The Impact of Product Portfolio and Innovation Strategy on Financial Performance

Profiting from Innovation: Decomposing the Impact of Product Portfolio Innovation Strategy on Financial Performance

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Abstract

Innovation is one of the most important issues facing business today. Its success is achieved by understanding the process, its payoffs, and managing both so that little gets left to chance. The major difficulty in managing innovation is that managers must do so against a constantly shifting backdrop -- technologies, competitors, and markets constantly evolve. Then, a critical challenge is separating distractions from real opportunities/threats as they set direction through innovation/marketing strategy and select optimal portfolio projects. This creates a natural tension that must be balanced in the portfolio strategy. In doing so, key strategic questions are what portfolio balance, innovation strategy, and market strategies provide the greatest financial reward. Thus, the purpose of this paper is to investigate the financial impact of competence in portfolio management as it relates to innovation and marketing strategy, enabling us to design a better portfolio strategy. This study investigates these questions in the context of the biomedical device industry using 15-years of product portfolio and financial data.

From our empirical analyses, we confirm that a longer product portfolio helps firm's financial performance. However, each component of portfolio serves different roles. Second, we find evidence of persistent first-mover advantage. That is, first-entered new products yield not only an immediate effect but also lagged effects. Third, we find short-term effects of (1) the balance between "old" and "new" portfolio (Introduction Intensity) and long-term effects of (2) the balance between "first-entered" and "late-entered" portfolio (Pioneering Intensity) on firm's performance. By understanding these performance trade-offs, we can develop better guidelines for optimizing portfolio and innovation strategies.

Introduction

Innovation is the process of bringing new products and services to market. Clearly, it is one of the most important issues facing business today (e.g., Hauser, Tellis, and Griffin, 2005). By finding new solutions to problems, innovation has the potential to create new markets and transform industries, or completely destroy them. Although the number of new product introductions continues to grow each year, the failure rate of new products has not necessarily improved over time, continuing to exceed 80% in some industries. At the same time, only a fraction of new products are considered to be highly innovative. Success in innovation is achieved by understanding the process, its payoffs, and managing both so that little gets left to chance. As a result, it is not surprising that there is a pressing need to connect innovation with growth and financial metrics (Hauser, Tellis and Griffin, 2006).

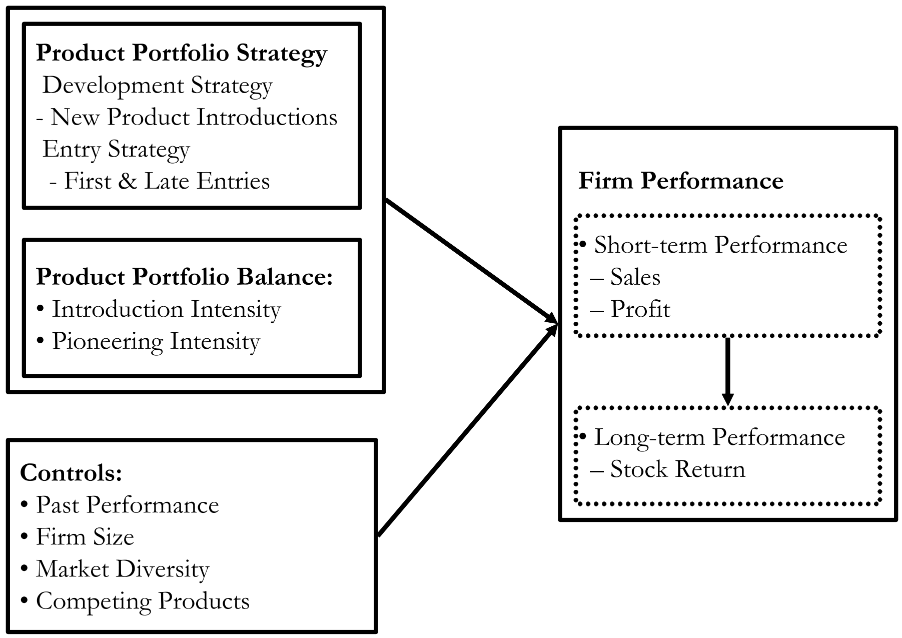
A major difficulty in managing innovation is that managers must do so against a constantly shifting backdrop -- technologies, competitors, and markets constantly evolve. A critical challenge facing managers today is separating distractions from real opportunities and threats as they set direction through innovation and market strategy and select projects for the product portfolio. There are two critical natural tensions that must be balanced in the portfolio strategy: the *introduction intensity* (or relative rate of new product introduction), and the *pioneering intensity* (or relative rate of first to market launches). In determining these portfolio strategies, key strategic questions are what portfolio balance, innovation strategy and market strategy provide the greatest financial reward in a dynamic environment? The purpose of this study is to shed light on these questions by decomposing the components of portfolio strategy. Specifically, we examine the financial impact of the components of product portfolio innovation strategy. The context of our study is the biomedical device industry using 15-years of product introduction data and financial data. The results of our study provide important managerial insights regarding how to design better portfolio strategies.

Literature

Product portfolio decisions are the manifestation of a firm's innovation and marketing strategies. The common approach to managing new product development (NPD) is to develop and manage a portfolio of specific projects (Wind and Mahajan 1997). All companies that engage in NPD face the important problem of selecting a project portfolio (Krishnan and Ulrich 2001; Loch and Kavadias 2002). Practically speaking, choosing the NPD portfolio determines the firm's strategy for the medium term future and is senior management responsibility (Roussel et al. 1991; Cooper et al. 2001). Operationally, portfolio decisions involve two strategic components: (1) a *development strategy* regarding the number and rate of new product introductions (i.e., introduction intensity), and (2) a *market entry strategy* regarding the relative speed to market (i.e., pioneering intensity). Past research suggests that better-managed firms structure their portfolios by striking a balance in the product innovation portfolio across these strategic components. However, past research has not systematically decomposed the components of portfolio strategy to examine how the components work together in relation to financial performance.

In the following sections we discuss the two strategic components of the product innovation portfolio. Our conceptual framework relating the components of the product innovation portfolio and firm performance is shown in Figure 1.

Figure 1 Conceptual Framework



Development Strategy

Development strategy is a characterization of the portfolio newness that is reflected by the scope (number and type) of new products in the portfolio and relative introduction intensity (rate of introduction). In determining the development strategy for the product portfolio, firms need to consider two opposite incentives. According to Bordley (2003), highly diverse product lines help firms to better satisfy heterogeneous needs and wants (Connor 1981; Lancaster 1979; Quelch and Kenny 1994) and the diverse line can also deter new entering competitors (Bananno 1987; Brander and Eaton 1984; Schmalensee 1978), leading to higher prices of remaining firms (Benson 1990; Putsis 1997). On the contrary, a narrow product line enables the firm to lower production costs due to scale economies (Baumol, Panzar, and Willig 1982) and it also can lower design and inventory holding costs, and reduce complexity in assembly (Lancaster 1979, 1990; Moorthy 1984).

In addition to the breadth and number of new products in the portfolio, NPD projects can also be described in terms of their degree of innovativeness. Only about 10% of all new products are radical, "new to the world products" (Booz, Allen & Hamilton 1982; Martin 1995), however, research suggests that these new-to-the-world products bring firms the disproportionate contribution to profitability. Due to the risk and required investment, firms are often reluctant to undertake radical innovations. Instead, firms focus more on "me-too" products (e.g., product line extensions, improvements to current products, or cost reductions). Conventional wisdom suggests there should be some balance between incremental and radical products in the portfolio to account for multiple time horizons (shorter and longer term considerations), and to increase organizational capability for learning (Wind and Mahajan 1997).

Market Entry Strategy

Market entry strategy is a characterization of speed-to-market and is reflected by the number and type of entry decisions (first vs. late to market) and the relative pioneering intensity. In managing a series of NPD projects, the firm decides the timing and sequence of product introduction, i.e., the relative priority of development activities (Krishnan and Ulrich 2001). This timing decision represents an interesting trade-off of cannibalization versus faster accrual of profit (Krishnan and Ulrich 2001). Faster development cycles reduce the discrepancies between the development and launch periods. The real challenge is how to do speed the development cycle without deteriorating the quality of the product and its price (Cohen, Eliashberg, and Ho 1996; Wind and Mahajan 1997).

A related issue is new product entry timing from a competitive strategy perspective (Wind and Mahajan 1997), i.e., the question of first-mover advantage (Golder and Tellis 1993; Kerin, Varadarajan, and Peterson 1992). This past research suggests that the benefits of early entry include not only increased profitability but also competitive advantages (market share and customer mind share) associated with pioneering, first-mover advantage. An interesting conundrum is that companies sometimes place great emphasis on rapid new product introduction, rushing products to market, with no consideration of optimal time of entry. It is critical to ask whether the market is primed and ready for the new innovation.

Firm Performance Metrics

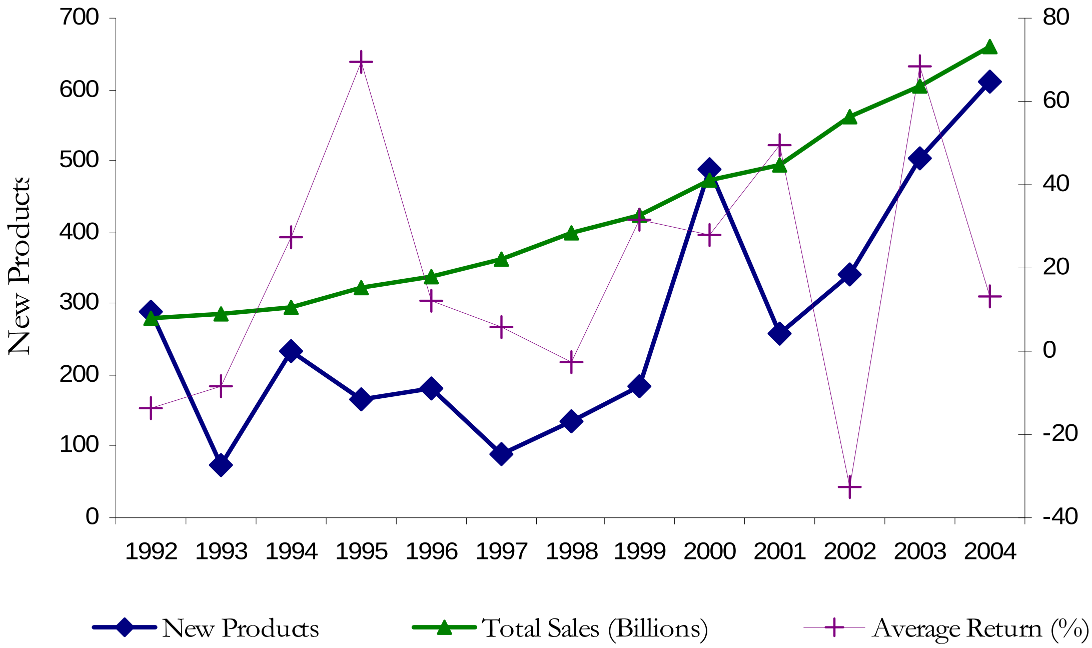
Sales has been proposed as the most important measure of business performance on which managers should focus (Reichheld 2003), and is a measure of firm performance that is often closely associated with the marketing function. Similarly, gross profit (sales revenue minus cost of selling) is an indicator of the firm's value chain, specifically measuring a firm's ability to convert inputs into valuable outputs (Bell et al. 2002; Ittner and Larcker 1998).

Our long-term metric of financial performance is a firm's market-adjusted abnormal return (i.e., the rate of return minus the average rate of return of the stock market). This is forward-looking and captures the net present value of future rents after accounting for risk. This measure is the most widely-used metric in finance literature to measure a firm's financial performance (e.g., Kothari and Warner 2006). Since shareholders are the owners of the firm, they are an important constituency. That is, their interests should be included in making business decisions (Day and Fahey 1988). It is a common practice that boards of directors link a large portion of a top executive's compensation to the firm's stock return (e.g., Guay 1999). Clearly, a firm's performance (i.e., sales and profit) is a key source of increasing the shareholder's return.

Empirical Context: Biomedical Device Industry

The context for our proposed study is the biomedical device industry. By all measures of growth – employment trends, production values, global market share, venture capital financing, and R&D expenditures – the medical technology/device industry is one of the most vital and dynamic sectors of the US economy. This industry provides a very fitting context in which to investigate innovation and it is analogous to many other fast-pace, rapidly growing industries. The rate of innovation and technological change is exploding with emerging breakthroughs in device miniaturization, nanotechnology, molecular and gene-based diagnostics, information technology, and artificial organs and tissue engineering. The US is the global leader in innovation in medical technology development and the largest producer of medical devices and diagnostics (see Figure 2). Since all new medical devices are required to go through an approval process via the FDA, there is accessible objective data regarding innovation activities.

Figure 2 US Biomedical Device Industry Statistics



According to FDA's definition, a medical device is "an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory which is (1) recognized in the official National Formulary, or the United States Pharmacopoeia, or any supplement to them, (2) intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, in man or other animals, or (3) intended to affect the structure or any function of the body of man or other animals, and which does not achieve any of it's primary intended purposes through chemical action within or on the body of man or other animals and which is not dependent upon being metabolized for the achievement of any of its primary intended purposes."

Our study involves the development of an extensive database of innovation activities in the biomedical device industry across 14 years. The dataset is mainly built from two sources. First, we collected a complete census of new product introduction activities for biomedical devices from the FDA database. The FDA data allows us to develop proxy measures of market entry strategy and market newness, as well as indicators of competitive intensity within specific product categories during the same time period. Second, we collected annual financial information for all public firms that sold biomedical devices over the same time period using COMPUSTAT/CRSP data. The COMPUSTAT/CRSP data provides us with various indicators of financial performance, as well as organizational support/assets and marketing capability.

In total, our data covers 14 years of product portfolio activities in medical device industry (1991-2004), including 138 public firms in 1578 product-market segments with the total of 3471 products. The medical device industry includes seven sub-industries, defined by COMPUSTAT database[1], and 19 medical specialties, defined by the FDA[2].

Data Description: Variable Definitions and Descriptive Statistics

In the following sections, we briefly describe the operational variable definitions. A summary of the variable definitions and descriptive statistics are reported in Table 1.

Product Portfolio Strategy

We decompose product portfolio strategy based on the development strategy and entry strategy components. For a given year, a firm has a set of new products (*NewProd*) and existing products (*OldProd*) in its portfolio. At the same time, depending on the entry strategy, a product is introduced either as first in the product-market segment (*First*) or as late in the segment (*Late*). Applying these two categorizations, we can decompose the product portfolio strategy in a 2x2 classification scheme (i.e., *FirstOld*/*LateOld* and *First New*/*LateNew*). Table 2 illustrates this decomposition of the product portfolio strategy.

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[1] Seven sub-industries are (1) DENTAL EQUIPMENT & SUPPLIES, (2) ELECTROMEDICAL APPARATUS, (3) LAB ANALYTICAL INSTRUMENTS, (4) OPHTHALMIC GOODS, (5) ORTHO, PROSTH, SURG APPL, SUPLY, (6) SURGICAL,MED INSTR, APPARATUS, and (7) X-RAY & RELATED APPARATUS. The corresponding NAICS codes are 334516, 334517, 334510, 339112, 339113, 339114, and 339115. Note that we exclude pharmaceutical category to focus on firms whose main business is medical device. As a result, several big pharmaceutical firms (e.g., Pfizer, J&J etc.) are not a part of our data even though they introduce many medical devices in the industry.

[2] The medical specialties are Anesthesiology, Clinical Chemistry, Cardiovascular, Dental, ENT (Ear, Nose, Throat), Gastroenterology/Urology, Hematology, General Hospital, Immunology, Microbiology, Neurology, OB-GYN, Ophthalmic, Orthopedic, Pathology, Physical Medicine, Radiology, General and Plastic Surgery, and Clinical Toxicology.

Table 1 Variable Definitions and Descriptive Statistics

Variable	Definition	Mean	Std Dev
Portfolio Scope	# of product portfolio (= OldProd + NewProd)	17.03	45.17
OldProd	# of existing product portfolio (= FirstOld + LateOld)	13.91	37.82
FirstOld	# of first-entered existing product	8.16	21.73
LateOld	# of late-entered existing product	5.75	18.38
NewProd	# of new product portfolio (= FirstNew + LateNew)	3.12	10.59
FirstNew	# of first-entered new product	1.17	4.53
LateNew	# of late-entered new product	1.96	7.89
Portfolio Balance			
Introduction Intensity	Percentage of new products in product portfolio, weighted by time since introduction	0.17	0.34
Pioneering Intensity	Percentage of first-entered products in product portfolio (= (# of first-entered products)/(# of product portfolio))	0.26	0.34
Control			
Size	Asset (in million dollar)	502.05	1461.70
NMarket	# of product-market segment	14.19	33.76
CProducts	Average # of competing products in product-market segments	2.68	3.07
Performance			
Sales	Sales (in million dollar)	405.29	1048.95
Cost	Cost (in million dollar)	157.06	404.05
Profit	Sales – Cost of selling	248.24	691.61
Return	Adjusted stock return	0.21	0.67

Note: In estimation, the portfolio scope measures are adjusted by the number of product-market segment (NMarket) and we take log of Size, Sales, Cost, and Profit. Also, Introduction and Pioneering Intensities are adjusted by industry averages.

Table 2 Product Portfolio Strategy Decomposition

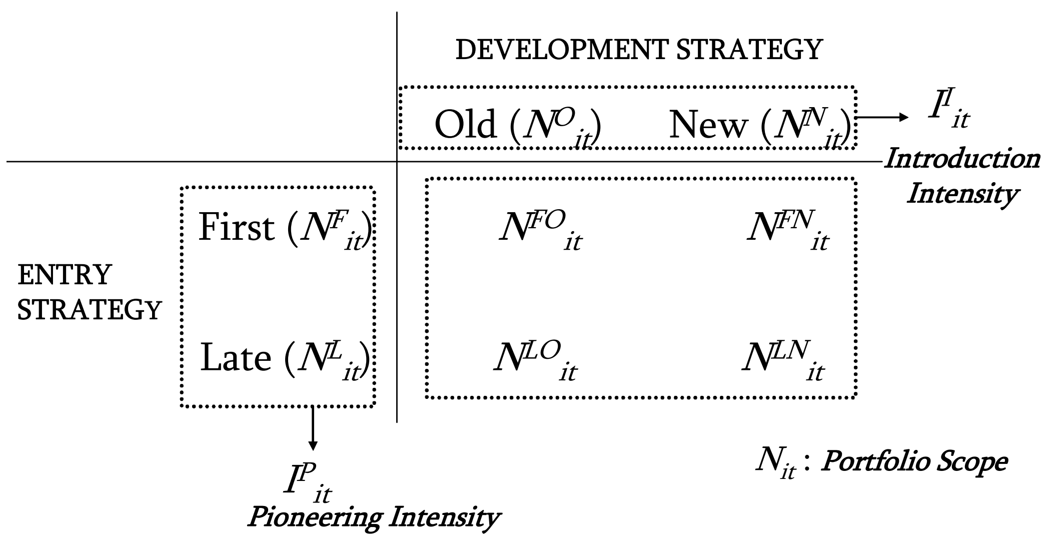
Portfolio		Development Strategy	
		Old (***OldProd***)	New (***NewProd***)
Entry Strategy	**First**	First-entered (***FirstOld***)	New to market (***FirstNew***)
	Late	Late-entered (***LateOld***)	New to firm (***LateNew***)

For model estimation, the four portfolio strategy component measures are adjusted by the number of product-market segments (*NMarket*), so that the measures represent portfolio strategies in each market segment.

Product Portfolio Balance

We capture the portfolio balance using two measures: *Introduction Intensity* and *Pioneering Intensity* (Figure 3).

Figure 3 Product Portfolio Balances



Introduction Intensity is defined as the percentage of new products in the product portfolio. It is weighted by time since introduction of each product in the portfolio.

$$I^I_{it} = \frac{\sum_{j=1}^{N^N_{it}} a_{ijt}}{\sum_{j=1}^{N_{it}} a_{ijt}} = \frac{N^N_{it}}{\sum_{j=1}^{N_{it}} a_{ijt}}, \qquad (1)$$

where a_{ijt} = time since introduction of product *j* in firm *i*'s portfolio at time *t*.

Pioneering Intensity is defined as the percentage of first-entered products in the product portfolio. It captures the portfolio's average time to market or rate of pioneering.

$$I^{P}{}_{it} = \frac{N^{F}{}_{it}}{N_{it}}, \tag{2}$$

In addition, we add quadratic terms of these variables, which is consistent with the idea of balancing. These quadratic terms capture the rate of changes in the portfolio balance measures. Introduction and Pioneering Intensities are adjusted by industry average to control any bias associated with a specific time window.

Firm Performance

We include 3 firm performance measures (i.e., *Sales, Profit*, and *Return*). By considering both short-term performance (i.e., *Sales* and *Profit*) and long-term performance (i.e., *Return*), we can examine another dimension of portfolio balance -- balance across different time horizons.

To control the spurious correlations between firm size and the performance variables, we use the log of Sales and Profit. The Return is obtained after adjusting any changes in the number of stocks (e.g., stock split).

Control Variables

We control firm size (*Size*), market diversity (*NMarket*), and competition (*CProducts*). Firm size (*Size*) is measured by taking the log of the firm's total asset size. Firm size is a good proxy measure for a firm's previous performance and current resources, thus separating any size-related effect in the model. Market diversity is measured by the number of product-market segments. When there is a positive interaction among products (e.g., complementary cost/demand, economy of scope, etc.), diversification should be a better strategy. On the contrary, if there is a negative interaction among products (e.g., substitute cost/demand, cannibalization etc.), a concentration strategy should would work better. The market diversity variable allows us to determine the effect of product diversification strategy. We also measure a firm's average competitive environment by adding *CProducts* (average number of competing products), which are calculated within a product-market segment and then averaged across all product-market segments a firm is competing in.

In addition to these control variables, we add the lagged performance variable to further control any firm-specific persistent effects.

Empirical Model and Estimation Issues

To empirically investigate the effects of the strategic components of the product portfolio on the performance of firm *i* in year *t*, we construct the following fixed- and random-effect model:

$$\begin{aligned} Performance_{it} &= \alpha_{it} + \sum_k \beta_k PortfolioStrategy_{kit} + \sum_m \gamma_m Control_{mit} + \varepsilon_{it}, \\ \varepsilon_{it} &\sim N(0, \sigma_\varepsilon) \end{aligned} \tag{3}$$

In addition to the portfolio strategic components and control variables, we further control for any systematic changes over time and across industries by including fixed effects in each equation. The fixed effects capture average differences across the years of estimation and seven industries. We also include a random effects specification in each of the equations to account for possible heterogeneity across firms. After adding both fixed and random effects, the intercept is modeled as:

$$\alpha_{it} = \alpha + \sum_{t=2}^{14} \alpha_t Year_t + \sum_{k=2}^{7} \alpha_k Industry_k + \upsilon_i, \quad \upsilon_i \sim N(0, \sigma_\upsilon) \tag{4}$$

We conducted the analysis using standard empirical procedures for time-series cross-sectional data. Using a series of random-effect and fixed-effect multivariate regression, we estimate the effects of a set of product portfolio strategy measures (portfolio scope and intensities, i.e., balance) and control variables on a set of dependent variables (firm performance measures). To control firm-specific heterogeneity, the random effect component is estimated first. To control for year-specific heterogeneity, we added year dummies for each year.

Lastly, we added sub-industry dummies to control for segment-specific heterogeneity[3]. This combination of fixed-effects and random-effects corrections addresses violations of standard regression assumptions in cross-sectional time series data (e.g., Greene 2003). We estimate the model using a restricted MLE for variance components and GLS for fixed effect parameters (Bryk and Raudenbush 1992).

Estimation Results

Estimation results for the sales, profit, and return models are reported in Tables 3, 4, and 5, respectively. Overall our empirical estimation results indicate that our measures of product portfolio strategy and balance explain significant variance in firms' future business performance.

Sales Model

The estimating results for the sales equation are presented in Table 3. The estimated model fits the data well and all significant coefficients have the expected signs. In addition, the variance of the random effect is significant, implying that the average sales level is heterogeneous across firms.

First, we find that firm sales exhibit a state dependent persistence. That is, the lagged firm sales have significant positive effects on the current sales level. In addition, firm size (*Size*) is positively associated with sales, implying more firm-level resources lead to higher sales. However, after controlling for firm size, the number of product-market segments (*NMarket*) and the number of competing products (*CProducts*) are not significantly related with firm sales.

While the estimation results of control variables are very reasonable and reassuring, the effects of the product portfolio strategy are of central interest in our study. In the sales equation model 1, the number of new products in the portfolio (*NewProd*) is positively associated with sales. That is, firms offering a greater number of new product introductions tend to have higher sales volume. However, the number of products in the existing product portfolio (*OldProd*) does not have a significant effect on sales.

[3] For brevity, the estimates of fixed effects and intercept are not reported in the result tables.

Table 3 Estimation Result of Sales Model

	(log) Sales	
	Model 1	Model 2
<u>Portfolio Balance</u>		
Portfolio Scope		
OldProd	-0.077 (0.111)	
FirstOld		0.351 (0.162)**
LateOld		-0.017 (0.113)
NewProd	0.266 (0.115)**	
FirstNew		0.782 (0.174)***
LateNew		0.271 (0.115)**
Introduction Intensity	-0.808 (0.179)***	-0.831 (0.185)***
Introduction Intensity^2	0.352 (0.115)***	0.396 (0.118)***
Pioneering Intensity	-0.125 (0.117)	-0.581 (0.166)***
Pioneering Intensity^2	-0.043 (0.200)	0.345 (0.222)
<u>Control Variables</u>		
Lagged (log) Sales	0.064 (0.011)***	0.065 (0.011)***
Size	0.620 (0.020)***	0.616 (0.021)***
NMarket	0.001 (0.001)	0.001 (0.001)
CProducts	0.013 (0.008)	0.019 (0.008)**
Random Effects	$\Sigma_{(1,1)}$ = 0.784 (0.118)***	$\Sigma_{(1,1)}$ = 0.722 (0.109)***
Variance Component	σ^2 = 0.101 (0.005)***	σ^2 = 0.101 (0.005)***
Fit Statistics	-2 Res LL: 1167.8 AIC: 1171.8 BIC: 1177.6	-2 Res LL: 1157.9 AIC: 1161.9 BIC: 1167.7

* p<0.10; ** p<0.05; *** p<0.01.
Note: For brevity, intercept, year, and industry specific fixed effects estimates are dropped.

When we further decompose the product portfolio strategy, we find similar positive effects for the number of new products in the portfolio. In model 2, we find that *FirstOld* is positively associated with sales and only *LateOld* is not significant. That is, after controlling for portfolio size and balance, the first-entered existing product portfolio still increases current sales, but the positive effect of the late-entered product portfolio disappears. This implies the pioneering advantage persists over time in this industry. Also, among the decomposed portfolio strategy components, *FirstNew* has the strongest effect. We conjecture that this is because the creation of a new market segment is related to a new solution for on-going medical needs. Therefore, the new solution is immediately rewarded by consumers.

In model 2, the introduction intensity shows a convex relationship with firm sales -- the linear term is negative and the quadratic term is positive. That is, firms with more experience and proven products in the portfolio (i.e., fewer new products) enjoy higher sales. Thus, even though active introduction of new products has a positive effect on firm sales (i.e., *NewProd*), a product portfolio with entirely new products hurts firm sales. Also, even though the number of pioneering products (i.e., *FirstOld* and *FirstNew*) increases firm sales, firms with a higher pioneering intensity does not enjoy greater sales. These results suggest that the positive effects of new products and pioneering products depend on the balance relative to the existing product portfolio.

Profit Model

Generally, the portfolio balance measures have similar effects on cost of the product portfolio (see appendix). Thus, the effects on firm profits after controlling for costs of the product portfolio is of interest. The estimating results for the profit equation are presented in Table 4. The estimated model fits the data well and all significant coefficients have the expected signs. In addition, the variance of the random effect is significant, implying that the average profit level is heterogeneous across firms. In general, the estimation results for the profit equations are very similar to those of sales equation. This suggests that the effects of product portfolio persist even after controlling for cost.

Note that, with the decomposed product portfolio (Model 2 in Table 3), the number of competing products becomes significant in firm sales increases. This implies that the number of competing products is positively related with the overall market expansion and helps firm sales. However, the competitive pressure also increases the cost of the product portfolio (see appendix), leading to non-significant effect on profits (see Table 4).

Table 4 Estimation Result of Profit Model

	(log) Profit	
	Model 1	Model 2
Portfolio Balance		
Portfolio Scope		
OldProd	-0.013 (0.120)	
FirstOld		0.368 (0.176)**
LateOld		0.019 (0.122)
NewProd	0.189 (0.126)	
FirstNew		0.578 (0.191)***
LateNew		0.185 (0.126)
Introduction Intensity	-0.580 (0.201)***	-0.542 (0.209)***
Introduction Intensity^2	0.275 (0.126)**	0.283 (0.130)**
Pioneering Intensity	-0.053 (0.130)	-0.432 (0.181)**
Pioneering Intensity^2	-0.329 (0.225)	0.012 (0.251)
Control Variables		
Lagged (log) Profit	0.082 (0.012)***	0.080 (0.013)***
Size	0.711 (0.023)***	0.706 (0.023)***
NMarket	0.001 (0.001)	0.001 (0.001)
CProducts	0.004 (0.009)	0.011 (0.009)
Random Effects Variance Component	$\Sigma_{(1,1)}$ = 0.399 (0.071)*** σ^2 = 0.119 (0.006)***	$\Sigma_{(1,1)}$ = 0.383 (0.067)*** σ^2 = 0.119 (0.006)***
Fit Statistics	-2 Res LL: 1137.7 AIC: 1141.7 BIC: 1147.5	-2 Res LL: 1134.0 AIC: 1138.0 BIC: 1143.8

* p<0.10; ** p<0.05; *** p<0.01.
Note: For brevity, intercept, year, and industry specific fixed effects estimates are dropped.

Return Model

While the sales and profit models show the short-term relationships between product portfolio strategy and firm performance, the return model provides a long-term perspective, since the stock return is calculated from the discounted future cash flow. In the return model, to be consistent with the finance literature, we add two additional control variables: weighted market return and short-term firm performance[4].

The estimating results for the return equation are presented in Table 5. The estimated model fits the data well. Note that in the return model we add the log of firm profit to capture the effect of current performance on

[4] We examined both value-weighted and equally-weighted market returns, resulting in a similar set of results. To capture short-term performance, we also examined both profit and sales, leading to similar results.

the stock return, which is a long-term forward-looking measure. In this model, the variance of the random effect is not significant, implying that the average market-adjusted return is homogeneous across firms. As expected, firm profit has a positive effect on return. Consistent with the finance literature, firm size is negatively associated with the market-adjusted return. Also, the negative effect of the lagged return implies that a firm's stock return converges to market return over time, which is again consistent with finance literature.

Table 5 Estimation Result of Return Model

	Return	
	Model 1	Model 2
Market Return (weighted)	0.656 (0.122)***	0.682 (0.123)***
Portfolio Balance		
Portfolio Scope		
OldProd	-0.006 (0.135)	
FirstOld		-0.256 (0.181)
LateOld		-0.064 (0.143)
NewProd	0.141 (0.167)	
FirstNew		-0.066 (0.199)
LateNew		0.231 (0.176)
Introduction Intensity	0.011 (0.256)	-0.187 (0.273)
Introduction Intensity^2	-0.136 (0.208)	-0.077 (0.212)
Pioneering Intensity	0.223 (0.150)	0.410 (0.175)**
Pioneering Intensity^2	-0.405 (0.263)	-0.527 (0.270)**
Control Variables		
Lagged Return	-0.164 (0.034)***	-0.167 (0.034)***
Log(Profit)	0.158 (0.039)***	0.164 (0.039)***
Size	-0.162 (0.041)***	-0.161 (0.041)***
NMarket	-0.000 (0.001)	0.001 (0.001)
CProducts	0.012 (0.008)	0.003 (0.009)
Random Effects	$\Sigma_{(1,1)} = 0.0$ (0.0)	$\Sigma_{(1,1)} = 0.0$ (0.0)
Variance Component	$\sigma^2 = 0.400$ (0.020)***	$\sigma^2 = 0.399$ (0.020)***
Fit Statistics	-2 Res LL: 1596.8 AIC: 1598.8 BIC: 1601.5	-2 Res LL: 1596.8 AIC: 1598.8 BIC: 1601.6

* p<0.10; ** p<0.05; *** p<0.01.
Note: For brevity, intercept and industry specific fixed effects estimates are dropped. We report results from value-weighted market return. We examined both value-weighted and equally-weighted market returns, resulting in a similar set of results.

Contrary to the sales and profit models, the product portfolio strategy component variables are not significant any more. In fact, only pioneering intensity has a positive and concave effect (i.e., the linear term is positive and the quadratic term is negative). That is, the financial market only rewards a firm's overall capability to deliver new products first in the marketplace. This also suggests that portfolio size only has indirect effect on the market-adjusted return via firm's current profit (or sales). Thus, although the pioneering intensity does not have a positive immediate effect on firm's sales/profit, it has a long-term forward-looking effect on firm's performance by achieving a favorable position in the marketplace.

Conclusion, Implications and Future Research

Innovation is both the creator and destroyer of industries and corporations. Today, when competitiveness hinges on the ability to develop or adapt new technologies in products, services, and process, understanding the dynamics of industrial innovation and the related risks and rewards is essential for survival and success. Strategic leadership, investment, and creativity in product development must be aligned if firms are to build and sustain competitive success. To help these product portfolio decisions we empirically analyze the effects of the product portfolio and innovation on firms' financial performance.

Our key results are as follows. First, a longer product portfolio helps firm's financial performance. However, each component of portfolio serves different roles. Second, we have a persistent first-mover advantage. That is, first-entered new products yield not only an immediate effect but also lagged (or longer term) effects. So, we need to be first in the market, even though we might lose temporarily. Third, we need to balance between the amount of "old" products and "new" products to achieve a better level of portfolio freshness. Fourth, we need to balance between the amount of "first-entered" products and "late-entered" products to achieve a better distribution of effects across time. From a short-term perspective, an active introduction of pioneering product enhances firm performance (i.e., sales and profits), as long as the entire product portfolio maintains the balance by entering existing markets as a late mover. However, from a long-term forward-looking perspective, only pioneers receive rewards, after controlling a short-term performance.

This study has several key implications for practice. Our results will provide insight into the relative value and timing of return on investment in radical versus incremental innovation, alternative market entry strategies. By understanding the performance trade-offs of these different factors in the short- and long-term, we can develop better guidelines for optimizing portfolio and innovation strategies, and their dependence on both external and internal environmental conditions.

An advantage of conducting this study within an industry characterized by a technologically dynamic market in which new products play a critical role in continued industry growth is that the strengths and vulnerabilities of other prominent industries can easily be recognized by analogy. We believe our findings will be broadly generalizable to industries with similar characteristics; e.g., healthcare and life sciences in general, computer and telecommunications, electronics and chemicals.

For future research, in addition to the effects of product portfolio, we can further investigate the drivers/determinants of product portfolio. For example, technological capability, which is one of key drivers, can be measured using patent data. The patent data can provide indicators of the rate of technological change, firm-level innovation capability, and innovativeness. Also, we can supplement these objective datasets with qualitative data from industry trade association publications and expert opinions from managers. This will enable us to measure the degree of technical innovations and investigate asymmetric effects of innovation (i.e., radical vs. incremental innovation).

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