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TECHNOLOGICAL AND PRODUCT-MARKET EXPERIENCE AND THE SUCCESS OF NEW PRODUCT INTRODUCTIONS IN THE PHARMACEUTICAL INDUSTRY

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The growth and development of a firm depend on its ability to introduce new products over time. To do this successfully, it requires technological knowledge, the ability to combine knowledge elements into valuable new products, and the complementary assets that facilitate the manufacturing, sales, and distribution of those products. We argue that these all develop as a function of a firm's experience in its technological and product-market domains. Moreover, given the prospect of complementarities among technological and product-market experience, the value of any one type of experience may be enhanced by the presence of another. Therefore, new products will be more successful when a firm possesses the appropriate stocks of technological and product-market experience. We test this idea by analyzing whether pharmaceutical firms' experience in their technological and product-market domains confer early advantages to their new product offerings, and lead to higher initial sales levels. Copyright © 2004 John Wiley & Sons, Ltd.

The growth and development of a firm depend on its ability to introduce new products over time (Dougherty and Hardy, 1996; Penrose, 1995). To do this successfully, it must assimilate a range of technological inputs into novel combinations, and it must ensure that these new products effectively meet the needs of the market (Fleming, 2002; Utterback, 1994). Schumpeter (1934) first emphasized this dual significance of invention and innovation. 'Inventions are very commonly the result of combining or recombining existing elements of knowledge into new syntheses (Ahuja and Lampert, 2001: 528).' However, an invention only becomes a successful innovation if it has a marketable use. And, as other researchers have shown, a firm may have 'great technological and inventive potential, but [remain] relatively unsuccessful in the commercialization of its products' (Fleming, 2002: 1064).

The question posed in this paper is 'What determines the success of a firm's new product introductions?' To address this question, we examine how pharmaceutical firms leverage different types of technological and product-market experience in order to enhance new product success. Consistent with recent strategy research, we view firms as bundles of strategic assets that combine to produce and deliver an evolving set of products (Barney, 1991; Levinthal, 1995; Montgomery, 1995). Some of these assets are critical determinants of new product success. These include the technological knowledge that derives from a firm's research and development activities (Teece, 1982), and the ability to combine disparate knowledge elements into valuable new combinations (Kogut and Zander, 1992). They also include the range of complementary assets that result from past participation in

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product markets (Mitchell, 1989; Teece, 1987). In light of this, we expect new product introductions to be more successful when a firm possesses superior technological knowledge, combinative capabilities, and complementary assets.

This said, there is a more fundamental question that must be addressed: where do these assets and capabilities come from (Helfat and Lieberman, 2002; Teece, Pisano, and Shuen, 1997; Teece and Pisano, 1995)? There is an increasing belief that 'some of the least imitable—and in that sense the most valuable—capabilities are those that can only come about over time through a gradual evolutionary process' (Barnett, Greve, and Park, 1994: 12). In other words, a firm's assets often develop as a function of its different experiences (Barnett and Hansen, 1996; Ingram and Baum, 1997; Levinthal and Myatt, 1994). This view aligns with Montgomery and Hariharan (1991: 73), who suggest that 'productive services are continually created in the ordinary processes of operation and expansion.' Technological knowledge develops as a result of a specific history of technological experience, while complementary assets (e.g., market-related knowledge, product reputations, distribution channels, and customer contacts) develop as a result of a specific history of product-market participation.

A firm with more experience in a given area has accumulated more of these assets, and this should enhance its new product success. This said, a diversified firm is active across a number of technological and product-market domains. As such, a new product may exploit *proximal* experience, which is closely associated with the specific needs of that product, to further leverage existing technological and product-market positions. A new product may also rely on more distant sources of experience as it explores novel ways to compete successfully (March, 1991). This more *distal* experience accumulates within the diversified firm, but is more closely aligned with other technological and product-market initiatives. We will argue that the presence of distal technological and product-market experience within a diversified firm enhances its general complementary assets, as well as its technological exploration, further contributing to new product success.

At the same time, the effects of the different types and sources of experience may be interdependent. Prior studies suggest that technological experience is more valuable to a firm that also has complementary product-market experience (Teece, 1987; Rothaermel, 2001; Tripsas, 1997). Moreover, the complementarity between technological and product-market knowledge may also facilitate the development of more valuable technological combinations. In other words, a firm's combinative capability is enhanced if it has both technological and product-market experience. That there may be positive synergies between these two types of experience seems at odds with an extensive body of thought that highlights the tensions between scientists and product-market managers (Leonard-Barton *et al*., 1994; Ruekert and Walker, 1987). Scientists are supposedly concerned only with creating 'better' products, while product-market managers only care about meeting the needs of current customers (Souder, 1981). We revisit this issue and argue that experience in the technological and product-market domains need not conflict. Rather, extensive market knowledge is an important complement to a firm's technological knowledge, as it tries to combine its knowledge elements into new products that better meet customer needs.

We test this view on new product success with an empirical examination of new pharmaceutical products introduced into the U.S. market between 1987 and 1992. It is clear that pharmaceutical firms depend on the success of their new product introductions as they seek to manage competition and improve financial performance (Schwartzman, 1976). Indeed, pharmaceutical firms regularly introduce new products in their efforts to sustain superior financial performance over time (Roberts, 1999). Given this importance, a number of researchers examine drug companies from the product-market side, looking at the factors that influence new product performance. Gatignon, Weitz, and Bansal (1990: 391), for example, examine the initial market performance of a sample of new pharmaceutical products introduced between 1978 and 1982 and find that the performance of new pharmaceutical products improves with 'the familiarity of the firm with similar markets and technologies.'

It is also clear that drug companies pay very careful attention to developments in the underlying technologies that support new products. Several researchers look explicitly at the processes that lead to the development of valuable new technologies within pharmaceutical firms (Graves and Langowitz, 1993; Henderson and Cockburn, 1996). In their detailed study of 10 pharmaceutical firms,

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Henderson and Cockburn (1994) show that a firm's R&D capability is driven by a combination of component and architectural competence; or by the ability to develop valuable new knowledge components plus the ability to combine diverse components into promising new technologies. Cockburn, Henderson, and Stern (2000) extend this argument by suggesting that early adoption of a more rational mode of drug discovery—and of the organizational features that support this new mode—conferred technological advantages to the leading firms. More recently, Thomke and Kuemmerle (2002) show that having access to a large and diverse library of chemical compounds provides an advantage in drug discovery, particularly when the firm also has complementary technological abilities.

We extend and integrate these studies by analyzing whether the different types of technological and product-market experience that accumulate within pharmaceutical firms have a subsequent impact on the market performance of their new products. The next section outlines our hypotheses and the logic that supports them. This is followed by a summary of the data used in the empirical analysis. The third section summarizes our results, while the last section offers some concluding remarks.

TECHNOLOGICAL AND PRODUCT-MARKET EXPERIENCE AND NEW PRODUCT SUCCESS

The knowledge and assets that develop in tandem with a firm's technological and product-market experience are critical determinants of its competitive successes and failures (Winter, 1987). The specific question that we ask is whether these two types of experience enhance the success of a firm's new product introductions. The logic that underpins our hypotheses is summarized as follows. Firms that possess appropriate stocks of assets should be more successful with their new product introductions. These assets are of three types: technological knowledge, combinative capabilities (or the ability to assimilate knowledge elements into valuable new combinations), and the complementary manufacturing, sales, and marketing assets that lead to more successful interfaces with customers.

Absent the ability to measure these (often intangible) assets with any degree of precision, we assume that they develop as a function of a firm's accumulated experience, and that different types of experience lead to the development of different types of assets (Barnett *et al*., 1994; Baum and Ingram, 1998; Ingram and Baum, 1997). In particular, technological knowledge accumulates as a function of technological experience, while product-market experience leads to the development of more valuable (specific and general) complementary assets. Finally, because product-market experience leads to a better understanding of market conditions and customer needs, technological and product-market experience interactively lead to the development of valuable combinative capabilities.

Technological experience

Several studies find relationships between indicators of technological experience and technological output (Henderson and Cockburn, 1994), the probability of introducing new products (Katila and Ahuja, 2002), and the probability of entering new markets (King and Tucci, 2002; Martin and Mitchell, 1998). We take this work as our foundation and assess the extent to which the knowledge that accumulates with a firm's technological experience translates into improved new product performance.

New product development involves technological search (Nelson and Winter, 1982), which may be localized or non-localized. Building on March (1991), Levinthal (1995) suggests that localized search is most helpful in reaching local optima, while the more general exploratory search improves the chances of reaching global optima. In new product development, local optima represent the highest performance levels that can be attained by recombining a narrow set of knowledge components. Global optima reflect performance levels that may be attained by searching across a more diverse set of knowledge elements. Our distinction between proximal and distal technological experience defines the set of knowledge elements with respect to a focal new product. Proximal experience facilitates local search, while distal experience enables more global search. Firms that have more of either type of experience may attain greater new product success. Proximal experience provides a firm with advantages making

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incremental improvements via exploitation, while distal experience provides advantages in exploration, which underlies more radical product innovations.

Proximal technological experience is thought to be beneficial because it most directly relates to the specific requirements of the focal product (Rosenkopf and Nerkar, 2001; Stuart and Podolny, 1996). Silverman (1999) finds that firms whose patents are most applicable to a given industry are more likely to diversify into that industry, suggesting that technological experience is most valuable when it is dedicated to the needs of the specific end market. The logic linking proximal technological experience to the accumulation of technological knowledge is straightforward. A strong history of cumulative technological effort leads to improved technological knowledge when the developmental process is characterized by what Dierickx and Cool (1989) call asset mass efficiency. In his discussion of firm heterogeneity, Nelson (1994: 261) argues that 'in many technologies, one innovation points more or less directly to a set of following ones, and the learning and complementary strengths developed in the former effort provide a base for the next round.' In support of this expected relationship, Henderson and Clark (1990) conclude that a firm's experience with a particular technology leads to the development of a particular type of innovative capability. Mitchell and Singh (1992: 350) reach a similar conclusion, noting that 'for many goods, technical participation at later stages requires a cumulative knowledge built up by participating in earlier phases.' This suggests that experience within a given technological domain generates more valuable new products:

Hypothesis 1a: The success of a new product is a positive function of the level of the firm's proximal technological experience.

Technological experience that accumulates within the firm, but that is not closely linked to the focal product introduction, may be considered more distant. For example, the technological experience that Glaxo accumulates in the hormone therapy area is proximal to any new product introduced into that area. While Glaxo conducts research in the hormone therapy area, it also accumulates technological experience in the bronchial therapy arena. Although this latter type of experience is proximal to a new bronchial therapy product, it is distal in respect to a new hormone product. The fact that Glaxo is active in a number of different technological areas may have implications for its new hormone therapy product success.

Broader search into distant technological areas has the potential of uncovering solutions that would otherwise be unexploited because of the inertia built into existing technology cycles. As such, the ability to search more broadly (while remaining inside the firm) creates the potential of solving problems in a radically different manner, and thereby generating more valuable innovations (Fleming and Sorenson, 2004). This is why firms that don't accumulate distal technological experience may end up trapped in suboptimal situations. They may be able to exploit existing positions, but they are less able to develop products that meet novel market requirements (Levinthal and March, 1993). We therefore expect a positive relationship between new product performance and distal technological experience:

Hypothesis 1b: The success of a new product is a positive function of the level of the firm's distal technological experience.

Finally, note that these two hypotheses suggest that technological experience improves the success of new product offerings. However, some new products are technological copies, or imitations of those introduced by other firms (Nelson and Winter, 1982), while others are more technologically novel, embodying new features or new functionality. We only expect the latter class of new products to rely on a firm's accumulated technological experience. In other words, the reason that technological experience facilitates new product success is that it allows a firm to introduce products that embody new technological knowledge. When new products are imitative and lack technological novelty, this type of experience should become less important.

Product-market experience

Teece (1987) first argued that a firm derives maximum benefit from its technological achievements if it also possesses an appropriate set of market-related assets. A firm's experience within product markets develops these complementary assets

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(e.g., reputations, manufacturing capabilities, distribution systems, and service and maintenance organizations) that improve its ability to manufacture, market, and distribute its new products (Roberts and McEvily, 2004). Thus, more experienced incumbents are expected to possess superior complementary assets (Mitchell and Singh, 1992). For example, Shapiro (1983) argues that reputations for quality develop as a function of consistent demonstrations of quality over time.

However, it is not clear how the complementary assets that accumulate as a result of different types of experience affect new product success. In their typology of resources, Helfat and Lieberman (2002) stress the difference between specific and general resources. We suggest that proximal experience gives the firm access to specific customers, established distribution channels, and area-specific reputations, all of which facilitate the introduction of new products into a particular area. At the same time, some of the assets that a firm needs are more general, and develop as a function of a broad portfolio of product-market activities We expect that both types of product-market experience will enhance the early success of its new product introductions:

Hypothesis 2a: The success of a new product is a positive function of the level of the firm's proximal product-market experience.

Hypothesis 2b: The success of a new product is a positive function of the level of the firm's distal product-market experience.

Interactions between technological and product-market experience

Hypotheses 1a through 2b suggest direct links between experience and new product success. In this section, we address the extent to which the different types of experience interact with one another. Many scholars have recognized important interdependencies among a firm's various attributes in determining overall competitive performance (Levinthal, 1995, 1997; Milgrom and Roberts, 1995; Rivkin, 2000; Roberts and Amit, 2003; Siggelkow, 2002). Moreover, a few empirical studies address the complementarity among specific technological assets; Helfat (1997) within the oil and gas industry, and Thomke and Kuemmerle (2002) in the pharmaceutical industry. However, no one has yet evidenced the complementarity between a firm's technological and market-related assets. Rather, the preferred empirical approach is to examine the independent importance of upstream (Afuah, 2002), or downstream (Bogner, Thomas, and McGee, 1996) assets for competitive advantage.

At the most general level, technological and product-market experience are complements if the value of one increases in the presence of the other. As suggested in the discussion preceding Hypotheses 2a and 2b, product-market experience improves a firm's ability to leverage its technological experience by endowing it with an appropriate set of complementary assets. Here, we suggest that product-market experience also complements technological experience by improving the likelihood that valuable new technological combinations are developed in the first place.

There is accumulating theory and evidence suggesting that the ability to develop valuable new technological combinations increases with a firm's exposure to product markets. This builds from recent thinking about dynamic capabilities (Loasby, 1998; Teece *et al*., 1997; Teece and Pisano, 1995). With deeper product-market experience, a firm has a better understanding of customer needs, and is therefore better able to tailor new offerings to meet those needs. In their analysis of radical innovation in the disk drive industry, King and Tucci (2002: 183) conclude that 'technological experience can increase understanding of new technologies [while] . . . market experience may increase some firms' understanding of new markets.' Martin and Mitchell (1998: 766) reach a similar conclusion: 'the quality of firms' information concerning future product-market developments and their readiness for new design introduction increase as they gain product-market experience.' More specifically, Von Hippel (1986) argues that an 'accurate understanding of user needs has been shown near-essential to the development of commercially successful new products.' Being more active in markets allows for better access to lead users, which leads to an improved ability to generate valuable new products. Finally, Sorenson (2000) argues and demonstrates that firms may use multiple product offerings to learn about the

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demand conditions that prevail within a given market.

More specifically, a firm's distal product-market experience tends to develop a general understanding of potential customer needs. When this is paired effectively with distal technological experience (which gives a firm technological knowledge that is not obviously related to the focal product domain), a firm's technological exploration is enhanced. Examples of this are evident within the pharmaceutical industry, including the case of Roche and Valium. In the course of developing a potential market for this product, it was ascertained that non-trivial side effects might prohibit effective market penetration. These negative side effects turned out to be valued positively in a different therapeutic domain. Thus, two distal sources of experience led to the technological and market knowledge that combined to create a successful new product in the psychotherapeutic drug market. We will interpret a positive interaction between distal product-market experience and distal technological experience as evidence of a *general combinative capability* (see Table 1).

This effect may also be observed more locally, as a firm uses its heightened understanding of local markets and customer needs to develop new combinations derived from its proximal technological experience. For instance, the successful introduction of a series of brand extensions leverages a specific combination of proximal technological and proximal product-market experience. We therefore interpret a positive interaction between proximal product-market and proximal technological experience as evidence of a *local combinative capability*:

Hypothesis 3a: The effect of distal technological experience on the success of a new product is an increasing function of the level of the firm's distal product-market experience.

Hypothesis 3b: The effect of proximal technological experience on the success of a new product is an increasing function of the level of the firm's proximal product-market experience.

Finally, firms also engage in technological boundary spanning (Rosenkopf and Nerkar, 2001). Boundary spanning refers to the ability to recombine knowledge across technological and organizational boundaries. Here, a firm's ability to use its distal technological knowledge to develop valuable new combinations for the focal market may be enhanced by a relatively large stock of proximal product-market knowledge. Alternatively, the product-market knowledge developed in other areas may help a firm to make sense of some of the possibilities inherent in its proximal technological knowledge. In either case, *boundary-spanning capabilities* are evidenced by a positive interaction between proximal (distal) product-market knowledge and distal (proximal) technological knowledge:

Hypothesis 3c: The effect of distal technological experience on the success of a new product is an increasing function of the level of the firm's proximal product-market experience.

Hypothesis 3d: The effect of proximal technological experience on the success of a new product is an increasing function of the level of the firm's distal product-market experience.

Our hypotheses are tested within the pharmaceutical industry, where new products are critical determinants of firm growth and profitability. As such, drug companies spend considerable time and effort developing and launching new products (Schwartzman, 1976). The analysis is based on product-level data collected by *Intercontinental Medical Statistics* (IMS) and patent information obtained from the *United States Patent and Trade Examiners Office* (USPTO), and covers the 1977 through 1993 period.

Table 1. Types of interaction effects

	Proximal technological experience	Distal technological experience
Proximal product-market experience	Local combinative capability	Boundary spanning
Distal product-market experience	Boundary spanning	General combinative capability

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DATA AND ANALYSIS

For each product, IMS identifies the producing firm, year of product introduction, and therapeutic market membership. They also provide annual information on product sales and total therapeutic market sales. The data are organized in a hierarchical structure similar to the *Standard Industrial Classification* system that is used to classify industries, with major therapeutic areas (or classes) divided into a series of more specific therapeutic markets. From the IMS data, we identified 534 'significant' new products that were introduced into 45 therapeutic areas within the U.S. market by 45 different firms between 1987 and 1992 (see Tables 2 and 3a).[1,2] These pharmaceutical firms introduce two different types of products: those with some degree of technological novelty and generics (see Table 2). The latter products are 'copies of branded pharmaceuticals, made after the original patent has expired' (Morton, 1999: 421). Generic products are listed in the IMS data (and therefore sold) under their generic names. The average first-year sales for the 165 generic products in the product introduction sample is $3.12 million (1986 dollars). The corresponding average for the 369 novel products is $18.85 million.

Gatignon *et al.* (1990) argue that the initial sales level is an appropriate indicator of new product success in the pharmaceutical industry, where a primary objective is to maximize the revenues associated with the fixed costs of product development and launch. Our dependent variable (*Initial Sales*) captures the total sales of a new product in its first full year on the market.[3] Because

[1] A 'significant' product is one that achieves at least $1 million in annual sales at some point during its lifetime.

[2] These firms introduced an additional 33 proprietary products, which are sold over-the-counter and do not require a doctor's prescription. Although we elect to focus on ethical products only, the analysis produces virtually identical results when the proprietary product introductions are included.

[3] We recognize that our analysis examines only a part of the problem faced by firms introducing new products, and that different types of experience may also buffer a firm's products from competition over time (Teece, 1987). We are not in a position

Table 2. New product introductions into U.S. pharmaceutical market, 1987–1992 (count of generic products in parentheses)

Firm	Count	Firm	Count
3M	3	Knoll	2
Abbott Laboratories	27 (11)	Lilly (Eli)	10
Alcon	5	Marion Merrell Dow[a]	6
Allergan	12	Merck	12
American Cyanamid	18 (9)	Mylan	24 (24)
American Home Products	23 (2)	Pfizer	10
Amgen	2	Procter & Gamble	13
Astra	9 (7)	Reed Carnrick	4
Bausch & Lomb	10 (3)	Rhone-Poulenc Rorer	8 (1)
Bayer (Miles Labs)	9	Roche	2
Boehringer Ing.	3 (1)	Rugby Labs	38 (38)
Boehringer Mannheim	4	Sandoz	9
Boots	2	Sanofi-Winthrop	7
Bristol-Myers Squibb[a]	36 (6)	Schein Pharmaceutical	20 (19)
Carter-Wallace	9	Schering-Plough	11
Ciba-Geigy	31 (18)	Searle	8 (2)
Fisons RX	4	Smithkline Beecham[a]	14
Forest Pharmaceutical	6 (1)	Sterling Winthrop	2
Glaxo	11	Syntex	8
Goldline	7 (7)	Upjohn	6
Hoechst-Roussel	8 (4)	Warner-Lambert	23 (12)
ICI	5	Wellcome	15
Johnson & Johnson	38		

[a] These three firms were involved in major mergers or acquisitions during the period under study. To simplify the analysis, they were treated as combined entities throughout the entire sample period. Follow-on analyses that exclude these three firms produce identical results.

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Table 3a. Therapeutic areas (labels from IMS data)

Therapeutic area	
Analgesics	Cough/Cold Preparations OTC
Anesthetics	Cough/Cold Preparations RX
Antacids and Antiflatulants	Dermatologicals
Antiarthritics	Diabetes Therapy
Anticoagulants	Diagnostic Aids
Anticonvulsants	Diuretics
Antidiarrheals	Enzymes
Antihistamines, Systemic	Hemorrhoidal Preparations
Anti-Infectives, Systemic	Hemostatics
Antimalarials	Hormones
Antinauseants	Laxatives
Anti-Obesity	Muscle Relaxants
Anti-Parkinson Drugs	Nutrients and Supplements
Antiseptics	Ophthalmic Preparations
Antispasmodic/Antisecratory	Parasympathetics
Anti-Virals	Psychotherapeutic Drugs
Bile Therapy	Respiratory Therapy
Biologicals	Sedatives
Blood Growth Factors	Smoking Deterrents
Cancer/Transplant Therapy	Suntan Preparations
Cardiovascular Therapy	Thyroid Therapy
Cholesterol Reducers	Vitamins
Contraceptives	

the sample of introductions covers a 6-year window, we converted each sales figure into 1986 dollars using the annual pharmaceutical producer price index obtained from the *U.S. Bureau of Labor Statistics*. Because its distribution is highly skewed, we log-transformed the real sales variable to generate our dependent variable.

Patent data are used to create the technological experience variables. This approach is consistent with others who have examined a firm's technological capabilities (Ahuja and Katila, 2001; Rosenkopf and Nerkar, 2001; Stuart and Podolny, 1996). We focus exclusively on USPTO Class 514 (Drugs and Bio-affecting Compositions), which has been identified as the key pharmaceutical class (McGrath and Nerkar, 2004; Penner-Hahn, 1998). Between 1977 and 1992, almost 50,000 patents were granted within this class. When a patent is granted, the USPTO assigns the invention to different technological areas. There are more than 1100 distinct areas within USPTO Class 514. Of these, 85 are therapeutic areas (with the remainder based on the molecular or chemical structure of the invention). Any patent that offers a direct contribution to a specific therapeutic area is assigned to one of the 85 therapeutic areas listed in Table 3(b). Unfortunately, the classification structure employed by the USPTO does not correspond directly with that used by IMS. We therefore mapped the 85 areas in Table 3(b) onto the IMS therapeutic areas listed in Table 3(a). To ensure that these mappings are appropriate, we contacted several medical professionals and provided them with descriptions of both classifications before asking them to link the USPTO areas with those used by IMS.[4] The mapping scheme (which is available from the authors on request) was used to develop the technological experience variables, which reflect the firm's accumulated stock of patents.

The technological experience variables are counts of each firm's pharmaceutical patents granted in the 10 years prior to the launch of the new product. We use this long time window because it takes considerable time for

to empirically assess issues relating experience to sustainability. However, note that in the overall data file there are 1495 products with both first-year sales information and information on sales in the product's peak sales year. These data suggest that the median time to peak sales is roughly 3 years. More importantly, the correlation between first-year and peak-year sales is 0.67.

[4] The authors thank Drs. Aris Persidis and Rahul Datar for their suggestions and advice on data coding.

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Table 3b. USPTO therapeutic subclasses within Class 514 (Drugs & Bio Affecting Compositions)

Therapeutic area	
Inflammation, Skin	Diabetes
Bite or Sting	Emollient
Dermatitis	Hair Treatment -Scalp
Pyretic	Hypoglycemia
Anesthetic, General	Diuretic
Anesthetic, Topical	Edema
Anesthetic, Local	Menstrual Disorder
Astringent, Nonfacial	Hemorrhoid Preparation
Antacid, Oral	Blood Substitute
Distemper	Blood Plasma Extender
Ulcer Treatment	Vasoconstrictor Nondecongestant
Antidote	Lhrh Like
Cholera	Collagen, Gelatin or Derivatives thereof
Meningitis	Fibrinopeptides, Blood-Coagulation Factors or Derivatives
Multiple Sclerosis	Kinin or Derivatives
Obesity	Phecmycin Series or Derivatives
Cirrhosis	Adrenocorticotropic Hormone or Derivatives
Immune Response Affecting Drug	Somatostatin or Derivatives
Influenza	Oxytocin, Vasopressin or Derivatives
Interferon Inducer	Calcitonin or Derivatives
Diarrhea	Enkephalin or Endorphin or Derivatives
Arthritis	Laxative
Anticoagulation	Caries
Irritant	Chelate
Malaria	Flea Control
Emesis Motion Sickness	Gallstone
Cystic Fibrosis	Geriatrics
Shock	Kidney Stone
Liver Disorder	Mouth Treatment
Measles	Uterine Motility
Tuberculosis	Muscle Relaxant
Coagulant	Muscular Dystrophy
Hodgkin's Disease	Anemia
Leukemia	Contact Lens Treatment
Antiradioactive	Ophthalmic
Antiarrhythmic	Asthma
Vasodilator	Decongestant
Venereal Disease	Sleep Aid Insomnia
Arteriosclerosis	Addiction
Contraceptive	Cosmetic, Facial
Estrogenic Agent Noncontraceptive	Repellent
Cough and Cold Preparation	Multiple Vitamins
Dandruff	

a pharmaceutical company to research, develop, and commercially launch a new drug (Temin, 1979).[5] Our data and mapping scheme allow us to decompose technological experience into two parts: *Proximal Technological Experience*, which counts those patents assigned to the same therapeutic area as the new product introduction; and *Distal Technological Experience*, which counts those patents assigned to other therapeutic areas.[6] Again, to correct for their skewed distribution, these variables were log-transformed before estimation (first adding one to each count to deal with the zero patent-count observations).

[5] We conducted additional analyses using a 5-year window to construct the experience variables and obtained an identical pattern of results.

[6] A third type of experience (*General Technological Experience*) counts the more general patents that are not assigned to any particular therapeutic area but are part of the pharmaceutical domain. We analyze this type of experience later in the paper.

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The product-market experience variables count the total product years of market experience that the introducing firm accumulated in the 10 years prior to a new product's introduction. A firm is therefore considered to have more experience if it has produced and sold more products, and if those products have been on the market for longer periods of time. As was the case with the technological experience data, we decomposed product-market experience into *Proximal Product-Market Experience* and *Distal Product-Market Experience* in order to distinguish the experience that accumulates within the focal therapeutic area from that which accumulates in other areas. Once again, these counts (plus one) were logged to account for their skewed distribution.

Because we are also interested in possible interactions among the technological and product-market experience variables, we incorporate a series of two-way interaction variables into our analysis. Given concerns about multicollinearity, we mean-centered each variable before constructing the interactions. A positive parameter estimate on any of the interaction variables indicates that the effect of one type of experience is increasing in the level of another, and suggests complementarities between the different types of accumulated experience.

Several control variables are included in the following models. Again, given the skewed distribution of the (continuous) control variables, each was log-transformed before inclusion in the models. As initial product sales are expected to be greater in larger markets, a *Market Size* variable controls for total (real) market sales in the year prior to introduction. This variable is measured at the level of the specific therapeutic market (and not the overall therapeutic area). We control for the competitive intensity of the market by including a variable (*Competitor Products*) that counts the number of competitors' products in the market in the year prior to introduction. We also include a variable (*Own Products*) that counts the number of the firm's own products in the market in the year prior to introduction. The *Generic* variable is set to one if the new product is introduced under a generic, and not a brand name, while the *Product Extension* variable indicates whether the new product's brand name is derived from the name of a product already on the market (e.g., *Bayer Plus* is an extension of *Bayer*). Finally, a *Technological Crowding* variable is included to control for differences in the amount of patent activity observed across the different therapeutic areas. This variable is a count of all patents granted to all firms in a particular therapeutic area over the 10 years prior to a new product's introduction.

Table 4 summarizes the descriptive statistics and pair-wise correlations among the variables used in this analysis. The *Initial Sales* variable ranges from 4.20 to 12.65. This corresponds to a range of first-year sales (in 1986 dollars) from $66.7 thousand to $311.7 million. On average, there are 13.15 competitor products in the market at the time of introduction and 0.99 products offered by the focal firm. The averages for the experience variables suggest that the average number of patents granted in the focal therapeutic area in the 10 years prior to introduction is 0.67. The corresponding average across all other areas is 18.11. The average number of product years of experience in the focal therapeutic area is 21.20 years. Finally, the average number of product years of market experience across all other areas is 300.87 years.

RESULTS

The pharmaceutical industry offers an excellent opportunity to look at how different historical patterns in technological and product-market experience within firms affect new product performance. Pharmaceutical firms tend to be active across a range of therapeutic areas. Across the entire 1977–93 period, the firms in our sample participated in an average of roughly 20 different therapeutic areas. Amgen, Allergan, and Boehringer Mannheim focused on a single area, while American Home Products was active in 51 areas. At the same time, there is an imperfect correspondence between the firms' technological and product-market experience. As shown in Table 4, the correlation between the proximal technological and proximal product-market experience variables is only 0.14. Of the 74 new products introduced into therapeutic areas in which the firms had no proximal product-market experience, the number of prior related patents ranged from zero to nine. Of the 338 new products introduced into areas in which the firm had no proximal technological experience, the number of prior product-years of product-market experience ranged from zero to 167 years. These data suggest that a firm's different types of experience do not correlate perfectly.

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Table 4. Sample statistics and correlations ($N = 534$)

	Mean	S.D.	Min.	Max.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Initial Sales	8.09	1.60	4.20	12.65	—	—	—	—	—	—	—	—
(2) Market Size	12.10	1.29	8.02	14.56	0.29*	—	—	—	—	—	—	—
(3) Competitor Products	2.65	1.000	0.00	4.19	−0.17*	0.46*	—	—	—	—	—	—
(4) Own Products	0.69	0.70	0.00	2.64	−0.07	0.15*	0.35*	—	—	—	—	—
(5) Technological Crowding	3.97	1.51	0.00	6.00	0.11*	0.17*	0.07	−0.02	—	—	—	—
(6) Technological $\text{Experience}_{\text{Proximal}}$	0.51	0.77	0.00	3.40	0.17*	0.01	−0.08	0.01	0.41*	—	—	—
(7) Technological $\text{Experience}_{\text{Distal}}$	2.95	1.66	0.00	5.26	0.27*	0.05	−0.04	0.14*	0.04	0.30*	—	—
(8) Product-market $\text{Experience}_{\text{Proximal}}$	3.10	1.60	0.00	5.75	−0.06	0.01	0.08	0.53*	0.01	0.14*	0.17*	—
(9) Product-market $\text{Experience}_{\text{Distal}}$	5.71	1.62	0.00	7.31	0.12*	0.21*	0.15*	0.18*	−0.03	0.00	0.56*	0.20*

* $p < 0.01$

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As such, they may contribute independently and differentially to its new product success. It is to this question that we now turn.

The models in Tables 5–7 are obtained using fixed-effects regression to account for the effects of unobserved factors that vary systematically across firms.[7] Model 1 in Table 5 includes the control variables in a model that pools novel and generic products. The significant parameter estimates suggest that initial sales are higher in larger therapeutic markets, but lower when there are more products offered by the focal firm, and especially by its competitors. The coefficients on the controls for generics and product-line extensions are both negative and significant. This latter result seems inconsistent with the idea that valuable market-related assets correspond with improved new product performance. By definition, product extensions trade off the brand name of an existing product. We suspect that this negative result may reflect a selection effect. Because many of the costs associated with establishing brands have already been incurred, firms may be willing to accept lower sales from their product-line extensions. We return to this issue in the concluding section of the paper.

Model 2 introduces the four experience variables. A likelihood ratio test suggests that they jointly improve the fit of the model. More specifically, a firm's proximal technological experience has a positive and significant impact on new product success. The two product-market experience variables are also positively associated with first-year sales, but only the distal effect is significant. These results thus offer support for Hypotheses 1a and 2b. Our next model examines the extent to which the experience variables interact in determining new product success. To prepare for

[7] We also estimated models that control for both firm and year effects. However, the year effects did not significantly improve the fit of the models (likely due to the fact that first-year sales were discounted to 1986, and that lagged total market sales was included as a control variable) and the reported results are unaffected.

Table 5. Results: all products

	Model 1	Model 2	Model 3
Market Size	0.528***	0.505***	0.502***
	(0.056)	(0.055)	(0.055)
Competitor Products	−0.384***	−0.384***	−0.382***
	(0.076)	(0.076)	(0.075)
Own Products	−0.164*	−0.187*	−0.179*
	(0.097)	(0.108)	(0.107)
Technological Crowding	0.015	−0.070	−0.063
	(0.040)	(0.044)	(0.044)
Generic	−1.243***	−1.179***	−1.188***
	(0.204)	(0.202)	(0.201)
Extension	−0.427***	−0.416***	−0.410***
	(0.154)	(0.153)	(0.152)
Technological $\text{Experience}_{\text{Proximal}}$	—	0.221**	0.554***
		(0.094)	(0.161)
Technological $\text{Experience}_{\text{Distal}}$	—	−0.263	−0.086
		(0.226)	(0.241)
Product-market $\text{Experience}_{\text{Proximal}}$	—	0.041	0.042
		(0.049)	(0.050)
Product-market $\text{Experience}_{\text{Distal}}$	—	1.157***	1.536***
		(0.241)	(0.298)
$\text{Technological}_{\text{Distal}} \times \text{Market}_{\text{Distal}}$	—	—	0.191**
			(0.090)
$\text{Technological}_{\text{Proximal}} \times \text{Technological}_{\text{Distal}}$	—	—	−0.285**
			(0.116)
N	534	534	534
Adjusted R^2	0.372	0.400	0.408
Likelihood Ratio Test	—	26.80***	9.94***
(relative to Model X)		(Model 1)	(Model 2)

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

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Table 6. Results: generic products

	Model 4	Model 5a	Model 5b[a]
Market Size	0.305***	0.298***	0.171
	(0.098)	(0.096)	(0.127)
Competitor Products	−0.146	−0.167	0.008
	(0.154)	(0.148)	(0.183)
Own Products	0.084	−0.109	−0.171
	(0.191)	(0.199)	(0.261)
Technological Crowding	0.030	−0.037	−0.037
	(0.047)	(0.052)	(0.085)
Technological $\text{Experience}_{\text{Proximal}}$	—	0.049	0.097
		(0.198)	(0.234)
Technological $\text{Experience}_{\text{Distal}}$	—	−0.360	−0.421
		(0.496)	(0.609)
Product-Market $\text{Experience}_{\text{Proximal}}$	—	0.132*	0.184*
		(0.078)	(0.104)
Product-Market $\text{Experience}_{\text{Distal}}$	—	1.053***	1.620***
		(0.266)	(0.532)
N	165	165	96
Adjusted R^2	0.056	0.140	0.044
Likelihood ratio test	—	20.05***	—
(relative to Model X)	—	(Model 4)	—

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$
[a] Estimated without products introduced by three dedicated generic producers (Goldline, Mylan, and Rugby Labs).

Model 3, we first introduced six interaction variables individually (see the Appendix). Only two of the interaction effects are individually significant at the $p < 0.10$ level: those between distal technological and distal product-market experience, and between proximal and distal technological experience. Model 3 shows that these interactions remain significant when included together, and that their inclusion improves the fit of the model. The specific parameter estimates suggest that proximal technological experience and distal market experience each improve new product performance. Although the main effect of distal technological experience is not significant, distal technological and distal product-market experience do interact positively in their relationship with initial product sales. This latter result is evidence of a general combinative capability (see Table 1). Finally, the interaction between the two technological experience variables is negative and significant.

Before commenting on the practical significance of these results, it is informative to see how the effects differ across two different types of product introductions: generics and novel products. Table 6 presents the results from a sample of 165 generic product introductions.[8] With the exception of the market size variable, none of the coefficients on the control variables are significant. The market size effect and the null results on the existing products variables are consistent with the results from previous studies of the generic segment of the pharmaceutical industry (Morton, 1999; Scott-Morton, 2000). When the four experience variables are included, only the product-market experience variables improve new product performance. Comparing across Models 2 and 5a, we see that for generic products proximal product-market experience (and the specific complementary assets that it brings) is particularly important.[9] Tests for interaction effects among the experience variables found none to be significant at

[8] The generic and extension control variables are not included in these models because they do not vary across the products, all of which are generics and none of which are extensions.

[9] Three of the sampled firms (Goldline, Mylan, and Rugby labs) are dedicated generic producers and did not introduce any novel products over the sample period. To ensure that the pattern of results in Table 5 is not driven by the distinction between novel vs. generic producers (as opposed to novel vs. generic products), we re-estimated Model 5a after removing the products introduced by these dedicated generic producers. As seen in Model 5b, the pattern of results is replicated.

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Table 7. Results: novel products

	Model 6	Model 7	Model 8
Market Size	0.630***	0.601***	0.611***
	(0.070)	(0.071)	(0.070)
Competitor Products	−0.481***	−0.470***	−0.464***
	(0.089)	(0.090)	(0.089)
Own Products	−0.204*	−0.187	−0.200
	(0.115)	(0.133)	(0.131)
Technological Crowding	−0.000	−0.069	−0.062
	(0.064)	(0.075)	(0.074)
Extensions	−0.368**	−0.358**	−0.365**
	(0.164)	(0.166)	(0.165)
Technological $\text{Experience}_{\text{Proximal}}$	—	0.216*	0.442***
		(0.117)	(0.157)
Technological $\text{Experience}_{\text{Distal}}$	—	−0.192	0.077
		(0.274)	(0.289)
Product-Market $\text{Experience}_{\text{Proximal}}$	—	0.020	0.049
		(0.064)	(0.065)
Product-Market $\text{Experience}_{\text{Distal}}$	—	1.015**	1.489***
		(0.465)	(0.482)
$\text{Technological}_{\text{Distal}} \times \text{Market}_{\text{Distal}}$	—	—	0.339***
			(0.113)
$\text{Technological}_{\text{Proximal}} \times \text{Technological}_{\text{Distal}}$	—	—	−0.301**
			(0.149)
N	369	369	369
Adjusted R^2	0.352	0.361	0.379
Likelihood ratio test	—	9.28***	13.04***
(relative to Model X)		(Model 6)	(Model 7)

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

conventional levels (see the Appendix). This pattern of results suggests that when new products do not embody any technological advances, the only experience that matters is a firm's proximal and distal product-market experience.

The results in Table 7 pertain to a 369-product sample of technologically novel product introductions. In Model 6, the pattern of results associated with the control variables replicates that found in Model 1. First-year product sales increase with the size of the market, but decrease with the number of existing products in the market. Once again, the product extension variable has a negative coefficient. When the four experience variables are added in Model 7, both proximal technological and distal market experience are positive and significant. Not surprisingly, the joint impact of the four variables is also significant. These results suggest that in this sample of novel product introductions new product performance is strongly influenced by the firm's technological experience within the focal therapeutic area. At the same time, a firm's distal product-market experience has an additional effect on new product performance. We again looked for significant effects among the six interaction terms and found a positive interaction between distal technological and distal product-market experience, and a negative interaction between proximal and distal technological experience (see the Appendix). When these two variables are added in Model 8, both are significant, while the main effects of proximal technological and distal product-market experience remain positive and significant.

The interaction effects described in Table 7 are non-trivial.[10] When the distal product-market experience variable reaches 3.17 (roughly 8% below its mean), the relationship between distal technological experience and initial sales becomes positive and significant. The corresponding inflection point

[10] Note that the demonstrations in this paragraph are based on the models with the two interaction terms included individually (see Appendix). We also examine the interaction between proximal and distal technological and product-market experience as a robustness check even though *ex ante* we don't expect any complementary effects between experiences of the same type.

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for distal technological experience is 1.22 (roughly 80% below its mean), above which the relationship between initial sales and distal product-market experience is positive and significant. This confirms that distal technological and distal product-market experience help with new product success only when a firm possesses a correspondingly high level of the other type.

We hypothesized positive complementary effects among technological and product-market experience. This said, Model 6 also finds a relationship between distal and proximal technological experience. This observed interaction is actually quite subtle. At very high levels of distal technological experience (i.e., levels more than one standard deviation above the mean), increases in proximal technological experience lead to decrements in initial sales levels. The corresponding inflection point for proximal technological experience is outside of the range of the variable. These calculations suggest that distal technological experience negatively moderates the relationship between initial sales and proximal technological experience, but that the converse moderating effect is not evident.

Follow-on analyses

The measures employed for technological and product-market experience are based on straight counts of patents and product-years. We are also interested in the extent to which firms with 'higher quality' experience fare better with their new product introductions. The logic underlying this concern is expressed by Mitchell and Singh (1992: 357), who note that 'the stronger the industry-related market and technological position of an incumbent, the broader its supporting assets.' To assess this claim, we generated variants of the technological experience variables, counting only those patents that attracted at least one citation in the five years after they were granted. This approach follows prior research that uses patent citations to indicate the technological importance of an innovation (e.g., Trajtenberg, (1990)). We also generated modified versions of the product-market experience variables, this time counting only products that were among the top three in sales in their respective markets. This approach follows Mitchell (1989), who equates a high market share of existing products with the possession of superior complementary assets. When the revised versions of the experience variables are substituted into Models 2, 5a, and 7, we obtain a similar pattern of results, but lower adjusted R^2 statistics (the adjusted R^2 declines to 0.379 in Model 2, 0.079 in Model 5a, and 0.350 in Model 7), as well as lower significance levels for some of the reported coefficients. The lower overall performance in the models using the quality-controlled experience variables suggests that the experience effects that we are observing relate more to accumulated participation in each domain, and less to the accumulation of 'highly successful' patents and products.

Our next concern relates to the possible effects of a firm's country of ownership. Of the 45 firms in our sample, 16 are headquartered outside the United States. Studies of technological innovation and market entry (e.g., Mitchell, 1989) find systematic differences across firms domiciled in different countries. The foreign distinction may be especially important in our analysis because the market experience measures account for U.S. product-market participation only. If firms also benefit from their non-U.S. product-market activity, and if the proportion of non-U.S. sales is higher for foreign firms, our results may be compromised. Moreover, although the patents surveyed for our technological experience measures do include inventions generated outside the United States, all are patents granted in the United States only. Each of these facts raises the prospect of unobserved differences across the United States and foreign firms in our sample.

Note that the results reported in Tables 5–7 are not affected by this problem because each model accounts for fixed firm effects. So, although we cannot specifically identify foreign firm effects, the reported results are independent of them. To isolate a foreign firm effect, we retrieved the estimated fixed effects from Models 3, 5a, and 8. Including only those firms with at least four observations in the data, we examine the distribution of these fixed effects across the United States and foreign firm subsamples. In all three cases, the average fixed effects for the two groups are not significantly different from one another (see Table 8).

A final concern relates to the potential effects of a third type of technological experience: general technological experience. In addition to related and unrelated patents, the firms in our sample produce a set of more general patents that fall within the pharmaceutical domain (i.e., within USPTO Class

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Table 8. Analysis of fixed effects

	All products ($N = 38$)	Generic products ($N = 10$)	Novel products ($N = 33$)
Average for U.S. firms	−4.656	−1.385	−6.563
Average for foreign firms	−4.020	−0.763	−5.509
Difference	0.636 ($p = 0.41$)	0.622 ($p = 0.61$)	1.054 ($p = 0.11$)
Correlation with $\text{Technological}_{\text{General}}$	0.296 ($p = 0.04$)	0.066 ($p = 0.43$)	0.331 ($p = 0.03$)

514), but are not assigned to a particular therapeutic area. We are interested in the extent to which this non-dedicated technological experience affects a firm's new product performance. However, an analysis of variance reveals that roughly 99 percent of the variance in the general technological experience variable (calculated as the log of the count of all non-dedicated patents in the 10 years prior to a product's introduction plus one) is between-firm variance. It seems that, at least within a 6-year time frame, the variance in general technological experience manifests itself within the stable firm differences that are netted out of our models. This observation is consistent with Helfat (1994), who finds persistent but stable differences in the R&D spending across firms in the petroleum industry.

This said, we expect general technological experience to have a positive effect on new product performance. To look at this, we return to the fixed effects from Models 3, 5a, and 8 to examine how they correlate with the firm averages of the general technological experience variable. Table 8 shows that, as expected, the correlations are all positive, and that the correlation is significant in the case of novel products, where technological experience should have the greatest impact. Firms with greater levels of general technological experience demonstrate improved new product performance. This effect is evident despite the fact that the knowledge derived from this general experience is 'far away' from any specific end-market application. We know from prior research that the drug discovery process is long and intense, and has a considerable stochastic component. In this context, it is possible that general technological experience helps a pharmaceutical firm to develop its absorptive capacity (Cohen and Levinthal, 1990), which may lead to more productive future research within specific therapeutic areas. In other words, a firm's general technological experience may also facilitate its new product performance indirectly by enhancing the value of its proximal technological experience. To assess the possibility, future research should examine the dynamic links between general and dedicated technological experience in order to offer a more complete account of the evolutionary process whereby technological initiatives translate into improved product-market performance.

DISCUSSION AND CONCLUSION

Our aim in this paper is to relate a firm's accumulated technological and product-market experience to the initial success of its new product introductions. At the most basic level, the findings in respect of proximal technological experience extend current research on the importance of developing valuable technological assets by linking those assets to the ultimate aim of a firm's technological endeavors: improved product-market performance. In doing so, we support Teece's (1982) suggestion that upstream R&D is the ultimate driver of competitive advantage. Firms invest in new technology in the hope that this investment will translate into more advantageous market positions. The positive and significant effect of proximal technological experience in Model 8 suggests that this does indeed occur. Moreover, when this result is compared with the null result in the sample of generic products, we explicitly tie the benefits of proximal technological experience to those products that rely on technological novelty.

The findings pertaining to distal technological experience suggest that this may also help a firm with its new products, but only if there is a concomitant high level of distal product-market experience (and only if the products require

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technological novelty for their success in the market). Taken together, the technological experience results suggest that a somewhat complex process governs its relationship with new product success. When a firm has technological experience dedicated to a given therapeutic area (i.e., proximal experience), the knowledge that derives from it stands for itself. However, when a firm relies on distal technological experience to graft together new products in a given therapeutic area, it requires complementary product-market experience to achieve a positive result. It requires what we call a general combinative capability. This suggests that in order for a firm to see the non-local value of its technological experience, and to execute the relevant combinations, it requires a strong product-market orientation that is implied by high levels of distal product-market experience.

The final interaction effect in Model 8 (i.e., that between proximal and distal technological experience) suggests a negative interplay between these two inventive processes. In other words, a commitment to a broad approach to technological development, and thus high levels of distal technological experience, makes the more local search option, and the corresponding higher levels of proximal technological experience, less viable.

In respect of proximal product-market experience, we find a positive and significant effect for generic products only. This suggests that when a firm's selling ability fully determines the success of its new products, it is beneficial to have the specific complementary assets that accumulate with prior market participation. The null result in the novel products model requires some justification. Although the main selling point for these new products derives from their technological novelty, one would still expect a benefit from the area-specific complementary assets that come from proximal market experience. The non-significant result may be explained with reference to the selection argument introduced earlier. Recall that the effect of the product-line extension variable is negative and significant. Although the firm already has a valuable brand name in the marketplace, the initial sales of its product extensions tend to be lower. We suggested that this might be due to a selection effect. If the risk and cost associated with a product that leverages the market position of an existing product are lower, then firms may introduce more products, even if those products achieve lower sales levels. This effect is observed by Ingram and Roberts (1999), who find that the number of products a firm has in the same therapeutic area dramatically increases the probability of subsequent product introductions. This less stringent selection means that firms will be introducing lower sales products, making it difficult to isolate the impact of improved complementary assets on new product success.

Finally, the distal product-market experience effect is evident across both types of products. This result is consistent with two different mechanisms. Some of the complementary assets that develop as a function of market experience are general, and thus portable across markets (Helfat and Lieberman, 2002). At the same time, a firm's combinative capabilities are honed by increased activity across product-markets. The strong and persistent results in respect of distal product-market experience suggest that the development and refinement of these assets strongly influences the growth and development of firms. If this type of experience accumulates more rapidly in large and diverse firms (Dierickx and Cool, 1989), then we may have an explanation for the high degree of persistence in the cohort of top pharmaceutical firms over time. Returning to the IMS data, we find that 24 of the top 30 firms in 1993 (in terms of total sales) were also among the top 30 firms in 1976 (three others were ranked numbers 32, 34, and 38). If these top firms were generating higher levels of distal product-market experience, which improves the success of their new product offerings, then our results help to explain the persistence of these dominant overall market positions.

This said, there is much more work to be done. As we already suggested, future research should look more closely at the dynamic interplay among the different types of technological experience in order to tease out subtler, and yet still important lead and lag effects in the development of technological capabilities. More specifically, experience accumulates, but also depreciates with time. Are there differences in the effects of older vs. more recent experience? Recent research suggests that a balance between new and old may be useful to maximize performance (Katila and Ahuja, 2002; Nerkar, 2003). At the same time, we must move past our exclusive emphasis on initial product-market performance and begin to examine whether the different types of experience also confer longer-term performance advantages

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for products and firms. This is particularly important because some of the early performance gains that we observe may be fleeting. Roberts (1999), for example, finds variance among pharmaceutical firms in their ability to sustain advantageous product-market positions over time. Therefore, our analysis is not yet a complete test of Teece's (1987) claims about the importance of complementary assets. We might want to revisit our analysis in order to examine the extent to which the assets that develop with the different types of experience are differentially imitable and/or differentially mobile across firms. With work that looks at the longer-term implications of technological and product-market experience set alongside further work on the historical processes that generate the relevant strategic assets, we will surely have a more comprehensive account of the dynamic processes that govern the distribution of competitive advantages across competing firms.

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APPENDIX. TECHNOLOGICAL AND PRODUCT-MARKET INTERACTION EFFECTS INCLUDED INDIVIDUALLY

	Model A1	Model A2	Model A3	Model A4	Model A5	Model A6
All products						
$\text{Technological}_{\text{Proximal}} \times \text{Market}_{\text{Proximal}}$	0.025 (0.053)	—	—	—	—	—
$\text{Technological}_{\text{Proximal}} \times \text{Market}_{\text{Distal}}$	—	−0.041 (0.089)	—	—	—	—
$\text{Technological}_{\text{Distal}} \times \text{Market}_{\text{Proximal}}$	—	—	−0.026 (0.026)	—	—	—
$\text{Technological}_{\text{Distal}} \times \text{Market}_{\text{Distal}}$	—	—	—	0.150* (0.089)	—	—
$\text{Technological}_{\text{Proximal}} \times \text{Technological}_{\text{Distal}}$	—	—	—	—	−0.240** (0.114)	—
$\text{Market}_{\text{Proximal}} \times \text{Market}_{\text{Distal}}$	—	—	—	—	—	−0.009 (0.025)
Generic products						
$\text{Technological}_{\text{Proximal}} \times \text{Market}_{\text{Proximal}}$	−0.073 (0.094)	—	—	—	—	—
$\text{Technological}_{\text{Proximal}} \times \text{Market}_{\text{Distal}}$	—	0.114 (0.215)	—	—	—	—
$\text{Technological}_{\text{Distal}} \times \text{Market}_{\text{Proximal}}$	—	—	−0.015 (0.040)	—	—	—
$\text{Technological}_{\text{Distal}} \times \text{Market}_{\text{Distal}}$	—	—	—	0.114 (0.309)	—	—
$\text{Technological}_{\text{Proximal}} \times \text{Technological}_{\text{Distal}}$	—	—	—	—	0.055 (0.212)	—
$\text{Market}_{\text{Proximal}} \times \text{Market}_{\text{Distal}}$	—	—	—	—	—	0.029 (0.072)
Novel products						
$\text{Technological}_{\text{Proximal}} \times \text{Market}_{\text{Proximal}}$	0.036 (0.068)	—	—	—	—	—
$\text{Technological}_{\text{Proximal}} \times \text{Market}_{\text{Distal}}$	—	0.056 (0.113)	—	—	—	—
$\text{Technological}_{\text{Distal}} \times \text{Market}_{\text{Proximal}}$	—	—	−0.043 (0.041)	—	—	—
$\text{Technological}_{\text{Distal}} \times \text{Market}_{\text{Distal}}$	—	—	—	0.302** (0.112)	—	—
$\text{Technological}_{\text{Proximal}} \times \text{Technological}_{\text{Distal}}$	—	—	—	—	−0.230* (0.148)	—
$\text{Market}_{\text{Proximal}} \times \text{Market}_{\text{Distal}}$	—	—	—	—	—	−0.014 (0.028)

** $p < 0.05$; * $p < 0.10$

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