

Key words: absorptive capacity; ambidexterity; dynamic capabilities; exploration and exploitation; innovation; technology sourcing
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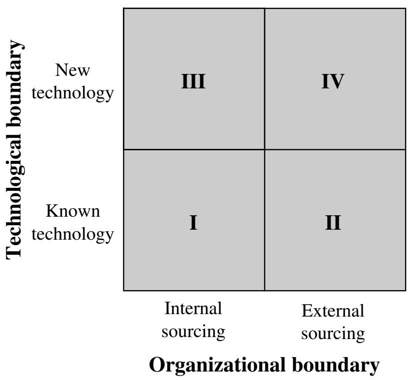
Introduction

The concept of ambidexterity, defined as an individual's ability to use both hands with equal ease, has been applied in various organizational contexts. Early work by Duncan (1976) suggests that organizations implement dual structures to manage trade-offs emerging from a simultaneous focus on alignment and adaptation. More recently, O'Reilly, Tushman, and their colleagues (O'Reilly and Tushman 2004, Tushman and O'Reilly 1996, Tushman et al. 2006) evoked the metaphor of a juggler to suggest that managers who are able to integrate and reconcile both exploratory and exploitative activities can produce a continuous stream of innovations, encompassing both incremental and radical innovations. Some consensus seems to emerge around the notion that organizational ambidexterity describes the "ability of a firm to simultaneously explore and exploit" (O'Reilly and Tushman 2007, p. 2). An exploration-exploitation lens has been applied to a wide range of different organizational phenomena such as innovation (Benner and Tushman 2003), strategic alliances (Lavie and Rosenkopf 2006, Park et al. 2002, Rothaermel and Deeds 2004), knowledge search and knowledge creation (Katila and Ahuja 2002, Nerkar 2003, Sidhu et al. 2007), and market entry (He and Wong 2004), among others.

Although we concur that applying an exploration-exploitation lens allows for important theoretical insights, we submit that a firm's ability to simultaneously explore and exploit is but one manifestation of organizational ambidexterity. Following Gibson and Birkinshaw (2004, p. 209),[1] we propose to extend the ambidexterity construct more broadly to describe a firm's *ability to simultaneously balance different activities in a trade-off situation*. Although managing these trade-offs frequently presents nontrivial organizational challenges, we further suggest that an organization's ability to reconcile and harness these trade-offs can enable it to effectively improve the firm's performance.

No existing research has applied an ambidexterity perspective to a firm's technology sourcing strategy to date. As firm competition has increased over the last few decades (Thomas 1996) and a firm's technology sourcing strategy has become increasingly critical to its performance (Hill and Rothaermel 2003, Nicholls-Nixon 1995, Rothaermel 2001), this lack of research points to a significant gap in the burgeoning ambidexterity literature. Furthermore, applying the ambidexterity hypothesis to technology sourcing also implies that extreme positions along the internal-external technology sourcing continuum may not be tenable: a firm that sources all of its technology internally is unlikely to enhance its performance because of increased risks, including obsolescence (Eisenhardt and Martin 2000, Powell et al. 1996, Teece et al. 1997); in contrast, relying exclusively on external technology sourcing can result in a competitive disadvantage, because a competence loss leads to an inability to capture the returns to innovation (Teece 1986).

Figure 1 Types of Exploitation and Exploration Along Technological and Organizational Boundaries



To more fully understand the performance implications of ambidexterity in a firm's technology sourcing strategy, we build on Rosenkopf and Nerkar's (2001) contribution highlighting a firm's organizational and technological boundaries as two important demarcation lines when firms search for knowledge. Trade-offs in a firm's technology sourcing strategy can thus arise from two dimensions: (1) whether a firm engages in exploration or exploitation, and (2) whether a firm sources its technology internally or externally. Based on the degree of uncertainty facing a firm (March 1991), the technology it searches for can be either known or new to the organization (Gaynor 1996). Regardless of the type of technology, however, managers must face the decision to source the technology either internally or externally. Based on this theoretical framework, four possible combinations of exploration and exploitation emerge (see Figure 1).

A firm's overall technology sourcing strategy consists of pursuing exploration and exploitation through combining internal and external sources of knowledge. Theoretically, therefore, we propose that ambidexterity benefits can arise by balancing these factors. First, we test the hypothesis that balancing internal and external technology sourcing of known and new technology has positive performance implications. Next, we go beyond advancing an ambidexterity-firm performance relationship by introducing a contingency perspective when hypothesizing that a firm's absorptive capacity—understood as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal 1990, p. 128)—positively moderates the inverted U-shaped relationship between its internal-external technology sourcing mix and firm performance. This moderating effect implies that the impact of ambidexterity in technology sourcing on firm performance is stronger in the presence of higher levels of absorptive capacity. An appropriate level of absorptive capacity allows a firm to overcome inherent tensions in ambidexterity that arise not only from the simultaneous pursuit of exploration and exploitation, but also from internal and external technology sourcing, thus allowing the firm to harness ambidexterity benefits more fully.

Due to the difficulty of obtaining fine-grained and theoretically proximal data pertaining to a firm's internal and external technology sourcing strategy as well as to the different types of technology sourced in terms of explorative and exploitative knowledge searches, there has not been any empirical examination applying the ambidexterity hypothesis to technology sourcing. We tested our theoretical model on a random, multi-industry sample of U.S. manufacturing companies. In particular, we obtained detailed data documenting a firm's internal and external technology sourcing strategy as well as the type of technology sourced through a mail survey, which we combined with secondary, publicly available archival data.

Theory and Hypotheses

A firm's organizational and technological boundaries are two important delineation criteria when sourcing for technology (Rosenkopf and Nerkar 2001). We focus herein on different types of exploitation *and* exploration along the following two dimensions: (1) sourcing of *known* versus *new* technology, and (2) *internal* versus *external* sources of technology. In particular, we assess the effects of different exploration-exploitation combinations along the organizational and technological boundaries, as depicted in Figure 1, on two important firm-level outcomes: firm innovativeness and firm financial performance. This allows us to extend the ambidexterity concept to include not only an exploration-exploitation dimension, but also to make the distinction between internal and external sources of knowledge, thus advancing a more refined theoretical model of ambidexterity and its impact on firm performance.

Because technology refers to the "practical application of knowledge" to "achieve a commercial or industrial objective,"[2] a natural first boundary a firm faces is the knowledge boundary. In this sense, the technological boundary denotes whether a firm sources a technology that builds on knowledge that is known or new to it (Gaynor 1996). Although a known technology builds upon the existing knowledge base held by the firm, the methods or materials used to achieve the firm's objectives can nonetheless steadily improve over time. Intel's continuous incremental innovations in microprocessors within the existing semiconductor architecture illustrate this well (Chesbrough 2003). In contrast, a new technology involves knowledge that is, by definition, novel to the firm, which must be derived from either an entirely new knowledge base or from a novel recombination of parts of the firm's established knowledge base with a new knowledge stream (Kogut and Zander 1992). The pharmaceutical industry's attempts to incorporate biotechnology, a radical process innovation, into their methods of drug discovery and development serve as a good example (Kenney 1986, Rothaermel and Hess 2007).

Because technology embodies knowledge-based resources (Appleyard 2003, Conner and Prahalad 1996), managers must decide whether to obtain this knowledge from internal research and development (R&D) operations or through external means. A second boundary that a firm faces, therefore, is the organizational boundary, because it separates internal and external sources of knowledge. The knowledge-based view of the firm suggests that organizational boundaries "correspond to a combination of current capabilities and expectations regarding future opportunities" (Kogut and Zander 1992, p. 385).

A firm's technology sourcing activities reveal its preference for how to combine internal and external sources of new and known knowledge. When considering a single transaction, a manager may choose to source a certain technology internally or externally, based on transaction-cost and knowledge considerations (Kogut and Zander 1992, Williamson 1985). When aggregating each technology sourcing decision up to the firm level, however, a (general) manager must likely decide on how to balance internal and external technology sourcing simultaneously. Although it is theoretically possible that a firm sources *all* of its technology internally or externally, an exclusive focus on either internal or external technology sourcing is unlikely, because the vast majority of firms across many industries have moved to an open innovation system, combining internal and external technology sourcing simultaneously (Chesbrough 2003, Laursen and Salter 2006). This shift does not, however, rule out the fact that firms dynamically adjust their focus on internal and external technology sourcing depending on a host of factors, including the type of technologies sourced, availability of external sources of technology, intellectual property protection, and industry dynamics. The critical issue lies within the managers' decisions regarding the preferred focus on internal versus external technology sourcing, and how this balance is dynamically adjusted in light of changing conditions. The capacity to do so is captured by our understanding of ambidexterity as a firm's ability to simultaneously balance different activities in a trade-off situation.

Technology Sourcing Mix and Firm Performance

Today, it appears virtually impossible for any single firm to keep abreast of all relevant technological advances exclusively through internal technology sourcing (Ettlie and Sethuraman 2002, Hagedoorn 1993, Powell et al. 1996). In 2007, for example, the U.S. Patent and Trademark Office (U.S. PTO, http://www.uspto.gov/) awarded a total of 182,932 patents.[3] Historically, as a reflection of its strong internal research prowess, IBM has been a worldwide leader in patenting. In 2007, IBM was awarded 3,142 patents. However, this number accounts for only 1.72% of all patents awarded that year, meaning that over 98% of patents awarded were assigned to inventors outside of IBM's boundaries.[4] It should come as no surprise that Brown and Eisenhardt (1997) found that firms that relied on external technology sourcing to probe and access cutting-edge knowledge held beyond the boundaries of the focal firm were more successful in their new product introductions than firms that focused on internal technology sourcing. Other researchers demonstrated that accessing technological knowledge held beyond the focal firms' boundaries improved their innovativeness (Ettlie and Pavlou 2006, Spencer 2003).

Chesbrough (2003) explains the increasing importance of external technology sourcing by advancing several factors that necessitate a shift in the knowledge landscape from closed innovation to open innovation. These factors include the increasing supply and mobility of skilled workers, the exponential growth of venture capital, the increasing availability of external options (such as spinning out new ventures) to commercialize ideas that were previously shelved, and the increasing capability of external suppliers; together, these factors now force even the largest companies, such as AT&T, IBM, GE, or Sony, to shift their innovation strategy toward a model that blends internal with external technology sourcing via licensing agreements, strategic alliances, joint ventures, or acquisitions. To generate important knowledge spillovers between internal and external technology sourcing, it now appears necessary for firms to pursue both sourcing strategies simultaneously (Appleyard 1996, Cassiman and Veugelers 2006, Laursen and Salter 2006, Rothaermel et al. 2006, Vanhaverbeke et al. 2002, Veugelers 1997).

Exploration and Exploitation. To more fully inform the theory development underlying the relationship between a firm's technology sourcing mix and firm performance, we apply the exploration-exploitation framework of organizational learning. March (1991, p. 85) stated that the "essence of exploration is experimentation with new alternatives," whereas the "essence of exploitation is the refinement and extension of existing competences." Subsequently, Levinthal and March (1993, p. 105) defined exploration as "the pursuit of new knowledge, of things that might come to be known," and exploitation as "the use and development of things already known." Applying these definitions, we understand exploration to be the sourcing of new technology and exploitation to be the sourcing of known technology. This perspective allows us to combine the exploration-exploitation framework with internal and external technology sourcing as depicted in Figure 1. In Quadrant I, a firm sources *known* technology from internal sources, thus engaging in *internal exploitation*. In Quadrant II, a firm sources *known* technology from external sources, thus engaging in *external exploitation*. In Quadrant III, a firm sources *new* technology from internal sources, thus engaging in *internal exploration*. Finally, in Quadrant IV, a firm sources *new* technology from external sources, thus engaging in *external exploration*. Through a combination of these two dimensions, we are able to more fully identify and illuminate the inherent tensions caused by ambidexterity in technology sourcing, and thereby differentiate their effects on firm performance.

The organizational learning literature provides further guidance on how to pursue internal and external technology sourcing of known and new technologies simultaneously (Huber 1991, Levinthal and March 1993, March 1991). The overarching hypothesis in this body of literature is that firms ought to maintain a balance between exploration and exploitation: "The basic problem confronting an organization is to engage in sufficient exploitation to ensure its current viability and, at the same time, to devote enough energy to exploration to ensure its future viability;" however, "the precise mix of exploitation and exploration that is optimal is hard to specify" (Levinthal and March 1993, p. 105). The difficulty of finding and managing a balance between pursuing exploration and exploitation is accentuated by the fact that firms are generally constrained by their resources, and managers often face a trade-off when allocating scarce resources to these activities. Yet the presence of concurrent exploration and exploitation is not sufficient to describe organizational ambidexterity. To be ambidextrous, organizations need to be able to effectively reconcile internal tensions that arise from pursuing exploration and exploitation simultaneously (Raisch and Birkinshaw 2008).

Organizations that engage in exploration at the expense of exploitation incur the substantial costs of experimentation without reaping the benefits thereof (March 1991). Failure often precipitates an organization's turn to this strategy; because the dynamic of failure turns organizations into "frenzies of experimentation, change, and innovation" (Levinthal and March 1993, p. 105). These organizations may explore too many distinctly different and novel technologies without possessing or commensurately developing the competences necessary to recognize and exploit the technological opportunities presented (Cohen and Levinthal 1990, Teece 1986). In the 1970s, for example, Xerox Corporation was under pressure in their core photocopier business by Japanese low-cost competitors, and thus focused on exploration activities in its Palo Alto Research Center. Corporate management at Xerox' headquarters, however, was looking for innovations in the photocopier business, and thus failed to appreciate and exploit many breakthrough innovations in computing software and hardware like an early word-processing application, the graphical user interface, the mouse as a pointing device, and even the first personal computer, all of which contributed to the emergence of the computing industry (Chesbrough and Rosenbloom 2002).

In contrast, organizations that engage in exploitation to the exclusion of exploration tend to suffer from obsolescence due to technological progress or changes in customer preferences (Levinthal and March 1993). Exploitation tends to drive out exploration when organizations are successful. Because organizations that develop a competence in a certain area tend to engage in that activity more frequently, they further enhance their specific competence, but simultaneously increase their opportunity cost of exploration (Levinthal and March 1993). Moreover, organizational success resulting from a particular competence is frequently based on earlier-period actions when an organization first commits itself to a specific routine, rather than on reflective and critical learning in which the connections between actions and outcomes are accurately specified (Nystrom and Starbuck 1984). As an established routine is refined and executed repeatedly over time, an organization is likely to be susceptible to superstitious learning when the old routine no longer fits a new situation, yet the "subjective feeling of learning is powerful, but misleading" (Levitt and March 1988, p. 326). As this process plays out over time, core competences can turn into core rigidities, and organizations can become trapped by their own competences, with potentially self-destructive consequences (Leonard-Barton 1992). Texas Instruments (TI), for example, developed a core competence in low-cost manufacturing of handheld calculators by following the learning curve concept popularized by the Boston Consulting Group (1972). When the basis of competition shifted, however, to also include differentiation through additional features and capabilities in handheld calculators, TI was unable to accommodate customer demand, because their core competence in low-cost manufacturing had turned into a core rigidity impeding the necessary product differentiation (Hill and Jones 2005).

Ambidexterity in Technology Sourcing. In the context of our framework, we consider an organization's ability to effectively reconcile tensions that arise from pursuing exploration and exploitation to be a necessary, but not sufficient, condition for ambidexterity in technology sourcing. An organization must also address a second source of tension arising from pursuing internal and external technology sourcing simultaneously. Because we predict that balancing internal and external technology sourcing can contribute to enhanced performance, it follows that an excessive focus on either internal or external technology sourcing is likely to lead to inferior performance due to the risks of obsolescence and competence loss (Brown and Eisenhardt 1997, Teece 1986, Teece et al. 1997). These dynamics appear to be especially salient in technologically progressive industries. For example, firms that sourced the new integrated circuit technology externally rather than developing the necessary R&D capabilities through internal technology sourcing experienced a sustained competitive disadvantage (Malerba 1985). In contrast, as Sørensen and Stuart (2000) documented in their study of the biotechnology and semiconductor industries, firms that exploited their internal R&D to a larger extent produced more innovations. These innovations tended to be merely incremental, however, and eventually led to the firms' obsolescence.

We define a firm's technology sourcing strategy as the simultaneous pursuit of exploration and exploitation when combining internal and external technology sourcing. This perspective differs from prior research, which describes delineating exploration and exploitation activities through *temporal separation*, *structural separation*, or *parallel structures* (Benner and Tushman 2003, Brown and Eisenhardt 1997, Gibson and Birkinshaw 2004, O'Reilly and Tushman 2007, Raisch 2008, Tushman and O'Reilly 1996). Ambidexterity in technology sourcing at the firm level, therefore, implies that managers combine internal and external sources of existing and new knowledge in a simultaneous fashion. We suggest that firms that maintain a balance between internal and external technology sourcing are more likely to attain enhanced performance, because this balance allows firms to leverage their core competencies and to mitigate weaknesses (Nicholls-Nixon and Woo 2003). Pursuing ambidexterity in technology sourcing, moreover, allows a firm to consider and utilize a greater number of combinations between internal and external sources of existing and new knowledge, which in turn should have positive performance implications. In support of this notion, Laursen and Salter (2006) provide empirical evidence that firms that externally search beyond a small number of sources enhance their innovative performance, albeit this relationship is characterized by diminishing returns as the number of external sources of new knowledge increases. Such benefits to ambidexterity in technology sourcing are also echoed in an interview that we conducted with an HP chief technologist, who stated: "A mixed [technology sourcing] strategy is generally better because it lets companies focus on what they're good at without having to do everything. It also lets companies enter important adjacent markets quickly."

Ambidexterity by our definition is a construct that is not directly observable, though it is not the only important theoretical construct to bear that fate. Godfrey and Hill (1995) demonstrated that unobservable constructs lie at the core of a number of influential theories in strategic management, and organization theory by extension. Given this nontrivial challenge impeding research attempting to expose theoretical predictions to empirical falsification, Godfrey and Hill (1995, p. 530) suggested:

> What scholars need to do is to theoretically identify what the observable consequences of unobservable [constructs] are likely to be, and then go out and see whether such predictions have a correspondence in the empirical world. The analogy here is with quantum mechanics, which has been confirmed *not* by observing subatomic entities (since they are unobservable) but by observing the trail left by subatomic entities in the cloud chambers of linear accelerators.

Applying this realist perspective to empirical research implies that if ambidexterity allows firms to balance internal and external technology sourcing of known and new technology, then we ought to be able to observe higher performance, on average, from firms that are successful in achieving such a balance. Enhanced performance, therefore, would be an observable consequence of the unobservable construct of ambidexterity (while holding everything else constant and controlling for alternative explanations).

Taken together, we propose that a curvilinear relationship between a firm's internal and external technology sourcing mix holds for its overall sourcing of both known and new technologies (Hypothesis 1). To further differentiate between tensions emanating from the simultaneous pursuit of internal and external technology sourcing versus tensions emanating from sourcing new versus known technologies, we spilt Hypothesis 1 by type of technology sourced, that is, known technology (Hypothesis 1A) versus new technology (Hypothesis 1B).

Hypothesis 1. *An inverted U-shaped relationship exists between a firm's total technology sourcing mix* (*of known* and *new technology*) *and its performance.*

Hypothesis 1A. *An inverted U-shaped relationship exists between a firm's technology sourcing mix of* known *technology and its performance.*

Hypothesis 1B. *An inverted U-shaped relationship exists between a firm's technology sourcing mix of* new *technology and its performance.*

Moderating Effect of Absorptive Capacity

Although ambidexterity along both the exploration-exploitation *and* internal-external boundaries is difficult to achieve because two different sources of trade-offs must be addressed simultaneously, we further posit that a firm's absorptive capacity allows it to accomplish this more effectively. In particular, we hypothesize that a firm's absorptive capacity positively moderates the relationship between its technology sourcing mix and firm performance. Absorptive capacity is generally developed through continuous funding of and engaging in R&D over time (Cohen and Levinthal 1990), allowing for the identification and exploitation of internal knowledge as emphasized by Rosenberg (1990, p. 171): "it requires a substantial research capability to understand, interpret and to appraise knowledge that has been placed upon the shelf—whether basic or applied. The cost of maintaining this capability [in terms of R&D dollars] is high ... ." A second important by-product of ongoing R&D investments is the creation of firm-specific knowledge that enables a firm to screen, evaluate, and take advantage of externally generated knowledge (Mowery 1983, Helfat 1994). Tilton (1971, p. 71), for example, observed this phenomenon in the semiconductor industry and concluded that R&D capability "provided an in-house technical capability that could keep these firms abreast of the latest semiconductor developments and facilitate the assimilation of new technology developed elsewhere."

A firm's external environment is rich with a diverse set of knowledge sources that can potentially underpin commercializable technologies: basic and applied R&D conducted by research universities and government laboratories, knowledge spillovers along the vertical value chain from suppliers or customers, horizontal knowledge spillovers from competitors, horizontal and vertical alliances, acquisitions of technology-based firms, and other formal and informal wells of knowledge like conferences, journal publications, patents, and so on. The extent to which a firm can screen, value, and utilize externally sourced technologies depends on the level of its absorptive capacity (Cohen and Levinthal 1989, 1990). Absorptive capacity, therefore, allows a firm to identify and value new knowledge that originates from beyond its boundaries, and to assimilate and integrate the new knowledge with the firm's existing knowledge (Arora and Gambardella 1994). In a similar fashion, Kogut and Zander (1992, p. 384) termed this "combinative capability," and defined it as a firm's ability "to synthesize and apply current and acquired knowledge," which allows the firm to identify and harness the spillovers due to the simultaneous pursuit of internal learning through R&D and external learning through alliances, joint ventures, and acquisitions.

A firm's absorptive capacity, however, is not merely directed outward through a focus on the acquisition and assimilation of external knowledge, but also encompasses a firm's ability to process knowledge internally. These two dynamics can result in a tension between a firm's internally focused knowledge processing capabilities and the firm's ability to explore and exploit external knowledge. Cohen and Levinthal (1990, p. 133) described this as a "trade-off between inward-looking versus outward-looking absorptive capacities" due to "the [required] efficiency of internal communication against the ability of the subunit to assimilate and exploit information originating from other subunits or the environment," and cautioned that "while both of these components are necessary for effective organizational learning, excessive dominance by one or the other will be dysfunctional." Ambidexterity in technology sourcing therefore allows firms to balance the internal and external dimensions of its absorptive capacity. On the flipside, at higher levels of absorptive capacity, ambidexterity in technology sourcing is not only enabled, but also becomes more necessary because of the hypothesized underlying inverted curvilinear relationship between technology sourcing mix and firm performance.

A similar conclusion can be reached when drawing on Zahra and George's (2002, p. 185) recent reconceptualization of the absorptive capacity construct into potential and realized absorptive capacities, where "potential capacity comprises knowledge acquisition and assimilation capabilities, and realized capacity centers on knowledge transformation and exploitation." Knowledge acquisition and assimilation capabilities are built through external technology sourcing, whereas knowledge transformation and exploitation capabilities are created as a by-product of internal technology sourcing. A firm's absorptive capacity, therefore, helps a firm to link external and internal technology sourcing, and thereby to benefit from ambidexterity in technology sourcing. Prior research affirms that firms with a higher level of absorptive capacity exhibit higher internal technological competence, utilize more alliances, and manage communications with their alliance partners more effectively (Nicholls-Nixon 1995, Nicholls-Nixon and Woo 2003, Rothaermel and Hill 2005).

A commensurate level of absorptive capacity facilitates ambidexterity in technology sourcing by allowing a firm to overcome the tensions inherent in the simultaneous pursuit of internal and external technology, thus avoiding competency traps and generating benefits that exceed its costs. To harness the tensions inherent in ambidexterity in technology sourcing requires that a firm be able to effectively integrate external and internal sources of known and new knowledge. A firm's absorptive capacity allows for the effective spanning of organizational and technological boundaries (Tushman 1977, Tushman and Katz 1980). This spanning of different organizational and technological boundaries, in turn, permits a firm to make novel linkages among different types of knowledge (Simon 1985). This sort of knowledge recombination and integration is enabled by a firm's absorptive capacity, and frequently underlies innovation (Kogut and Zander 1992, 1996; Grant 1996).

When a firm possesses an adequate level of absorptive capacity, it tends to not only be more sensitive to opportunities that present themselves in their technological environments, but also more proactive in exploiting those opportunities through combining internal and external sources of knowledge (Cohen and Levinthal 1990). At this state, an effective integration of external and internal sources of known and new knowledge is enabled, and the internal tensions due to ambidexterity are mitigated. As a consequence, ambidexterity in technology sourcing has a stronger effect on firm performance in the presence of higher levels of absorptive capacity. In parallel to Hypothesis 1, we propose to investigate this contingency perspective for a firm's overall technology sourcing strategy and for each type of technology sourced.

HYPOTHESIS 2. *A firm's absorptive capacity moderates the inverted U-shaped relationship between a firm's total technology sourcing mix* (*of known* and *new technology*) *and firm performance in such a fashion that the positive effect of ambidexterity in technology sourcing on firm performance is stronger when the firm possesses higher levels of absorptive capacity.*

HYPOTHESIS 2A. *A firm's absorptive capacity moderates the inverted U-shaped relationship between a firm's technology sourcing mix of* known *technology and firm performance in such a fashion that the positive effect of ambidexterity in technology sourcing on firm performance is stronger when the firm possesses higher levels of absorptive capacity.*

HYPOTHESIS 2B. *A firm's absorptive capacity moderates the inverted U-shaped relationship between a firm's technology sourcing mix of* new *technology and firm performance in such a fashion that the positive effect of ambidexterity in technology sourcing on firm performance is stronger when the firm possesses higher levels of absorptive capacity.*

Methodology

Sample and Data

The research setting for this study is the manufacturing sector of the U.S. economy.[5] We chose this context for a number of reasons. First, the original work on absorptive capacity by Cohen and Levinthal (1989, 1990) was conducted in the U.S. manufacturing sector; thus, we follow their lead. Second, this industrial sector comprises both low- and high-technology industries such as stone products (Standard Industrial Classification (SIC) 32) and pharmaceuticals (SIC 28), respectively. While we explicitly control for industry idiosyncrasies, the spectrum of our multi-industry sample enables us to test the effects of ambidexterity in technology sourcing on firm financial and innovative performance, and the moderating effect of absorptive capacity on this relationship, in a conservative fashion. Third, technology sourcing is critical throughout the entire manufacturing sector because it accounts for more than 90% of all technological innovations (Pavitt 1984). Finally, although the manufacturing sector produces a large number of innovations, it is not exposed to as great a volatility in the equity markets as, for example, the telecommunications sector, which makes the use of certain financial metrics less problematic.

The theoretical model proposed necessitates gathering internal firm data pertaining to a firm's technology sourcing mix through a survey instrument. Prior research in related areas also relied on a survey approach to gain this type of detailed data (cf. Cohen and Levinthal 1989, 1990; Cohen et al. 2000; Ettlie 1998; Ettlie and Pavlou 2006; He and Wong 2004; Laursen and Salter 2006; Levin et al. 1987; Lubatkin et al. 2006; Nicholls-Nixon and Woo 2003). We followed Dillman's (1978) total design method to create and conduct a mail survey in the most effective manner possible. As such, prior to administering the survey, we pilot tested the questionnaire on a group of five executives from different industries. The revised survey was then accompanied by a cover letter on official university letterhead explaining the objectives of the study and promising an executive report of the results, if desired. All respondents were ensured that their individual responses would be reported only in an aggregated manner, so that no individual firm could be identified. Finally, all respondents were assured strict confidentiality.

In 1999, the disclosure database of the Securities and Exchange Commission (SEC) listed a total of 4,768 firms in the manufacturing SIC codes, of which we drew a random sample of 1,500 firms. We then randomly ordered this list of 1,500 firms, and made telephone contact with 470 of them to solicit their participation in the study prior to mailing the survey. To ensure that the most qualified individual responded to the survey, and to confirm the mailing address and other relevant contact information, we placed a number of phone calls to each firm in the sampling frame prior to administering the survey. The chief technology officer or equivalent emerged as the person best positioned to respond to the questionnaire.

We also assessed interrespondent reliability across different executives within the same firm. In each case, we sent the questionnaire to two individuals, but each individual filled out and returned the questionnaire individually. Because the interrespondent reliability exceeded $r = 0.90$ in the first two cases and was well above the suggested cut-off point of $r = 0.70$ (Cohen et al. 2003), we relied on one respondent for each firm for the remaining sample. Moreover, concerns about potential interrespondent reliability were further mitigated by relying on the most knowledgeable individual among the senior management positions. Relying on one qualified individual as the respondent to our survey concerning a firm's technology sourcing mix, among other data, is also justified by the fact that the data requested in the survey is strategic in a nature, and thus only held at the top level of the firm or strategic business unit (SBU).

Crampton and Wagner (1994) demonstrated, through a detailed analysis of close to 43,000 correlations from survey-based research published in leading academic journals, that respondents' perceptions do not introduce a significant bias when the questionnaire items concern objective data, as in our case, rather than subjective data (see also Podsakoff et al. 2003). The respondents for our study were further motivated to accurately complete the survey by the opportunity to benchmark their technology sourcing strategies with other firms both within and outside of their industry. The interest in this study was quite high: 81% of the respondents requested an executive summary, and several respondents contacted the researchers directly to learn more about how this study could be applied to their specific context.

We surveyed the companies in 1999 to assess their technology sourcing mix, among other dimensions discussed below. We temporally separated the independent and dependent variables. In particular, we complemented the technology sourcing measure with objective performance measures based on secondary data over a four-year period (2000 to 2003). We did this not only to overcome a potential common method bias, but also to account for time lags in the relationships between technology sourcing mix and firm performance (Podsakoff et al. 2003). This approach follows the one applied by Hitt et al. (1997), and enabled us to apply lagged regression models to account for time effects in a more appropriate manner, thus strengthening any potential causality claims (Mitchell and James 2001).

After three rounds of follow-up letters, we yielded 143 useable surveys, representing a response rate of 30.4%. We dropped two fully completed and useable surveys where we assessed interrespondent reliability from the sample so as not to confound the independence of the observations. The final number of surveys used for analysis was 141 or 30%. This response rate compares favorably to prior studies, especially given the seniority of the survey respondents, who are generally part of their companies' top management teams. We assessed representativeness and a potential response bias along several dimensions such as R&D expenditures, revenues over assets, and market value. The tests indicated that the sample for this study is representative of the larger population from which it is drawn, and does not exhibit any nonresponse biases.

Dependent Variable

Firm Performance. Because firm performance is a multidimensional construct (Hart 1992), we assessed it along two dimensions: firm innovativeness and firm financial performance.

First, we proxied *firm financial performance* by a firm's return on equity (ROE). ROE is a commonly used variable in strategic management research to proxy firm financial performance because it assesses how efficiently a firm uses its resources. Moreover, using ROE as the dependent variable has the added benefit of negating the need to explicitly control for firm size, because ROE is a size-adjusted ratio. To recognize time lags and to attenuate annual fluctuations in the ROE data, we collected annual data for each firm during the four-year period between 2000 and 2003. Following prior research (Rothaermel 2001, Zahra et al. 2000), we then averaged the ROE data obtained over this time period to create a performance index. We applied a logarithmic transformation to enhance the normality of the variable's underlying distribution. All financial data were obtained from Compustat.

Second, we followed prior research that proxied *firm innovativeness* by a firm's patents (e.g., Ahuja 2000, Hagedoorn and Schakenraad 1994, Henderson and Cockburn 1994, Owen-Smith and Powell 2004, Rothaermel and Hess 2007, Rothaermel and Thursby 2007, Shan et al. 1994, Stuart 2000).[6] In particular, we proxied firm innovativeness by the total number of patents assigned to the firm by the U.S. PTO during the four-year time period between 2000 and 2003. The 141 sample firms obtained a total of 1,679 patents, or close to 12 patents per firm on average.

It is important to note that patent count data are highly correlated with citation-weighted patents, with their bivariate correlation generally above $r = 0.75$ ($p < 0.001$) across a wide range of industries, including manufacturing sectors (Hagedoorn and Cloodt 2003, Stuart 2000). This indicates that either patent counts or citation-weighted patents reasonably tap into the same theoretical construct proxying for innovativeness. Moreover, patent count data are also highly correlated with other indicators of firm innovativeness, including new product introductions (Hagedoorn and Cloodt 2003).

Independent Variables

Technology Sourcing Mix. Based on the theoretical model introduced above, we assessed a firm's technology sourcing mix along two boundaries: organizational and technological. We measured a firm's technology sourcing mix by the ratio of its external technology sourcing over its total technology sourcing, which is the sum of its internal and external technology sourcing, bound between 0 and 1 [(*External*/*Total*) *Tech Sourcing*].[7] We obtained these data from the survey respondents.

In a second step, we collected more fine-grained information based on the *type* of technology sourced: known or new technologies. In the survey instrument, we followed Gaynor (1996) and defined *known technologies* as "technologies that are being used by the firm for some time. They are not new to the firm or the industry." Because these technologies are known and familiar, when a firm sources these known technologies it engages in *exploitation*. We asked the survey respondents to indicate which percentage of each technology type the firm sourced internally versus externally. In regard to a firm's *technological* boundary, we measured a firm's sourcing mix of known technologies by the ratio of its external sourcing of known technologies over its total sourcing of known technologies, which is the sum of a firm's internal and external sourcing of known technologies, bound between 0 and 1 [(*External*/*Total*) *Tech Exploitation*].

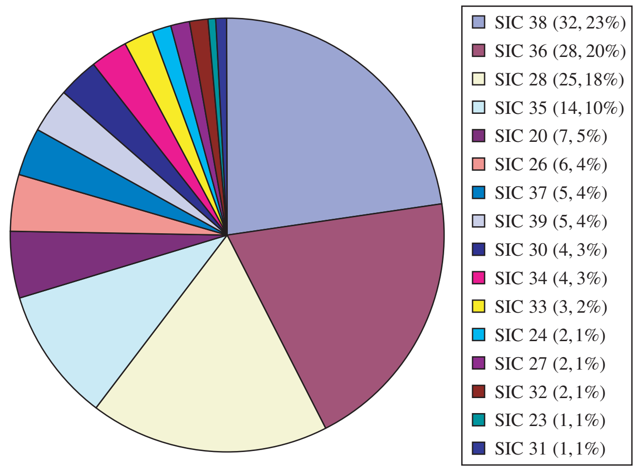
New technologies are defined as the inverse of known technologies, because what is not known must be new. Accordingly, when a firm searches for new technologies, it engages in *exploration*. Based on the second dimension of a firm's *technological* boundary, we measured a firm's sourcing mix of new technologies by the ratio of its external sourcing of new technologies over its total sourcing of new technologies, which is the sum of a firm's internal and external sourcing of new technologies, bound between 0 and 1 [(*External*/*Total*) *Tech Exploration*].

Moderating Variable

Absorptive Capacity. Following Cohen and Levinthal's (1989, 1990) original contribution, we proxied a firm's absorptive capacity by its R&D expenditures (in millions of dollars), which is considered to be a reflection of a firm's willingness to invest in absorptive capacity. We collected annual R&D expenditure data for the five-year time period between 1995 and 1999 to compensate for annual fluctuations. Following Cohen and Levinthal (1989, 1990), we averaged the R&D data obtained over this time period to create an R&D index to account for annual fluctuations caused by, for example, differences in effect and timing of business cycles across multiple industries. Whereas absorptive capacity is the moderating variable of this study, the direct effect of absorptive capacity is included in all regression models. This enabled us to assess the moderating effect of absorptive capacity in a conservative fashion above and beyond its direct effect.[8]

Absorptive Capacity Focus. To assess the focus of a firm's absorptive capacity in more detail, and thus to isolate the moderating effect of absorptive capacity more fully, we obtained data from the survey that indicates (1) what percentage of a firm's total R&D activity is dedicated to the development and maintenance of *internally* developed technologies, and (2) what percentage of a firm's total R&D activity is dedicated to the acquisition and further development of *externally* sourced technologies. These data enabled us to explicitly control for a firm's *external focus in absorptive capacity* by creating a ratio of a firm's R&D activity that is dedicated to the acquisition and further development of externally sourced technologies over its total R&D activity, which is the sum of its R&D activity dedicated to the development and maintenance of internally *and* externally sourced technologies, bound between 0 and 1.

Figure 2 **Industry Distribution by Two-Digit Standard Industry Classification Codes***



*A legend for SICs can be found in Endnote 5. The number of firms and percentage of sample are in parentheses.

Control Variables

When assessing the effect of a firm's technology sourcing mix on firm financial and innovative performance, it is critical to control for the firm's prior financial performance, prior innovativeness, as well as its external sourcing experience. In addition, we controlled for the firms' different industries, degrees of diversification, economies of scope, number of technologies used, and the dynamism of the technological and market change encountered in the firms' respective industries. We detail each control variable below.

Lagged Firm Performance. To control for a potential specification bias arising from unobserved heterogeneity (Jacobson 1990), we included lagged firm performance measures, for both *firm financial performance* and *firm innovativeness*. We constructed these control variables in the same fashion as the dependent variables described above, but for the five-year time period between 1995 and 1999.

Industry Characteristics. Because the manufacturing sector of the U.S. economy comprises different industries, we controlled for unobserved industry idiosyncratic effects through the inclusion of a set of *industry fixed effects*. Figure 2 shows the industry distribution of the sample firms by SIC codes.

A large majority of the sample firms (99 or 71%) are active primarily in only four SICs: 32 or 23% in SIC 38 (Precision Instruments), 28 or 20% in SIC 36 (Electronic, Electrical Equipment), 25 or 18% in SIC 28 (Chemicals and Allied Products), and 14 or 10% in SIC 35 (Machinery and Computer Equipment). None of the remaining 12 SICs account for more than 5% of the sample. Thus, we included four different industry dummy variables (the firm is in SIC $38 = 1$, 0 otherwise; the firm is in SIC $36 = 1$, 0 otherwise; the firm is in

SIC 28 = 1, 0 otherwise; and the firm is in SIC 35 = 1, 0 otherwise) in the regression models to explicitly control for unobserved industry idiosyncrasies.

External Sourcing Experience. Following prior research (Hoang and Rothaermel 2005, Rothaermel et al. 2006), we controlled for a firm's past experience in alliances and acquisitions through the number of alliances (*Alliances*) entered and acquisitions (*Acquisitions*) consummated, during the five-year period from 1995 to 1999 to attenuate annual fluctuations. These data were obtained through a detailed content analysis of the companies' SEC filings and articles in the business press (e.g., *Wall Street Journal*), retrieved through electronic databases such as Lexis-Nexis. The qualitative descriptions of each alliance and acquisition were analyzed in detail to ensure that we included only the ones that are indeed technology related. Furthermore, to ensure an unbiased coding of these data, we employed two research assistants (both graduate students) who were blind to the theory and hypotheses contained in this study. The research assistants were not aware of each other, and they attended different institutions. To assess the reliability of the underlying coding scheme, we had each research assistant independently code strategic alliance and acquisition data. The intercoder reliability was satisfactory because it was $r = 0.95$ for the acquisition data and $r = 0.88$ for the alliance data, both well above the suggested threshold of $r = 0.70$ (Cohen et al. 2003).

Level of Diversification. Since Rumelt's (1974) seminal work, a link between a firm's level of diversification and performance has been established. A detailed review of empirical research over the last three decades has validated a direct effect of diversification on firm performance (Palich et al. 2000). Moreover, Lubatkin et al. (2006) suggest that a firm's level of diversification influences the effectiveness of ambidexterity. Although we were unable to apply Rumelt's (1974) categorization for different degrees of diversification due to a lack of a firm's revenue breakdown by different SICs, we were able to control for the firm's level of diversification through counting the number of the different SIC codes at the three-digit level in which a firm is active. These data were obtained from the SEC disclosure database.

Economies of Scope. We not only controlled for the firm's level of diversification, but also assessed the relationship between different SIC codes in which the focal firm was active. This is pertinent because the extent of economies of scope that a firm can capture is an outflow of the type of diversification in which the firm engages (Rumelt 1974). The closer the SIC codes are related to one another, the greater the potential for economies of scope, which we operationalized formally as

$$Economies\ of\ Scope = 1 + \sum_{i=1}^{n}\sum_{j=1}^{n} comb_{i,j} \quad \forall\, i \neq j,$$

where $comb_{i,j}$ measures the sum of the relatedness between any combination of two SIC codes i and j across the SIC codes a firm is active in (n). For each combination, $comb_{i,j}$ assumes the value of 3 if the SIC codes are identical for the first three digits and different at the fourth digit. In the same fashion, $comb_{i,j}$ assumes the value of 2 if the SIC codes are identical for the first two digits and different at the third digit. The data to construct this measure were obtained from the SEC disclosure database.

Number of Technologies. Controlling for the number of technologies that a firm sources aids in strengthening the reliability of the different technology sourcing indices introduced above because a firm's technology sourcing data are necessarily aggregated to the firm level to assess their effect on different dimensions of firm performance. Moreover, the total number of technologies sourced by a firm is likely to influence its preference for internal versus external technology sourcing. These data were obtained from the survey respondents. We relied on a three-point Likert scale survey item, with 1 = fewer than 100 technologies, 2 = between 100 and 1,000 technologies, and 3 = more than 1,000 technologies.

Technological and Market Dynamism. The degree of dynamism that a firm experiences in its product markets is likely to have a direct bearing on the firm's performance. In particular, prior research has documented that the nature of technological change varies across different industries (Zahra 1996). We controlled for the rate of technological change that a firm faces by having the survey respondents indicate the rate of technological change that the firm is experiencing in its product markets on a seven-point Likert scale, with "slow" and "fast" as the anchors (*Technological Change*).

To create a construct to proxy for market dynamism, we drew upon three different items from the survey. These items assessed how long a firm's most important product remains profitable, how predictable a firm's product markets are, and whether a firm's market share is stable or volatile. Because these three survey items were, as expected, highly correlated, we conducted a factor analysis using principal components to identify fewer parsimonious constructs in the data set. The factor analysis of these data resulted in a single factor with an eigenvalue greater than 1.5, well above the recommended 1.0 cut-off point (Pedhazur 1997). All three items used in the factor analysis exhibited strong loadings (greater than 0.70) on this single factor, and the factor accounted for 51% of the variance. We standardized each dimension and then took the arithmetic average of the three items loading on the single factor to create the *Market Change* construct.

Estimation Procedure. When proxying firm performance by its financial performance, we estimated the regression models using ordinary least squares in Models 1–5. Here, we applied a Huber-White sandwich estimator, which corrects for heteroscedasticity and provides robust standard errors, and is thus considered to be a more conservative estimation procedure (Greene 1997). When proxying firm performance by its innovative performance, we estimated the regression model using a Poisson estimation (Models 6–10), because the dependent variable (number of patents) is a count variable taking on discrete nonnegative integer values, including zero. In particular, we applied the following specification of a Poisson regression model:

$$E(Patents_i/X_i) = e^{\beta X_i},$$

where $Patents_i$ is the expected number of patents assigned to firm i, and X_i is a vector of repressors containing the independent and control variables described above.

Furthermore, to allow for a meaningful comparison of the variables measured along different scales and to reduce potential collinearity, we standardized all independent variables before entering them into the regression models. Following Cohen et al. (2003), we standardized the variables for the interaction terms prior to creating the respective cross products. Although this procedure improves the interpretability of the data, it does not affect the significance levels of the beta coefficients. To assess the threat of collinearity, we estimated the variance inflation factors (VIFs), and found the average VIFs for all direct effect variables to be 1.87, with a maximum value of 3.84 when estimating firm financial performance, and 1.84, with a maximum value of 3.28 when estimating firm innovative performance. In both estimations, the VIFs were well below the recommended ceiling of 10 (Cohen et al. 2003).

Results

Table 1 depicts the descriptive statistics and bivariate correlation matrix. In regard to total technology sourcing combining known and new technology, the average sample firm sources 51% of its technology externally. When differentiating by type of technology, the average sample firm sources 46% of its known technology internally and 56% of its new technology externally. The coefficients of variance for the three different technology sourcing ratios range from 55% to 72%, indicating a fairly normally behaved distribution of the technology sourcing mix variables.

Table 2 presents the regression results when predicting firm financial performance (Models 1–5), whereas Table 3 presents the regression results when predicting firm innovative performance (Models 6–10). Models 1 and 6 depict the respective baseline models including all of the control variables as well as the moderating variable. As expected, the level of a firm's absorptive

Table 1 Descriptive Statistics and Bivariate Correlation Matrix

	Mean	St. dev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Firm financial performance	2.28	4.09																			
2. Firm Innovativeness	11.91	32.44	−0.001																		
3. Lagged firm financial performance	0.03	1.39	−0.036	0.005																	
4. Lagged firm innovativeness	9.70	21.35	0.010	0.769	0.056																
5. SIC 28 (chemicals and allied products)	0.18	0.38	−0.067	−0.085	0.015	−0.028															
6. SIC 35 (machinery and computer equipment)	0.10	0.30	−0.036	−0.072	−0.007	−0.095	−0.154														
7. SIC 36 (electronic, electrical equipment)	0.20	0.40	−0.077	−0.004	0.100	0.061	−0.231	−0.165													
8. SIC 38 (precision instruments)	0.23	0.42	0.079	0.044	0.074	0.008	−0.252	−0.180	−0.270												
9. Alliances	1.63	3.35	0.137	0.199	−0.321	0.159	−0.015	−0.049	−0.083	−0.102											
10. Acquisitions	2.26	3.07	0.037	0.584	−0.161	0.520	−0.069	−0.113	−0.076	−0.145	0.277										
11. Diversification	2.13	1.46	0.067	0.180	0.004	0.165	−0.119	0.002	−0.277	−0.027	0.106	0.347									
12. Economies of scope	3.07	5.49	0.059	−0.026	0.005	0.001	−0.098	−0.013	−0.156	−0.106	0.035	0.121	0.705								
13. Number of technologies	1.26	0.51	0.033	0.004	−0.079	0.109	−0.087	0.113	−0.110	0.027	0.271	0.058	0.144	0.171							
14. Technological change	3.73	1.62	0.010	0.123	−0.081	−0.016	−0.108	−0.049	0.256	0.067	0.019	0.026	−0.150	−0.213	−0.099						
15. Market change	3.79	0.74	−0.039	0.023	−0.044	−0.053	0.122	−0.048	0.136	−0.123	0.034	−0.166	−0.068	−0.047	0.017	0.132					
16. External focus in absorptive capacity	0.38	0.25	−0.011	−0.106	−0.113	−0.047	−0.160	−0.131	−0.007	0.062	−0.040	0.062	0.198	0.173	0.003	−0.097	−0.248				
17. Absorptive capacity	7.31	65.17	0.172	−0.003	−0.307	0.044	−0.042	−0.034	−0.037	−0.042	0.795	0.104	−0.062	−0.032	0.291	−0.033	0.003	−0.058			
18. (External/total) tech sourcing	0.51	0.28	0.078	0.052	0.026	0.031	0.026	0.017	0.037	−0.139	−0.103	0.105	0.049	0.015	−0.018	0.048	−0.128	0.248	−0.081		
19. (External/total) tech exploitation	0.46	0.33	0.067	−0.129	0.041	−0.021	0.072	−0.020	0.004	−0.170	−0.034	0.114	0.179	0.118	0.078	−0.057	−0.150	0.232	0.009	0.552	
20. (External/total) tech exploration	0.56	0.36	−0.032	0.035	−0.066	0.008	0.023	0.079	0.030	−0.228	−0.080	0.125	0.042	−0.011	−0.030	−0.035	−0.087	0.255	−0.058	0.595	0.218

Table 2 Relationship Between Technology Sourcing Mix and Firm Financial Performance

	Model 1 ROE	Model 2 ROE	Model 3 ROE	Model 4 ROE	Model 5 ROE
Constant	0.7012*** (0.0445)	0.6989*** (0.0433)	0.7682*** (0.0466)	0.7922*** (0.1207)	0.8240*** (0.1247)
Lagged firm financial performance	0.0325 (0.0359)	0.0428 (0.0372)	0.0379 (0.0364)	0.0268 (0.0428)	0.0220 (0.0418)
SIC 28 (chemicals and allied products)	−0.0630† (0.0405)	−0.0738* (0.0405)	−0.0758* (0.0409)	−0.0591† (0.0404)	−0.0638† (0.0424)
SIC 35 (machinery and computer equipment)	−0.0240 (0.0350)	−0.0326 (0.0371)	−0.0326 (0.0374)	−0.0191 (0.0354)	−0.0194 (0.0377)
SIC 36 (electronic, electrical equipment)	−0.1178* (0.0611)	−0.1193* (0.0599)	−0.1169* (0.0598)	−0.1168* (0.0609)	−0.1155* (0.0610)
SIC 38 (precision instruments)	−0.0874† (0.0674)	−0.0814 (0.0706)	−0.0889 (0.0728)	−0.0776 (0.0757)	−0.0867 (0.0782)
Firm innovativeness	−0.0343 (0.0587)	−0.0333 (0.0608)	−0.0295 (0.0613)	−0.0208 (0.0612)	−0.0099 (0.0637)
Alliances	−0.0700 (0.0680)	−0.0869 (0.0715)	−0.0768 (0.0734)	−0.0780 (0.0732)	−0.0759 (0.0771)
Acquisitions	0.0777 (0.0649)	0.0675 (0.0641)	0.0633 (0.0636)	0.0685 (0.0687)	0.0607 (0.0711)
Diversification	0.0355 (0.0851)	0.0346 (0.0854)	0.0211 (0.0879)	0.0380 (0.0836)	0.0344 (0.0860)
Economies of scope	0.0268 (0.0651)	0.0171 (0.0654)	0.0268 (0.0658)	0.0169 (0.0655)	0.0176 (0.0671)
Number of technologies	0.0128 (0.0386)	0.0191 (0.0382)	0.0213 (0.0386)	0.0026 (0.0449)	0.0058 (0.0466)
Technological change	0.0311 (0.0455)	0.0312 (0.0459)	0.0312 (0.0475)	0.0289 (0.0460)	0.0318 (0.0489)
Market change	0.0711 (0.1068)	0.0975 (0.1029)	0.0908 (0.1049)	0.0692 (0.1037)	0.0701 (0.1094)
External focus in absorptive capacity	0.0247 (0.0541)	0.0100 (0.0591)	−0.0063 (0.0587)	0.0126 (0.0641)	0.0019 (0.0664)
Absorptive capacity	0.1887*** (0.0568)	0.2108*** (0.0601)	0.9431* (0.5382)	0.1888*** (0.0589)	0.5338 (1.1475)
(External/total) tech sourcing		0.3266** (0.1270)	0.6125*** (0.1283)		
{(External/total) tech sourcing}^{2}		−0.2667** (0.1086)	−0.5079*** (0.1064)		
(External/total) tech sourcing × absorptive capacity			3.4378* (1.7736)		
{(External/total) tech sourcing}^{2} × absorptive capacity			−3.0389* (1.3742)		
(External/total) tech exploitation				0.0296 (0.0512)	0.0535 (0.1318)
{(External/total) tech exploitation}^{2}				−0.0104 (0.0566)	−0.2376* (0.1238)
(External/total) tech exploration				−0.0487 (0.0534)	0.1312 (0.1407)
{(External/total) tech exploration}^{2}				−0.0845 (0.0770)	0.1089 (0.1608)
(External/total) tech exploitation × absorptive capacity					0.2988 (1.4435)
{(External/total) tech exploitation}^{2} × absorptive capacity					−2.5336* (1.2908)
(External/total) tech exploration × absorptive capacity					1.9918† (1.3754)
{(External/total) tech exploration}^{2} × absorptive capacity					2.1501 (2.2452)
R^2	0.17	0.21	0.22	0.19	0.20
Partial F-statistic		3.24*	6.99***	0.36	1.22

Notes. Standard errors are in parentheses.
$^{\dagger}p < 0.10$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

Table 3 Relationship Between Technology Sourcing Mix and Firm Innovativeness

	Model 6 Patents	Model 7 Patents	Model 8 Patents	Model 9 Patents	Model 10 Patents
Constant	1.7907*** (0.0380)	1.7719*** (0.0389)	1.9554*** (0.0586)	1.7173*** (0.0615)	2.5902*** (0.0876)
Lagged firm innovativeness	0.3790*** (0.0211)	0.3994*** (0.0217)	0.4321*** (0.0226)	0.3663*** (0.0228)	0.5214*** (0.0299)
SIC 28 (chemicals and allied products)	−0.1106** (0.0457)	−0.1415** (0.0469)	−0.1667*** (0.0474)	−0.0566 (0.0477)	−0.1557** (0.0524)
SIC 35 (machinery and computer equipment)	−0.0177 (0.0462)	−0.0259 (0.0464)	−0.0417 (0.0466)	−0.0110 (0.0465)	0.0109 (0.0472)
SIC 36 (electronic, electrical equipment)	0.0025 (0.0458)	0.0009 (0.0460)	0.0048 (0.0464)	0.0460 (0.0471)	0.0632 (0.0514)
SIC 38 (precision instruments)	0.4342*** (0.0409)	0.4201*** (0.0412)	0.4025*** (0.0415)	0.4305*** (0.0429)	0.3838*** (0.0452)
Firm financial performance	0.0603* (0.0264)	0.0637** (0.0260)	0.0502* (0.0258)	0.0682** (0.0262)	0.0894*** (0.0263)
Alliances	0.6901*** (0.0292)	0.6753*** (0.0300)	0.7459*** (0.0328)	0.6638*** (0.0344)	0.8597*** (0.0512)
Acquisitions	0.2616*** (0.0316)	0.2561*** (0.0327)	0.2363*** (0.0331)	0.2284*** (0.0331)	0.0887** (0.0370)
Diversification	−0.1997*** (0.0490)	−0.2015*** (0.0490)	−0.2784*** (0.0507)	−0.1355** (0.0519)	−0.1966*** (0.0562)
Economies of scope	−0.0114 (0.0715)	−0.0353 (0.0730)	0.0316 (0.0722)	0.0103 (0.0722)	0.1359* (0.0703)
Number of technologies	0.1730*** (0.0290)	0.1543*** (0.0295)	0.1706*** (0.0302)	0.1692*** (0.0292)	0.1858*** (0.0303)
Technological change	0.2466*** (0.0309)	0.2468*** (0.0314)	0.2474*** (0.0313)	0.2238*** (0.0316)	0.2388*** (0.0323)
Market change	0.3265*** (0.0522)	0.3698*** (0.0536)	0.3406*** (0.0542)	0.1956*** (0.0565)	−0.0490 (0.0620)
External focus in absorptive capacity	−0.0625* (0.0334)	−0.0647* (0.0365)	−0.1332*** (0.0390)	−0.0783* (0.0377)	−0.2038*** (0.0429)
Absorptive capacity	−0.5792*** (0.0385)	−0.5627*** (0.0387)	1.5873** (0.5510)	−0.5271*** (0.0423)	12.2995*** (0.9208)
(External/total) tech sourcing		0.3611*** (0.1076)	1.0989*** (0.1617)		
{(External/total) tech sourcing}^{2}		−0.4291*** (0.1148)	−1.0218*** (0.1685)		
(External/total) tech sourcing × absorptive capacity			9.6766*** (1.6811)		
{(External/total) tech sourcing}^{2} × absorptive capacity			−8.3950*** (1.8688)		
(External/total) tech exploitation				−0.2160*** (0.0368)	−1.6214*** (0.1473)
{(External/total) tech exploitation}^{2}				0.0003 (0.0452)	0.2126† (0.1541)
(External/total) tech exploration				0.1834*** (0.0404)	1.2012*** (0.1432)
{(External/total) tech exploration}^{2}				0.0704† (0.0480)	−0.7261*** (0.1518)
(External/total) tech exploitation × absorptive capacity					−14.7358*** (1.5339)
{(External/total) tech exploitation}^{2} × absorptive capacity					0.4265 (1.6696)
(External/total) tech exploration × absorptive capacity					11.0701*** (1.5187)
{(External/total) tech exploration}^{2} × absorptive capacity					−8.7142*** (1.6199)
R^2	0.80	0.80	0.82	0.82	0.87
Partial F-statistic		7.07**	13.86***	15.24***	34.73***

Notes. Standard errors are in parentheses.
†$p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

capacity is positively correlated with the firm's financial performance (Model 1). Contrary to expectations, however, a firm's level of absorptive capacity is negative and statistically significant when predicting firm innovativeness (Model 6). In a post hoc analysis, we also inserted the squared term of absorptive capacity, and the results reveal that the relationship between absorptive capacity and firm innovative output is nonlinearly positive; moreover, the direct effect of absorptive capacity is no longer statistically significant.[9] Also noteworthy is the fact that absorptive capacity exerts a positive and statistically significant effect on a firm's innovativeness when assessing the moderation effects between absorptive capacity and overall technology sourcing mix ($p < 0.01$ in Model 8) and between absorptive capacity and technology exploration ($p < 0.001$ in Model 10). These results provide initial evidence that it is appropriate to look at absorptive capacity as the moderator variable in the relationship between technology sourcing mix and firm performance.

To test the theoretical model we have developed, we applied hierarchical moderated regression. Moderated regression is a relatively conservative method for examining interaction effects because the interaction terms are tested for significance after all lower-order effects, including absorptive capacity, have been entered into the regression equation (Jaccard et al. 1990). Moderation effects are supported only if the model containing the interaction terms represents a statistically significant improvement over the model containing the direct effects (Baron and Kenny 1986). This is indeed the case for Models 2 and 3 when predicting firm financial performance ($p < 0.05$ and $p < 0.001$, respectively), and for Models 7–10 when predicting firm innovative performance ($p < 0.01$ or smaller).

In Hypothesis 1, we suggested that the relationship between a firm's technology sourcing mix of known and new technology and its performance is an inverted U-shape, implying that ambidexterity in technology sourcing enhances the firm's financial and innovative performance. In Models 2 and 7, because the linear terms for technology sourcing mix are positive and significant, whereas the squared terms for technology sourcing mix are negative and significant ($p < 0.01$ in Model 2 and $p < 0.001$ in Model 7), we find support for our hypothesis.

In Hypotheses 1A and 1B, we differentiated a firm's overall technology sourcing mix, and investigated an ambidexterity hypothesis in technology sourcing along known and new technology separately. We do not find support for either hypothesis based on the results reported in Models 4 and 9. When predicting firm financial performance (Model 4), none of the hypothesized coefficients reach statistical significance; neither is the overall model an improvement over the baseline (Model 1). When predicting firm innovative performance (Model 9), however, the results indicate opposing forces of exploitation and exploration: a firm's external focus in technology exploitation is negatively related to innovativeness, whereas a firm's external focus in technology exploration is (nonlinearly) positively related to innovativeness. Although we fail to find support for an ambidexterity hypothesis in technology sourcing by technology type alone, the results, taken together, suggest that firms enhance their innovative performance when they focus internally on exploitation through the sourcing of known technologies and externally on exploration through the sourcing of new technologies.

In Hypothesis 2, we proposed that a firm's absorptive capacity moderates the inverted U-shaped relationship between technology sourcing mix and firm performance so that the positive effect of ambidexterity in technology sourcing on firm performance is stronger when the firm possesses higher levels of absorptive capacity. To test this hypothesis, we inserted the interactions between the technology sourcing variables (linear and squared terms) and absorptive capacity in Model 3 when predicting firm financial performance, and in Model 8 when predicting firm innovativeness. The results obtained support Hypothesis 2. In both models, the results reveal that the interaction between the linear technology sourcing term and absorptive capacity is positive and significant, whereas the interaction between the squared technology sourcing term and absorptive capacity is negative and significant ($p < 0.05$ in Model 3 and $p < 0.001$ in Model 8). These results imply that the relationship between the technology sourcing mix of known and new technology and firm performance remains an inverted U-shape when assessing the moderating effect of absorptive capacity. As predicted, absorptive capacity moderates this relationship in such a fashion that the positive effect of ambidexterity in technology sourcing on firm performance is stronger when the firm possesses higher levels of absorptive capacity. It is also noteworthy that this relationship holds for predicting both firm financial and firm innovative performance.

In Hypotheses 2A and 2B, we assessed the moderating effect of absorptive capacity on the relationship between technology sourcing of known and new technology, respectively, and firm performance. We do not find support for either Hypothesis 2A or 2B when predicting firm financial performance (Model 5), because inserting the respective moderating effects does not lead to the required significant improvement in model fit over the baseline (Model 1). When assessing the moderating effect of absorptive capacity on the relationship between different types of technology (known and new) and firm innovative performance, we find that we must reject Hypothesis 2A, because absorptive capacity moderates the relationship between external technology exploitation and firm innovative performance in a negative fashion (Model 10). However, we accept Hypothesis 2B, because the interaction between the linear term of external technology exploration and absorptive capacity is positive and significant, whereas the interaction between the squared external technology exploration term and absorptive capacity is negative and significant (both at $p < 0.001$ in Model 10). These results imply that the relationship between external technology exploration and firm innovative performance remains an inverted U-shape when assessing the moderating effect of absorptive capacity. That is, absorptive capacity moderates this relationship in such a fashion that the positive effect of ambidexterity in technology exploration on firm innovativeness is stronger when the firm possesses higher levels of absorptive capacity.

To gain further insights into the moderating effect of absorptive capacity on ambidexterity in technology sourcing, we plotted the significant results obtained in Models 3 and 10, which are depicted in Figures 3 and 4.[10] In support of Hypothesis 1, both graphs illustrate the underlying inverted U-shaped relationship between technology sourcing mix and firm performance. Moreover, the figures reveal that absorptive capacity exerts a positive moderating effect on the technology sourcing-firm performance relationship. Figure 3 provides visual support for Hypothesis 2, which postulates that the effect of ambidexterity in technology sourcing on firm performance is stronger when the firm possesses higher levels of absorptive capacity. This relationship also holds when considering a firm's technology exploration, thus Figure 4 lends graphical support for Hypothesis 2B. Both figures demonstrate that ambidexterity in technology sourcing becomes much more critical to firm performance when a firm possesses higher levels of absorptive capacity. This relationship is highlighted by the fact that the slopes in the inverted U-shaped technology sourcing mix-firm performance relationship become much steeper as a firm's absorptive capacity increases. In other words, a high level of absorptive capacity does not only allow a firm to pursue ambidexterity in technology sourcing, but also enables it to more fully capture the benefits inherent in ambidexterity.[11]

Figure 3 **Moderating Effect of Absorptive Capacity on Relationship Between Technology Sourcing Mix and Firm Financial Performance**

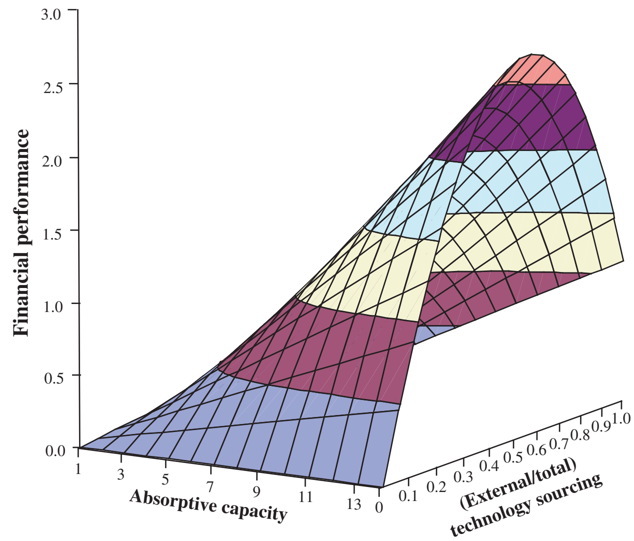
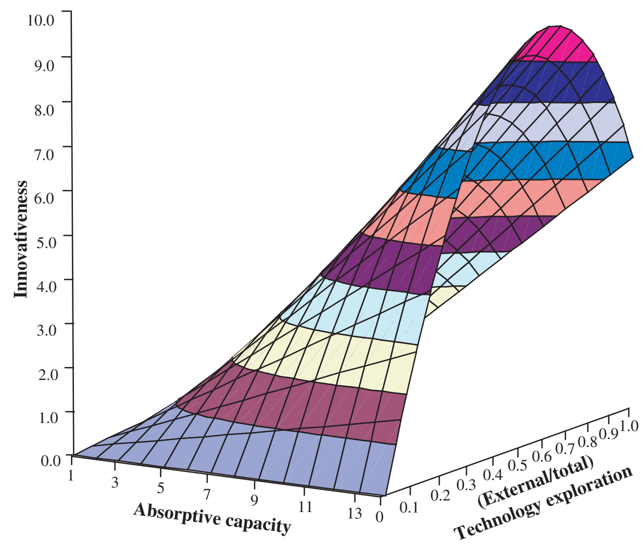


Figure 4 **Moderating Effect of Absorptive Capacity on Relationship Between Technology Exploration and Firm Innovativeness**



Discussion

Based on an understanding of ambidexterity as a firm's ability to simultaneously balance different activities in a trade-off situation (Gibson and Birkinshaw 2004), we develop and test a theoretical model linking ambidexterity in technology sourcing to firm performance. Our baseline hypothesis is that there is an inverted U-shaped relationship between a firm's technology sourcing mix and firm performance, which in turn implies that pursuing ambidexterity in technology sourcing enhances firm performance. We find strong support for this relationship when testing it on a random multi-industry sample of U.S. manufacturing companies and assessing firm performance along both innovative and financial dimensions. Our results resonate with the few prior empirical studies that have investigated an ambidexterity hypothesis in different contexts (e.g., Lubatkin et al. 2006, Sidhu et al. 2007). For example, Tushman et al. (2006) demonstrate benefits to ambidexterity in exploration and exploitation when generating a stream of both incremental and radical innovations, whereas He and Wong (2004) provide evidence that ambidexterity in exploiting existing product market positions versus exploring new product market domains enhances sales growth.

Although deriving the normative recommendation that ambidexterity in technology sourcing has performance benefits has intuitive appeal, accomplishing ambidexterity is far from being a trivial managerial exercise. The difficulty lies in the fact that ambidexterity in technology sourcing not only requires firms to address the documented trade-offs when pursuing exploration and exploitation simultaneously (O'Reilly and Tushman 2007, Raisch 2008), but also to address the trade-offs that arise when combining internal and external technology sourcing (Figure 1). When investigating ambidexterity in technology sourcing, we emphasize two areas from which potential trade-offs can emerge: (1) internal versus external technology sourcing, and (2) sourcing of known technology (exploitation) versus sourcing of new technology (exploration).

Although we explicitly consider two dimensions of ambidexterity, it is important to note that we go beyond an ambidexterity–firm performance relationship when we theorize that a firm's absorptive capacity moderates the underlying curvilinear relationship. We thus attempt to mitigate a relative theoretical and empirical dearth in ambidexterity research, which resonates with Raisch and Birkinshaw's (2008, pp. 7, 19) observation that "despite the rapidly expanding number of studies referring to organizational ambidexterity, empirical tests of the ambidexterity-performance relationship remain scarce," and studies on "more complex relationships moderated by additional variables are [even] scarcer." Accordingly, we advance a contingency perspective as we propose that a firm's absorptive capacity exerts a positive moderating effect on the ambidexterity–firm performance relationship. We find that firms with greater levels of absorptive capacity obtain commensurately greater benefits from ambidexterity in technology sourcing. This is because greater levels of absorptive capacity allow these firms to not only mitigate the tensions arising from a simultaneous pursuit of exploration and exploitation in a technology strategy that combines internal and external sources, but also to harness the spillovers that are generated when pursuing ambidexterity along these two different dimensions.

Our results imply that absorptive capacity allows a firm to balance and reconcile seemingly contradictory tensions arising from the simultaneous pursuit of internal and external technology sourcing of known and new technology. In short, absorptive capacity is the fulcrum that allows firms to leverage ambidexterity. Not only do the results underscore that the performance-enhancing effects of ambidexterity in technology sourcing are stronger in the presence of higher levels of absorptive capacity, they also illustrate that ambidexterity itself becomes more important. Along with higher levels of absorptive capacity, it becomes necessary to strike a balance between the inward- and outward-looking components of absorptive capacity because of the accompanying performance discounts caused by an imbalance (Cohen and Levinthal 1990). For example, a dominance of inward-looking absorptive capacity frequently leads to the pathology of the not-invented-here syndrome (Katz and Allen 1982), whereas a dominance of outward-looking absorptive capacity can lead to a hollowing out of a firm's competencies (Hamel 1991). The ability to effectively balance the two different components of absorptive capacity allows a firm to integrate diverse sources of knowledge, which Grant (1996, p. 375) postulated to be "the essence of an organizational capability."

Consistent with the prediction based on the organizational ambidexterity construct, the results are strongest when investigating a firm's overall technology strategy that combines the sourcing of known and new technologies through internal and external sources simultaneously. Our fine-grained analysis along organizational and technological boundaries allows us to differentiate tensions emanating from the simultaneous pursuit of internal and external technology sourcing versus tensions emanating from sourcing new versus known technology. The results indicate that a stronger internal tension exists when both types of technology (new and known) are procured concurrently in a firm's technology sourcing strategy. The strong evidence pointing to the benefits of ambidexterity are likely due to a firm's ability to harness the tension arising through engaging in explorative (i.e., sourcing of new technology) and exploitative (i.e., sourcing of known technology) activities simultaneously. This implies that the tension generated from sourcing known *or* new technology in isolation seems less than that of pursuing known *and* new technology simultaneously from internal and external sources. Accordingly, when differentiating the results by technology type (known versus new), we find support only for the moderating effect of absorptive capacity when considering explorative activities of sourcing new technology, whereas support for a positive moderating effect is strong and consistent in a firm's overall technology strategy that combines known and new technology from internal and external sources.

Limitations and Future Research

As with any study that sets out to expose theoretical propositions to empirical falsification (Popper 1959), this study contains several limitations, which in turn open the path for future research. We focus here on tensions that arise from a firm's overall internal-external technology sourcing strategy of known and new technology, and then differentiate this relationship by technology type (known versus new technologies). In essence, we tested the horizontal combinations of the theoretical model advanced and depicted in Figure 1. Although this allows us to identify the source of internal tensions as mainly emanating from a simultaneous pursuit of exploring new technology and exploiting known technology through a combination of internal and external knowledge sources, we expect that looking at exploration-exploitation combinations along the diagonals in Figure 1 will yield additional theoretically interesting alternative combinations that are likely to create significant internal organizational tensions. This is exemplified by technology strategies that focus on (1) internal sourcing of known technology (exploitation) combined with external sourcing of new technologies (exploration), and (2) internal sourcing of new technology (exploration) combined with external sourcing of known technology (exploitation). The additional theoretical exposition of ambidexterity in technology sourcing noted here is ripe for future empirical investigation.

Although the notion that balancing internal and external technology enhances firm performance along different dimensions has general appeal, further research should test the ambidexterity hypothesis in different research settings and time periods to enhance the external validity of the findings presented here. Although the generalizability of our findings can certainly be strengthened, we emphasize that, because we drew on a random multi-industry sample, the results of this study are more generalizable than ones that would have been obtained from a single-industry study. Finding significant results that hold across different industrial sectors represents a more conservative approach than obtaining significant results based on a single-industry sample (Hitt et al. 1998).

The temporal dynamics of technology sourcing also need to be addressed. Questions like, "How does a firm's technology sourcing mix change over time, and how is it affected by the dynamism inherent in the industry's environment?" provide fruitful avenues for future research. One would expect that a performance-enhancing technology sourcing mix changes during the life cycle of an industry and is also contingent upon environmental dynamism. Given higher levels of absorptive capacity, frequently found in technology-intensive industries, achieving and maintaining ambidexterity in technology sourcing becomes a strategic imperative, because failure to do so can result in significant performance penalties. This finding resonates with recent research that the likelihood of ambidexterity is higher in more dynamic environments (Raisch 2008), leading us to suggest that the need for organizations to achieve ambidexterity is positively correlated with the dynamism of the respective environment. This proposition presents a valuable point of departure for future research. A coevolutionary perspective (Lewin et al. 1999) appears to be a promising theoretical lens through which researchers can tackle some of these interesting questions.

Finally, although the theoretical model advanced above and depicted in Figure 1 is based on two important demarcation lines (organizational and technological boundaries), it is important to note that using a dichotomous perspective does not allow for a deeper understanding of sourcing dimensions that can also be captured by a continuum. For example, based on the theoretical model advanced in this paper, a joint development project would be, by definition, classified as external technology sourcing. Future research can help to complement our model by developing and testing a theoretical framework that is built on continuous rather than dichotomous dimensions when further illuminating the ambidexterity construct.

Conclusions

Taken together, our findings have a number of important managerial implications. First, managers should consider that although ambidexterity in technology sourcing appears to enhance both firm innovative and financial performance, an overly strong reliance on either internal or external technology sourcing can have negative performance implications. This implies that managers should create and maintain a complex organizational design that not only enables firms to effectively engage in potentially conflicting activities simultaneously, but also allows them to combine short-term alignment with long-term adaptability (Tushman and O'Reilly 1996, Raisch 2008). Our managerial recommendation for dynamically balancing strategic alternatives seems to hold not only in the area of technology sourcing investigated here, but also in other important strategic areas such as growth, change, leadership, and organizational culture. This has been demonstrated by Probst and Raisch's (2005) in-depth study of 100 strategic mega failures that destroyed over $2.5 trillion due to managerial reliance on extremes along different strategic continuums rather than on attempts to balance important trade-offs. It appears that achieving balance in regard to a number of strategic leverage points allows firms to not only avoid premature failure, but may also lay the foundation for enhanced performance, providing further support for extending the ambidexterity construct beyond an exploration-exploitation trade-off.

Second, ambidexterity in technology sourcing is a necessary, but not solely sufficient, condition for improving firm performance. The spillovers between internal and external technology sourcing, among other benefits, are not automatic. It takes an appropriate level of absorptive capacity to proactively harness the benefits derived from ambidexterity in technology sourcing, as spillovers inherent in internal and external technology sourcing synergistically reinforce one another in the presence of higher levels of absorptive capacity. Although higher levels of absorptive capacity allow managers to take advantage of ambidexterity in technology sourcing, maintaining a balance between internal and external technology becomes a much more important task at higher levels of absorptive capacity because the penalties in terms of performance loss due to an imbalance in technology sourcing strategy are much more pronounced.

In conclusion, one must consider that enhanced firm performance requires a balance between internal and external technology sourcing of known and new technology, yet "the precise mix of exploitation and exploration that is optimal is hard to specify" (Levinthal and March 1993, p. 105). Therefore, we suggest that achieving and maintaining an internal-external technology sourcing mix matched with a commensurate absorptive capacity to attain enhanced firm performance can be considered a firm-level dynamic capability, because it is reflective of a "firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al. 1997, p. 516). In more general terms, ambidexterity is a dynamic capability when a firm is effective in strategically integrating a simultaneous pursuit of exploration and exploitation through combining internal and external sources of technology. Organizational ambidexterity, however, is not simply achieved through organizational structure, but requires a shared vision, a common set of values, and a reward system that enables managers to resolve the paradox of ambidexterity and harness its benefits (O'Reilly and Tushman 2007).

Balancing internal and external technology sourcing along the exploration-exploitation dimensions is a challenging but necessary task for managers (Smith and Tushman 2005), because "maintaining an appropriate balance between exploration and exploitation is a primary factor in system survival and prosperity" (March 1991, p. 71). Ambidexterity in technology sourcing not only requires successful balancing of exploration and exploitation, but also successful balancing of internal and external technology sourcing. This, in turn, implies that the routines, processes, and skills that firms need to have in place are fundamentally different depending on the type of tension emanating from different dimensions of organizational ambidexterity (Raisch 2008).

We close by echoing the recent conceptual insight offered by O'Reilly and Tushman (2007, p. 9) emphasizing that ambidexterity is a "senior team capability [that] may be a key discriminator between those firms that thrive as environments shift versus those that do not" (see also Klarner et al. 2008, Lubatkin et al. 2006). Because a firm's technology sourcing strategy and the level of its ongoing R&D spending are largely determined by its senior managers, who were also the targets of our survey, we provide some initial evidence for the necessity for and benefits of ambidexterity when looking at the relationship between technology sourcing strategy, absorptive capacity, and firm performance. When harnessed appropriately, ambidexterity in technology sourcing can enable a firm to dynamically reconfigure and leverage internal and external knowledge resources, paving the way for enhanced financial and innovative performance.

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Endnotes

[1]"The simple idea behind the value of ambidexterity is that the demands on an organization in its task environment are always to some degree in conflict (for instance, investment in current versus future projects, differentiation versus low-cost production), so there are always trade-offs to be made. Although these trade-offs can never entirely be eliminated, the most successful organizations reconcile them to a large degree, and in so doing enhance their long-term competitiveness" (Gibson and Birkinshaw 2004, p. 209). For a review and synthesis of the ambidexterity literature as well as a comprehensive model of the antecedents, moderators, and outcomes of organizational ambidexterity, see Raisch and Birkinshaw (2008).

[2]*Merriam-Webster's Collegiate Dictionary* (3rd ed.) and *American Heritage Dictionary* (4th ed.).

[3]Source: U.S. Patent and Trademark Office (http://www.uspto.gov/).

[4]IBM itself provides an interesting case study of how it developed ambidextrous capabilities (see Harreld et al. 2007, Wood et al. 2007).

[5]The Bureau of Economic Analyses of the U.S. Department of Commerce defines the manufacturing sector as the firms active in the SIC system between SIC 2000 and SIC 3999: Food and Kindred Products (SIC 20); Tobacco Products (SIC 21); Textile Mill Products (SIC 22); Apparel, Finished Products from Fabrics and Similar Materials (SIC 23); Lumber and Wood Products except Furniture (SIC 24); Furniture and Fixtures (SIC 25); Paper and Allied Products (SIC 26); Printing, Publishing and Allied Industries (SIC 27); Chemicals and Allied Products (SIC 28); Petroleum Refining and Related Industries (SIC 29); Rubber and Miscellaneous Plastic Products (SIC 30); Leather and Leather Products (SIC 31); Stone, Clay, Glass, and Concrete Products (SIC 32); Primary Metal Industries (SIC 33); Fabricated Metal Products, except Machinery and Transport Equipment (SIC 34); Industrial and Commercial Machinery, and Computer Equipment

(SIC 35); Electronic, Electrical Equipment and Components, except Computer Equipment (SIC 36); Transportation Equipment (SIC 37); Measuring, Analyzing and Controlling Instruments; Photographical, Medical, Optical Guidance; Watches, Clocks (SIC 38); Miscellaneous Manufacturing Industries (SIC 39).

[6]Although it is widely accepted in the literature to use patents as a proxy for firm-level innovativeness, technically speaking, patents are a proxy for firm inventiveness.

[7]Because the percentage of external technology sourcing is bound between 0 and 1, it follows that the percentage of internal technology sourcing is the inverse of external technology sourcing and equals (1 − external technology sourcing). This relationship is true also for the type of technology sourced as detailed immediately below.

[8]In the regression analysis, we used R&D expenditures rather than R&D intensity (R&D expenditures divided by revenues), because financial ratios as independent variables obscure their effects on the dependent variables, due to the fact that a ratio combines two different variables as numerator and denominator, respectively. In general, when applying ratios as independent variables, it is quite difficult to disentangle whether their joint effect is based on the numerator as hoped for, or driven by the denominator. To overcome this potential bias, linear coefficients are preferred over ratios as independent variables because they enhance the clarity in attribution when interpreting the regression coefficients (Pedhazur 1997). As an illustration, although absolute R&D expenditures tend not increase in a constant fashion with firm size, it does not follow that larger firms have a lower R&D productivity than smaller firms, because larger firms are, for example, able to spread the fixed cost of R&D, e.g., maintaining a laboratory of a necessary threshold size, over a larger R&D activity. The larger firms' returns to R&D, therefore, may actually increase rather than decrease, as one could incorrectly conclude when using, ceteris paribus, an R&D intensity measure (e.g., R&D expenditures divided by revenues) instead of straight R&D expenditures (Cohen and Klepper 1996).

It is important to note that Cohen and Levinthal (1989, 1990) used R&D expenditures divided by revenues as their proxy for absorptive capacity because it was the dependent variable of their study, rather than an independent variable, as in our study. Whereas the use of financial ratios as independent variables is discouraged, employing financial ratios as dependent variables has several benefits, some of which we have described above. Thus, Cohen and Levinthal's (1989, 1990) use of R&D intensity as a proxy for absorptive capacity is methodologically similar to our use of ROE as a proxy for firm financial performance, because firm size is implicitly controlled for due to the use of a size-adjusted ratio as the dependent variable. However, when using absorptive capacity as an independent variable, the preferred approach is to use a direct measure like R&D expenditures, while using a size-adjusted dependent variable like ROE. Our use of a direct-effect measure, rather than a ratio, affords a more straightforward interpretation of the results, especially in light of the fact that absorptive capacity is the moderating variable in this study.

[9]Due to space constraints, these results are not reported in this paper, but are available from the first author upon request.

[10]Due to space constraints, we do not include a graphical depiction of third set of significant moderation results obtained in Model 8. This graph is similar in shape to the ones depicted here, and is available upon request from the first author.

[11]*Sensitivity Analyses*. We explored the robustness of the results presented above in several additional analyses. In all of the following, the results remained robust:

- We explicitly controlled for firm size by inclusion of a firm's revenues. Similar to the lagged performance index, we obtained annual firm revenue data from Compustat for the five-year time period between 1995 and 1999. We then averaged these data to assuage annual fluctuations. For clarity, we prefer to present the results in the paper as they are, because (1) they do not change if an additional explicit control for firm size, like revenues, is included; (2) firm financial performance is proxied by ROE, a size-adjusted ratio; and (3) the expected high correlation between R&D expenditures and firm size.
- We proxied absorptive capacity by R&D intensity (R&D expenditures/revenues).
- We explicitly controlled for (1) industry-level R&D expenditures proxied by R&D expenditures, and for (2) industry-level R&D intensities proxied by R&D expenditures divided by revenues. We constructed the industry-level controls at two-digit SICs.
- We inserted an indicator variable for firms in high-tech industries (defined as SICs 25, 35, or 38), instead of the four different industry indicator variables currently employed.
- We defined external technology sourcing as any technology developed with the help of an external source. In the case of multidivisional corporations, we also assessed whether the results are robust to defining external technology sourcing to obtaining technology from outside an SBU but within the larger corporation. There was no significant difference in results when defining external technology sourcing as external to the SBU or external to the corporation.
- The results for firm financial performance remain robust to shortening the time window. As the time frame for measuring firm financial performance, however, is extended from currently four years to five and even six years, the significance of the results for firm financial performance wanes. In contrast, the results for firm innovative performance are somewhat sensitive to shortening the window for obtaining patents from four to two years. The results, however, are robust to extending the window for obtaining patents from four to six years.

Any unreported regression results are available from the first author upon request.

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