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Product-line expansion and resource cannibalization

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Abstract

Diversification research argues that new products are more successful when they leverage a firm's intangible resources, which may support multiple activities without engendering rivalry for their use. However, numerous complementary resources may also be needed to exploit a firm's intangibles. If these resources are in limited supply, or if it takes time to acquire and assimilate additional resource capacity, then new products may impose costs on existing products by cannibalizing the services of firm resources. Our analysis of product introductions within the pharmaceutical industry provides evidence of resource cannibalization and suggests that product market experience helps offset some of these costs.

JEL classification: L2-firm objectives; Organization; Behavior

Keywords: Diversification; Resources; Product introduction

A central mission of diversification research is to understand the logic of the multi-product firm (Teece, 1982). Although firms may choose to specialize and produce a single offering, single-product firms are the exception rather than the rule (Teece, 1994). In light of this, researchers seek to explain why firms compete with multiple products and to specify the performance consequences of this product-line diversification. The composition and performance of corporate portfolios are explained using market power, agency and resource-based

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arguments (Montgomery, 1994). According to the last, when firms hold excess resources that are fungible yet subject to factor market imperfections, it is efficient to exploit them internally by expanding product offerings into new markets or within existing markets (Teece, 1980). Empirical research supports the view that multi-product firms are more successful when they diversify around a core set of (particularly intangible) resources (Montgomery and Wernerfelt, 1988; Silverman, 1999).

However, recent studies also suggest that efforts to diversify the firm may have negative consequences (Lichtenberg, 1992). Porter (1996, p. 76) argues that "compromises and inconsistencies in the pursuit of growth will erode the competitive advantage a company had with its original [product] varieties or target customers". This is consistent with Barnett et al. (1994), who find that although multiunit banks display enhanced performance overall (in the form of better survival prospects), this masks corresponding competitive weaknesses at the individual unit level. Schoar (2002) shows that the productivity of a firm's existing plants declines following its diversification moves and attributes this to management devoting more time and resources to the issues and problems encountered in the new facilities. Finally, Barnett and Freeman (2001) demonstrate that the short-term probability of failure increases when an organization simultaneously introduces many new products. This effect is thought to be due to the costs associated with coordinating across a range of new and pre-existing products.

We propose that much of this downside associated with product-line expansion is caused by resource cannibalization, or the diversion of firm resources from existing to new products. Resource cannibalization occurs whenever the capacity of key resources such as the complementary assets needed to exploit intangibles successfully is limited. If resource capacity is left unchanged, then fully utilized resources must be diverted from their existing applications. Even if resource capacity can be augmented, the assimilation, customization and coordination of old and new resources typically consumes the services of existing ones (Prescott and Visscher, 1980). These adjustment costs mean that the effects of resource cannibalization may be reduced, but not eliminated by bringing additional resources into the firm.

If our theory is correct, then the effects of resource cannibalization should be less pronounced in situations where more of the required resources are freely available. Prior research suggests that firms learn to consume resources more efficiently as they accumulate experience. This comes about as they begin to avoid mistakes and to solve problems more effectively. Experience also leads to the development of routines that enable activities to function more automatically (Argote, 1999). As this occurs, firms require fewer resources to accomplish the same sets of tasks. Because the downward adjustment of resource stocks does not (and probably can not) occur instantaneously, increasing experience leaves the firm with more excess resource capacity. This leads us to predict that the level of experience that a firm has in the focal product market attenuates the cannibalizing effects of new product introductions.

To explore these ideas, we examine whether new product introductions affect the competitive positions (i.e., market shares) of a firm's existing products. Our empirical analysis is set in the U.S. pharmaceutical industry, where product introductions are critical determinants of firm performance (Comanor, 1986; Henderson and Cockburn, 1994; Schwartzman, 1976). Pharmaceutical firms regularly introduce new products in their efforts to sustain superior

financial performance over time (Roberts, 1999). They also possess a range of valuable intangibles, including technological and market knowledge, corporate reputations and brand names, which offer incentives for product-line expansion.[1] Because growth and diversification around these intangibles should engender less resource rivalry, this setting provides a relatively conservative one in which to test our resource cannibalization arguments.

The next section develops our arguments. This is followed by a summary of the data and measures used to test them. The ensuing analysis provides evidence of resource cannibalization that is moderated by the level of product market experience. Introducing new products engenders reductions in the market shares of a firm's existing products, especially in markets where the firm has low levels of experience. A series of follow-on analyses shows that the negative impact of new product introductions is felt across the full range of existing products and is especially strong for the firms' newer and higher sales products. This suggests that the resource tension is greatest between new introductions and the firms' most promising existing products. We then demonstrate that even introductions of major products into different markets adversely affect the competitive positions of products in the focal market. All of these findings support our resource cannibalization theory. The paper closes with an analysis of the temporal dimension of resource cannibalization and a discussion of how our results affect current thinking about the overall performance implications of product diversification.

1. Resource cannibalization

A firm is a system of productive resources, both tangible and intangible (Wernerfelt, 1984). Tangible resources include financial and physical assets, while intangibles include technological and market knowledge, management skill, organizational routines, and a firm's brand image and corporate reputation (Barney, 1991). Because intangibles tend to expand with use, they are often carried in excess capacity (Itami, 1987). Penrose (1995), for example, maintains that a firm continuously acquires new knowledge about the properties and uses of the resources that it employs. Some of this knowledge is not relevant for a firm's current activities and is thus considered surplus. A firm has an incentive to exploit surplus intangibles internally because associated transaction costs are frequently too high to make selling them profitable (Teece, 1980, 1982). Two other characteristics are emphasized as reasons why a firm should expand or diversify around its intangibles. They tend to be fungible (i.e., useful in several product market applications), and they tend to be non-rivalrous in that their use in one activity has little or no impact on their availability for others (Dierickx and Cool's (1989)). For all these reasons, intangibles are able to support a greater level and breadth of activity than are tangible resources.

Although new products may exploit intangibles without affecting their usage in other activities, they also require additional complementary resources. As Teece (1998, p. 72) stresses, "the design for a new automobile is of little value absent access to manufacturing

[1] Our focus is on new product introductions and not the product development process. Therefore, the range of resources with the most potential for cannibalization are those required to manufacture, distribute, sell, and support pharmaceutical products.

and distribution facilities". A firm may hold some of these complementary resources in excess supply, but this is unlikely to be the case for all resources. Dierickx and Cool (1989) analysis of asset stock accumulation argues that different resources develop at different rates. Hence, a firm may carry surplus technological knowledge at the same time that its other organizational capabilities are strained. Resources that are acquired (e.g., plant and equipment or distribution facilities) are often subject to physical and economic constraints that make it efficient to increase capacity only in fixed increments (Ghemawat, 1987). Both factors suggest that the amount of idle capacity at any point in time differs across the various resources that a firm utilizes internally.

Consequently, while surplus intangibles offer inducements to diversify, such growth may strain the capacity of some of the complementary resources needed to leverage them (Penrose). In particular, to introduce new products successfully, a firm requires manufacturing, marketing, sales, and distribution resources, as well as managerial time and attention to guide and coordinate the process (Teece, 1987). If any of these resources are fully utilized, then services devoted to new initiatives means foregone usage in current activities. Moreover, efforts to overcome capacity limitations require the firm to acquire and assimilate additional resources or to reconfigure existing activities. These activities may also tax the resources that support existing products (Prescott and Visscher). We refer to any diversion of services provided by a firm's resources from existing products to new initiatives as resource cannibalisation.

Resource cannibalization occurs for several reasons. Most fundamentally, the capacity of existing resources may be constrained. For example, in the pharmaceutical industry (the context of this study), sales reps have a limited amount of time and finite cognitive capacity to devote to detailing products to physicians, managed-care organizations, and hospital administrators. Any additional products to support mean less time and effort available for existing products. Correspondingly, the time that physicians are prepared to spend with a firm's sales reps is also very limited, suggesting that even the social capital of the firm (Coleman, 1988) has a fixed capacity. A recent survey indicated that 87 percent of all sales calls allow for less than 2 minutes of product-related discussion (Health Strategies Group, 2000). Therefore, new products will compete with existing products for limited customer attention.

When products compete for limited resources, newer products may receive more attention than existing ones. Because they are new, they require more effort to understand and to sell effectively (Shiffrin and Schneider, 1977). New initiatives also tend to generate more excitement and therefore more managerial interest (McNamara and Bromiley, 1997). In support of this, Schoar finds that the productivity of recently acquired plants tends to improve, while the performance of the same firm's existing plants suffers. One of the causes of this 'new toy' effect is the diversion of managerial attention from the older to the newer plants.

If a firm is aware of pending resource bottlenecks, it may try to overcome them by acquiring more of the needed resources. New equipment may be purchased and additional personnel may be hired. However, before these resources can be employed as effectively as existing ones, they must be customized to the specific operating environment of the firm. New equipment must be debugged, and new employees must acquire a basic understanding of the firm's policies and products (Hatch and Mowery, 1998; Tyre and Hippel, 1997). To assimilate the new resources, managers may also need to alter material flows and work

teams as well as develop new procedures (Adler and Clark, 1991). Therefore, firms must dedicate some existing resources to assimilate the newer ones (Lichtenberg, 1988). In the pharmaceutical industry, the most experienced sales reps tend to be used in training and mentoring new recruits (Kodiyalam et al., 1988). Hence, some portion of their time and effort is diverted from selling existing products whenever the firm expands to support new products.

Even after resources have become acquainted with the specific firm environment, it takes time for them to become as productive as older generations of the same resource (Argote). Sales reps may be trained in a firm's selling procedures, but the ability to apply that knowledge effectively is acquired through experience (Baldwin and Ford, 1988). Along these lines, efficiency in diagnosing and resolving physicians' problems is essential in the pharmaceutical industry (Kodiyalam et al.). This skill is at least partially tacit and improves through accumulated experience (Wagner et al., 1999). As long as new resources are less productive, some capacity of the older resources may be redirected from supporting existing products to launching new ones.

Thus far, we have focused on the costs of adding specific resources. However, firm resources are not employed in isolation. Rather, firms are complex systems of resources, and their use must be coordinated to achieve overall objectives (Penrose). Whenever new resources are introduced, there is the potential for coordination costs as existing resources and routines are realigned to accommodate the novelty (Adler, 1990). Lichtenberg (1988) argues that expansionary resource investments are more disruptive than replacement investments precisely because they require modification to a larger number of associated resources and policies. Whereas an airline might only need to reconfigure the cockpits in replacement airplanes, it must acquire new gates and hangars as well as modify its overall flight plan when it expands its fleet to serve new markets (Goolsbee and Gross, 1997). Along the same lines, a firm's sales plans must be adapted to accommodate a larger number of salespeople and products. When managerial attention is focused on making changes to these coordinative routines, it is diverted from the task of supporting ongoing operations (Penrose). Until the system fully re-develops, the team's performance will likely suffer (Liang et al., 1995).

Consequently, the full complement of resources needed to support a firm's new products may not be available in excess capacity to the same extent as are the intangibles that new products are designed to leverage (Capron and Mitchell, 1998). This leads to rivalry for fully utilized resources, whose services are (at least temporarily) cannibalized by new product launches. Because these costs are typically borne by existing products, we hypothesize that *the performance of existing products declines with the introduction of new products* (hypothesis 1).

2. The moderating effect of experience

Although introducing new products taxes a firm's resources and imposes costs on its existing products, a firm's product market experience should moderate this impact. Experience enhances the capacity and the quality of a firm's intangible resources (Dierickx and Cool, 1989; Itami, 1987; Levinthal, 1995). Part of this gain comes from contextual knowledge that accumulates as a firm engages in a particular activity over time (Cohen and Levinthal,

1989). As sales reps learn about specific therapeutic areas, they find it easier to absorb new information about products that treat related diseases. Resource capacity also expands as tasks start to function semi-automatically (Nelson and Winter, 1982; Penrose, 1995). For example, the process of detailing products to physicians requires less effort for sales reps familiar with existing products and the specific needs and preferences of physicians. This frees up capacity for learning about new products and for developing presentations to sell them. Experience also promotes more efficient use of tangible resources, as a firm develops routines for repeated tasks, and heuristics to address recurring problems (Argote). Therefore, with more experience in the market, fewer bottlenecks arise when resources are required to support new products.

Experience also refines the higher-order routines used by firms to develop or refine their systems of resources. Routines for assimilating new resources into the organization and for adapting coordinative routines to changes in the nature and scale of complementary resources may be better defined. Lessons learned from prior experience with other product introductions may have been incorporated into a firm's routines, allowing it to anticipate better the additional demands on resource capacity. Anderson (1995), for example, finds that firms with more experience operating specific types of manufacturing operations incur lower set-up costs between production runs.

This increased efficiency makes it likely that a firm has an excess supply of more of its complementary resources and that existing products will bear lower costs of resource cannibalization. Thus, *product market experience reduces the negative impact of new product introductions on the competitive performance of a firm's existing products* (hypothesis 2).

In summary, new product introductions should cannibalize resources and therefore harm the competitive positions of a firm's existing products. However, firms with more market experience should experience lower adverse effects due to the increased likelihood of holding excess resources and the increased aptitude in dealing with resource adjustment issues. In the following sections, we test these hypotheses by examining product introductions into the U.S. pharmaceutical industry over the 1977–1993 period.

3. Data and analysis

The following analysis is based on product-level data supplied by *Intercontinental Medical Statistics America* (IMS) covering the 1977–1993 period. For each pharmaceutical product, the IMS data identify the producing firm, its therapeutic market membership, and its year of introduction. They also provide annual information on product and total therapeutic market sales. In any year, a pharmaceutical firm may sell more than 100 different drugs in a product portfolio that changes from one year to the next. To keep the project manageable, only those products that achieved at least US$ 1 million in sales in some year during the sample period are included.[2] A total of 4914 products and 50,142 product-year observations meet this sampling criterion. These products account for more than 95 percent of total U.S. pharmaceutical sales in any 1 year. Because it was not possible to track the

[2] Note that the data include all annual observations for each product that surpasses this threshold.

activity of the smaller firms over the entire sample period, the final analysis is based on a subset of 70 firms that were among the top drug producers over the period. These firms account for more than 93 percent of the total sales represented by our sample.

The IMS sales data are organized in a hierarchical structure similar to the *Standard Industrial Classification* system used to classify industries.[3] Although different products sold within the same (five-digit) therapeutic market may be imperfect substitutes, the degree of product substitutability is much greater within as opposed to across therapeutic markets (Gatignon et al., 1990). Over the entire period, 458 different therapeutic markets are represented in our sample. However, additions and consolidations affect this level over time. In 1993, the number of unique therapeutic markets in the sample was 376, with the average firm participating in 31 different markets. The broadest firms in 1993 were American Home Products (124 markets) and Bristol Myers Squibb (93 markets), while Amgen participated in just one market.

We use these data to calculate the overall annual market share for each firm within each therapeutic market:

$$\text{market share}_{ijt} = \frac{\text{sales}_{ijt}}{\text{sales}_{jt}} \times 100$$

where sales_{ijt} are the sales of firm i in market j in year t, and sales_{jt} are the total sales for market j in that year.[4] For firms with multiple products in the same market, the sales of all products are summed to determine sales_{ijt}. We net out the sales of the products introduced in year t, as our interest is in the effect of these introductions on the market positions of existing products.

Table 1 summarizes this product introduction activity over the sample period. The 70 firms in our sample were responsible for 1341 of the 1966 new products introduced between 1978 and 1993. To assess the impact that these introductions have on the market shares of existing products, we generate two product introduction count variables. When a product is introduced into the focal market by the focal firm, it is coded in-market. If it is introduced by the focal firm into a different market, it is coded other-market. Note that because our unit of analysis is the specific product market and because firms tend to participate in a number of different markets, a product introduction may be in-market in one observation and other-market in several others. For example, a new product introduced by American Home Products in 1993 would be 'in' the market into which it was introduced and 'other' to the 123 remaining markets in which American Home Products participated. The introduction variables (*Own Introductions* and *Other-Market Introductions*) are annual counts of these two types of product introductions.

[3] The major product classes include Analgesics, Antacids and Antiflatulents, Antiarthritics, Anti-Infectives, Antispasmodic/Antisecretory, Biologicals, Respiratory Therapy, Cancer/Transplant Therapy, Cardiovascular Therapy, Contraceptives, Cough/Cold Preparations, Dermatologicals, Diabetes Therapy, Diagnostic Aids, Diuretics, Hormones, Hospital Solutions, Nutrients and Supplements, Ophthalmic Preparations, Psychotherapeutic Drugs, and Vitamins. These are divided into smaller therapeutic markets down to the five-digit level.

[4] We assume that firms seek higher as opposed to lower market share outcomes over time. This may be because market share is itself a valid indicator of performance (Kimura, 1990), or because higher market share may be leveraged in pursuit of greater financial returns (Kekre and Srinivasan, 1990; Lieberman and Montgomery, 1988).

Table 1
Counts of new product introductions, 1978–1993

	Introductions by firms in sample	Introductions by excluded firms	Total introductions
1978	58	4	62
1979	48	8	56
1980	57	39	96
1981	66	11	77
1982	75	27	102
1983	98	60	158
1984	88	40	128
1985	92	64	156
1986	121	72	193
1987	129	83	212
1988	97	53	150
1989	101	53	154
1990	71	29	100
1991	88	32	120
1992	90	34	124
1993	62	16	78
Total	1341	625	1966

Our *Market Experience* variable is based on the total product-years of experience that a firm has in the focal product market. It is calculated by summing the ages of all products within the focal product market. The variable also incorporates the experience that a firm accumulated with products that have since been discontinued (roughly 17 percent of the 3673 products sold by the 70 firms in our sample were taken off the market before 1993). Consider a firm with two products in a market in 1993, one introduced in 1977 and the other in 1990. This firm would have accumulated 19 years of experience in that market. If the firm had also sold another product in this market between 1977 and 1987, then an additional 10 years of market experience would be carried forward through to 1993.

Because of the high temporal stability of market share outcomes (Mueller, 1986), the following models control for lagged market share. They also control for whether the market in question is a *Proprietary Market*. Products in ethical markets require prescriptions and are dispensed by pharmacists, while proprietary products are available over-the-counter (i.e., without prescriptions). The proprietary control variable accounts for any effects that these differences (and the corresponding differences in the firms' marketing and distribution strategies) may have on market share dynamics. A third control variable accounts for observed changes in the extent to which firms emphasize different product classes over the sample period. It is constructed by first determining the proportion of each firm's total sales derived from each (two-digit) product class in each year. For each class, we then subtract the proportion reported in the first sampled year from the corresponding proportion in the last year. This *Product Class Emphasis* variable is positive when a given class accounts for an increasing proportion of total firm sales over the sample period. We expect the coefficient on this variable to be positive: market shares should remain higher in those product classes that receive greater emphasis from the firm over the sample period. The final control variable (*Competitor Introductions*) is the count of the number of new products introduced into the

market by competing firms. Because it captures the impact of new competition within the market, the coefficient on this variable should be negative.

After deleting observations due to the use of a lagged market share variable, we remove observations for which lagged market share was greater than 95 percent (or less than 5 percent). This eliminates those cases in which market share is effectively constrained to move in one direction only and reduces the final sample to 13,367 observations.[5] Descriptive statistics and pair-wise correlations are found in Table 2. The average overall market share is 27.516 percent. Firms introduced an average of 0.037 products into the focal market and 2.296 products into other markets. Competitors introduced an average of 0.437 products into the focal market. Finally, the average of the market experience variable is 22.347 product-years.

4. Results

Because we have observations from 70 different pharmaceutical firms, we used random effects regression models to account for unobserved firm effects on the market share variable (Greene, 2000).[6] Our main results are reported in Table 3. Model 1 includes the control variables. As expected, the coefficient on the lagged market share variable indicates a high degree of persistence in market share outcomes over time. The positive coefficient on the proprietary market variable suggests that market shares tend to be higher in these markets. As expected, the estimated effect of product class emphasis is also positive. Market shares tend to remain higher in product classes whose contributions to total firm sales are increasing over the sample period. Finally, there is evidence of a significant negative impact on a firm's market share when competing firms introduce new products into the market.

Model 2 adds the variable that counts the number of new products introduced by the firm into the focal market. A likelihood ratio test indicates that this variable significantly improves the fit relative to Model 1. As predicted, a firm's own introductions into the market have a negative impact on the market shares of existing products. Models 3 and 4 include the market experience variable and then its interaction with the product introduction variable.[7] According to Model 3, the experience variable by itself does not improve the fit of the model. However, including the interaction term significantly improves the fit relative to Model 3. Although the main effect of experience is not significant in Model 4, the experience-introduction interaction is positive and significant. This supports the hypothesized moderating effect of market experience on resource cannibalization.

The final model in Table 3 tries to isolate better the adverse impact of new product introductions on the market share performance of existing products. One possible interpretation of the results from Model 4 is that firms introduce new products in response to declining market shares of their existing products. To assess this possibility, we calculate

[5] The coefficients that pertain to our key arguments are unchanged when we include the full range of the lagged market share variable.

[6] Hausman tests (Greene) supported the use of random effects over fixed effects specifications.

[7] To account for the prospect of multicollinearity, we re-estimated all models using interactions based on mean-centered variables. The signs and significance levels for all variables were virtually identical.

Table 2
Descriptive statistics and correlations (N = 13,367)

	Mean	S.D.	Min.	Max.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Market share	27.516	22.123	0.000	100.000	–	–	–	–	–	–	–	–
(2) Lagged market share	27.948	21.963	5.000	94.995	0.961	–	–	–	–	–	–	–
(3) Proprietary market	0.127	0.333	0.000	1.000	0.034	0.029	–	–	–	–	–	–
(4) Product class emphasis	0.296	17.627	−98.213	95.500	0.007	−0.005	−0.058	–	–	–	–	–
(5) Competitor introductions	0.437	1.134	0.000	21.000	−0.124	−0.111	−0.075	0.014	–	–	–	–
(6) Own introductions	0.037	0.216	0.000	8.000	−0.003	0.019	0.004	0.017	0.109	–	–	–
(7) Other-market introductions	2.296	2.172	0.000	14.000	0.016	0.018	0.019	−0.013	0.006	0.019	–	–
(8) Market experience	22.347	22.602	0.000	262.000	0.157	0.170	−0.090	−0.120	0.042	0.059	0.089	–
(9) Experience × introductions	1.124	11.106	0.000	480.000	0.029	0.040	−0.005	−0.009	0.075	0.716	0.025	0.184

Table 3
Product introductions, market experience and the market share performance of existing products (standard errors in parentheses)

	Model 1 (controls)	Model 2 (introductions)	Model 3 (experience)	Model 4 (interaction)	Model 4a (control for MS history)
Constant	0.673*** (0.183)	0.719*** (0.187)	0.745*** (0.190)	0.792*** (0.189)	0.371*** (0.150)
Lagged market share	0.965*** (0.002)	0.966*** (0.002)	0.966*** (0.003)	0.966*** (0.003)	0.968*** (0.003)
Proprietary market	0.442*** (0.172)	0.444*** (0.172)	0.429*** (0.173)	0.422*** (0.173)	0.569*** (0.179)
Product class emphasis	0.016*** (0.003)	0.017*** (0.003)	0.016*** (0.003)	0.016*** (0.003)	0.013*** (0.003)
3-year change in market share	–	–	–	–	0.042*** (0.006)
Competitor introductions	−0.335*** (0.048)	−0.292*** (0.048)	−0.290*** (0.048)	−0.288*** (0.048)	−0.229*** (0.047)
Own introductions	–	−1.999*** (0.247)	−1.989*** (0.247)	−2.945*** (0.354)	−1.939*** (0.376)
Market experience	–	–	−0.002 (0.002)	−0.004 (0.003)	0.002 (0.003)
Market experience × own introductions	–	–	–	0.026*** (0.007)	0.013** (0.007)
N	13367	13367	13367	13367	10465
Log-likelihood	−43125.7	−43092.9	−43092.7	−43085.7	−32932.2
LR test for incremental improvement (over Model *x*)	–	65.6*** (Model 1)	0.4 (Model 2)	14.4*** (Model 2)	–

** $P < 0.05$.
*** $P < 0.01$.

the change in a firm's market share in focal market over the *t*-3 through *t*-1 period. For markets into which new products were introduced, this average market share change is −0.516. The corresponding average for markets into which no products were introduced is −0.220. This difference is not statistically significant ($t = 0.624$; $P = 0.533$). Therefore, the data do not suggest that firms are introducing more products into markets in which their existing products are in relatively steep decline. This increases confidence that the results in Model 4 are not spurious. Consistent with this conclusion, we ran an additional model that includes the variable that captures these historical market share changes. As would be expected, the coefficient on the market share change variable in Model 4a is positive and significant. However, the negative effect of new product introductions and the moderating effect of experience are still evident.

5. Alternative explanations

Our argument is that the competitive positions of existing products are impaired by the introduction of new products and that this is due to the cannibalization of resources required by those existing products. However, the results in Table 3 are open to alternative interpretations. For example, the negative product introduction effect may signify product cannibalization rather than resource cannibalization. The result may also be an artifact of firms deliberately shifting resources from less attractive existing products to more promising new ones. To strengthen our interpretation of the evidence, we rule out these alternative hypotheses by isolating situations in which product cannibalization is less likely (at least relative to the expected level of resource cannibalization), and those in which firms have a smaller incentive to divert resources away from existing products intentionally.

Before reporting these follow-on analyses, note that some of the specific results from Model 4 increase confidence in our interpretation. First, although the coefficient on the product introduction variable does reflect some combination of product and resource cannibalization, the magnitude of this effect (−2.945) relative to the impact of introductions by competitors (−0.288) is instructive. One expects competitors to be more inclined to steal sales from incumbent products.[8] As such, the roughly 10 times greater impact of own product introductions suggests that we are observing something more than a simple cannibalization of the sales of one product by another. Moreover, it is difficult to explain why the extent of product cannibalization would be lower in markets in which firms have more experience. Our resource cannibalization argument explains this effect with reference to the more efficient use of firm resources as experience accumulates.

In terms of the prospect of intentional resource diversion away from existing products, note that all models in Table 3 control for the emphasis that the firm places on the focal product class. Therefore, Model 4a shows that the observed negative effect of product introductions is evident even after controlling for overall product class em-

[8] In a recent article, Pharmacia Chief Executive Fred Hassan stressed that his company would expend "careful effort to maximize all three [pain-relief] products and *minimize cannibalization* (Mantz and Pasha, 2001, emphasis added)".

phasis and the recent market share performance of existing products in the market, two variables that should capture the tendency to divert resources away from existing products.

This said, we conducted several follow-on analyses on subsets of the data to isolate situations in which firms are less likely to divert resources away from existing products intentionally. Firms have less incentive to deliberately reduce the sales of their best-selling and their newest products. Moreover, these products tend to require greater support and hence require more of a firm's resource capacity. Therefore, if product introductions negatively affect the market share of a firm's best-selling and newer products, this is more likely due to the strain placed on the ability to support those products. To assess the first possibility, we return to the product-level data file and divide the products at the median of annual sales (US$ 2.025 million). We then aggregate each sub-group into two different market share measures that represent the larger versus smaller products. If firms are simply shifting resources away from less attractive products, then we expect most of the market share impact to be borne by the smaller products. Model 5a analyzes the market shares of the higher sales products. The signs and significance levels of the coefficients on the variables of interest are roughly the same as in Model 4. In Model 5b (which examines the lower sales products), the negative product introduction effect is identified with less precision, and the interaction effect is not significant. Model 5c goes one step further and isolates the top-selling product in each market in each year. It seems clear that if a firm has the dominant product in a market, it has the least incentive to divert resources intentionally from it to support new ones. This said, the coefficient on the product introduction variable in Model 5c (−4.420) is considerably more negative than that in Model 4. The coefficient on the introduction–experience interaction term is also more substantial, so our results are strongest in the case where the prospect for intentional resource diversion is lowest.

We then divide the products at the median of product age (9 years) and again aggregate each sub-group into two different market share measures. Models 6a and 6b analyze the aggregate market shares of the newer and older products, respectively. The adverse effect of product introductions on newer products (which are still protected by patents and less likely to be the target of deliberate resource diversion) is substantially greater than the effect on the older products.[9] Moreover, the experience interaction is only significant in the newer products model. Overall, these analyses generate a similar pattern of results: product introductions tend to have a significant negative effect on the shares of the firms' more promising existing products.

The final models in Table 4 determine whether a deeper analysis of the context surrounding new product introductions produces results that are consistent with our theory. In Model 7, we examine the impact on existing products of two different types of introductions: major versus minor. We first divided the 1341 product introductions into those that achieved more

[9] In support of this idea, Moore (1996, emphasis added), quoting Arvind Desai, notes that "both Pfizer Inc. and Sandoz have used such internal cannibalization strategies successfully to blunt the impact of generic competition *on major drugs that lost their patent protection*".

Table 4
Follow-on analyses (standard errors in parentheses)

	Model 5a (high-sales existing products[a])	Model 5b (low-sales existing products[a])	Model 5c (top products in market)	Model 6a (newer existing products[b])	Model 6b (older existing products[b])	Model 7 (major vs. minor intros[c])	Model 8a (low average age[d])	Model 8b (high average age)
Constant	0.714*** (0.218)	0.492* (0.298)	1.368*** (0.475)	3.291*** (0.318)	0.043 (0.234)	0.792*** (0.192)	1.502*** (0.205)	−0.278 (0.222)
Lagged market share	0.948*** (0.003)	0.955*** (0.007)	0.945*** (0.006)	0.890*** (0.008)	0.963*** (0.003)	0.966*** (0.003)	0.956*** (0.004)	0.973*** (0.003)
Proprietary market	0.630*** (0.230)	−0.074 (0.385)	1.259*** (0.390)	−0.846 (0.523)	0.740*** (0.260)	0.407*** (0.173)	0.077 (0.236)	1.000*** (0.253)
Product class emphasis	0.022*** (0.004)	0.005 (0.008)	0.021*** (0.007)	0.009 (0.008)	0.006 (0.005)	0.017*** (0.003)	0.015*** (0.004)	0.010** (0.005)
Competitor introductions	−0.173*** (0.058)	−2.247*** (0.358)	−0.876*** (0.138)	−0.285*** (0.102)	−0.363*** (0.063)	0.276*** (0.048)	−0.266*** (0.063)	−0.402*** (0.077)
Own introductions	−2.703*** (0.437)	−3.733** (1.650)	−4.420*** (0.793)	−5.481*** (0.699)	−1.356*** (0.516)	–	−3.632*** (0.456)	−2.129*** (0.628)
Major intros	–	–	–	–	–	−4.809*** (0.612)	–	–
Minor intros	–	–	–	–	–	−2.200*** (0.452)	–	–
Market experience	0.006** (0.003)	−0.005 (0.006)	0.001 (0.005)	−0.028*** (0.007)	0.011*** (0.003)	−0.004 (0.003)	−0.018** (0.007)	0.011*** (0.003)
Market experience × own intros	0.024*** (0.008)	−0.002 (0.052)	0.040*** (0.013)	0.048*** (0.013)	0.007 (0.009)	–	0.061*** (0.014)	0.009 (0.009)
Market experience × major intros	–	–	–	–	–	0.032*** (0.011)	–	–
Market experience × minor intros	–	–	–	–	–	0.030*** (0.011)	–	–
N	10608	3032	4713	3162	7630	13367	6677	6690
Log-likelihood	−35902.6	−10271.3	−16601.0	−11183.9	−24399.0	−43075.3	−21869.2	−21084.7

[a] Cut-off is the median annual sales for all products (US$ 2.025 million).

[b] Cut-off is the median annual age of all products (9 years).

[c] Major introductions are those with more than US$ 2.025 million of first-year sales.

[d] Cut-off is the median of average age of all firm products in the focal market (10.33 years).

* $P < 0.10$.

** $P < 0.05$.

*** $P < 0.01$.

than US$ 2.025 million in sales (the median annual sales of all products in the sample) in their first year and those that did not. The major introductions had an average initial market share of 10.427 percent, compared to 2.531 percent for the minor introductions. By isolating the impact of this latter group of introductions, we demonstrate that even when new products do not achieve substantial market positions for themselves, they still impose resource costs on existing products. The results show the predicted negative effect of minor product introductions as well as the moderating effect of market experience, although the effects are smaller than those associated with major introductions. Note, however, that while the average initial market share of the minor introductions is roughly one-quarter that of the major introductions, their impact on the market share of existing products is almost half that associated with the major introductions. This suggests that even when products do not capture substantial sales on their own, they still impose resource cannibalization costs on existing products.

Finally, we divided the sample into markets where the average age of a firm's existing products is below versus above the median (10.33 years). Our resource cannibalization arguments suggest that existing products should be hurt more by introductions in markets with lower average product ages. These markets tend to be dominated by newer products, and this relatively recent introduction activity should leave the firm with fewer excess resources to support the new offerings. As shown in Models 8a and 8b, the results are in the expected direction. When existing products are newer on average, the adverse impact of product introductions (-3.632) is much greater than in markets dominated by older products (-2.129). Moreover, we only see a significant moderating effect of market experience in the low average age sample.

As a final test of our theory, we examine the additional impact of product introductions into markets other than the focal market. There is very little possibility that these other-market introductions cannibalize the sales of products in the focal market. Therefore, any observed negative effect could only indicate resource cannibalization. On the other hand, these new products are less likely to utilize and, therefore, cannibalize the same market-specific resources. For example, products in the same markets are likely to demand the attention of the same sales reps. Because there is less direct resource conflict across product markets, competition for firm resources may not be as intense. According to Model 9 in Table 5, the overall impact of these other-market introductions is negative, but not significant. However, when we follow the logic of Model 7 and break the overall set of new products into major versus minor introductions, we see that major introductions (i.e., those that achieve more than US$ 2.025 million in first-year sales) generate a significant negative other-market introduction effect. The resource requirements of major new products introduced elsewhere in the firm do lead to the cannibalization of resources required by products in the focal market. Finally, note that Model 10 includes a control for the emphasis that the firm places on the focal product class. Therefore, the other-market result is not arbitrarily picking up a firm's decision to de-emphasize the focal product class. To ensure the robustness of this result, Model 10a presents the same model with extremely low-emphasis product classes (i.e., those for which the emphasis variable is more than one standard deviation below the average) excluded. Given that major other-market introductions still have a negative effect in the sample of products that are of stable or increasing importance to a firm, we conclude that the result is not spurious.

Table 5
Incorporating other-market product introductions (standard errors in parentheses)

	Model 9 (other-market introductions)	Model 10 (major vs. minor introductions)	Model 10a (excluding low-emphasis cases)
Constant	0.818*** (0.195)	0.823*** (0.197)	0.827*** (0.217)
Lagged market share	0.966*** (0.003)	0.966*** (0.003)	0.966*** (0.003)
Proprietary market	0.421** (0.173)	0.419*** (0.173)	0.335** (0.181)
Product class emphasis	0.016*** (0.003)	0.016*** (0.003)	0.019*** (0.004)
Competitor introductions	−0.288*** (0.048)	−0.289*** (0.048)	−0.292*** (0.052)
Own introductions	−2.944*** (0.354)	−2.951*** (0.353)	−2.886*** (0.372)
Market experience	−0.003 (0.003)	−0.003 (0.003)	−0.005* (0.003)
Market experience × own introductions	0.026*** (0.007)	0.026*** (0.007)	0.024*** (0.007)
Other-market introductions	−0.017 (0.030)	–	–
Other-market major intros	–	−0.108* (0.059)	−0.109* (0.062)
Other-market minor intros	–	0.027 (0.039)	0.033 (0.040)
N	13367	13367	12328
Log-likelihood	−43085.5	−43083.7	−39897.1
LR test for incremental improvement (over Model *x*)	0.4 (Model 4)	3.6** (Model 9)	–

* $P < 0.10$.
** $P < 0.05$.
*** $P < 0.01$.

6. Lead and lagged effects

Our final set of analyses focuses on the temporal impact of new product introductions. We introduced the paper by arguing that product introductions impose resource costs on existing products. In developing this idea, we examined the specific processes through which such costs are incurred. Although it is beyond the scope of this paper to explicate fully the lead and lag structure of resource cannibalization, we are in a position to address two specific questions. First, do the firms effectively anticipate their resource needs and begin the adjustment process in advance of new product introductions? Second, to what extent are the resource cannibalization costs short-run phenomena? In response to the first question, we re-estimate Model 2, this time adding a variable that captures the 1-year lead of new product introductions. Firms that anticipate the resource needs of their new products may begin the process of resource adjustment prior to the actual introduction date. If this preparation consumes valuable firm resources, then the negative impact of product introductions may be felt in the year prior to their arrival. Model 11 tests for this effect and finds that the coefficient on the lead introduction variable is negative but not significant Table 6.[10] Either resource requirements are not effectively anticipated, or (more likely) the preparation that can be done in advance (e.g., hiring new employees and purchasing new equipment) is not as costly as that which occurs

[10] This result also dispels concerns that firms tend to introduce new products into markets where the sales of their existing products are expected to decline. The insignificant coefficient on the lead of introduction variable suggests that there is no such downward trend in market shares in those markets in the year prior to introduction.

Table 6
Lead and lag effects of new product introductions (standard errors in parentheses)

	Model 11 (lead effects)	Model 12 (lag effects)	Model 12a (lag effects)
Constant	0.756*** (0.114)	0.494*** (0.141)	0.315*** (0.169)
Lagged market share	0.966*** (0.003)	0.965*** (0.002)	0.968*** (0.003)
Proprietary market	0.324*** (0.170)	0.548*** (0.166)	0.613*** (0.173)
Product class emphasis	0.016*** (0.003)	0.011*** (0.003)	0.009*** (0.003)
Competitor introductions	−0.279*** (0.048)	−0.257*** (0.047)	−0.284*** (0.048)
Own introductions	−2.051*** (0.251)	−1.677*** (0.243)	−1.520*** (0.249)
1-year lead of own introductions	−0.073 (0.254)	–	–
1-year lag of own introductions	–	−2.798*** (0.254)	−2.363*** (0.262)
2-year lag of own introductions			−0.346 (0.267)
N	11943	13220	11650
Log-likelihood	−38200.9	−42263.2	−36860.8

*** $P < 0.01$.

post introduction. Given the importance of physician time and the opportunity cost of the experienced employees, many of the costs incurred to bring new resources online are associated with activities that cannot be undertaken until their actual use commences. This implies that the costs associated with resource cannibalization may be hard to avoid, even when anticipated.

The second question relates to the duration of the resource cannibalization effects. If most of the resource costs are adjustment costs, then the impact of new products should be felt on or about the year of introduction. Consistent with this, Lichtenberg (1988) finds that the bulk of the adjustment costs associated with assimilating new plant and equipment into a firm's productive capacity is incurred in the year the investment is actually made. If, however, resource diversion is more permanent, then we expect to see more enduring negative impacts. To address this question, we estimate a variant of Model 2 that includes a 1-year lag of new product introductions. The results from Model 12 show that the contemporaneous effect of product introductions is still evident. However, there is an additional negative effect induced by the lagged introduction variable. This suggests that existing products are still affected by new introductions in the year following their arrival. Moreover, this latter impact seems to be quite dramatic.[11] Given the observed 1-year lag effect, we ran another model that includes a 2-year lag of the introduction variable and found the coefficient on this variable to be insignificant (see Model 12a). This leads us to conclude that the main impact of new product introductions on existing products is short-term and felt in the first 2 years.

[11] Caution must be used when interpreting the relative magnitudes of the current and lagged introduction effects. The current-year impact may be dampened as new products may have arrived at any point during the calendar year. Assuming that new products are introduced uniformly throughout the year, then the average new product has an impact in only half of its first year on the market. If we then double the estimated current-year introduction effect, it is greater than that experienced in the next year.

7. Discussion and conclusions

The most 'optimistic' (Montgomery, 1995) view on product diversification is that intangible resources offer the prospect for growth and diversification because they are valuable and are available at no opportunity cost to the firm's other activities. In this paper, we temper this outlook by suggesting that there may be costs to weigh against the purported benefits. Although some key intangibles may be freely available, all of the complementary resources required to exploit them are not. Introducing new products may therefore impose resource costs on a firm's existing products. Our results support this proposition by demonstrating that new product introductions by firms in the U.S. pharmaceutical industry correspond with reductions in the market shares of the firms' existing products.

Given the prospect of product cannibalization, the adverse effect of in-market introductions cannot be unambiguously attributed to resource cannibalization. However, the impact of a firm's own introductions is considerably more harmful than are product introductions by competitors. Because competitors have a greater incentive to steal incumbent sales, the additional impact of own introductions is evidence of resource cannibalization. Moreover, it is difficult to generate a product cannibalization interpretation for the moderating effect of market experience. On the other hand, resource cannibalization is expected to be lower at higher levels of experience because of the increased effectiveness and efficiency of a firm's existing resources. Similarly, there is no product cannibalization interpretation for the adverse effects of major other-market introductions. By definition, product cannibalization in this context is trivial.

Therefore, arguments based on resource diversion fit the data very well. Moreover, in follow-on analyses, we show that this diversion is probably not due to firms deliberately shifting resources away from less attractive products. If this were the case, the majority of the cannibalization effect would be felt by the firms' smaller and older (and therefore less attractive) products. Our results indicate that the adverse effects of new product introductions tend to be felt by higher sales and newer existing products, while the impact on the smaller and older products is considerably less pronounced. This result is not consistent with intentional resource diversion. However, it is consistent with resource cannibalization, as the valuable resources that are most needed by the product introductions are probably those that effectively support larger and newer products.

With this in mind, we must stress that our analysis does not advocate a complete reversal of the optimistic orientation toward product-line diversification. Rather, it highlights some important factors that must be considered when determining the full effects of new product introductions. For instance, the coefficients from Models 7 and 10 suggest that major product introductions have a more adverse impact on in-market products (-4.809) than on products that are in other markets (-0.108). This is consistent with our theory. In-market introductions lead to product as well as resource cannibalization. They also compete more directly for the same market-specific resources. However, to assess the overall impact of a new product introduction, we must consider that any given introduction is in-market to fewer markets than it is other-market. Because pharmaceutical firms tend to compete in many therapeutic markets, an average product introduction is in-market to 0.535 markets, but other-market to 38.507 markets. Therefore, the overall impact on the market shares of existing products for a major product introduction (assuming minimum market experience)

Table 7
Total impact of major and minor introductions on market shares of existing products (at different levels of experience)

Level of experience	In-market effects[a]	Other-market effects[b]	Total effect	Number of introductions whose initial market share offsets the 'total effect'
Major introductions				
0.0	−2.573	−4.159	−6.732	136 (29.9 percent)
22.3	−2.191	−4.159	−6.350	143 (31.4 percent)
45.0	−1.802	−4.159	−5.961	148 (32.5 percent)
Minor introductions				
0.0	−1.177	0.000	−1.177	265 (29.9 percent)
22.3	−0.819	0.000	−0.819	359 (40.5 percent)
45.0	−0.455	0.000	−0.455	497 (56.1 percent)

[a] Each introduction was 'in-market' to an average of 0.535 markets.
[b] Each introduction was 'other-market' to an average of 38.507 markets.

is −6.732, which breaks into −2.573 for in-market effects and −4.159 for all other-market effects (see Table 7). The aggregate other-market impact is actually more severe because its impact is felt across the firm. The same cannot be said for minor product introductions, which generate an in market effect of −1.177, but no significant other-market effect.

To get a better feel for the overall impact of new product introductions, we may compare these typical market share losses to the initial (i.e., first year) market shares of the new products introduced by the sampled firms. This indicates the extent to which there are net short-term costs associated with introducing new products. Of the 455 major new products introduced by our sampled firms, only 136 (or 29.9 percent) achieve a market share that exceeds this loss threshold in their first year on the market. Taking this a step further, we may quantify the moderating effects of product market experience. Calculations based on the interaction effects from Model 7 show that the total adverse impact of a typical product introduction falls to −6.350 as a firm moves from virtually no experience towards the average level. At this level, 143 (or 31.4 percent) of the major new product introductions have initial market shares that surpass the loss threshold. When market experience increases to one standard deviation above its mean, the net effect of major product introductions becomes −5.961. At this level of experience, 148 (or 32.5 percent) of the introductions surpass the loss threshold. The offsetting effect of market experience is more dramatic in the sample of 886 minor product introductions. At the minimum level of the experience variable, 265 (or 29.9 percent) of the new products achieve initial market shares that offset the losses experienced by existing products. At one standard deviation about the mean of the experience variable, this number grows to 497 (or 56.1 percent).

As these demonstrations suggest, if we are to offer a complete account of the logic of product market diversification, performance effects must be examined in both directions. Our analysis suggests that a better understanding of the trade-offs that are present, and the specific forms they take, is needed. In line with this, we encourage additional research that looks at different industry contexts, uses different performance measures (e.g., financial performance), and examines impacts over longer time horizons. This latter suggestion is

especially important given the likelihood that positive product synergies may develop over time and that certain firm resources accumulate as a function of product market participation.

The focus of this paper is on the immediate impact of new product introductions, and although a follow-on analysis suggests that the negative impact of new product introductions may persist into the second year, we cannot address the question of whether new product introductions harm existing products over the long term. In fact, the observed moderating effect of product market experience suggests that increasing product market participation over time may create organizational resources that smooth the introduction of new products. In addition, there may be demand-side economies of scope with respect to product-line breadth. For example, physicians may prefer to purchase several products from a particular sales representative to economize on their own time. Offering more products in a particular area might increase the reputation and visibility of the salespeople and facilitate garnering more face time with physicians. We expect these types of effects to manifest themselves over time. Thus, it is important to consider long-term tradeoffs in order to assess fully new product impacts. Future studies investigating various performance outcomes, timeframes, and industry contexts will help determine when the costs of new product introduction more than outweigh the expected benefits.

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