PATHWAY TO ORGANIZATIONAL AMBIDEXTERITY: WHY AND HOW FIRM EXPLOITATION PROMOTES ITS FUTURE EXPLORATION

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Abstract

This paper addresses the challenge that firms face in pursuing organizational ambidexterity because of the tendency for firm exploitation to crowd out firm exploration. Overcoming this challenge, this paper outlines why and how firm exploitation promotes its future exploration in the context of the firm’s product innovation process. March’s (1991) exploration-exploitation choice multitheoretical perspectives are employed to identify exploration and exploitation as distinct innovation learning processes that produce unique innovation outcomes: exploration creates product invention while exploitation generates product adoption and product innovation. This paper explains why firms choose to invest in either future exploration or future exploitation, and how experiential learning gained through exploitation is transformed, through the knowledge evolution cycle of variation, selection, replication and retention within the product innovation process, into knowledge/experience needed for future exploration. This paper contributes to organizational learning and innovation theories in three ways by: (1) demonstrating that March’s multitheoretical perspectives provide a rich context for identifying the series of strategic innovation decisions and intraorganizational pathway that explain why and how firm exploitation promotes its future exploration, thus facilitating development of organizational ambidexterity; (2) highlighting exploitation’s experiential learning and the knowledge evolution cycle as the necessary condition for transforming experience into knowledge/experience required for exploration and achieving organizational ambidexterity; and (3) emphasizing investment of firm resources in absorptive capacity relative to complementary assets as the sufficient condition for developing such knowledge/experience and maintaining organizational ambidexterity. This paper contributes to ambidexterity scholarship by reconciling four tensions cited by scholars as impeding further ambidexterity research.
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Introduction

Organization Science recently published a special issue on organizational ambidexterity, the ability of firms to simultaneously balance and combine exploration and exploitation necessary for their enhanced innovation and performance (Andriopoulos and Lewis 2009, Cao et al. 2009). At the firm level of analysis, the special issue’s articles are silent regarding March’s (1991) concern that over time firm exploitation may crowd out firm exploration (Levinthal and March 1993, March 2006), and thus eliminate organizational ambidexterity and diminish innovation rates among established firms. While there is some evidence to support this concern (e.g., Sørensen and Stuart 2000), there is also support for the opposite view (e.g., Chandy and Tellis 2000, Sorescu et al. 2003). Taking a view different from March’s (1991), some scholars have asserted that exploitation promotes future exploration (Cao et al. 2009, Holmqvist 2004, Zollo and Winter 2002), thus maintaining organizational ambidexterity and firm innovativeness. This paper tests this assertion by asking: Why and how can firm exploitation promote its future exploration?

Absent from the literature today is identification of a specific, intraorganizational pathway that shows how experiential learning from exploitation promotes knowledge/experience required for future exploration. To identify such a route, three necessary steps are taken. First, to establish a foundation for this experience-to-knowledge/experience path, this paper defines exploitation and exploration as distinct learning processes that produce unique outcomes within the specific context of the firm’s product innovation process. Second, this paper identifies key constructs that comprise the firm’s product innovation process and relates them to exploration and exploitation. Third, this paper takes an evolutionary view over time and identifies a series of strategic innovation decisions within the product innovation process, as well as a specific path through it, that respectively explain why and how experiential learning from exploitation leads to knowledge/experience required for future exploration and organizational ambidexterity.

This paper contributes to organizational learning and innovation theories in several ways. First, this paper demonstrates that the multitheoretical base established by March (1991) in his seminal article
on the exploration-exploitation dichotomy provides a rich context for identifying the series of strategic innovation decisions and intraorganizational pathway that explain why and how firm exploitation promotes its future exploration and develops organizational ambidexterity. Second, this paper highlights the importance of experiential learning gained from exploitation and the knowledge evolution cycle (Zollo and Winter 2002) as the necessary condition for the transformation of experience into knowledge/experience required for exploration and achieving organizational ambidexterity. Third, this paper emphasizes the investment of firm resources in absorptive capacity relative to complementary assets as the sufficient condition for the development of knowledge/experience required for exploration and maintaining organizational ambidexterity. This paper also contributes to ambidexterity scholarship by reconciling four tensions cited by scholars as impeding further research progress in that field.

**Literature Review**

A review of the organizational learning and innovation literature uncovers the origins of an exploitation-exploitation pathway in the product innovation process. Five salient literature topics are explored: (1) exploration and exploitation are clarified as distinct innovation learning processes that respectively produce outcomes of product invention and product adoption/innovation; (2) March’s (1991) four theoretical perspectives of exploration and exploitation provide a foundation for a product innovation process theory and (3) suggest constructs for the product innovation process framework; (4) Zollo and Winter’s (2002) knowledge evolution cycle across functional domains over time suggests a mechanism how innovation-related experience can influence future invention-required knowledge/experience; and (5) a review of the innovation literature finds positive effects where product innovation-related experience influences future product invention-required knowledge/experience.

**Exploration and Exploitation as Innovation Learning Processes**

March (1991, p. 72) views the twin organizational learning processes of exploitation as the “refinement of an existing technology” and exploration as the “invention of a new one.” While March (1991) associates exploration with innovation, it is because he (Levinthal and March 1993, p. 106) employs innovation in broad terms, encompassing both product invention (“[m]ost new ideas are bad ones, so most innovations
are unrewarding ("successful innovations, when first introduced"). March (1991) connects exploration with the outcome of variation achieved by the process of learning from knowledge search and discovery, while linking exploitation with the outcome of selection gained by learning from experience in refinement and implementation. Levinthal and March (1993) echo the role that experiential learning plays in successfully exploiting inventions (new ideas) by introducing innovations. Experiential learning, or "learning by doing" (Argote et al. 1990, p. 141), is a process involving existing knowledge, perception, cognition and experience where knowledge is created through the transformation of experience (Corbett 2005, Kolb 1984). Hence, exploration and exploitation are seen as different learning processes that produce different types of outcomes. While exploration and exploitation by themselves are orthogonal (independent) because knowledge can be an infinite resource (Gupta et al. 2006), their employment requires scarce resources, such as management attention, capital and facilities, and thus they act as competitors along a continuum; hence, scarce resources can promote internal selection pressures that often drive the selection of exploitation over the variation of exploration (March 1991).

**Exploration-Exploitation Choice Theoretical Perspectives**

March (1991, p. 72) offers four theoretical perspectives about the choice between exploration and exploitation: (1) rational-choice models (Simon 1955) that employ a "theory of rational search" (March and Simon 1958); (2) limited-rationality theories (Simon 1955) that involve the "role of targets or aspiration levels in regulating allocations to search" (Cyert and March 1963, Kahneman and Tversky 1979); (3) organizational learning studies that distinguish "between refinement of an existing theory and invention of a new one" (Levinthal and March 1981); and (4) evolutionary models that involve "balancing the twin processes of variation and selection" (Campbell 1965). March’s (1991) four theoretical perspectives together constitute this paper’s theoretical foundation.

*Rational Search.* March’s (1991) exploration-exploitation choice perspective of rational search addresses different types of knowledge and learning associated with exploration and exploitation. March (Levinthal and March 1993; March 1991) and other scholars link knowledge search and discovery to exploration while relating experiential learning to exploitation (Baker and Sinkula 2007, Gavetti and Levin-
thal 2000, Rosenkopf and Nerkar 2001, Vermeulen and Barkema 2001). Scholars have identified two key dimensions in the functional knowledge search space: functional knowledge and knowledge search. Functional knowledge consists of three value-chain domains: basic science, technology and product markets (Cohen and Levinthal 1989, Jansen et al. 2006, Rothaermel and Deeds 2004). Knowledge search includes no search (experiential learning), local search, and distant search; exploitation happens when there is no knowledge search, while exploration occurs when there is local or distant knowledge search (Baker and Sinkula 2007, Gavetti and Levinthal 2000, March 1991, Rosenkopf and Nerkar 20011, Vermeulen and Barkema 2001). Because of different value-chain domains, no, local and distant knowledge searches can take place in the three domains and, since these learning activities are independent (orthogonal) and interacting (Gupta et al. 2006), they can occur simultaneously to produce various knowledge/experience combinations that yield different kinds of product inventions (Fleming 2001, Kogut and Zander 1992, Schumpeter 1934). Hence, exploration and exploitation across different domains can coexist within the same firm (Lavie and Rosenkopf 2006), thereby supporting organizational ambidexterity.

Limited Rationality. March’s (1991) exploration-exploitation choice perspective of limited rationality (Simon 1955) compares aspiration levels with performance levels in light of slack and other resource constraints (Cyert and March 1963). The limited-rationality perspective assumes that search is constrained (exploitation) if the most preferred alternative is above but near target aspiration levels, and that search is stimulated (exploration) if the most preferred alternative is below target aspiration levels (March 1991, March and Simon 1958).

As catalysts for organizational change, innovations are jointly determined by three factors: motivation to change, opportunity to change and capability to change (Greve 1998, Greve and Taylor 2000). For motivation to change, firm performance feedback employs gaps between performance levels and aspiration levels to recognize problems and take actions. If performance is above aspiration levels, firms choose status quo or low-risk alternatives, and innovations decrease in frequency (Greve 2002). If performance falls below aspiration levels, firms engage in solution searches (Cyert and March 1963), and tend to select riskier courses of actions, e.g., innovations (Bromiley 1991, Kahneman and Tversky 1979).
About *opportunity to change*, organizations are constrained by availability of their resources, especially organizational slack levels (Audia and Greve 2006). Actions resulting from performance below aspiration levels are moderated by the presence or absence of organizational slack, respectively leading to either greater risk-taking (Cyert and March 1963) or less risk-taking (Audia and Greve 2006). For *capability to change*, firm internal and external selection environments influence the rate at which competing routines succeed each other (Greve 2002). The number and relative strengths of competitors in markets directly affect the strength of external selection pressures on firms (Greve 2002).

*Organizational Learning.* March’s (1991) third exploration-exploitation choice perspective distinguishes between inventing a new technology that requires exploration of new alternatives (variety) and refinement of existing technology as exploitation that requires improvement in competence in existing routines (reliability; Holmqvist 2004, March 1991). The outcomes of invention and innovation have often been conflated (Fleming 2001), even though Schumpeter (1939) states that invention and innovation are two separate processes, and that invention and innovation are independent outcomes (Schumpeter 1934). This paper joins other scholars by distinguishing between invention as the discovery of new knowledge and the process of commercializing inventions as innovation (Hill and Rothaermel 2003, Schumpeter 1934).

If one connects exploration with variation and exploitation with selection as March (1991) did, and notes that invention (new ideas) is the outcome of variation, while innovation is the outcome of internal and external selection (Birkinshaw et al. 2008, Campbell 1965), one can logically link the outcome of exploration with product invention and the outcome of exploitation with product innovation. Following that logic, Rothaermel and Deeds (2004) note that firms pursue search to develop new knowledge as inventions that can be exploited, and that exploitation requires prior exploration. Rothaermel (2001) links invention with exploration and invention commercialization (innovation) with exploitation.

Some scholars view the invention commercialization process that yields innovations as partly exploratory in nature. They view as local knowledge search experimentation with product inventions in new contexts that produce new kinds of products, as well as process innovation that follows product
innovation. They overlook that during invention exploitation, no new knowledge is discovered through search; instead, experience is gained from experimenting with the invention’s form and function, including its manufacturing process (Fleming 2001, Gavetti and Levinthal 2000). Zollo and Winter (2002) term this type of exploitative learning as replication, a step between selection and retention, where reproduction of inventions in spatially diverse contexts generates experiential learning, “opening variety of context,” and not knowledge search, “opening variety of content” (Gilsing and Noteboom 2006, p. 3).

Product innovation, however, is not the only outcome of exploitation. Exploitative processes also encompass vicarious learning and interorganizational imitation that complement experiential learning, and can lead to firm product adoptions as complements of product inventions (Levinthal and March 1993, March 1991, Miner and Raghavan 1999, Terlaak and Gong, 2008). Product adoption follows three phases: initiation, where firms learn vicariously of others’ product innovations, determine the value of others’ product innovations to their organizations, and propose their adoption; adoption decision entails firms using experiential learning to evaluate their potential product adoptions from a variety of technical and other criteria, deciding to adopt others’ product innovations for their own commercial purposes, and allocating resources for the product adoptions’ acquisition, modification and integration into their product innovation processes; and implementation encompasses firms’ experiential learning via adoption modification, probationary use, acceptance and use by customers until they become part of the organizations’ routines (Damanpour and Schneider 2006, Nelson et al. 2004).

Evolutionary Models. March’s (1991) fourth exploration-exploitation choice perspective includes variation-selection-retention (VSR) processes: (1) variation, the generation of new alternatives, can emerge through blind or random changes or from deliberate efforts constrained by time and other resources; (2) selection, the choice among alternatives for new and old alternatives with the greatest value, can result either from competition for scarce resources or vicariously using prior knowledge and anticipating competitive environment selection; and (3) retention, the preservation and reproduction of previously selected alternatives to capture maximum value, resulting in consistency over time and across units, involves forces that promote selected initiatives for future use such as formalization or codification.

**Product Innovation Process Constructs**

To better understand how the innovation learning processes of exploration and exploitation respectively yield outcomes (also constructs) of product invention and product innovation, six additional key innovation constructs are examined. Internal and external selection environments represent the product innovation process framework’s decision criteria. Performance feedback and firm resources represent the input and output of organizational learning. Absorptive capacity enables both exploration and exploitation, while complementary assets enable only exploitation.²

*Internal and External Selection Environments.* The firm’s VSR processes, including its product innovation process, operate in its internal and external selection environments and across multiple levels of analysis, e.g., product, firm, market/industry. Within firms, *internal selection* results from deliberate managerial choice among alternatives for future use, and involves bounded rationality, politics, and recognition of distinctive competencies based on differentiated skills, routines and complementary assets (Aldrich 1999, Burgelman 1994, Henderson and Stern 2004). In firm product markets, *external selection* encompasses customer expectations, competition, dominant designs, appropriability regimes and their interactions (Burgelman 1994, Teece 1986). Henderson and Stern (2004) and Sørensen and Stuart (2000) find that internal and external selection are interwoven processes. March’s (1991) four theoretical perspectives support internal and external selection environments as constructs because: (1) rational search obtains knowledge from internal and external selection environments; (2) limited rationality involves internal/external selection pressures on the firm’s decision-makers; (3) organizational learning and memory are fundamental to the operation of the internal selection environment; and (4) evolutionary models’ VSR processes describe how the two selection environments function over time.
**Performance Feedback and Firm Resources.** March and Simon (1958) observe that firm cognitive processes include feedback (performance-aspiration comparison), problem-solving (new alternatives search and evaluation), attention shown by executives, and action (resource commitment). Holmqvist (2004) notes that a primary way in which exploitation can promote exploration is from questioning sparked by *dissatisfaction* with existing routines, a form of *performance feedback*. Van de Ven and Polley (1992) find that firms adaptively learn to adopt courses of action that produce positive results, and that successes obtain continued *firm resources* while those that fail do not. Hence, performance feedback can be considered an input to organizational learning while firm resources can be viewed as an output. March’s (1991) limited-rationality view is the primary theoretical support for performance feedback and firm resources as constructs.

**Absorptive Capacity.** Cohen and Levinthal (1989, 1990) first introduced absorptive capacity as a firm-level construct by noting that firm knowledge acquisition and application are based on its prior experience with similar or related knowledge. Levinthal and March (1993) observe that such acquired knowledge in various domains allows a firm to evaluate potential investments in new knowledge in those domains. Since then, scholars have recognized the various roles that absorptive capacity serves in the firm’s innovation process as: (1) *input* through its association with, or promotion of, exploration (Koza and Lewin 1998, Lavie and Rosenkopf 2006, Nemanich et al. 2007) and as an enabler of both exploration and exploitation (Todorova and Durisin 2007, Zahra and George 2002); (2) *output* as an ability enabled by the interplay between exploration and exploitation (Andriopoulos and Lewis 2009, Jansen et al. 2006); (3) *both input and output* of inventive activities by serving as both an antecedent and outcome of exploratory learning (Van den Bosch et al. 1999, Zahra and George 2002); and (4) as an *intermediary* by serving as both a mediator and moderator of innovation (Van den Bosch et al. 2003).

Organizational knowledge obtained from prior learning begins within individuals, and then is further developed through social interaction (Crossan et al. 1999, Cyert and March 1963). Some outcomes of learning include explicit knowledge from learning vicariously and imitation (Miner and Raghavan 1999, Terlaak and Gong 2008) and tacit knowledge from learning by doing (Argote et al. 1990,
Nonaka, 1994). Hence, one can conclude that *absorptive capacity is knowledge/experience embodied in human resources.*

Absorptive capacity’s role as an enabler of both exploration and exploitation is supported by all of March’s (1991) four theoretical perspectives. In terms of rational search, limited rationality and organizational learning, absorptive capacity represents the fruits of past functional knowledge searches as well as experiential learning—triggered by performance compared to target aspiration levels—that support exploration’s inventive outcomes and promotes exploitation’s innovative outcomes. Absorptive capacity provides evolutionary variation by facilitating combinations of old and new ideas while promoting selection and retention by serving as *organizational memory* of experiential learning why past variations were selected (Walsh and Ungson 1991).

*Complementary Assets.* Teece (1986) was the first to recognize complementary assets helped firms appropriate greater innovation profits, a distinctly exploitative role. Complementary assets are resources that increase the marginal returns of other related assets, e.g., movie studios and cinemas (Lachmann 1947, Stieglitz and Heine 2007). Reviewing the literature, complementary assets consist of tangible assets and intangible, capitalized assets that increase the appropriability of innovation profits. Levinthal and March (1993, p. 106) note that a firm’s “return from any particular innovation” is “partly a function of an organization’s experience with the new idea” (invention). The employment of complementary assets produces experience tied to these tangible and capitalized assets (Taylor and Helfat 2009, Teece 1986, Tripsas 1997). For example, specialized complementary assets in the form of proprietary manufacturing processes necessary for effective product innovation (invention commercialization) requires the configuration of dedicated capital equipment that embodies the firm’s product development and manufacturing experience (Teece, 1986). Tripsas (1997) observes that the customer-relations experience embodied in firm sales/service networks serve as difficult-to-imitate complementary assets. Teece (1986) notes that patents and trade secrets, developed from experience gained through product and process R&D efforts, can serve as effective complementary assets. One can conclude that *complementary assets reflect experience that is embodied in physical and capital resources.*
Other scholars have valued the role that complementary assets serve in innovation, especially the link between complementary assets and exploitation (Koza and Lewin 1998; Nemanich et al. 2007, Tripsas 1997). Arora and Ceccagnoli (2006) assert that complementary assets intervene between product invention and product innovation, an exploitative role supported by others (e.g., Rothaermel and Deeds 2004, Stieglitz and Heine 2007, Teece 1986). Stieglitz and Heine (2007, p. 13) emphasize the role of complementary assets in exploiting newly created knowledge in firm innovation, and observe that firm strategic direction is needed to “coordinate complementary learning processes that lead to the creation of new assets,” supporting this paper’s conclusion that experiential learning in the product innovation process reflects the experience that is embodied in complementary assets. Stieglitz and Heine (2007) also highlight the role that complementary assets and associated learning processes play in adding value to new knowledge developed during exploration and product invention. Taylor and Helfat (2009) describe complementary assets functionally, e.g., finance, marketing, manufacturing, and identify functional activities that comprise complementary assets, e.g., marketing a product, that provide experiential learning to the firm. Taking a fine-grain approach, Taylor and Helfat (2009) note that firms’ success in achieving core technological transitions and organizational ambidexterity depends on how well they manage their organizational linkages involving old and new complementary assets, implying investments in the latter. In a fashion similar to absorptive capacity, complementary assets’ role as an enabler of exploitation is also supported by March’s (1991) four theoretical perspectives. Having identified the constructs comprising the product innovation process, attention is now turned to the mechanism by which knowledge/experience is transmitted across firm domains over time.

Knowledge Evolution Cycle

Knowledge Evolution. Zollo and Winter (2002) offer a recursive VSR knowledge evolution cycle that adds replication as a step between selection and retention, a step that includes knowledge sharing/transfer, adaptive variation and problem solving, where copying of routines in diverse contexts generates new information requiring significant cognitive efforts to analyze, often causing routines to be
modified or new ones created in the variation phase. Winter and Szulanski (2001) note that experiential
learning gained from exploiting in different contexts is the essence of replication.

Knowledge Development. Knowledge development is at the heart of knowledge management and
organizational learning theories. Nonaka (1994) employs the cross-functional team as the firm’s basic
building block in organizational knowledge creation, endorsing Cohen and Levinthal’s (1990) cross-
functional project team as a key vehicle by which knowledge at the group level is raised to the
organizational level. Crossan et al. (1999) observe that organizational learning entails: (1) group
interpretation of individual intuition occurring in the context of their functional domain; (2) learning that
becomes integrated as it is embedded in the group; and (3) learning that becomes institutionalized as
integrated group learning in the functional domains transfers across the firm through formalization of
company-wide interaction and communication patterns. They term exploration learning that moves up
from individual to group to firm levels (feed forward), and exploitation learning that moves down from
firm to group to individual levels (feedback).

Innovation-Related Experience Influences Future Invention-Required Knowledge/Experience
Reflecting on the literature reviewed so far, product innovation (exploitation) can promote future product
invention (exploration) only if knowledge/experience embodied in absorptive capacity and experience
embodied in complementary assets influence knowledge/experience contained in future absorptive capac-
ity. Since absorptive capacity in one time period influencing itself in a later period is unremarkable, this
paper focuses on the influence of complementary assets on future absorptive capacity. Scholars have
identified where experience associated with exploitation (complementary assets) has influenced future
knowledge/experience linked to both exploration and exploitation (absorptive capacity). A review of 41
papers and one book identifies 28 effects where innovation-related experience influences future know-
ledge/experience: 15 are positive for all types of innovation; five are positive but subject to diminishing
returns; five are positive only for incremental innovation; and three are negative, so that 25 out of the 28
effects (see following) show that innovation-related experience influences future knowledge/experience.
Innovation-Related Financial Management Experience. Financial management experience gained by better management of innovation profits enhances subsequent levels of R&D expenditures and thus increases technological knowledge/experience (Dushnitsky and Lenox 2005, Helfat 1997). This section holds one positive effect of innovation-related experience on future knowledge/experience.

Innovation-Related Management Experience. Management experience related to innovation includes corporate reputation, firm strategy and routines. Such enhanced corporate reputation increases the likelihood that firms attract more innovation-knowledgeable and experienced personnel, thereby increasing market, operational and technological knowledge/experience (Castanias and Helfat 1991). Also, a superior corporate reputation gained from innovations benefits the firm’s customer franchise, improves the chances that needed market knowledge/experience is obtained, and increases the likelihood that additional market and product invention opportunities are found (Chandy and Tellis 2000, Itami and Roehl 1987). Innovation-related management experience shapes firm strategy to build future market, operational, and technological capabilities that increases market, operational and technological knowledge/experience, thereby enhancing the likelihood of product invention (Itami and Numagami 1992). Firm diversification strategies derived from product innovation cause mixed effects: International diversification strategies enhance R&D intensity and subsequent product invention while product diversification strategies attenuate R&D intensity and follow-on product invention (Hitt et al. 1997, Stimpert and Duhaime 1997). Innovation-related management experience establishing and maintaining organizational routines increases exploitation effectiveness but diminishes subsequent exploration for new knowledge. This negative effect attenuates the likelihood of product invention (Ahuja and Lampert 2001, Galunic and Rodan 1998, Leventhal and March 1993, March 1991). In this section, there are four positive effects and two negative effects of innovation-related experience on future knowledge/experience.

Innovation-Related Market Experience. Market experience linked to innovation contains market entry experience and market share. Market entry experience from innovations leads to increased market and technological knowledge/experience. First, the firm’s market experience gives it sufficient market knowledge/experience to enter other related markets, increasing the likelihood that products for the
related markets are invented (Cattani 2005, Klepper and Simons 2000, Mitchell 1989, Tripsas 1997). Second, the firm’s product sequencing experience obtains customer feedback sooner, increases market knowledge/experience by allowing a quicker determination of the optimal market position, and raises technological knowledge/experience by aiding in optimal product design. Identifying best market position and achievement of the optimal product design spurs product invention (Helfat and Raubitschek 2000, von Hippel 1986). Third, the firm’s experience in related markets allows it to pursue product inventions where it understands customer preferences and unarticulated needs, and where exists greater technological opportunity and higher appropriability (Cohen and Levinthal 1989 1990, Helfat and Raubitschek 2000, Teece 1986, von Hippel 1986). Fourth, firms’ experience in partial external selection (product-market failures) leads firms to increase their rates of internal selection, removing products before they became obsolete; such experience serves as catalysts for new product development (Henderson and Stern 2004). Firms with larger market share increase market and operational knowledge/experience because they tend to: (1) enter new, related market segments (Mitchell 1989); and (2) have greater sales volumes giving them more operational knowledge/experience (Itami and Roehl 1987). In this section, there are five positive effects of innovation-related experience on future knowledge/experience.

**Innovation-Related Operational Experience.** Operational experience related to innovation includes customer service experience, manufacturing experience and sourcing experience. Customer service experience from innovations and solving customer problems increases market, operational and technological knowledge/experience by giving the firm insights into: (1) customer needs and preferences, (2) making better-quality, incremental products, and (3) designing and developing better, incremental products. Such knowledge/experience development raises the chances of subsequent product inventions (Itami and Roehl 1987). Innovation-related manufacturing experience increases the firm’s operational and technological knowledge/experience. The firm’s experience in manufacturing product innovations provides insights to management concerning optimal operational structures, systems, incentives, etc. (Helfat and Peteraf 2003), and gives it knowledge/experience about improving product design and quality while lowering its operating costs, promoting future incremental product inventions (Abernathy and Clark
1985, Helfat and Peteraf 2003, Helfat and Raubitschek 2000, Teece 1986). The firm’s experience in manufacturing one product category gives it the knowledge/experience to produce other, related product categories, again spurring product invention (Helfat and Peteraf 2003, Helfat and Raubitschek 2000, Mitchell 1989). Firms with manufacturing experience pursue product R&D in those same areas, thus increasing the likelihood of incremental product inventions while decreasing the chances for radical product invention (Teece 1986). *Sourcing experience* enhances technological knowledge/experience that increases the possibility of future product invention. The firm’s innovation-related experience with its equipment suppliers provides information on better manufacturing techniques and quality improvement processes, while similar experience with materials suppliers provides the firm with better information on materials and more effective processes employing those materials, thus spurring product invention efforts (Cohen and Levinthal 1989, Dyer and Singh 1998). However, the more equipment/materials suppliers are used, the lower is the level of subsequent R&D expenditures (Cohen and Levinthal 1989). In this section, there are two positive effects, three effects positive only for incremental products, and one effect positive but subject to diminishing marginal returns.

*Innovation-Related Technological Experience.* Technological experience linked to innovation includes dominant design, exploratory (R&D) alliance experience, internal R&D experience, patent estate, product development experience, product technology experience and technologically-related acquisitions. The firm’s *dominant design* gives it greater incentive to pursue incremental product invention to improve performance/reliability and engage in process invention to lower production costs (Abernathy and Clark 1985, Dosi 1982, Teece 1986). Innovation-related exploratory (R&D) *alliance experience* increases technological knowledge/experience that leads to future product invention. First, exploratory alliance experience gives small firms access to financial resources from large firms that allows small firms to make future R&D outlays that lead to future product invention (Deeds and Hill 1996, Lerner and Merges 1998, Lerner et al. 2003, Rothaermel and Deeds 2004). Second, R&D alliances span firm boundaries, decrease reliance on local search, and increase the likelihood of external technological knowledge/experience acquisition and assimilation, thereby increasing chances of future R&D aimed at
radical inventions (George et al. 2001, Rosenkopf and Nerkar 2001), but this increase in knowledge/experience is subject to diminishing marginal returns (Rothaermel 2001). Third, experience gained from prior R&D alliances increases technological knowledge/experience reflected in patent filings, but this increase is also subject to diminishing returns (Deeds and Hill 1996, Hoang and Rothaermel 2005).

Internal R&D experience from innovation increases the likelihood of future R&D, one that uses external knowledge/experience aimed at both incremental and radical inventions—the latter requiring the combination of novel with established technologies (Cohen and Levinthal 1990, Helfat 1997). Internal R&D experience as complementary assets is distinguished from R&D knowledge/experience as absorptive capacity because innovation requires experience-embodied R&D/manufacturing equipment and processes while the technological personnel involves embodied R&D knowledge/experience. The firm’s patent estate, accrued in the process of achieving innovation, stimulates R&D expenditures and future product invention (Dushnitsky and Lenox 2005). The firm’s product development experience provides knowledge/experience to management concerning optimal technological structures, systems, incentives, etc., and raises its chances of designing later incremental inventions with better product features, but in doing so could lead to core rigidities or competency traps (Hill and Rothaermel 2003, Leonard-Barton 1992, Levitt and March 1988, Sørensen and Stuart 2000). Firm product technology experience in using similar technologies across its products promotes the development of its core technologies that, in turn, spurs future product invention; however, this effect is subject to diminishing marginal returns (Helfat 1997, Itami and Roehl 1987). Firm technologically-related acquisitions raises its technological expertise, positively influencing the likelihood of future product inventions in areas held by those acquisitions (Capron et al. 1998, Puranam et al. 2006). Based on the similarity and relatedness of knowledge between the firm and its acquisition, there are diminishing marginal returns (Ahuja and Katila 2001, Prabhu et al. 2005). In this section, there are three positive effects, two effects positive only for incremental products, four effects positive but subject to diminishing marginal returns, and one negative effect.

Theory Development
Having found that the literature supports the general hypothesis that innovation-related experience (complementary assets) influences future knowledge/experience (absorptive capacity), attention now turns to developing theory that explains how this influence operates. Theory building begins with innovation-related definitions, indicators and context of exploration and exploitation, followed by the product innovation process framework composed of eight constructs. This section concludes with propositions explaining why and how experiential learning from exploitation, following the knowledge evolution cycle, promotes future knowledge and experience necessary for exploration.

**Exploration and Exploitation Definitions, Indicators and Context**

*Definitions.* Based on March’s (1991) four exploration-exploitation choice theoretical perspectives and in the context of the product innovation process, exploration can be defined as *that part of the innovation process involving local or distant knowledge search that produces functional knowledge variation with the aim of creating product invention alternatives* (Campbell 1965, Hill and Rothaermel 2003, March 1991, Rosenkopf and Nerkar 2001, Schumpeter 1934). In similar fashion, exploitation can be defined as *that part of the innovation process involving no knowledge search but experiential learning and/or vicarious learning that produces functional knowledge selection with the aim of choosing product invention/adoptions, replication of selected product inventions/adoptions so as to evaluate their potential commercialization, and retention of replicated product inventions/adoptions through their commercialization as product innovations* (Argote et al. 1990, Campbell 1965, Corbett 2005, Hill and Rothaermel 2003, Kolb 1984, March 1991, Miner and Raghavan 1999, Rosenkopf and Nerkar 2001, Schumpeter 1934, Terlaak and Gong 2008, Winter and Szulanski 2001, Zollo and Winter 2002). Since exploration and exploitation are learning processes and not outcomes, indicators reveal when choices are made.

*Indicators.* Investment in absorptive capacity is a clear indicator of exploration, while investment in complementary assets is an unambiguous indicator of exploitation (Koza and Lewin 1998, Nemanich et al. 2007). Since firms often pursue both exploration and exploitation, an investment emphasis on absorptive capacity relative to complementary assets indicates a firm’s choice for exploration, while a relative investment emphasis on complementary assets would indicate an exploitative choice (Mizik and Jacobson...
In each of the propositions that follow, the firm’s choice to **explore**, by investing more in absorptive capacity relative to investing in complementary assets, promotes future exploration, while the firm’s choice to **exploit**, by investing more in complementary assets relative to investing in absorptive capacity, does not promote future exploration but instead favors future exploitation.

**Context.** This paper’s theoretical framework is embedded in the context of the firm’s product innovation process over the knowledge evolution cycle of variation, selection, replication and retention. Using March’s (1991) four theoretical perspectives, a literature review of internal and external selection environments’ and their interface’s antecedents of exploration and exploitation identifies 31 antecedents cited by 36 scholars (summary available upon request). March’s (1991) views of rational search, limited rationality and organizational learning are more often found in the internal selection environment, while his evolutionary models perspective is seen more frequently in the external selection environment.

From the literature mentioned in the paragraph above, several internal and external selection environment exploration-exploitation decision antecedents have been frequently employed by scholars as key factors. Four key internal selection environment factors include firm technological knowledge-market experience scope (Helfat 1997, Helfat and Raubitschek 2000, Henderson and Stern 2004, Hill and Rothaermel 2003, Winter and Szulanski 2001), prior organizational learning as market experience from being market leader or market follower (Greve 2007, Lavie and Rosenkopf 2006, Min et al. 2006, Shankar 2006), CEO job and firm tenure (Finkelstein and Hambrick 1996, Miller and Shamsie 2001, Nemanich et al. 2007, Wu et al. 2005), and firm performance compared to target aspiration levels in the presence or absence of slack (Audia and Greve 2006, Garcia et al. 2003, Greve 2002 2003). Four key external selection environment factors include customer need diversity (Adner and Levinthal 2001, Hauser et al. 2006), appropriability regime (Malerba and Orsenigo 1996), environmental dynamism (Jansen et al. 2006, Jansen et al. 2009), and competitive intensity (Garcia et al. 2003, March 1991). Since internal and external selection are interwoven processes (Henderson and Stern 2004, Sørensen and Stuart 2000), it makes sense to treat internal and external selection environment exploitation-exploitation decision antecedents as interacting with each other.
Product Innovation Process Framework and Knowledge Evolution Cycle

Framework. Following the introduction of all eight innovation-related constructs in the literature review, this paper now positions them both temporally and spatially. (See Figure 1.) Five findings from prior scholarship support this effort. First, the firm’s overall product innovation process is embedded in its internal and external selection environments (Burgelman 1994, Henderson and Stern 2004, Teece 1986). Next, absorptive capacity (Todorova and Durisin 2007, Zahra and George 2002) and complementary assets (Arora and Ceccagnoli, 2006, Rothaermel and Deeds 2004, Teece 1986) intervene (mediate) in the relationship between product invention and product innovation. Further, both performance feedback and firm resources follow product innovation (or its absence in the case of new firms) and precede product invention (Audia and Greve 2006, Greve 2003). Then, absorptive capacity intervenes in (mediates) the relationship between firm resources and product invention (Van den Bosch et al. 2003). (While prior scholarship advocates moderating and mediating roles for absorptive capacity in product invention, and similar roles for absorptive capacity and complementary assets in product innovation, firm resources is an antecedent of the three aforementioned constructs, thus violating the requirement that moderators be independent (Baron and Kenny 1986); hence, this framework employs only mediating roles.) Lastly, the product innovation process is recursive (Holmqvist 2004, Zollo and Winter 2002). Figure 1 portrays the theory domain, suggesting that the firm’s current product innovation (exploitation) can influence future product invention (exploration), with arrows representing material and information flows moving only from left to right along the path of time. To ensure theoretical rigor this paper focuses on incumbent firms, since new market entrants during all evolutionary cycle phases will often choose exploration over exploitation to attack established incumbents but also because they lack established innovation routines that can be exploited (Hill and Rothaermel 2003, Katila and Shane 2005).

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Insert Figure 1 about here

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Replication. Explanation of how firms’ exploitation promotes their future exploration begins at the point when product inventions and product adoptions are selected and the replication phase of the product innovation process begins. Hence, a replication, retention, variation and selection cycle is examined. (Replication takes place in Figure 1 in the relationships between product invention/adoption, product innovation, absorptive capacity and complementary assets, where the focus is on the product invention/adoption—complementary assets—product innovation mediating relationship.) In replication, firms experiment with their recently selected product inventions and product adoptions under different contexts, e.g., different customer segments and geographic markets, thus gathering from their experiential learning additional product-related and market-related knowledge/experience necessary for the commercialization of those product inventions/adoptions as product innovations and for use in future exploration (Hill and Rothaermel 2003, Winter and Szulanski 2001, Zollo and Winter 2002.)

Firms’ applications of their product inventions/adoptions in different contexts occur while their internal and external selection environments interact. A key internal selection environment factor related to firms’ different product-market contexts is the scope of their technological knowledge (absorptive capacity) and market experience (complementary assets) gained from previous product innovations and embodied in their human, physical and capital resources, e.g., R&D/market personnel, plant and equipment, patents granted (Cohen and Levinthal 1990; Teece 1986). In this case, replication involves transfer of technological knowledge/market experience on either a broad or narrow scope: (1) a broad scope often seeks to adapt firms to their external environments, strongly shapes their contexts, and possibly redefines their identities; and (2) a narrow scope, applicable to a relatively stable external environment, only modifies practices, technologies or equipment that often just require minor organizational accommodations (Winter and Szulanski 2001). Technological knowledge/experience from internal R&D, product development and product technology experience provides firms with the capability to combine novel with established technologies, develop optimal technological structures, and achieve economies of scope with their core technologies (Cohen and Levinthal 1990, Helfat 1997, Hill and Rothaermel 2003, Itami and Roehl 1987). Market entry experience provides firms with better, quicker customer feedback that leads to great-
nderstanding of optimal market positions and optimal product designs, as well as increasing internal selection rates (Helfat and Raubitschek 2000, Henderson and Stern 2004, von Hippel 1986).

A key external selection environment factor is the diversity of customer needs. Firms’ successes in designing and introducing new products to markets depend upon those products closely matching customer needs (Hauser et al. 2006). Market demand heterogeneity—customers with different needs and requirements—influence firm innovation choices (Adner and Levinthal 2001). Customer needs reflect minimum performance requirements that product technology must meet so that customers would be willing to purchase that product, as well as customer motivation to pay for product performance (Adner and Levinthal 2001). At different stages of the market life cycle, customers’ minimum performance requirements and willingness to pay will vary (Adner and Levinthal 2001).

During replication, firms decide to experiment with their recently selected product inventions/adoptions, gathering new knowledge through experiential learning that enhances their absorptive capacity and promotes future exploration (Lavie and Rosenkopf 2006, Nemanich et al. 2007). Firms that do not experiment with their selected product inventions/adoptions continue to exploit their previous product innovations. Firms that hold narrow technological knowledge/market experience scope and encounter markets with homogenous customer needs will tend to focus on efficiency rather than experimenting with their product inventions because of bounded rationality (Simon 1955) and insufficient incentives to invest in product variety (Hauser et al. 2006). Emphasis on efficiency leads to greater investment in complementary assets linked to greater price competition in the markets of homogenous user needs (Hill and Rothaermel 2003, Shankar, 2006, Teece 1986). (See Figure 2.) Where firms hold narrow technological knowledge/market experience scope and face markets with heterogeneous customer needs, they have incentives to experiment and will tend to do so (Hauser et al. 2006, Hill and Rothaermel 2003). This experimentation yields additional knowledge through experiential learning, thus enhancing absorptive capacity and promoting future exploration (Lavie and Rosenkopf 2006, Nemanich et al. 2007). Where firms hold broad technological knowledge/market experience scope and face markets with homogeneous user needs, they will tend to focus on efficiency rather than experimenting with their product inventions.
because of insufficient incentives to invest in product variety (Hauser et al., 2006, Hill and Rothaermel 2003). Again, emphasis on efficiency leads to greater investment in complementary assets needed for competition over price rather than product features (Hill and Rothaermel 2003, Shankar, 2006, Teece 1986). When firms hold broad technological knowledge/market experience scope and encounter markets with heterogeneous user needs, they will tend to experiment in more diverse contexts (Hauser et al., 2006, Hill and Rothaermel 2003). This experimentation requires greater investment in absorptive capacity relative to complementary assets, and promotes future exploration (Lavie and Rosenkopf 2006, Nemanich et al. 2007). Replication’s expected experimental bias is constrained by a mixture of bounded rationality (narrow scope) and lack of investment incentives (homogenous user needs), such that choices to experiment or focus on efficiency are balanced. Hence, the following is proposed:

**Proposition 1a.** Firms replicating selected product inventions/adoptions that possess narrow technological knowledge/market experience and face homogeneous user needs in their markets will tend to focus on efficiency by increasing investments in complementary assets relative to investments in absorptive capacity, thus promoting future exploitation.

**Proposition 1b.** Firms replicating selected product inventions/adoptions that possess narrow technological knowledge/market experience and face heterogeneous user needs in their markets will tend to experiment by increasing investments in absorptive capacity relative to investments in complementary assets, thus promoting future exploration.

**Proposition 1c.** Firms replicating selected product inventions/adoptions that possess broad technological knowledge/market experience and face homogeneous user needs in their markets will tend to focus on efficiency by increasing investments in complementary assets relative to investments in absorptive capacity, thus promoting future exploitation.

**Proposition 1d.** Firms replicating selected product inventions/adoptions that possess broad technological knowledge/market experience and face heterogeneous user needs in their markets will tend to experiment by increasing investments in absorptive capacity relative to investments in complementary assets, thus promoting future exploitation.

At the end of the replication process, firms decide to retain their previous knowledge/experience or to supplant it with new knowledge/experience gained in replication (Zollo and Winter 2002).
Retention. In firm innovation processes, retention is the preservation and reproduction of previously selected alternatives (product inventions/adoptions) to capture maximum value that results in consistency over time and across units, by involving forces that promote selected alternatives for future use by formalizing or codifying routines that seem to be effective (Amburgey et al. 1994, Campbell 1965, Holmqvist 2004, Volberda and Lewin 2003). In retention, the comparison of prior organizational learning with replication-generated learning affects the firm’s decision to continue to exploit previous product innovations using existing product-related routines or to commercialize their recently replicated product inventions/adoptions through routine modifications (Lavie and Rosenkopf 2006, Volberda and Lewin 2003, Zollo and Winter 2002). (Retention occurs in Figure 1 in the product innovation—performance feedback relationship.) Firm decisions to retain experience gained from prior innovations or to exploit the experience recently obtained through replication operates within the context of firms’ interacting internal and external selection environments. A key internal selection environment factor is firms’ previous organizational learning in the form of market experience as either market leader or market follower, that represents the level of the firm’s demonstrated innovation competence, a competence that tends to reinforce the firm’s future behavior in that arena (Greve 2007, Lavie and Rosenkopf 2006). As market leaders, firms have greater market share that garnered them increased market knowledge/experience from entering new, related market segments (Mitchell 1989) and enhanced operational knowledge/experience from greater sales volumes (Itami and Roehl 1987). Market leader experience reflects firms’ success in introducing incrementally-new products (really-new product-market leaders have a much higher risk of failure) that increase product line breadth—actions related to exploration; market follower experience reflects firms’ success in asymmetrically responding to market leaders’ product line actions via price actions—actions linked to exploitation (Min et al. 2006, Shankar 2006).

A key external selection environment factor is the appropriability regime faced by firms. Weak appropriability regimes place product innovators’ profits at risk because there are few restrictions on competitors’ taking away some of the innovators’ profits through imitation, and firms have greater incentives to exploit new inventions for subsequent commercialization; tight appropriability regimes keep product
innovators’ profits relatively safe because competitors are constrained from taking away some of the innovators’ profits by the innovators’ complementary assets, e.g., patent grants, network standards, proprietary manufacturing processes, exclusive distribution channels, and there is a greater chance that prior innovations will continue to be exploited by innovating firms (Malerba and Orsenigo 1996, Teece 1986).

Interaction of the two retention antecedents involves prior organizational learning in the form of market experience either as market leader or market follower and appropriability regime. When firms are market followers and operate within weak appropriability regimes often found in market growth, they will tend to exploit newly replicated inventions by attempting to increase their product lines in anticipation of future market leader product line extensions, thus enhancing their absorptive capacity that, in turn, promotes future exploration (Shankar 2006, Teece 1986, Winter 2000). (See Figure 3.) Firms that are market followers and face tight appropriability regimes often found in market maturity will tend to exploit by retaining their prior product innovations and decreasing their prices in anticipation of future market leader product line extensions, thus increasing their complementary assets that do not promote future exploration (Shankar 2006, Teece 1986). Firms that are market leaders and confront weak appropriability regimes will tend to exploit newly replicated inventions by increasing their product lines in reaction to past market followers’ product line extensions and to thwart market follower imitations by increasing lead times, thereby enhancing their absorptive capacity that promotes future exploration (Malerba and Orsenigo 1996, Min et al. 2006, Shankar 2006, Teece 1986, Winter 2000). Firms that are market leaders and operate within tight appropriability regimes have incentives to exploit by retaining their prior product innovations and employing product invention patent grants, process trade secrets and complementary assets such as distribution channels to appropriate maximum profits from their innovations, thus not promoting future exploration (Shankar 2006, Teece 1986, Winter 2000). Expected retention bias toward exploitation is constrained due to threats of competition and imitation, such that choices to exploit new product inventions or prior product innovations are balanced. Thus, the following is proposed:

Proposition 2a. Firms that have market follower experience and are faced by weak appropriability regimes will tend to choose to exploit newly replicated inventions by increasing investments in absorptive capacity, thereby promoting future exploration.
Proposition 2b. Firms that have market follower experience and are faced by tight appropriability regimes will tend to choose to exploit prior innovations by increasing investments in complementary assets, thereby promoting future exploitation.

Proposition 2c. Firms that have market leader experience and are faced by weak appropriability regimes will tend to choose to exploit newly replicated inventions by increasing investments in absorptive capacity, thereby promoting future exploration.

Proposition 2d. Firms that have market leader experience and are faced by tight appropriability regimes will tend to choose to exploit prior innovations by increasing investments in complementary assets, thereby promoting future exploitation.

As product innovations encounter the external selection environments, firms gain performance feedback. Such feedback leads to variation in firm product innovation processes (Adner and Levinthal 2001).

Variation. After retention, firms enter the variation phase of the evolutionary cycle that is heavily influenced by changing internal and external selection environments. In variation, firms decide to either not explore by continuing to use existing product designs or explore new product designs. (In Figure 1, variation takes place in the relationships between performance feedback, firm resources, absorptive capacity and complementary assets, where the focus is on the performance feedback—firm resources—absorptive capacity relationships.) Variation in firm product innovation processes involves blind or intentional creation of new technological or organizational alternatives such as product inventions, routines and competencies (Aldrich 1999, Amburgey et al. 1994, Campbell 1965). Creation of new product invention alternatives occurs within the context of interacting internal and external selection environments.

A key internal selection environment factor is CEO job and firm tenure, a proxy for senior management’s perception of its internal and external selection environments, their proclivity for change, and their use of knowledge search or experiential learning to solve problems and exploit opportunities (Finkelstein and Hamrick 1996, Miller 1991, Miller and Shamsie 2001, Nemanich et al. 2007, Wu et al.)
CEO job and firm tenure affects the firm’s strategic aspirations that are reflected in the performance feedback construct (Audia and Greve 2006, Finkelstein and Hamrick 1996, Greve and Taylor 2000). CEO job and firm tenure are related to innovation-related management experience that, in turn, affects firm strategy such as international diversification and product diversification (Itami and Numagami 1992, Hitt et al. 1997, Stimpert and Duhaime 1997). A key external selection environment factor is environmental dynamism, i.e., whether the environment is dynamic or stable (Dess and Beard 1984, Jansen et al. 2006, Jansen et al. 2009).

Firms explore when they jointly possess short-tenured CEOs and experience dynamic environments, or employ long-tenured CEOs while confronting stable environments. Short-tenured CEOs (outsiders) encountering dynamic environments are not constrained by existing management paradigms and industry “rules of the game,” and instead can initiate knowledge search to explore new paradigms and try to rewrite industry rules through emphasis on strategy formulation, while long-tenured CEOs (insiders) operating in stable environments are able to maintain their paradigms while initiating knowledge search to explore for incremental inventions within mature markets or seek new markets (Finkelstein and Hamrick 1996, Jansen et al. 2009, Wu et al. 2005). (See Figure 4.) When firms conduct knowledge searches, they make investments in their absorptive capacity (Cohen and Levinthal 1990). Firms exploit when they have short-tenured CEOs and face stable environments, or employ long-tenured CEOs while confronting dynamic environments. Short-tenured CEOs (outsiders) facing stable environments must confront existing management paradigms and industry rules and overcome bounded rationality by learning experientially and thus exploit through emphasis on strategy implementation, while long-tenured CEOs (insiders) encountering dynamic environments are unable to initiate knowledge search because cognitively they cannot handle rapid environmental changes and, under stress, they revert to experiential learning and exploit within their existing paradigms (Finkelstein and Hambrick 1996, Jansen et al. 2009, Simon 1955, Wu et al. 2005). Exploitation of existing paradigms tends to lead to investments in complementary assets that promote future exploitation at the expense of future exploration (Nemanich et al.
Exploitation and exploitation choices are balanced in the variation phase, with an expected variation bias toward exploration constrained by CEO bounded rationality. Hence, the following is proposed:

**Proposition 3a.** Firms with short-tenured CEOs that face stable environments will tend to exploit by increasing investments in complementary assets relative to investments in absorptive capacity, thus promoting future exploitation.

**Proposition 3b.** Firms with short-tenured CEOs that face dynamic environments will tend to explore by increasing investments in absorptive capacity relative to investments in complementary assets, thus promoting future exploration.

**Proposition 3c.** Firms with long-tenured CEOs that face stable environments will tend to explore by increasing investments in absorptive capacity relative to investments in complementary assets, thus promoting future exploration.

**Proposition 3d.** Firms with long-tenured CEOs that face dynamic environments will tend to exploit by increasing investments in complementary assets relative to investments in absorptive capacity, thus promoting future exploitation.

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**Selection.** Following variation, firms choose to maximize the value of their product offerings by selecting existing or new product designs. (Selection occurs in Figure 1 in the firm resources—product invention/adoption relationship.) Once firm innovation processes generate product invention and product adoption alternatives, firms face selection forces that competitively eliminate those alternatives due to internal pressures for stability and homogeneity and external constraints such as customer preferences and competition (Aldrich 1999, Amburgey et al. 1994, Campbell 1965). Internal selection pressures comprise firm performance-aspiration level comparisons, coupled with the presence or absence of organizational slack, that interact with external selection pressures dominated by competitive intensity. Strong competitive intensity, indicated by greater competitive density in the focal market, often induces firm exploration to enable the organization to survive, while little or no competition, indicated by lesser competitive density, tends to foster firm exploitation (Garcia et al. 2003, March 1991). As firms enter a new market, both product supply and demand are enhanced, with the latter partially resulting from product innovation (Agarwal and Bayus 2002). As the market matures, increased competition can yield
either constant product performance with falling prices (process innovation) or stable prices with increasing product performance (product innovation; Adner and Levinthal 2001).

Firms tend to explore when their performance levels are below their aspiration levels, regardless if there is weak or strong market competition, provided slack is present; firms also choose to explore when faced by strong competition and their performance levels are at or above their aspiration levels, so long as slack is present (Garcia et al. 2003, Greve 2002). (See Figure 5.) Firms explore in the forms of local and distant knowledge searches that enhances absorptive capacity and promotes future exploration (Lavie and Rosenkopf 2006, Nemanich et al. 2007). Firms exploit only when their performance levels are at or above aspiration levels and market competition is weak (Garcia et al. 2003, Greve 2002, March 1991), or when they have no organizational slack (Greve 2003). Such exploitation tends to increase complementary assets at the expense of absorptive capacity, promoting future exploitation at the expense of exploration (Nemanich et al. 2007). If organizational slack is available, an expected bias toward exploitation as selection is overcome by strong internal and external competitive forces that favor a majority of choices for exploration (March 1991). However, if conditions of organizational slack availability and unavailability are both considered, exploitation is favored, validating March’s (1991) prediction that in the competition within the firm for scarce resources, exploitation crowds out exploration (Garcia et al. 2003, Greve 2002 2003, March 1991). Thus, the following is proposed:

Proposition 4a. If organizational slack is present, firms with performance levels below their aspiration levels faced by weak market competition will tend to explore by increasing investments in absorptive capacity relative to investments in complementary assets, thus promoting future exploration.

Proposition 4b. If organizational slack is present, firms with performance levels below their aspiration levels faced by strong market competition will tend to explore by increasing investments in absorptive capacity relative to investments in complementary assets, thus promoting future exploration.

Proposition 4c. If organizational slack is present, firms with performance levels at or above their aspiration levels faced by weak market competition will tend to exploit by increasing investments in complementary assets relative to investments in absorptive capacity, thus promoting future exploitation.

Proposition 4d. If organizational slack is present, firms with performance levels at or above their aspiration levels faced by strong market competition will tend to
explore by increasing investments in absorptive capacity relative to investments in complementary assets, thus promoting future exploration.

Proposition 4e. If organizational slack is not present and regardless of firm performance levels relative to their aspiration levels and the type of market competition faced, firms will tend to choose to exploit by increasing investments in complementary assets relative to investments in absorptive capacity, thus promoting future exploitation.

Discussion

Theoretical Implications

Four major theoretical implications stem from this paper. First, the series of strategic innovation decisions captured by this paper’s propositions address the multistage problem raised by Fang and Levinthal (2009). Second, the outcomes of these strategic innovation decisions influence the development of organizational ambidexterity. Third, this paper reconciles the four “central tensions” necessary to advance organizational ambidexterity research (Raisch et al. 2009, p. 685). Fourth, this paper highlights the central role played by absorptive capacity in achieving and maintaining organizational ambidexterity.

Strategic Innovation Decisions and the Multistage Problem. This paper’s intraorganizational pathway, wherein innovation-related experience from exploitation promotes future knowledge/experience needed for exploration, follows a series of strategic innovation decisions that firms make as they progress through their product innovation processes. This series of strategic innovation decisions form the basis of answering why firm exploitation promotes its future exploration. These decisions’ outcomes in the four knowledge evolution cycle stages in the product innovation process answer the question how firm exploitation promotes its future exploration. Experiential learning gained from exploitation and the knowledge evolution cycle (Zollo and Winter 2002) is identified as the necessary condition for the development of knowledge/experience required for exploration. The investment of firm resources in absorptive capacity relative to complementary assets is seen as the sufficient condition for the development of knowledge/experience required for exploration.
The series of strategic innovation decisions described in this paper follow the pattern of multi-stage problems described by Fang and Levinthal (2009): While these decisions have long-term consequences, decision-making feedback is not immediately available; and decisions made in an earlier stages, e.g., retention, influence the returns to decisions made in later stages, e.g., selection. Using investments in absorptive capacity as one example of the multistage problems initially facing firms in their product innovation processes, Cohen and Levinthal (1990, p. 149) caution that “because absorptive capacity is intangible and its benefits are indirect, one can have little confidence that the appropriate level, to say nothing of the optimal level, of investment in absorptive capacity is reached.” However, as firms gain experience managing their absorptive capacity and complementary assets, they have a greater likelihood of achieving and maintaining organizational ambidexterity (Cao et al. 2009, Taylor and Helfat 2009).

Organizational Ambidexterity. Achieving and maintaining organizational ambidexterity stems from the collective outcomes of the series of strategic innovation decisions. Because of bounded rationality and lack of incentives, replication decision outcomes jointly overcome exploratory bias and balance the promotion of future exploration and exploitation. (See Figure 2.) Due to threats of competition and imitation, retention decision outcomes collectively overcome exploitative bias and balance the promotion of future exploration and exploitation. (See Figure 3.) Because of bounded rationality, variation decision outcomes jointly overcome exploratory bias and balance the promotion of future exploration and exploitation. (See Figure 4.) Due to competitive pressures, selection decision outcomes collectively overcome exploitative bias and favor the promotion of future exploration over exploitation so long as slack is available. If slack is unavailable, selection decision outcomes jointly favor the promotion of future exploitation over exploration, as predicted by March (1991). (See Figure 5.) Overall decision outcomes mirror selection outcomes, with the promotion of future exploration slightly favored as long as slack is available. If not, promotion of future exploitation is slightly favored among firm decision-makers.

The theoretical framework identifying different exploration-exploitation choices under different conditions generally supports Lavie and Rosenkopf’s (2006) findings that exploration and exploitation are
balanced across domains over time. Moreover, they ascribe internal pressures to be tensions between
ing organizational inertia and absorptive capacity, in line with this paper’s view that firms make series of
strategic innovation decisions, choosing between continuing to exploit prior product innovations or to
explore for new product invention/adoption alternatives through knowledge searches and/or experiential
and vicarious learning that enhance future absorptive capacity.

**Four Tensions Necessary to Advance Ambidexterity Research.** This paper addresses the four
tensions cited by Raisch et al. (2009) to achieve further progress in organizational ambidexterity research.
The first tension is *differentiation* and *integration* as “alternative or complementary pathways to
ambidexterity” (Raisch et al. 2009, p. 685), where *differentiation* focuses on the separate of exploration
and exploitation qualities of the innovation paradox, e.g., profits versus product breakthroughs, while
*integration* emphasizes the interdependence between paradox opposites and enables coordination
(Andriopoulos and Lewis 2009). This paper balances this tension by highlighting differentiation of
exploration and exploitation as separate innovation learning processes with distinct activities and
outcomes, while demonstrating integration of exploration and exploitation through the knowledge
evolution cycle within the context of the product innovation process. The tensions of differentiation and
integration of exploration and exploitation are resolved by this paper through its explanation of why and
how firm exploitation promotes its future exploration.

The second tension is whether ambidexterity displays itself at the *individual* or *organizational
levels* (Raisch et al. 2009). More broadly, Raisch et al. (2009, p. 686) cite “a need for theories that
capture ambidexterity across multiple levels of analysis.” While this paper’s focus is primarily focused at
the firm level of analysis, it incorporates *individual* ambidexterity in its variation decision propositions
that incorporate CEO job and firm tenure as a key internal selection environment factor that influences the
firm’s decision to explore or exploit. *Organizational* ambidexterity is abundant in this paper through the
firm’s employment of its absorptive capacity to enable product invention/adoption and product
innovation, the outcomes of exploration and exploitation. Other influencers of organizational
ambidexterity include the other internal selection environment factors employed in the replication,
retention and selection decision propositions. This paper’s propositions employ organizational key factors interacting with environmental key factors, an approach embracing multiple levels of analysis favored by Raisch et al. (2009) for advancing organizational ambidexterity research.

The third tension of static versus dynamic focuses on whether ambidexterity is achieved by the firm by either static, e.g., configuration adoption, or dynamic, e.g., configuration development, means (Raisch et al. 2009). This paper reconciles these tensions by emphasizing both a static view that explains how experiential learning is gained from employment of existing complementary assets, and a dynamic view that emphasizes why there are investments in future absorptive capacity and complementary assets.

The fourth tension deals with interrelationships between firm internal and external knowledge processes (Raisch et al. 2009). This paper reconciles this tension by incorporating internal and external knowledge search as well as experiential and vicarious learning in its conceptual framework. This paper’s overall implications about achieving and maintaining organizational ambidexterity stem from its pathway where experiential learning gained from exploitation develops knowledge/experience required for future exploration, and from decisions to invest in future absorptive capacity and complementary assets.

**Role of Absorptive Capacity in Organizational Ambidexterity.** This paper focuses on enhancing future absorptive capacity. It supports findings made, and addresses issues raised, by scholars of that construct. This paper is aligned with Zahra and George’s (2002, p. 198) conclusion that absorptive capacity is based on “past experience, knowledge complementarity, and diversity of knowledge sources,” and Todorova and Durisin’s (2007, p. 783) assertion that “Future absorptive capacity is determined by the current absorption of new knowledge in organizational routines and processes.” This paper meets Lane et al.’s (2006) call for future research that better explores process aspects of absorptive capacity using a longitudinal model. This paper also follows Todorova and Durisin’s (2007) suggestion for the use of feedback loops in dynamic models of absorptive capacity.

This paper’s product innovation process (see Figure 1) positions absorptive capacity in dual mediating roles, one for product invention generated by exploratory learning, and another for product innovation produced by exploitative learning, an ambidexterity foreseen by Cohen and Levinthal (1989,
p. 594) in their depiction of the “dual role of R&D” in creating the capability to assimilate and exploit new knowledge. Zahra and George (2002) further highlight the explorative-exploitative nature of absorptive capacity. Further, Lane et al. (2006) describe two outputs of absorptive capacity as knowledge outputs and commercial outputs, corresponding to the product innovation process’ product invention and product innovation, respectively.

Given the ambidextrous nature of absorptive capacity in exploration and exploitation, what role does it play in organizational ambidexterity? The authors of the seminal article on organizational ambidexterity, Tushman and O’Reilly (1996), emphasize that to be ambidextrous and successfully adapt, organizations must be able to change their strategies, structures and culture. Knowledge embodied in absorptive capacity has affected firm strategy (McGrath and Nerkar 2004; Mintzberg et al. 1998; Van Den Bosch et al. 2003), firm structure (Grant 1996, Nonaka 1994; Santos and Eisenhardt 2005), and organizational culture (Child and Rodriguez 2003, Schein 1992). Thus, absorptive capacity appears to have a strong link to organizational ambidexterity. Rothaermel and Alexandre (2009, p. 774) are more forthright, asserting that “absorptive capacity is the fulcrum that allows firms to leverage ambidexterity.”

Managerial Implications

Implications for managers are threefold. First, firms need to effectively capture their innovation-related experience, gained from experiential learning during replication and retention, through judicious investments in innovation-related complementary assets. By effectively capturing this experience, firms will be better able make investments in absorptive capacity relative to complementary assets to develop knowledge/experience needed for future exploration. Second, investments in absorptive capacity can achieve greater balance between exploration and exploitation, and thus promote greater firm ambidexterity. Third, this paper also highlights the significant role that the firm’s strategic decision-making process has on organizational learning, resource allocation, product innovation and organizational ambidexterity. To optimize firm performance, firm decision-makers need to better understand why and how their organizations conduct knowledge searches and learn from their experiences, why and how their firms make investments in absorptive capacity and complementary assets, and why and how experiential
learning gained from exploitation promotes future knowledge/experience required for exploration and for achieving and maintaining organizational ambidexterity.

**Empirical Implications**

This paper’s decision-making framework provides indicators of the exploration-exploitation decisions, respectively investments in absorptive capacity and complementary assets, because the two innovation learning processes are often intangible events. Absorptive capacity has been operationalized in various ways, such as R&D intensity (Cohen and Levinthal 1989 1990), the number of exploratory alliances made (Koza and Lewin 1998, Rothaermel and Deeds 2004), and the number of technological acquisitions completed (Ahuja and Katila 2001, Puranam et al. 2006). Complementary assets have been operationalized in several ways, to include advertising, capital investments, exploitative alliances and non-technological acquisitions (Ahuja and Katila 2001, Mizik and Jacobson 2003, Rothaermel and Deeds 2004). Measures of exploration and exploitation choices reflect comparisons of investments to increase absorptive capacity relative to complementary assets and visa versa, such as the remainder of advertising expenses less R&D expenses divided by total assets (Mizik and Jacobson 2003), the proportion of exploratory alliances to total alliances (Rothaermel and Deeds 2004), and the proportion of technological acquisitions to total acquisitions (Ahuja and Katila 2001). These exploration-exploitation relative measures also capture, to some extent, the degree of firms’ organizational ambidexterity. Given sufficient variation in firm internal and external selection environments, this paper’s propositions are clearly testable.

**Limitations and Future Research Directions**

This paper includes internal and external selection environment factors that scholars have found to influence exploration-exploitation decisions that lead to organizational ambidexterity, but it cannot claim to be all inclusive in its approach. This paper employed the VSR evolutionary cycle (Campbell 1965) but, due to space constraints, this paper did not examine *whole-part competition*, where selection among variations at one level, e.g., CEO job and firm tenure, conflict with selections made at a higher level, e.g., market competition (Baum 1999). Other theoretical perspectives, e.g., resource-based view (e.g., Rosenkopf and Nerkar 2001), real-options reasoning (e.g., McGrath and Nerkar 2004), may be able to
generate additional theoretical insights. While firm strategy is not explicitly modeled in this paper, firm strategy is present in the product innovation process framework through the performance feedback aspiration levels and the series of strategic innovation decisions (see Figure 1). While this paper examines product innovation, it does not study four other types of innovation identified by Schumpeter (1934), process, market, sourcing and organizational, that could serve as other contexts to examine why and how firm exploitation promotes its future exploration and, ultimately, organizational ambidexterity.

Conclusion

This paper outlines how firm exploitation, linked to experiential learning and product innovation, promotes its future exploration that is tied to knowledge search and product invention, thereby illustrating the pathway to organizational ambidexterity. Using March’s (1991) four theoretical perspectives to build a product innovation process framework, this paper explains why and how organizational knowledge/experience is developed from experiential learning using Zollo and Winter’s (2002) knowledge evolution cycle of variation, selection, replication and retention. This innovation-related knowledge evolution is seen as series of strategic innovation decisions that firms make in choosing between investments in absorptive capacity that promote future exploration or investments in complementary assets that favor future exploitation, choices and their consequences that are integral to achieving and maintaining organizational ambidexterity.
End Notes

1Rosenkopf and Nerkar (2001, p. 289n2) successfully defend their notion of local search as exploration from a reviewer who sees it as exploitation by reminding the reviewer that March (1991) links search with exploration and not with exploitation.

2Some scholars believe that complementary assets also enable exploration, pointing to Helfat (1997) as a clear example. Helfat (1997, p. 343) employs “two sorts of complementary assets” in her paper that predict the level of coal conversion R&D, an exploratory activity: “(1) refining-based technological knowledge within the firm,” which this paper considers to be absorptive capacity; and “(2) assets which the firm could utilize in commercializing the outcome of coal conversion R&D,” which this paper agrees are complementary assets. Only Helfat’s (1997) first variable (absorptive capacity) consistently, significantly predicts her exploratory dependent variable, while her second variable (complementary assets) does not. This empirical finding supports this paper’s alignment of complementary assets exclusively with exploitation and absorptive capacity with both exploration and exploitation. This paper’s alignment is based on a separate study, available upon request, of theoretical and empirical product innovation journal articles found in 20 leading management, marketing, entrepreneurial and innovation journals between 1992 and mid-2009, using a multiple-criteria search for the words “invention” or “innovation” in article abstracts, either “exploration” or “exploitation” in article texts, and either “absorptive capacity” or “complementary assets” in article texts. This search yielded the following results: Six articles used absorptive capacity in an exploratory capacity and complementary assets in an exploitative capacity (e.g., Levitas and McFadyen 2009); 12 other articles used absorptive capacity in both roles (e.g., Zahra and George 2002); an additional 12 articles employed absorptive capacity in either role (e.g., Benner and Tushman, 2002, Rosenkopf and Almeida 2003), while a remaining three articles employed complementary assets solely in an exploitative capacity (e.g., Stieglitz and Heine 2007). None of these 33 articles used complementary assets in an exploratory role.
References


Figure 1  A Temporal and Spatial View of the Product Innovation Process

*Performance Feedback assesses aspiration levels that are incorporated in Firm Strategy.

P1a-d = Propositions 1a, 1b, 1c, 1d

Material flow  Information flow  Combined flow
Figure 2  Firm Innovation Process Replication Phase’s Impact on Future Exploration

<table>
<thead>
<tr>
<th>Customer Needs Diversity</th>
<th>Homogeneous</th>
<th>Heterogeneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broad Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus on Efficiency—</td>
<td>Exploit New Inventions—Promotes Future Exploration (Proposition 2c)</td>
<td>Exploit Prior Inventions—Promotes Future Exploration (Proposition 2d)</td>
</tr>
<tr>
<td>Promotes Future</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exploitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Proposition 1c)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Narrow Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotes Future</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exploitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Proposition 1a)</td>
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</tbody>
</table>

Figure 3  Firm Innovation Process Retention Phase’s Impact on Future Exploration

<table>
<thead>
<tr>
<th>Appropriability Regime</th>
<th>Weak</th>
<th>Tight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Leader</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exploit New Inventions—Promotes Future Exploration (Proposition 2c)</td>
<td>Exploit Prior Inventions—Promotes Future Exploration (Proposition 2d)</td>
<td></td>
</tr>
<tr>
<td>Market Experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Prior Organizational Learning)</td>
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</tbody>
</table>
Figure 4  Firm Innovation Process Variation Phase’s Impact on Future Exploration

<table>
<thead>
<tr>
<th>Environmental Dynamism</th>
<th>Stable</th>
<th>Turbulent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long CEO Job and Firm Tenure</td>
<td>Explore—Promotes Future Exploration (Proposition 3c)</td>
<td>Exploit—Promotes Future Exploration (Proposition 3d)</td>
</tr>
<tr>
<td>Short CEO Job and Firm Tenure</td>
<td>Exploit—Promotes Future Exploration (Proposition 3a)</td>
<td>Explore—Promotes Future Exploration (Proposition 3b)</td>
</tr>
</tbody>
</table>

Figure 5  Firm Innovation Process Selection Phase’s Impact on Future Exploration

<table>
<thead>
<tr>
<th>Competitive Intensity</th>
<th>Weak</th>
<th>Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance At or Above Aspirations</td>
<td>Explore—Promotes Exploit—Future Exploitation (Prop. 4c)</td>
<td>Exploit—Promotes Exploration (Prop. 4e)</td>
</tr>
<tr>
<td>Performance Aspirations Comparisons</td>
<td>Exploit—Promotes Exploration (Prop. 4e)</td>
<td>Explore—Promotes Exploit—Future Exploitation (Prop. 4d)</td>
</tr>
<tr>
<td>Performance Below Aspirations</td>
<td>Explore—Promotes Future Exploitation (Prop. 4a)</td>
<td>Exploit—Promotes Future Exploitation (Prop. 4b)</td>
</tr>
</tbody>
</table>

*Organizational slack is available above or right of the diagonal line in each cell, while slack is unavailable below or left of the diagonal line in each cell.