A Story of Breakthrough vs. Incremental Innovation:
Corporate Entrepreneurship in the Global Pharmaceutical Industry

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ABSTRACT
Breakthrough innovations are difficult to create; yet they are critical to long-term competitive advantage. This highlights the considerable opportunities and risks that face corporate entrepreneurs. We study the complex explorative and exploitative entrepreneurial processes of multinational firms operating in the global pharmaceutical industry. We analyze over 1,500 new drug approvals by the U.S. Food and Drug Administration (FDA). We find that a successful track record in breakthrough innovation significantly increases the likelihood of a current breakthrough, while achievements in non-generic incremental innovation do not have a significant effect. A strong foundation in generic incremental innovation hinders breakthrough performance. Thus, incremental innovation processes appear to be heterogeneous. Products that emerge from joint ventures and alliances are more likely to be breakthroughs. Foreign subsidiary participation in innovation processes did not significantly inhibit breakthroughs. These suggestive findings support the decentralization literature that highlights the benefits associated with exploiting knowledge from foreign centers of excellence. Contrary to the literature arguing that younger firms tend to have greater advantages in “exploration”, we do not find firm age to be a significant predictor of the likelihood of breakthrough innovation.

Keywords: corporate entrepreneurship, intrapreneurship, breakthrough innovation, incremental innovation, organizational ambidexterity, open innovation, foreign subsidiaries, strategic alliances and global pharmaceutical industry

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THE CORPORATE ENTREPRENEURSHIP PERSPECTIVE

According to Snow (2007), *innovation* (the introduction of a new product, service) and *entrepreneurship* (the founding of a business) are virtually one and the same. The history of innovation research is vast and due to the continual rising of new challenges there remains a call for new theorizing. Snow (2007) argues that future research should be linked to strategic entrepreneurship allowing for a better understanding of firm opportunity-seeking and advantage-seeking activities. While there is currently no dominant theory on innovation, there is agreement that innovation is a complex, difficult-to-measure construct (Fischer, 2001; Tidd, 2001) that involves newness to some degree to either the adopting unit (Rogers, 1983) or the marketplace, sector or industry (Lawson and Samson, 2001) and has a positive effect on firm performance (e.g., Zahra, 1991; Zahra and Coven, 1995). According to DiMasi (2000), the impact on performance can be profoundly long-term. Pharmaceutical firms in their study maintained relatively stable company leadership positions for new product introductions and innovative output over a thirty-five year time span.

Scholars and practitioners have argued that entrepreneurs must not just innovate occasionally, but often, quickly and efficiently to ensure future growth from revenues generated from customers purchasing new and improved products and services. Cooper (2007) states that “the behavior of entrepreneurs and the influences upon that behavior are clearly at the heart of strategic entrepreneurship” (p. 145). To this end, academics have determined that there are core elements such as firm-differences, competitive environment, strategy, task complexity and management style that affect the entrepreneurial processes and innovative outcomes across firms. A number of theoretical perspectives have been used to examine the innovation process including cognitive theory, dynamic capabilities, institutional theory, market orientation, resource-based view, socio-technical approaches, transaction cost economics, and so on. We integrate and review the literatures from knowledge management, learning organizational theory and organizational ambidexterity to develop an integrative framework for corporate entrepreneurship.

For many scholars, Schumpeter is the seminal thinker for the literature on innovation (Schumpeter, 1934, 1939, 1942). He provided one of the first counter-perspectives to the mainstream
viewpoint held by neo-classical economists and historians of science and history that innovation is not a “black box” exogenous activity that could only be understood after the serendipitous event had occurred. Yet, in spite of the large body of literature on the subject, there is still much that is not understood about how innovative opportunity is created within the firm (Leiblein, 2007). Notwithstanding, scholars contend that Schumpeter’s theory of “creative destruction” is as relevant today as it was then and thus researchers continue to study the nuances of innovation from new perspectives.

Scholars of corporate entrepreneurship research traditionally have focused on ways in which firms can create positive changes within the organization involving new businesses and new product development (Narayanan, Yi, and Zahra, 2009). The two key phenomena that best define the processes surrounding corporate entrepreneurship are: (1) the birth of new businesses or internal venturing and (2) the transformation of organizations through renewed patterns of resource deployment (Guth and Ginsberg, 1990). Within the wider context of corporate entrepreneurship, corporate venturing focuses on the first component of Guth and Ginsberg’s (1990) definition with added attention to the processes that firms use both internally (i.e., new innovative businesses) and externally (i.e., licensing and strategic alliances) to create new opportunities within existing firm portfolios. Most of the research in this domain has focused on the parent organization rather than the venture unit or the new venture itself (Narayanan et al., 2009). We examine the impact that the firm’s foreign subsidiary activities, emanating from greenfield operations versus acquired units, and strategic alliance relationships have on its intra-firm innovativeness.

The term “strategic entrepreneurship” is a relatively new term in the literature and refers to the connection between the entrepreneurship and strategic management literatures (Kuratko and Audretsch, 2009). It refers to the second component of Guth and Ginsberg’s (1990) definition and further elaborates on how firms must enhance their responsiveness to change, increase their willingness to take risks and engage in innovative decision-making (Phan, Wright, Ucbasaran, and Wee-Liang, 2009). A strategic entrepreneur or one possessing this dominant logic must embrace the uncertainty surrounding the innovation and diffusion process and at the same time inspire intrapreneurship within the firm (Kuratko and Audretsch, 2009).
Strategic entrepreneurship research is becoming increasingly important as firms that were once not thought of as being entrepreneurial must become so if they want to prosper in the global marketplace. One of the significant challenges facing scholars in the field is that there needs to be a better understanding of the heterogeneity of corporate entrepreneurship activities (markets, products, established versus start-ups) from a broader life-cycle perspective (Phan, et. al., 2009). In this paper, we study how firm entrepreneurship changes over time, examining a total of 1,496 commercialized innovations (breakthrough and incremental), approved by the U.S. Food and Drug Administration (FDA), for the years 1993-2002. We incorporate product innovations prior to 1993 to capture past organizational learning. Our sample consists of public firms and includes smaller, start-up firms, medium-sized firms and larger, mature firms. The 98 firms in our study ranged from being in their first year of business to being 163 years old and had net sales from as little as $0 dollars to $52.2 billion. Recognizing that firms’ home bases may differ in terms of environmental inertia, institutional rigidities and opportunities for organizational learning, we control for national country differences for the major global pharmaceutical players in our study (US, UK and Switzerland). Further, we recorded the number of new efficacy supplements (a means whereby firms exploit their existing innovation portfolios) generated from these core drugs (1992-2002) up until the year 2008 for both public and private firms.

According to a recent report in Businessweek, Mandel (2009) finds that the last decade of American innovative spirit has not been “an era of rapid innovation…(but)…an era of innovation interrupted…(leading to)…today’s financial crisis” (p. 34). In the healthcare field alone, there have been estimated to be far too many clinical-test breakthrough pipelines that were once promising but ended up as failures (e.g., cancer treatments, cloning, and gene therapy) even with strong in-house global R&D facilities. In 2007, Pfizer announced plans to close five facilities (research and manufacturing) that employed 10,000 workers due to (1) an insufficient number of breakthroughs in the pipeline and (2) a risk of losing almost 41% of its sale revenue to generic competition following the loss of patent protection for its two most profitable drugs, Zoloft and Norvasc (Smith, 2007). Not surprisingly, in 2007 the United
States’ Census Bureau, recorded a US trade deficit of $53 billion in high-tech areas such as life sciences compared to the $30 billion trade surplus it recorded in 1998 (Mandel, 2009).

As a consequence, we recognize that the announcement of novel innovations may not only push the firm out of its established knowledge platform, but also may have a profound impact on its ability to generate significant future profits. Given the magnitude that breakthrough innovations have on the economic growth of a nation and the long-term survival of a firm in its industry, it is crucial to understand the key factors that underpin successful corporate entrepreneurship. Our study focuses on the global pharmaceutical industry where the discovery, development and commercialization of new knowledge are particularly important for the delivery of innovative new products to the marketplace. We develop an integrative framework of corporate entrepreneurship and study the firm’s ability simultaneously manage two very different types of innovation processes — breakthrough (explorative new products) and incremental (exploitative new products) (see Figure 1).

Organizational Ambidexterity and Corporate Entrepreneurship

One of the most critical insights of Nelson and Winter’s seminal study (1982) was that it shed light on how organizations and their deliberate problem-solving efforts to innovate define the introduction of newness to a society. Their approach concentrated on historical techno-economic change and how the very basic attributes of newness continue to captivate the attention of consumers, corporate innovators, investors, business practitioners, and management scholars. An important question arises with regard to the definition of innovation and newness. Scholars have suggested that “breakthrough” and “incremental” innovation labels for both process and product innovations are not necessarily tangible, concrete categories; they specify the extremes of the continuum of technological change. Typically, breakthrough innovations start the cycle of technological change (e.g., the polio vaccine, personal computers). Over time, incremental innovations in form of new features, extensions, variations or complements to an
existing product line (e.g., needle-less vaccine delivery systems, laptop computers) build on the dominant designs created by breakthrough innovations. Incremental process innovations frequently involve innovations in production efficiency and/or product quality (Kuratko and Welsch, 2001; Tushman and Nadler, 1986; Utterback and Abernathy, 1975). According to Anderson and Tushman (1991), the length of time needed to establish a dominant design depends on whether or not the innovation enhances or destroys current knowledge. Typically, a longer time period is required for innovations that destroy current industry know-how.

From a punctuated equilibrium perspective, technological progress evolves through long periods of relatively minor changes punctuated with short dramatic events of breakthrough change (Romanelli and Tushman, 1994). These short periods of radical change are referred to as “technology discontinuities,” which create price and/or performance improvements relative to current technologies (Tushman and Anderson, 1986). According to Tushman and O’Reilly (1996), periods of discontinuous change are most likely to materialize when there are major downtrends resulting from changes in the firm’s external environment (e.g., regulatory, technological, political and economic changes). March’s (1991) seminal piece on organizational ambidexterity suggests that the internal tensions between these two organizational modes of innovation learning activities – breakthrough (exploration) versus incremental (exploitation) – are distinctly and fundamentally different from one another.

While the traditional exploration-exploitation framework views breakthrough and incremental innovations as being on two ends of the same continuum, the focus of scholars most recently has been on firms that can and indeed thrive in dynamically changing environments through simultaneously balancing and reconciling these complementary, yet competing tensions (e.g., Rothaermel and Deeds, 2004). Traditionally, Schumpeter and neo-Schumpeterian scholars have highlighted how “creative destruction” is critical to earning above-average rents in the endogenous economic system. Others in the literature have related creative destruction to breakthrough inventions (Ahuja and Lampert, 2001), breakthrough innovations (Mote, Boylan, and Rice, 2001), discontinuous innovations (Abernathy and Utterback, 1978), pioneering products (Ali, 1994) and disruptive innovations (Christensen, 1997). Contemporary
Schumpeterian scholars have given closer attention to the theoretical and empirical complexities associated with integrating both breakthrough (exploration) and incremental (exploitation) innovation activities inside the firm (Raisch and Birkinshaw, 2008).

Firms that are able to pursue exploitation and exploration activities in parallel are more likely able to achieve long-term gains. By not becoming too trapped in a never-ending spiral of searching for breakthrough opportunities emanating from potentially unrewarding trends in the external environment (Levinthal and March, 1993; Tushman and O’Reilly, 1996), firms are able to reap returns from existing knowledge capabilities (Palmer and Brookes, 2002). Nokia Corporation, the foremost mobile phone supplier is an example of a firm that was able to successfully and simultaneously combine both exploration and exploitation activities in a favorable way (Masalin, 2003; Mudambi, 2008). To thwart core rigidities and dependence on highly specific settings (Leonard-Barton, 1992), firms need to actively pursue both breakthrough and incremental innovations to sustain competitive advantage. Our model builds on the strategic alliance literature that has found that firms are better able to manage these paradoxical demands through partnering (Rothaermel and Deeds, 2004; Rothaermel and Boeker, 2008).

**Firm Size and Corporate Entrepreneurship**

All firms engaging in strategic entrepreneurship must purposefully implement both opportunity-seeking and advantage-seeking activities to create new wealth and competitiveness (Ireland, Hitt, and Simon, 2003). Ketchen, Ireland and Snow (2007) find that the strategic entrepreneurial process continues to be mysterious and that some firms regardless of size are more dependable in their ability to produce high rates of innovations. So far, a common theme in the literature is that firm size is an important factor in the breakthrough innovation development process. During the 1950s and 1960s, an era dominated by economies of scale and big labor unions, large firms regarded not only as having greater productive efficiency than small firms, but also as being the “engines” of innovative progress.

Schumpeter (1942) warned that innovation in large corporations was being reduced to routine procedures in which teams of specialists were trained to produce technological changes that followed
predictable knowledge conditions. The dominant logic of the day created a lack of internal flexibility, which further created a complex system of self-sustaining, reliable routines that were narrow in scope and did not instigate organizational conflict (Mote et al., 2001). Unfortunately, these deliberate and rather mechanical sets of organizational routines through bureaucratic control structures failed to encourage the exploration of radical breakthrough opportunities (Nelson and Winter, 1982). Large firms, in essence, became trapped by their familiarity, maturity and propinquity or need to “search” for new incremental solutions to well-known market domains (Ahuja and Lampert, 2001).

Since the mid-1970s, however, through the dynamic process of deconcentration and decentralization the trend toward ever larger giant enterprises has been reversing. Average firm size has decreased and the share of sales from entrepreneurial firms, defined as smaller, younger, family-owned and/or new start-up businesses, has grown (Audretsch, 1995). The literature supports the notion that although small firms are limited by their production, marketing, financial and human resources, they are more likely to “search” for and produce more novel innovations than larger firms (Almeida and Kogut, 1997; Hannan and Freeman, 1984; Rothaermel and Boeker, 2008). While some suggest that fostering innovation inside large firms cannot coexist within most bureaucratic structures, others have focused on describing how firms can develop successful processes that can exist within “routinized” frameworks (e.g., Ahuja and Lampert, 2001; Kuratko and Hornsby, 1997).

The past few decades have witnessed an increasing emphasis on traditional learning theories (Cyert and March, 1963) that have attempted to understand how organizations of all sizes can gain knowledge from past innovative behaviors to stimulate future entrepreneurial growth. Starting from Peterson and Berger’s (1972) seminal work, researchers have focused on identifying the organizational and environmental factors that influence corporate innovation. The desire to pursue innovative thinking inside the enterprise arose during the entrepreneurial economy of the 1980s (Kuratko and Welsch, 2001). Scholars sought to understand the process that established firms used when entering into new business ventures (e.g., Burgleman, 1983).
Earlier researchers such as Miller (1983) established the theoretical framework and research methodology to examine the main linkages between environmental, strategic, and organizational variables and a firm’s entrepreneurial activities. Management experts at that time suggested that innovation was the vehicle through which entrepreneurs create the potential for wealth-producing resources (Drucker, 1985). Gifford Pinchott first developed the concept of intrapreneurship to describe the entrepreneurial activities inside large corporate structures. Corporate intrapreneurship is viewed as a necessary component of corporate entrepreneurship and refers to the firm’s change agents that challenge the status quo and constantly initiate new innovative thinking (Kuratko and Audretsch, 2009).

According to Birkinshaw (1997), the corporate entrepreneurial behavior leading to the “birth of new businesses” (Guth and Ginsberg, 1990) can be best described as a “focused entrepreneurial strategy”. Managers at 3M have successfully pursued this type of strategy (Birkinshaw, 1997). By following a “lead user process strategy,” the managers at 3M were able to set forth a new strategic goal, in the mid-1990s, that challenged the company to produce thirty percent of its product line from products that did not exist in the company’s portfolio of products four years ago (von Hippel, Thomke, and Sonnack, 1999). Corporate entrepreneurship requires management to encourage all employees to pursue the development of new opportunities. According to (Phan et al., 2009), corporate entrepreneurship succinctly refers to “renewal” based on two phenomena (1) corporate venturing (Narayanan et al., 2009) and (2) strategic entrepreneurship (Kuratko and Audretsch, 2009).

Given that today’s high-tech economy supports a greater number of sophisticated competitors than ever before, managers recognize that they can no longer derive value by focusing on known strategic competencies (Vale and Addison, 2002). To cope successfully with these ever-changing environments, firms must be open-minded enough to continually “search” for new avenues to develop new products for new markets (Ireland, Covin, and Kuratko, 2009; Kuratko and Audretsch, 2009). In many cases, directing a flow of “entrepreneurial events”, defined as any unplanned combination of economic resources initiated by the vague outlook of temporary monopoly profits (Binks and Vale, 1990), within the firm is being viewed as a strategic competency. According to Phan et. al. (2009), it is important to
note that small and large firms face the same risks as they attempt to exploit and create new knowledge. From a learning organizational perspective, large and small firms engaged in strategic entrepreneurship often find it advantageous to join forces and share complementary opportunity-seeking and advantage-seeking knowledge competencies. Specifically, large firms may have to “think small” and small firms may have the “think big” to instigate real change (Ireland et al., 2009).

THEORY DEVELOPMENT AND HYPOTHESES

We have argued that corporate entrepreneurs, regardless of size, need to actively and simultaneously pursue exploitative (incremental) and explorative (breakthrough) innovation opportunities that meet market needs. Now, we integrate these concepts from a knowledge management and organizational learning perspective and formulate our hypotheses.

The Role of Accumulated Past Knowledge in Corporate Entrepreneurship

From a learning perspective, organizational “routines” typically guide and constrain processes by which new knowledge is assimilated and organized (Nelson and Winter, 1982). Routines that lead to market-based objectives create path-dependent future actions whereas projects that do not materialize as anticipated are quickly eliminated or temporarily shelved (Ahuja and Lampert, 2001). The firm’s ability to apply the lessons learned during these types of experiences makes a difference in its speed and integrative innovative abilities over another firm facing a similar situation. Put differently, learning builds upon existing knowledge domains and other familiar assets and these influences affect the direction of future entrepreneurial behaviors (e.g., Nerkar, 2003; Teece, 1988).

Extensive past experience with a particular knowledge or innovation practice may also result in greater inertia for change or learning. In the case of strong in-house R&D facilities, particularly among large firms (e.g., Fischer, 2001), established mental models geared toward incremental solutions may be the norm. The strategy literature on learning suggests that while innovation is fostered by diversity in experience, repeated spirals of competition and cooperation within a familiar setting can also lead to blindness to new opportunities and threats that transcend specific settings (Levinthal and March, 1993).
Within this context, newer innovation models may be viewed as less attractive and such projects may have lower rates of acceptance by entrepreneurial decision-makers.

We argue that due to the increasing pressures being placed on today’s firms, those investing in searches for opportunities that leverage past knowledge increase their risk of being “locked out” from acquiring and investing in newer breakthrough technologies (Narula, 2002). Fewer accumulated breakthrough knowledge experiences and even breakthrough failures may further create a “familiarity trap” and prevent firms from sensing opportunities beyond their typical knowledge domain (e.g., Ahuja and Lampert, 2001; Hayward, 2002). It is our contention that increased access to successfully accumulated breakthrough endeavors will expand the firm’s pool of valuable, complementary resources from which it can search for solutions to new technological processes (Levitt and March, 1988).

Reduced association with past incremental innovation successes may also create a tolerance for ambiguity and an appreciation of knowledge complexity. This tolerance is particularly important for the development of breakthrough capabilities where the firm’s core technologies are already pushed into new, uncharted territories. Ahuja and Lampert (2001) found that firms that were able to experiment with novel, emerging and pioneering technologies were more successfully able to overcome familiarity traps that typically inhibited breakthrough practices in the past. According to Nerkar (2003), researchers should measure the impact of successfully commercialized products to better understand current research on explorative and exploitive activities. To this end, we argue that prior experience with successfully commercialized breakthrough innovations is an internal resource that is valuable, unique and difficult to imitate and thus enhances the firm’s competitive advantage (Barney, 1991). Hence, we hypothesize:

**Hypothesis 1.** The greater the firm’s pre-existing stock of breakthrough innovations, the greater the likelihood that the current innovation will be a breakthrough rather than an incremental.

**Hypothesis 2.** The greater the firm’s pre-existing stock of incremental innovations, the lower the likelihood that the current innovation will be a breakthrough rather than an incremental.
The Role of Foreign Subsidiaries in Corporate Entrepreneurship

A firm's production of knowledge constitutes a resource underpinning sustainable competitive advantage (Barney, 1991). It has been suggested that knowledge from a particular national location embodies more than its national culture, but rather its entire national system of innovation (NSI) (Lundvall, 2007; Mudambi, 2008). Researchers have found that NSIs, although seemingly resistant to changes, do change, but in a manner that is slower than what firms need in terms of new technological requirements. For instance, Narula (2002) found that larger, more traditional, resource-intensive sectors that were highly embedded within Norway’s NSI benefited most from the close-knit relationships developed nearby their home location of competence. By virtue of having research facilities in certain geographic regions, foreign subsidiaries can be used to tap into unique local technological capabilities.

The literature on geographic knowledge sourcing of innovation in the context of the parent-foreign subsidiary dyad reveals two different models - centralization and decentralization. A centralization strategy is more of a learning-by-doing process that demands greater specialization (Cohen and Klepper, 1996). Scale economies in R&D are achieved in single geographic locations, preferably within a regionally or a nationally concentrated knowledge cluster. Empirical evidence supports the notion that knowledge spillovers tend to occur in geographically localized clusters (e.g., Jaffe, Trajtenberg, and Henderson, 1993). There are both demand-driven (e.g., close interaction with customers) and supply-side (e.g., spillover advantages) reasons why geographical proximity at a single location is preferred. Sakakibara and Porter (2001) found that intense domestic rivalry among a sample of Japanese industries was positively associated with international trade performance. The extent to which the R&D efforts by MNEs are undertaken in their home country depends on the nature of the industry in which it operates, the incentives of the host country, the absolute size of the home country, the nature of knowledge itself, and the extent of foreign competition (Cantwell and Mudambi, 2005).

The counter argument to this philosophy is that centralization leads to risks of “lock-in” into technological and institutional systems of innovations that are self-reinforcing and not always efficient.
The *decentralization* concept of managing, developing, and exploiting global knowledge from strategically advantageous “centers of excellence” is not new. Other related concepts include Bartlett and Ghoshal’s (1989) *transnational organization*, Prahalad and Doz’s (1987) *multi-focal organization*, Hedlund’s (1986) *heterarchy*, Cantwell and Mudambi’s (2005) competence-creating subsidiaries and Perlmutter’s (1969) *geocentric organization*. According to de Meyer (1992), a tightly coordinated, yet decentralized strategy allows firms: (1) the ability to reap the benefits of cost differentials in different countries (*traditional neo-classical economic theory*), (2) the capacity to become more responsive to markets (*international product life cycle theory*) (Vernon, 1966) and (3) the potential to reduce difficulties with technological transfer of know-how through networks (*transaction cost approach*) (Teece, 1981).

Frost, Birkinshaw and Ensign (2002) found that MNEs need to re-assess the innovative role played by foreign subsidiaries. A survey of the literature reveals that there are a limited number of frameworks that examine how the innovation function of foreign subsidiaries affects firm outcomes (Frost, 2001; Frost, Birkinshaw, and Ensign, 2002). Most frameworks have characterized the knowledge and financial linkages between the MNE parent, its subsidiaries (Asakawa, 2001) and most recently its subsidiary host sites (Cantwell and Mudambi, 2005; Mudambi, 2008). Current research suggests that firms are gradually allowing their foreign R&D subsidiaries to take on more specialized roles based on the comparative advantages of the subsidiary’s location. This perspective view asserts that when subsidiaries take on important roles such as “centers of excellence” intra-firm knowledge flows are greater (e.g., Frost, 2001; Frost *et al.*, 2002).

Notwithstanding, decentralization strategies are complicated, costly and require a great deal of expertise. Further, foreign subsidiaries that undertake knowledge-intensive activities have been found to be difficult for headquarters to control (Mudambi and Navarra, 2004). This may be why some studies report an overall insignificant flow of cross-border knowledge sharing. For instance, by using patent statistics as a proxy for measuring the world’s largest firms in different countries and sectors, researchers have determined that the technological production activities of firms are far from globalized (e.g., Jaffe *et
al., 1993; Patel and Pavitt, 1991). Most recently, Kelley, Peters and Colarelli O’Connor (2009) reported that a firm’s knowledge base is theoretically likely to be enhanced when organizational members share similar, but uniquely different and diverse knowledge structures. However, in reality it is difficult to recruit global organizational members that want to participate in high risk projects filled with uncertainty, unfamiliarity and potential failure. Put simply, they found that organizational members were more cautious to be seen as failing on a global rather than on a local platform and thus were less willing to collaborate with others particularly on breakthrough innovation projects involving organizational legitimacy concerns.

Building on this logic, we argue that foreign subsidiaries have their own individual characteristics and unique ties with their parent organizations. We contend that even though the decentralization of subsidiary roles is increasing and firms are tapping into NSIs for knowledge spillovers, subsidiaries are still required to undertake traditional support functions with central oversight of their R&D budgets. According to Aldrich and Kim (2007), people within these environments are likely to be constrained by “small world networks”. Thus, it can be difficult for subsidiaries to secure the kind of long-term support and financial resources necessary for the exploration of technological breakthroughs.

The path to developing novel products within the global pharmaceutical industry is a long and expensive process due to strict governmental regulations which forbid firms from marketing new product developments without approval from the relevant government agency (e.g., the Food and Drug Administration in the U.S.). For instance, it can cost upwards of $800 million and fifteen years of clinical research to bring a new drug to the market. Moreover, less than one percent of drugs tested will end up being used by patients and of those drugs that are approved only thirty percent will recover their R&D expenses (Dimasi, Hansen, and Grabowski, 2003). With these seemingly insurmountable costs, we hypothesize that foreign “centers of excellence” from greenfield operations will be more reluctant to engage in and be associated with high risk projects aimed at breakthrough innovation. We suggest that when firms increase their heterogeneity of collaborative efforts outside of their home-base system of innovation, they are more likely to open up the doorway to exploit technology trajectories that are
predictable and slow down their existing product life cycles or ‘s-curves’ (Rogers, 1983). From this rationale, we suggest the following:

**Hypothesis 3.** Innovations emanating from foreign subsidiaries are less likely to be breakthrough innovations rather than incremental.

**Hypothesis 4.** Innovations emanating from greenfield operations are less likely to be breakthrough innovations rather than incremental.

The Role of Joint Ventures and Strategic Alliances in Corporate Entrepreneurship

By engaging in acquisition and alliance strategies, firms increase their scope of future learning possibilities. The idea that creativity, synergies and new ideas come from the interaction and recombination of these potentially conflicting knowledge sets is well-accepted in the knowledge literature (Simon, 1985). In fact, knowledge that is not regularly renewed can lead to “core rigidities” in technological innovation advancement (Leonard-Barton, 1992) so that “firms are compelled to augment their R&D capacity by collaborating and sourcing-in … discoveries, inventions, and innovations from other players and institutions” (Markman, Siegel and Wright, 2008: p. 1401).

Due to the ongoing and growing importance of partnerships, joint ventures, alliances and other forms of collaborative learning experiences, Lane and Lubatkin (1998) refined Cohen and Levinthal’s (1990) “absorptive capacity” construct to examine the inter-organizational learning aspects that occur in knowledge sharing alliances. As firms participate in these alliances, they face unique challenges. Moreover, it is argued that alliances have to benefit both partners, if they are to “reduce risk and facilitate knowledge transfer” (Cumming and Macintosh, 2000: p. 360). If alliance partners are unwilling to devote energies into resource combination, then the empirical benefit from such knowledge sharing is limited (Wiklund and Shepherd, 2009). In many cases, some firms may naturally take on the role of “student firm”, while other firms may take on the role of “teacher firm”. Inter-organizational and intra-organizational learning has been found to be positively enhanced when the student-teacher learning dyad shared similar basic knowledge bases, compensation practices, and research communities (Lane and Lubatkin, 1998; Yang, Mudambi and Meyer, 2008).
While it is important that alliance dyads share basic experiences, it is equally important that their knowledge experiences do not become so similar to one another that there is little room for creativity, collaboration, continuous learning and most importantly, the exploration of breakthrough opportunities. In other words, even though alliance characteristics (sizes and structure) vary greatly across firms and industries, firms entering into them should continually have something new to learn from each other. The joining of diverse, yet complementary skill sets is an essential and necessary component of technological innovation (Cohen and Levinthal, 1990; March 1991; Kotabe and Swan, 1995; Rosenkopf and Schilling, 2007). In many cases, new and established firms benefit most from alliance partnerships. Rothaermel and Boeker (2008) found that biotechnology and pharmaceutical firms entered into alliances when the biotechnology firm was younger. Cultural factors also matter according to Coombs, Mudambi and Deeds (2007). They found that foreign firms, unlike domestic firms, entered into alliances to access local knowledge embedded in dominant regional clusters. Their results suggest that foreign firms value location-specific knowledge because they are not only able to have access to “direct types of knowledge”, but they are also able to tap into “indirect types of knowledge” (i.e., specialized resources and information only available through network membership). Finally, the literature on open innovation provides strong evidence of the value of re-combining diverse knowledge resources (Laursen and Salter, 2006; von Hippel, 1998). Given these positive and convincing arguments, we hypothesize the following:

**Hypothesis 5.** Innovations emanating from joint ventures and strategic alliances are more likely to be breakthrough innovations rather than incremental.

**METHODOLOGY**

**Data**

Our objective in this study was to examine empirical data on corporate entrepreneurs that are attempting to balance the competing demands associated with developing breakthrough and incremental product innovations. We gathered data from the global pharmaceutical industry since it is an industry that is both science- and technologically-intensive and has a high propensity to create both types of new product innovations. According to a recent IMS Health Report, worldwide sales in the industry were
approximately $643 billion dollars in 2006. Our initial sample was drawn from the population of US-based multinationals and foreign multinationals operating in the United States that received approval from the U.S. Food and Drug Administration’s (FDA) Center for Drug Evaluation and Research (CDER) that their new products were “safe” and “effective” for marketing under U.S. law.

The FDA’s new drug application (NDA) is a lengthy process. It involves extensive analysis of clinical testing methods as well as reviews of labeling information and manufacturing methods. Applications are nearly 100,000 pages long and take about two years to be processed; average testing periods are more than eight years. Receiving FDA approval for the marketing of a new drug often has a fundamental impact on the firm’s growth and profitability. For instance, investors who had a strong financial stake in the company Bristol-Myers Squibb received a fifteen percent decrease in their stock values when the FDA refused to review the firm’s breakthrough cancer treatment candidate, Erbitux, in which the firm has invested more than a billion dollars (Sellers, 2002).

We limited our sample to product innovations that occurred over the time period 1992-2002. This sample comprised a total of 2,885 new drugs ($n = 2,590$ incrementals, $n = 295$ breakthroughs) from both private and public firms. For our final analysis, private companies, companies that only created abbreviated new drug applications (generics) and firms that did not create innovations after 1992 were excluded. This left a total of 1,789 new products in our dataset. Due to missing financial and other construct measures, our final usable samples (depending on model specification) comprised between 1,699 and 1,496 new products from 98 firms.

Companies in the pharmaceutical industry exploit these product innovations through new efficacy supplements (NESs) that represent a labeling modification to the original innovation. Up until the year 2008, we recorded 16,684 NESs to our original sample of 2,885 new drugs. FDA review of these applications takes approximately six to twelve months. NESs are marketed as new innovations proposing to add a new usage to an already approved product. No matter how many supplements are created, these innovations still maintain their original new product application number.
Constructing Measures

**Breakthrough and incremental innovations.** The FDA has a detailed evaluation system to determine whether or not a new drug is “new to the market” or a “product improvement”. Thus, we believe that our measure is appropriate for the organizational ambidexterity focus developed in our paper. Product innovations were coded as 1 for breakthrough and 0 for incremental. Drugs which the FDA defines as new molecular entities (NMEs) are new active ingredients that have never been marketed before in any other form in the United States. We recorded these products as *breakthrough innovations*. We classified *incremental innovations* as (1) new drug applications (NDAs) chemical types that have been marketed in the U.S. before in one form or another (e.g., a non-generic new chemical dosage form) according to FDA standards and (2) all abbreviated new drug applications (ANDAs) or generics that are bioequivalent to previously approved NDAs. Further, we gathered data on new efficacy supplement applications (NESs) up until 2008 for all original new drug applications from the years 1992-2002. We computed the number of NESs per year since drugs developed in 1992 are more likely to accumulate more NESs than drugs developed in 2002. We classified NESs as another exploitative and incremental form of corporate entrepreneurship (see discussion section).

**Prior accumulated knowledge.** This construct was measured as the stock of breakthrough (prior breakthrough) and incremental (prior incremental) product successes that the firm had in 1992, the year before the period of analysis (1993-2002). For incremental innovations, we further categorized between non-generic versus generic forms of innovation. While both product categories involve some form of minor technological change to an existing knowledge platform, theorists, scientists and the FDA draw a distinction between them. Non-generics, unlike generics are protected by patents. Once a patent has expired, a generic alternative can be sold. Generic innovations often radically increase price competition among firms as well as the number of choices available to consumers in a product class category.

**Foreign subsidiary unit.** An essential aspect of this study was to characterize how foreign subsidiary knowledge impacts corporate entrepreneurship activities. To accomplish this objective, we initially recorded the name of the firm for each FDA approved drug application. We further determined whether
or not the firm was a subsidiary or the parent firm. Based on information from CHI Research Inc’s Tech-Line Products of Companies and extensive additional public records (e.g., 10-k reports, press releases, Mergent, Who owns Whom, etc.) we were able to properly unify parent-subsidiary relationships. We recorded the two-digit country code for both parent and subsidiary firm. Foreign subsidiaries were coded as 1 and domestic subsidiaries were coded as 0.

**Greenfield operations.** This construct was specified by identifying, through public records (e.g., 10-k reports, press releases, Mergent, Who owns Whom, etc.), whether or not the subsidiary was a greenfield operation (coded as 1) or acquired (coded as 0) up until the year 2002.

**Joint venture, strategic alliances.** The degree to which the parent firm relied on a joint venture or other forms of strategic alliances was measured by analyzing the self-report information on the FDA new drug application. If more than two companies were responsible for a NDA, then this information was listed on the original FDA application. Through public records (e.g., 10-k reports, press releases, Mergent, etc.), we recorded whether or not specific drugs were the creation of joint ventures and/or other alliance agreements. We coded 1 for JVs and alliances and 0 otherwise.

**Firm-level controls.** As discussed earlier, firm age (continuous) and firm size (continuous) are important influences on corporate entrepreneurship. Thus, we needed to control for these influences. We gathered data at the parent firm level. First, we collected information on the firm’s date of incorporation from Mergent. We subtracted this date from the year in which a new product was developed. Firms in our study ranged from being in their first year of business to being over 150 years old. Financial data for firm net sales and firm R&D intensity were gathered from 10-k reports, Mergent, Edgar and Osiris. Firm size was measured as the firm’s net sales per year (in thousands). A large body of empirical work has examined the relationship between R&D resources and firm performance. It is well established that increasing R&D intensity positively affects firm outcomes (e.g., DeSanctis, Glass, and Ensing, 2002). This is particularly evident in the pharmaceutical industry where R&D is vital to firm performance. R&D intensity was measured as a ratio of R&D expenditures by the firm to its total net sales.
National System of Innovation (NSI). Given the current research on NSIs, we expected that a parent firm’s NSI or its home-base headquarters location to have a significant influence on its corporate entrepreneurial behavior. We defined a firm’s NSI as the country in which the firm is headquartered. Firms were coded based on internationally recognized two-digit codes. We generated three primary NSI dummy variables for the firms in this study: United States (US), United Kingdom (UK), and Switzerland (CH). Firms from less represented countries and territories such as Belgium (BE), Bermuda (BM), Canada (CA), Denmark (DK), France (FR), Finland (FI), Germany (DE), Ireland (IE), Israel (IL), Japan (JP), and the Netherlands (NL) were coded as “other” or zero.

Industry controls. The global pharmaceutical industry was selected as the primary focus of this study. For each parent firm, we gathered information on their primary standard industry classification code (SIC) from Mergent. We classified firms according to their 4-digit SIC code. Mainstream pharmaceutical firms (coded as 1) had the following SIC codes: 2833 (medicinal chemicals), 2834 (pharmaceutical preparations), 2835 (in vitro diagnostic substances) and 5122 (drugs, drug proprietaries). Pharmaceutical-related firms (coded as 0) were from the following SIC code classifications: 2836 (biological products), 2841 (soap), 2844 (toilet, perfumes), 2869 (organic chemicals), 2874 (fertilizer), 2891 (adhesives), 3563 (gas compressor), 3841 (surgical), 3851 (ophthalmic), 8733 (non-commercial research), etc.

Additional product controls. We controlled for whether or not the new product was a prescription (RX) or an over-the-counter (OTC) drug. Further, in this research, we controlled for patent knowledge (Jaffe et al., 1993) since patents encompass know-how into the inner-workings of product and process technologies (Kogut and Zander, 1993). The appropriateness of utilizing patent data as a measure of innovation is well recognized in the literature (Cantwell, 1989). The pharmaceutical industry relies heavily on patent protection and has a high propensity to patent. Data on 1,273 product patents for new drug approvals were initially obtained from CDER’s Electronic Orange Book. Excluding private firms, products created before 1992, and products with missing values, our final sample included a total of 1,208 patent counts used to protect 443 of the 1,496 products. Firms in our study used as many as fourteen patents and as few as zero patents to protect their new innovations.
ESTIMATION AND RESULTS

We adopt a discrete probabilistic approach to estimating the likelihood associated with breakthrough versus incremental innovation. Each product innovation is categorized in a bivariate manner as either a breakthrough or not. This generates a discrete limited dependent variable that we estimate using unconditional maximum likelihood logit. We chose this estimation method since it is relatively less sensitive to assumptions regarding the error distribution and therefore likely to produce more robust results (Aldrich and Nelson, 1984). Since our sample includes data on 98 firms over the period 1992-2002, we estimated the models using firm fixed effects with time (year) dummies.

The fixed effects logit model is consistent in the number of units (Chamberlain, 1980). Further, it has been shown that the bias associated with the unconditional fixed effects logit model tends to become insignificant when the number of units exceeds 16 (Katz, 2001) or 20 (Greene, 2004). Thus the unconditional maximum likelihood fixed effects logit model is appropriate given the large number of firms in our sample. Nonetheless, we estimate the model using conditional maximum likelihood logit as a robustness check. None of our results are qualitatively affected.

We estimate the likelihood that a particular innovation will be a breakthrough innovation based on firm, industry and location level variables. Conversely, the estimation provides the likelihood that an innovation will not be a breakthrough and therefore be an incremental innovation. The summary statistics related to all the variables used in the analysis are presented in Table 1. The correlations of all these variables appear in Table 2.

We first estimate a set of models (Models 1, 2 and 3) using only our basic control variables. These results are presented in Table 3. We find reassuring parameter stability across the three models, a finding that is supportive of robustness. The likelihood ratios indicate that the models are all highly significant. Furthermore, all the specifications have in-sample predictive accuracies of greater than 85%, a very high rate of success (Graubard and Korn, 1999).

We find that firm size is a consistently a significant covariate of breakthrough innovation and therefore is an important control. R&D intensity is also a significant covariate in Models 1 and 2.
Comparing Models 1 and 2 with Model 3, we find that when we introduce the patent count associated with the product innovation, R&D intensity is no longer significant. This can be interpreted as evidence in support of the process view of innovation (Basberg, 1987: 133), wherein R&D is an input into the patenting process, which in turn is an input in the innovation process (Ernst 2001; Macdonald, 2004). Products aimed at the prescription drug market are significantly more likely to be breakthrough innovations. We obtain some significant results related to UK and Swiss headquarters location, but these stem from the firms’ prior innovation profiles and disappear in the full models.

Estimates of our hypothesized models are presented in Table 4. We first present results for an exploratory specification (Model 4) in which we include total prior innovations as a regressor. This regressor emerges as highly significant, indicating preliminary support for our thesis of path dependency in innovation performance. Next, we estimate a specification where we unpack prior innovations into breakthrough and incremental categories. Prior incremental innovations are further disaggregated into non-generic and generic innovations in these specifications (Model 5).

Prior breakthrough innovations are highly significant and raise the likelihood that the current innovation is a breakthrough. This result provides evidence in support of Hypothesis 1. Prior non-generic incremental innovations are not significant. However, a larger stock of prior generic innovations significantly reduces the likelihood that the current innovation will be a breakthrough and correspondingly increases the likelihood that it is incremental. Therefore the support for Hypothesis 2 is mixed: the nature of prior incremental innovation seems to matter. In our final and most detailed specification (Model 6), we were left with 1,496 product innovations. In this model, we include the location and nature of the innovating unit. We find that innovations emerging from foreign subsidiaries do not have a significantly lower likelihood of being breakthrough innovations than those developed in home country units. Thus, the data do not appear to support Hypothesis 3 that posited a “home country bias” in breakthrough innovations. Focusing on the nature of the innovating unit, we find that innovations emanating from greenfield operations are not less likely to be breakthrough innovations,
contrary to Hypothesis 4. However, innovations originating from joint ventures and strategic alliances are significantly more likely to be breakthroughs. This provides evidence in support of Hypothesis 5.

DISCUSSION AND IMPLICATIONS

Contributions and Future Research

According to Baron (2007), “…entrepreneurship happens because entrepreneurs conceive of new products or services and then develop them through the launch and operation of new ventures. In this sense, entrepreneurs truly are the active element in new venture creation… But which aspects of their behavior and cognition are most relevant and hence most deserving of careful attention?” (p. 167). Our model adds insight into what conditions cause some entrepreneurs to be more successful than others (Baron, 2004). A primary theme in our paper has been to uncover and identify those competencies that allow firms to “break through” traditional firm “routines” and create unprecedented new innovations that have the potential to increase the quality of our lives. Throughout our paper, we have noted that successful long-term growth hinges on the firm’s ability to punctuate these more explorative types of innovations alongside exploitative types of incremental innovations (Raisch and Birkinshaw, 2008). Our corporate entrepreneurship model emphasizes the collective importance of developing both “mountain climbing” (i.e., the “ex ante” discovery process is replete of uncertainty) and “mountain building” (i.e., the “ex post” value of discovery process is uncertain) types of innovations (Alvarez and Barney, 2007).

From an organizational learning perspective, a key contribution of our work is the insight that breakthrough and incremental innovations follow different logics. We find supporting evidence that innovation is an outcome of expertise based on accumulated assets (e.g., Dierickx and Cool, 1989) whereby prior experience in breakthrough innovation increases the likelihood that a current innovation will be breakthrough. In contrast, the effects of prior experience in incremental innovations are more complex, depending on whether the experience is in the non-generic or generic realm. Prior experience in generics significantly reduces the likelihood that the current innovation will be a breakthrough (and
increases the likelihood that it will be incremental). However, prior experience in non-generics does not significantly impact the likelihood of breakthrough innovation.

It is possible that non-generic incremental innovation depends many of the same creative processes that underpin breakthrough innovation, so that the difference between the two is more one of scale (Nelson and Winter, 1982). Prior experience in non-generic innovation does not appear to create a "familiarity trap" (Ahuja and Lampert, 2001) that negatively affects the firm’s absorptive capacity to assimilate and develop new breakthroughs. Conversely, it may be the case that an increase in cumulative generic knowledge significantly reduces the knowledge complexity and diversity within the firm, which dampens the need for effective communication and coordination necessary for new learning and technological change. Thus, we find that prior innovation experience in generics handicaps or results in greater inertia for breakthrough innovation.

This finding has important implications for organizational ambidexterity (Raisch and Birkinshaw, 2008; Tushman and O'Reilly, 1996). Our results imply that in the global pharmaceutical industry, an exploitation strategy focused on incremental innovation in generics is incompatible with organizational ambidexterity. However, an exploitation strategy focused on incremental innovation in non-generics is compatible with the successful pursuit of breakthrough innovation and hence with organizational ambidexterity. The ambidexterity literature needs to recognize that exploitation strategies are likely to be heterogeneous and that only some of these strategies are compatible with organizational ambidexterity.

The benefits and costs associated with sharing knowledge across national borders has been a topic of much discussion. With regard to the organization of innovation, we find that innovation experience dominates country of origin location effects. When we ran our full model with all hypothesized variables, industry, product type and patent count emerge as significant predictors of breakthrough innovation, while headquarters locations became insignificant. It may be the case that through the use of today’s ever-advancing electronic technologies, traditional geographic proximity concerns have decreased over the years. As a result, it has become easier for firms to increase their frequency of international knowledge sharing activities. Moreover, current research recognizes the important role that foreign
subsidiaries play in the context of competence creation (e.g., Cantwell and Mudambi, 2005; Frost, Birkinshaw and Ensign, 2002).

A goal of this study was to better understand the parent-subsidiary dyad and to go beyond previous studies that have made arguments both for and against the decentralization of knowledge creation in MNEs. Interestingly, in our analysis, we do not find support for a “home country bias” in breakthrough innovation. At a broader level, additional research is needed to understand whether or not innovation networks are becoming truly globalized. For instance, Patel and Pavitt (1991) found that nearly ninety percent of US patenting activities during 1985-1990 were concentrated in the firm’s home country. Further analysis is needed to understand how the world has changed since these seminal studies were conducted.

We found intriguing results with regard to the effect of firm organization and architecture on innovation. Greenfield operations and acquired units do not differ significantly in terms of the likelihood of breakthrough versus incremental innovation. However, innovations emanating from joint ventures and alliances are significantly more likely to be breakthroughs, very much in line with the recent literature on open innovation (Laursen and Salter, 2006). This suggests a link between firm organization and R&D outcomes. Greenfield operations and acquired units are generally assessed on the basis of bottom line performance as profit centers (e.g., Delios and Beamish, 2001). Hence, they have an incentive to focus on what has been called “loss prevention” (Chandler, 1991). Firms with this mentality tend to be relatively myopic in their decision-making with tendency toward using financial tools (e.g., IRR, NPV) that support shorter-term, less risky projects (Mote, Boylan and Rice, 2001). Correspondingly, they have a strong disincentive to undertake breakthrough innovations, which by their very nature are highly risky and unlikely to yield bottom line results in the short run.

By contrast, strategic alliances and non-equity joint ventures tend to be assessed as cost centers (Hamel and Prahalad, 1990), since it is always difficult and often impossible to assess them on the basis of their bottom line contributions. As such, they are more likely to be treated by their multiple parent locations as a type of “strategic option” (Bowman and Hurry, 1993). Further, the lack of single
headquarter locus of control allows for the retention of a diversity of skill sets, a very important precursor to breakthrough innovation (Powell, Koput and Smith-Doerr, 1996). Put simply, diversity is less likely to be stamped out in strategic alliances. Firms are allowed to bring their own individual perspectives to the partnership filled with a unique repertoire of skills, knowledge and strategic assets. The dynamic interaction between partners increases organizational learning resulting in greater innovative performance. Thus, our findings are consistent with breakthrough innovations occurring and being ascribed to joint ventures and strategic alliances (Cohen and Levinthal, 1990; March 1991; Kotabe and Swan, 1995; Laursen and Salter, 2006; Rosenkopf and Schilling, 2007). It is likely that following a breakthrough the joint venture or strategic alliance will be acquired by one or the other party; subsequent exploitative incremental innovations would then be ascribed to the acquired unit. This storyline is consistent with our results.

Our results also indicate some notable conclusions about firm age and firm size on corporate entrepreneurship activities. In general, empirical research supports the notion that smaller and younger firms tend to be more innovative than larger firms because they have less crowded local knowledge networks, which reduces inertia and increases the exploration of new opportunities (e.g., Almeida and Kogut, 1997; Hannan and Freeman, 1984). Older and larger sized firms tend to have more rigid organizational “routines”, which limits the rewards associated with corporate intrapreneurship. Sorensen and Stuart (2000) reported contradictory findings with respect to age and innovation. They found that even though older firms were more likely to have higher rates of innovation than younger firms, they had greater difficulties than their younger counterparts in creating innovations that matched the current technological needs of their buyers. The data in our research suggest that an important factor affecting the creation of breakthroughs was firm size, not firm age. The influence of firm age on the firm’s propensity to innovation was not conclusive. Future research is necessary to explore this preliminary finding in more detail.

We also present data that raise some intriguing research questions. Firms exploit both breakthrough and incremental innovations as platforms to generate further types of incremental
innovation. In our database, these types of innovation appear as “new efficacy supplements” (NESs). These drugs represent a modification to an existing new drug application. While they are not assigned a new drug application number, they are considered as new product innovations and must meet conditions specified by the FDA before they can be legally marketed. We tracked these efficacy supplements for each of the innovations in our study starting from the year 1992 to the year 2002, for both public and private firms, up until the year 2008. The results are presented in Table 5. For the 2,885 original new drugs in our database, we recorded a total of 16,684 efficacy supplements. We found that some drugs over their lifetime were the basis for over 75 efficacy supplements, while some led to no efficacy supplements at all. We find that overall, breakthrough innovations and incremental innovations appear to generate about the same number of NESs per year (0.465 vs. 0.458). It is possible however that breakthrough and incremental innovations are exploited in different ways. We suggest that tracking and analyzing the future exploitation of commercialized innovations is a fruitful path for further research.

Limitations and Future Research

This study has limitations, which proffer opportunities for future research. There exists considerable research about the importance of industry-related pressures and how deviation from the norm may dramatically affect the firm’s performance. This study recognizes that responding to industry-level demands may have different repercussions for different firms. A generalizability concern of this study is that it focused on a single industry, albeit an important one. The path to developing new products within the global pharmaceutical industry is a long and expensive one. A consideration for the future is to examine corporate entrepreneurship variations across other industries.

Another limitation is that our study was based on secondary data analysis from legally constituted organizations. Like all research of this kind, we were unable to measure the firm’s attitudes, opinions and perceptions about the effectiveness/ineffectiveness of product-level innovation strategies. We believe that
the collection of primary data can enhance our empirical understanding of the link between entrepreneurship and corporate innovation (Snow, 2007).

In this study, we measured entrepreneurship by examining only breakthrough and incremental commercialized innovations. Due to the type of data that we collected, there were relatively small numbers of breakthroughs. While much of the current literature is based on examining this dichotomy, it is well recognized that the innovation continuum between breakthrough and incremental contains many shades of gray. Future research should develop more sophisticated innovation models that specifically recognize the innovation continuum while examining the link between commercialized innovations of this kind and market performance.

CONCLUSION
In this study, we examined the corporate entrepreneurship activities of firms in the global pharmaceutical industry (see Figure 1). We examined a total of about 1,500 commercialized innovations from the years 1993-2002, accounting for the effect of past organizational learning. From a managerial and theoretical perspective, we have shown that developing breakthrough and incremental innovations are complex processes and appear to be based on different logics. Our results support the view that breakthrough innovations are based on accumulated expertise as represented by a successful prior track record in managing this process.

In contrast, the effect of accumulated expertise in incremental innovation varies depending on whether the experience is in non-generics or generics. Prior experience in innovation in generics reduces the likelihood of breakthrough innovation while prior experience in non-generic innovation does not. Thus, while breakthrough innovation seems to be highly path dependent, incremental innovation seems to be a more heterogeneous phenomenon. Some forms of incremental innovation (i.e., in non-generics) are compatible with breakthrough innovation and hence with organizational ambidexterity. Other forms of incremental innovation (i.e., in generics) significantly reduce the likelihood of breakthrough innovation and are therefore incompatible with organizational ambidexterity.
It is important to note that for the firms in our study acquiring foreign subsidiary knowledge did not negatively impact their breakthrough capabilities. While foreign subsidiaries have long been considered bases for innovatory activities, many studies have suggested that truly breakthrough innovations will be concentrated in the firm’s home base. In a relatively large and comprehensive database, we find that innovations emanating from foreign subsidiaries are as likely to be breakthroughs as those emerging from the firm’s home base. Finally, we find that innovations stemming from alliances and joint ventures are more likely to be breakthroughs. As emphasized in the literature on alliances and open innovation, it is likely that the diversity implicit in such organizational forms is supportive of breakthrough innovation.

Corporate entrepreneurship is increasingly viewed as a valuable instrument for rejuvenating and revitalizing existing companies. Our results indicate the nature of innovation policy makers may expect from existing populations of firms. We provide evidence that intangible resources in form of accumulated expertise are critical signals presaging future success in breakthrough innovation. We also provide evidence that incremental innovation processes are heterogeneous and that some are less conducive to breakthrough innovation than others.
REFERENCES


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**Notes:**
1. If Pharmaceuticals (SIC = 2833, 2834, 2835, 5122), industry = 1; else = 0.
2. If Prescription drug, product type = 1; else = 0.
3. Prior innovations = stock of past firm innovative activities.
Table 2. Correlation Matrix and Descriptive Statistics

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<td>.046</td>
<td>.413</td>
<td>.013</td>
<td>.086</td>
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<td>Prior breakthrough (3)</td>
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<td>Prior generic (3)</td>
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<td>-.23</td>
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<td>-.01</td>
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<td>Greenfield operation</td>
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<td>.039</td>
<td>.027</td>
<td>.039</td>
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<td>-.12</td>
<td>-.12</td>
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<td>JV, alliance, etc.</td>
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<td>-.17</td>
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<td>.111</td>
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<td>.189</td>
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<td>-.97</td>
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Notes: (1) If Pharmaceuticals (SIC = 2833, 2834, 2835, 5122), industry = 1; else = 0
(2) If Prescription drug, product type = 1; else = 0.
(3) Prior innovations = stock of past firm innovative activities.
Table 3. Estimation of the Likelihood of Breakthrough Innovations: Base-line Control Models (1993-2002) – Maximum Likelihood Logit Results with firm fixed effects$^{(1)}$

**Regressand:** Breakthrough innovation = 1 if FDA New Drug Approval is an New Molecular Entity; otherwise = 0 (incremental innovation)

<table>
<thead>
<tr>
<th>REGRESSOR</th>
<th>MODEL 1</th>
<th>Coefficient (‘t’ Stat$^{(4)}$)</th>
<th>MODEL 2</th>
<th>MODEL 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>-2.27 (4.89)$^{***}$</td>
<td>-4.14 (4.08)$^{***}$</td>
<td>-5.51 (4.23)$^{***}$</td>
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</tr>
<tr>
<td><strong>Controls</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm Age (Years)</td>
<td>1.4×10$^{-3}$ (0.74)</td>
<td>2.4×10$^{-3}$ (1.23)</td>
<td>2.1×10$^{-3}$ (0.91)</td>
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</tr>
<tr>
<td>Firm Size (Sales)</td>
<td>4.5×10$^{-8}$ (5.61)$^{***}$</td>
<td>5.0×10$^{-8}$ (5.09)$^{***}$</td>
<td>4.8×10$^{-8}$ (4.91)$^{***}$</td>
<td></td>
</tr>
<tr>
<td>R&amp;D Intensity</td>
<td>0.03 (2.71)$^{***}$</td>
<td>0.05 (2.54)$^{**}$</td>
<td>8.5×10$^{-3}$ (0.61)</td>
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</tr>
<tr>
<td>HQ Location: US</td>
<td>-0.20 (1.17)</td>
<td>-0.16 (1.34)</td>
<td>-0.28 (1.81)*</td>
<td></td>
</tr>
<tr>
<td>HQ Location: UK</td>
<td>0.68 (2.49)$^{**}$</td>
<td>0.72 (2.51)$^{**}$</td>
<td>0.32 (1.26)</td>
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</tr>
<tr>
<td>HQ Location: CH</td>
<td>-0.93 (3.31)$^{***}$</td>
<td>-1.12 (3.02)$^{***}$</td>
<td>-1.23 (3.22)$^{***}$</td>
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</tr>
<tr>
<td>Industry dummy$^{(2)}$</td>
<td>-0.25 (0.81)</td>
<td>-0.32 (0.79)</td>
<td>0.38 (0.94)</td>
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<tr>
<td>Product type$^{(3)}$</td>
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<td>2.81 (2.82)$^{***}$</td>
<td>2.95 (2.83)$^{***}$</td>
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</tr>
<tr>
<td>Patent count</td>
<td>-</td>
<td>-</td>
<td>0.27 (4.26)$^{***}$</td>
<td></td>
</tr>
<tr>
<td><strong>Diagnostics</strong></td>
<td></td>
<td></td>
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<td>N</td>
<td>1699</td>
<td>1696</td>
<td>1498</td>
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<tr>
<td>Log-Likelihood</td>
<td>-590.9231</td>
<td>-582.7721</td>
<td>-476.3685</td>
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<tr>
<td>Restricted Log-Likelihood</td>
<td>-675.4641</td>
<td>-675.0252</td>
<td>-573.5764</td>
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<tr>
<td>d.f.</td>
<td>115</td>
<td>116</td>
<td>117</td>
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<tr>
<td>Likelihood Ratio</td>
<td>169.082 (0.001)</td>
<td>184.5062 (0.000)</td>
<td>194.4158 (0.000)</td>
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<td>$\chi^2$(d.f.); (‘p’ value)</td>
<td>0.8915</td>
<td>0.9014</td>
<td>0.9128</td>
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</tbody>
</table>

**Notes:**
(1) Time dummies included.
(2) If Pharmaceuticals (SIC = 2833, 2834, 2835, 5122), industry = 1; else = 0
(3) If Prescription drug, product type = 1; else = 0.
(4) ‘t’ statistics computed using White’s heteroskedasticity-consistent variance-covariance matrix.

$^{***}$ - ‘t’ statistics significant at the 1% level;

$^{**}$ - ‘t’ statistics significant at the 5% level;

$^*$ - ‘t’ statistics significant at the 10% level.
Table 4. Estimation of the Likelihood of Breakthroughs: Hypothesized Models, Full Controls (1993-2002) – Maximum Likelihood Logit Results with firm fixed effects

Regressand: Breakthrough innovation = 1 if FDA New Drug Approval is an New Molecular Entity; otherwise = 0 (incremental innovation)

<table>
<thead>
<tr>
<th>REGRESSOR</th>
<th>MODEL 4</th>
<th>Coefficient ('t' Stat(^5))</th>
<th>MODEL 5</th>
<th>Coefficient ('t' Stat(^5))</th>
<th>MODEL 6</th>
<th>Coefficient ('t' Stat(^5))</th>
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</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>-4.34 (3.78)***</td>
<td>-3.72 (4.36)***</td>
<td>-5.09 (4.31)***</td>
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<td></td>
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</tr>
<tr>
<td>Controls</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Firm Age (Years)</td>
<td>-1.1×10(^{-3}) (0.52)</td>
<td>1.9×10(^{-3}) (0.83)</td>
<td>1.7×10(^{-3}) (0.54)</td>
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<tr>
<td>Firm Size (Sales)</td>
<td>4.9×10(^{-8}) (4.42) ***</td>
<td>3.1×10(^{-8}) (2.70) ***</td>
<td>2.1×10(^{-8}) (2.22)**</td>
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<tr>
<td>R&amp;D Intensity</td>
<td>4.6×10(^{-3}) (0.61)</td>
<td>7.4×10(^{-3}) (0.34)</td>
<td>1.9×10(^{-3}) (0.14)</td>
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<tr>
<td>HQ Location: US</td>
<td>-0.41 (2.41)**</td>
<td>-0.14 (0.62)</td>
<td>-0.54 (1.43)</td>
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<tr>
<td>HQ Location: UK</td>
<td>-0.33 (0.73)</td>
<td>-0.38 (1.12)</td>
<td>-0.72 (1.61)</td>
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<tr>
<td>HQ Location: CH</td>
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<td>0.49 (0.58)</td>
<td>0.38 (0.92)</td>
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<tr>
<td>Industry dummy(^2)</td>
<td>0.12 (0.17)</td>
<td>1.14 (1.96)*</td>
<td>1.17 (2.17)**</td>
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<tr>
<td>Product type(^3)</td>
<td>2.48 (2.53)***</td>
<td>3.13 (2.90)***</td>
<td>3.35 (2.88)***</td>
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<tr>
<td>Patent count</td>
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<td>0.24 (1.16)</td>
<td>1.09 (1.81)*</td>
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<tr>
<td>Prior non-generic(^4)</td>
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<td>0.09 (1.42)</td>
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<td>Prior generic(^4)</td>
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<td>-0.31 (8.06)***</td>
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<td>Foreign unit</td>
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<tr>
<td>Greenfield operation</td>
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<td>-</td>
<td>0.43 (1.07)</td>
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<td>JV, alliance, etc.</td>
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<td>-</td>
<td>1.83 (2.92)***</td>
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<td>286.2512 (0.000)</td>
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Notes:  
(1) Time dummies included.  
(2) If Pharmaceuticals (SIC = 2833, 2834, 2835, 5122), industry = 1; else = 0  
(3) If Prescription drug, product type = 1; else = 0.  
(4) Prior innovations = stock of past firm innovative activities.  
(5) ‘t’ statistics computed using White’s heteroskedasticity-consistent variance-covariance matrix.  
*** - ‘t’ statistics significant at the 1% level;  
** - ‘t’ statistics significant at the 5% level;  
* - ‘t’ statistics significant at the 10% level.
Table 5. Innovation and Exploitation: New Efficacy Supplements Associated with Original New Drug Approvals (NDAs) through 2008

<table>
<thead>
<tr>
<th>Innovation Type</th>
<th>Firm type</th>
<th>Number of NDA Innovations 1992-2002</th>
<th>Number of NES(^{(1)}) per NDA innovation per year* up to 2008</th>
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</thead>
<tbody>
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<td>Breakthrough</td>
<td>Public</td>
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<tr>
<td></td>
<td>Private</td>
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<td>0.513</td>
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<tr>
<td></td>
<td>All firms</td>
<td>295</td>
<td>0.465</td>
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<td>Incremental</td>
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<td>Private</td>
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<tr>
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<td>All firms</td>
<td>2590</td>
<td>0.458</td>
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Notes: (1) NES = New Efficacy supplement.