The Financial Rewards of New Product Introductions in the Personal Computer Industry

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Based on data from firms in the personal computer industry, we study the effect of new product introductions on three key drivers of firm value: profit rate, profit-rate persistence, and firm size as reflected in asset growth. Consistent with our theoretical development, we find that new product introductions influence profit rate and size; however, we find no effect on profit-rate persistence. Interestingly, we also find that the effect of new product introductions on profit rate stems from a reduction in selling and general administrative expenditure intensity rather than through an increase in gross operating return. Notably, firms decrease their advertising intensity in the wake of a new product introduction. Firm profitability in this industry apparently benefits from new product introductions because new products need less marketing support than older products.
(*New Product Introductions; Firm Value; Personal Computer Industry; Empirical Analysis*)

1. Introduction

Academics, practitioners, and consultants share the belief that new products are important to the long-term financial success of a firm. For example, based on results from an annual innovation poll by *Fortune* magazine, consultants at Arthur D. Little claim that innovative companies achieve the highest shareholder returns (Jonash and Sommerlatte 1999). Cooper (1998) states that new products are vital to the success and continued prosperity of the corporation. Drucker (1999) maintains that, in the era of "profound transition" that we are entering, only organizations with a systematic policy of innovation are likely to succeed.

These views are consistent with empirical event-study research that has found a positive association between new product announcements and stock return. For example, Chaney et al. (1991) find an average daily excess return of 0.25% for new product announcements one day before to one day after the announcement. Subsequent event studies looking at the stock market reaction to information associated with new product announcements reinforce this finding of a positive stock market reaction to new products (e.g., Koku et al. 1997).

How new products influence firm value, however, is less clear. While advantageous in isolating an impact on firm value, event studies are limited in their ability to explain *why* the effect occurs, i.e., event-study analysis does not address what mechanisms or underlying drivers are influenced by new products. Further, previous research studies provide few, and often contradictory, insights concerning how new products influence the underlying drivers of firm performance. Consequently, our understanding of the effects of new product introductions on the financial rewards of a firm is very much incomplete.

The argument that new product activity enhances firm value rests on the basic idea that new products

0025-1909/03/4902/0197$5.00
1526-5501 electronic ISSN

provide transitory advantages that allow firms to obtain private (as opposed to public) returns to innovation (e.g., Arrow 1962). In the absence of this effect, firms would have no incentive to undertake the risky investment required for new product development and market introduction. Innovating firms can take advantage of this transitory advantage via several mechanisms. First, new products incorporating advanced features and capabilities can lead to higher sales and firm growth. Second, firms may attempt to enhance their profits by targeting segments that yield high margins. Third, new products can allow a firm to lower its costs by targeting its current customers with "new and improved" products instead of having to incur the expenses related to finding new customers for its existing, older products. Fourth, new products may transform the firm's capabilities and allow profits to persist over a longer period of time.

These mechanisms suggest that the study of innovation effects (e.g., new product introductions) on firm value requires and provides interdisciplinary insights. Innovation is not an isolated activity of the firm. Rather, it is interrelated with the other business functions—in particular, marketing. These mechanisms also suggest that innovation can influence a number of different performance outcomes. As such, understanding the effect innovation has on business performance requires assessing its effect on different drivers of financial valuation.

Financial valuation models differ in their emphasis on different considerations, but typically share common assumptions that lead to similar implications with respect to key drivers of the stock market valuation of firms. Consistently, three key drivers of firm performance emerge from financial valuation models—profit rate (i.e., size-adjusted earnings), the persistence of profit rate (i.e., the length of time that a firm's advantage or disadvantage in the market place exists, which is commonly captured by the time-series properties of profit rate), and the size of the firm (i.e., assets). Profit rates are a primary component of all valuation models as a firm's profit rate has a direct effect on its market value. That is, all else being equal, the greater the firm's profit rate, the greater the firm's stock market value. The effect of profit rate on valuation, however, depends on other considerations. For example, the effect of profit rate on market value is accentuated for larger firms and firms that are growing. This effect is positive for firms with profit rates greater than the cost of capital, and negative for firms with profit rates less than the cost of capital (e.g., McTaggert et al. 1994). Profit-rate persistence has a similar interactive effect. Higher persistence results in long-term gains (losses) for firms with positive (negative) profit rate less cost of capital differentials (Kormendi and Lipe 1987, Levonian 1994).

We empirically examine the effect of new product introductions on these three key drivers of firm value. We further examine the relationship between new product introductions and the components of firm profitability (gross operating income, selling, general, and administrative (SG&A) expenditures, and components of SG&A). These analyses allow us to gain insights into how new products influence firm value. The context for our study is the personal computer (PC) industry, a technologically dynamic market in which new products have played a critical role in continued industry growth. Consistent with our theoretical development, we find that new product introductions in this industry influence profit-rate and firm size. We find no effect on profit-rate persistence. Our empirical results further indicate that the effect of new product introductions on profit rate stems from a reduction in SG&A expenditures, most notably advertising intensity, rather than through an increase in gross operating income.

2. New Product Introductions and Firm Financial Performance

To gain insight into the underlying mechanisms that link new product introductions to changes in firm value, in this section we consider how new product activity (i.e., the number of new products a firm introduces in a year) might influence the key financial drivers of firm value (i.e., profit rate, profit-rate persistence, and size).

2.1. Firm Profits

In line with conventional wisdom, we hypothesize that:

Hypothesis 1. *Firm profit rate is positively related to its new product activity.*

Empirically, the work of Geroski et al. (1993) is perhaps most directly related to this hypothesis. In a study of product, process, and material innovations introduced by manufacturers in the United Kingdom from 1945–1983, they find a significant (but what they label as "modest") positive effect of innovation on profit margins. A concern, however, which the authors note, is that commercial success is one of the criteria used to select innovations for their study; i.e., their data contain only successful innovations. Because sample bias is present in their study, the reported results may overstate the true effects of new products on profit rate.

Support for this hypothesis might also come from previous research examining the effect of variables such as R&D expenditures and patent activity that are expected to be correlated with new product introductions. But here we find weak or conflicting evidence. While a number of studies have reported surprisingly large estimated effects of R&D (e.g., Pakes 1985), others question its size, and report effects consistent with normal returns (e.g., Erickson and Jacobson 1992). And, even though patent statistics are thought to be closely related to innovation, studies consistently find that patent counts are not associated with financial performance (e.g., Griliches et al. 1991).

Although the hypothesis of a positive association between profit rates and new product introductions is widely presumed, the lack of any strong and direct empirical support in the published literature raises important questions. For example, the costs associated with new product introductions may outweigh any increase in sales revenues. Consistent with this idea, Bayus and Putsis (1999) find that personal computer firms with longer product lines have higher costs as well as higher market share. Indeed, their results indicate that the cost increases associated with a broader product line and new product introductions dominate any potential demand increases in this industry. Consequently, to understand more fully the relationship of new product introductions and firm profitability, a closer examination of the components of firm profitability is warranted.

While much of the discussion associated with the effect of new product introductions on profit rates focuses on gross operating return (i.e., [revenue minus cost of goods sold]/assets), other components of profit also might be influenced. New product introductions do not occur in isolation, but rather interact with other activities of the firm, in particular, marketing. As such, the effect of new product introductions on profits will depend on interrelationships with these other activities whose costs are part of SG&A expenditures.

One possibility is that SG&A expenditures will increase because the new product requires additional support (e.g., increased advertising) or development efforts (e.g., increased R&D). Indeed, the marketing literature highlights new product introductions as an action requiring increased advertising. Bly (1993, p. 125), for example, notes that "introducing many new products to the market dramatically increases your advertising expenditures. In fact, the new product innovator will spend more than twice as much on advertising and promotion as a business with fewer new products." Thus, the prevailing view is that it is necessary to invest heavily in advertising during the initial stages of a product introduction and that this front-end commitment tends to dissipate initial stage profits.

While less widely articulated, a competing view about the interrelationship between new products and SG&A activity also exists. Under this view, new products may be less costly to market than existing products. Thus, it is products that lag behind the technology frontier or that fail to offer an obvious reason for purchase that require more intensive demand-creating marketing activities. Angell (2000), in the context of pharmaceuticals, takes an even more extreme position. She contends that "the less important the drug, the more marketing it takes to sell it. Important new drugs do not need much promotion. Me-too drugs do" (p. 1903). Further, the new product can be targeted to current customers, instead of having to find new customers for the existing products. In this case, more efficient use could be made of advertising and selling resources; e.g., less advertising and personal selling resources may be needed to reach target sales levels for new products.

Only by empirically studying the effect of new product introductions on the components of profit rate can we gain insights into these possible phenomena. To our knowledge, these issues have not been explored in the published literature.

2.2. The Persistence of Firm Profits

Our working hypothesis concerning the persistence of firm profit rate is

Hypothesis 2. *The persistence of firm profit rate is positively related to its new product activity.*

Geroski et al. (1993) note that there are two schools of thought regarding how an innovation can contribute to a firm's superior performance. An innovation contributes either by being the "product of the innovation process" that temporarily enhances a firm's market position, or by the "process of innovation" that allows profit to persist because it transforms the firm's internal capabilities. Both mechanisms are consistent with this hypothesis. The profitability of an innovating firm may exhibit greater persistence because the firm does not introduce just one new product but continues to introduce new products over time and, as such, reduces imitation by competitors. Further, to the extent that innovation transforms a firm's capabilities, this creates an asset that competitors may find difficult to imitate.

However, past research has rarely investigated, and thus has yet to produce consistent results regarding, the possible effects of new product introductions on the persistence of firm profit rates. Roberts (1999) investigates the issue, but reports findings that we are cautious to build upon. His study looks at the effect of the relative proportion, which is assumed to be fixed across time, of sales derived from innovative products on the persistence of profits for firms in the pharmaceutical industry. He finds that this innovation measure is positive and significantly related to profit persistence for firms with previous period's profits below the mean, but is insignificant for firms with previous period's profits above the mean. These results are somewhat surprising in that they imply that innovative activity lengthens the time period for negative returns, but not for positive returns. Some methodological concerns—firm innovativeness is modeled as time invariant and the role of other potential firm-specific effects are not captured in the model—suggest that the issue be more closely examined.

2.3. Firm Size

Consistent with the widespread viewpoint, we hypothesize that:

Hypothesis 3. *Growth of firm size, as reflected in asset growth, is positively related to its new product activity.*

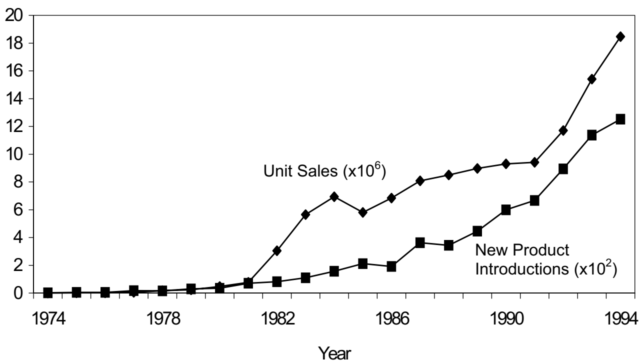
This hypothesis is consistent with Sutton's (1998) theory of endogenous sunk costs (e.g., R&D expenditures and the resulting new product introductions), in that a firm can grow in size as it reinvests its profits into the development of future new products. Further, even though new product introductions may lead to a competitive advantage, this may not directly show up as a higher profit rate for the firm. The firm may plow back its profits into expenditures anticipated to influence longer-term profits or make use of its advantage by increasing market share. In agreement with this, Bayus and Putsis (1999) find that market share is positively related to firm product line length in the PC industry. While we strongly expect new product introductions to be positively associated with firm growth, we are unaware of past research documenting this result.

3. The Personal Computer Industry

The empirical setting for our study is the PC industry. A PC can be defined as a general purpose, single-user machine that is microprocessor based and can be programmed in a high-level language. The historical reviews by Langlois (1992) and Steffens (1994) suggest that the PC industry is a rich and dynamic setting in which to study how new product introductions influence firm value. Many, but not all, firms were active in introducing new products, and products based on old and new technology were in the market contemporaneously throughout this period. Frequent new product introductions, ease of firm entry and exit, and the inability by any single firm to establish a long-term competitive advantage are prominent features of this industry.

As shown in Figure 1, the PC industry has witnessed rapid growth since its inception in 1974. PC

Figure 1 The U.S. Personal Computer Industry, 1974–1994



Source. IDC Processor Installation Census.

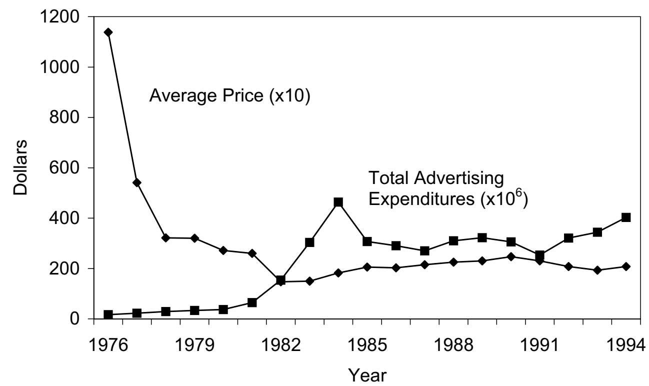
unit sales grew from under 500,000 units in 1980 to over 18 million units in 1994. Both hardware and software technology has improved substantially over this period. For example, the microprocessors[1] used in the first-generation personal computers (e.g., Intel's 8080 and Zilog's Z80) have been continuously superseded by later technology generations (e.g., Intel's 80286, 80386, 80486, Pentium). Each new microprocessor is associated with increased processing speed, enabling the development and use of more sophisticated operating systems, graphics, and application packages. Not surprisingly, the proliferation of advanced technology has encouraged frequent new product introductions in this industry (see Figure 1).

While it is apparent that technology advances and new product introductions continue to be a driving force in the PC industry, firm success is also heavily dependent on its marketing activities (e.g., Steffens 1994). As shown in Figure 2, prices dramatically declined over the first eight years in this industry due to the continuous downward cost trajectory of critical components such as memory chips and hard disk drives (e.g., Curry and Kenney 1999). More recently, average prices have been relatively stable as products have been enhanced with greater technological sophistication. As distribution channels and served-customer segments expanded over time, firm marketing activities included the development and implementation of integrated and coordinated marketing campaigns as well as corporate image programs (Steffens 1994). Figure 2 shows that the advertising expenditures for computers increased during the early 1980s and were relatively stable through the 1990s.[2] Steffens (1994) appropriately sums up the marketing situation for firms in this industry:

> For whilst it is accepted that "brand name" in some market sectors that are heavily price dependent will count for little, it still remains true to say that in historical terms, as the market for personal computers continues to segment across an increasingly complex range of customer groups, it is important for competitors and entrants to recognize that having a "brand name" in general purpose computers or indeed even in general purpose personal computers, will not be sufficient to guarantee an effective brand presence in another market segment. (p. 257)

Thus, it is evident that firms undertake substantial investments in advertising in this industry.

Figure 2 Marketing Activities in the U.S. Personal Computer Industry



Source. Average price is from the IDC Processor Installation Census; Total advertising expenditures are from Leading National Advertising Ad$ Summary reports for B311: Computers & data processing equipment.

[1] As discussed in Steffens (1994), the most parsimonious way to describe the technology generations of personal computers is to compare their microprocessors or CPUs (central processing unit). The CPU is the brain of the computer because it contains the arithmetic and logic component, as well as the core memory and control unit for the computer. Thus, CPU design determines the computer's overall power and performance.

[2] Although these advertising expenditure data are for all computers and data-processing equipment, we note that the top three computer advertisers in 1981 sold PCs, the top seven computer advertisers in 1982 sold PCs, and for 1983 forward, the top ten computer advertisers sold PCs. As such, advertising expenditures for PCs mirror this same pattern as that presented in Figure 2.

4. Data

One of the main barriers to research on this topic is the availability of appropriate, objective data on new product introductions *and* matching information on financial performance at the firm level. Fortunately, suitable data for the PC industry can be obtained by merging information from two sources. Details on product introductions by PC manufacturers come from International Data Corporation's (IDC) *Processor Installation Census*. Financial data, including information on assets, income, sales, cost of goods sold, advertising, R&D, and other SG&A expenses, are obtained from Standard and Poor's COMPUSTAT annual data files.

The IDC *Processor Installation Census* database provides a listing of all new PC products introduced between 1974 and 1994. IDC is the oldest among the various firms that track the American computer industry and is widely respected as having a very accurate picture of activity in this industry. The IDC data include details about the manufacturer name, brand name, CPU, and introduction date for each PC product introduced.[3] Following prior research with these data (e.g., Bayus and Putsis 1999), we consider a new product to be any new, unique brand-CPU combination because manufacturers generally incur significant expenses associated with the production and launch of each brand model (e.g., Apple Computer's Lisa and Macintosh are each considered to be a new product although they use the same Motorola 68000 CPU).[4]

The COMPUSTAT database provides financial data for publicly traded firms on the New York, American, and NASDAQ stock exchanges. We make use of both the industrial and industrial research files to capture not only firms that survived through the end of the data period, but also those that did not survive. Merging the IDC data with COMPUSTAT data restricts the PC firms that can be studied. For instance, our sample includes only publicly traded companies. Further, we only include firms for which their primary business is the manufacture of PCs. Thus, for example, IBM is not considered in our analysis as the financial data reported by COMPUSTAT aggregate across its substantial non-PC businesses. Our matching process yields a panel of 16 firms who were in the PC market for all or some of the period 1974 to 1994, generating a total of 141 pooled cross-section time-series observations. In the data, there is a broad range of years of data available per firm; 13 firms have over 5 years of data, with 6 of these having over 10 years of data.

Because our analysis is restricted to publicly traded firms and only those that do not have substantial activity in markets other than PCs, our sample of firms (and thus our results) may not be representative of the population of all companies in the PC industry. Also, because the number of firms in the sample is relatively small, 16, the influence of the practices of individual firms may be influential. Nonetheless, firms included in our analysis are important in their own right, e.g., the 16 firms in our sample account for almost one-third of PC industry sales in every year during our data period. Further, our sample includes large firms (e.g., Apple, Compaq, Dell, Gateway) as well as smaller firms, early market entrants (3 firms in 1977, 1 in 1978) as well as later entrants (2 in 1987, 1 in 1988), and survivors as well as nonsurvivors (7 of the 16 firms in the sample disappeared from the market by the end of the data period). Altogether, there are 1,070 new product introductions represented in the data, with a per-firm range of 2 to 136 new products. Finally, we note that the pattern of sales and new product introductions for these 16 firms parallels the industry patterns in Figure 1.

5. Empirical Analysis

To empirically estimate the effect of new product introductions on the business performance of firm *i*

[3] This level of detail is only available through 1994 because IDC changed its data collection procedure to a more aggregate format in 1995. Also, products with CPUs that could not be identified due to proprietary technology are excluded from our analysis.

[4] As part of our empirical analysis to be discussed in the next section, we also considered other "new product" definitions. These included new product technologies (the first introduction of a PC based on a new microprocessor generation, e.g., 8-bit, 16-bit, 32-bit, 64-bit) and new product models (the first introduction of a product based on a unique CPU, e.g., Intel's 80286, 80386DX, etc.). Because the variables based on these various definitions are highly correlated, our estimation results are very similar for all of these measures.

in year t (Perf_{it}), we begin with a base model of the form

$$\text{Perf}_{it} = \alpha_i + \beta_1 \text{Intro}_{it} + \beta_2 \text{Intro}_{it-1} + \phi \text{Perf}_{it-1} + \sum_{t=1}^{T} \delta_t \text{Time}_t + \varepsilon_{it}. \quad (1)$$

Perf_{it} is the performance of firm i in period t, Intro_{it} is the number of new product introductions for firm i in period t, and Time_t, $t = 1, \ldots, T$, are annual dummy variables where each variable takes on the value 1 if year $= t$, 0 otherwise. We make use of two measures of performance, i.e., return on assets (ROA) and asset growth, as dependent measures.[5] The coefficients β_1 and β_2 depict the effect that product introductions have on performance. The coefficient ϕ captures the autoregressive pattern of performance and, as such, its persistence.

In addition to including variables reflecting the effects of current and lagged new product introductions (Intro_{it}, Intro_{it-1}), Equation (1) allows for unobserved, time-invariant firm-specific effects via the intercept α_i.[6] Dynamic firm effects are modeled by including lagged performance Perf_{it-1} in the model. By including annual dummy variables in the model, we control for yearly factors that affect all firms in the sample, which includes macroeconomic conditions and industrywide influences. These dummy variables remove unrelated variation, allowing us to better isolate the effects of new product introductions and the potential for spurious correlation that would be generated by any possible time-based common associations among the variables, e.g., industry life-cycle effects. Because we include both current-term and lagged new product introductions in the model, this specification allows for serial correlation (current-effects) as well as a state-dependent (persisting) dynamic relationship. As such, this model allows for a wide range of possible effects and influences.

Because of the firm-specific fixed effects α_i in (1), empirical estimation requires taking first differences of the data, which removes the firm-specific intercept. This, in turn, necessitates the use of instrumental variable estimation to obtain a consistent estimate of the persistence parameter ϕ, because differencing induces correlation of Perf_{it-1} with the error term of the differenced model. Following Anderson and Hsiao (1982), we use lagged values of firm performance at time period $t-2$ as instruments.

5.1. Profit Rate

Model 1.1 in Table 1 presents the results of estimating Equation (1) with ROA as the dependent measure. We find positive effects for new product introductions. The estimated effects for current and lagged

Table 1 The Effect of Product Introductions on Drivers of Business Performance

	Model 1.1 Return on assets	Model 1.2 Return on assets	Model 1.3 Asset growth
New product introductions$_t$	0.85 (3.95)	0.78 (3.33)	0.63 (2.46)
New product introductions$_{t-1}$	1.14 (5.85)	1.29 (4.83)	1.21 (4.97)
Dependent variable$_{t-1}$	0.06 (0.36)	0.25 (0.90)	0.22 (2.35)
Dependent variable$_{t-1}$* New product introductions$_t$	—	−0.46 (−0.84)	—
N*	109	109	109
F-statistic, P-value	[2.67, 0.0009]	[2.57, 0.001]	[2.65, 0.0009]

Note. Each model also includes annual dummy variables not reported here (t-statistic in parentheses).

Definitions. Return on assets: Operating $\text{income}_t/\text{assets}_t$. Asset growth: $\log(\text{assets}_t)-\log(\text{assets}_{t-1})$. New product introductions: number of brand models $\text{introduced}_t/\text{assets}_t$.

*The number of observations available for analysis is less than the total number of observations in the data sample because of the use of first differences and the presence of a lagged explanatory factor, i.e.; we "lose" two years of data for each firm in our sample.

[5] We use ROA and asset growth (as opposed to, in particular, ROE and equity growth) in that we wish to focus on operating returns, which depend on the total resources (i.e., assets) that the firm has deployed.

[6] This is only necessary when ROA is the dependent measure. For the asset growth relationship, parameter estimates from the model allowing for fixed effects and those from the model constraining α_i to be the same across firms are in very close correspondence. As a Hausman (1978) specification test cannot reject the null hypothesis of no firm-specific differences in growth rates, we make use of the more efficient estimator constraining the intercept for asset growth to be constant across firms.

new product introductions are 0.85 and 1.14, respectively, and each is significant at the 1% level. We also tested for longer-term effects, but found no evidence of an effect lasting beyond one year. For example, the estimated effect of new product introductions lagged two years was 0.16 with a *t*-statistic of 0.73. This limited duration of effect is consistent with the dynamic and highly competitive nature of the PC industry. In industries where isolating mechanisms and barriers to imitation are more substantial, e.g., in pharmaceuticals where patent protection plays a key role, we would expect new product introductions to have longer-term effects.

As a sensitivity check, we also explored the role of new product introductions on an ROA measure based on net income as opposed to operating income. Our conclusions are the same in that we find a highly significant association between the net-income-based ROA measure and both current and lagged new product introductions. Analyses based on ROE (return on stockholders equity) also generate similar conclusions.

A possibility is that new product introductions are not exogenous, but rather are influenced by current-term firm profitability. Further, both new product introductions and firm profit may be jointly influenced by a contemporaneous shock. These two possibilities would generate biased coefficient estimates in our analysis. To assess these cases, we constructed an instrumental variable estimate for the change in new product introductions (based on values of the series lagged two periods, which gave rise to a first-stage R^2 of 0.28) and undertook a Hausman (1978) specification test. This test assesses whether the estimated parameter generated from instrumental variable estimation is significantly different from the least squares estimate. We obtain a test statistic of 0.19, compared to a $\chi^2(1)$ 5% critical value of 3.84. Thus, we cannot reject the null hypothesis that product introductions are *not* influenced by current-term profits.[7] In other words, we find no evidence to suggest the presence of simultaneous feedback.

This absence of simultaneity is consistent with the advanced time commitment necessary for product introductions; i.e., they are planned well in advance. We do, however, observe an effect of lagged profits on introductions. Profits lagged one year are negatively correlated with a product introduction. This negative association is consistent with firms not wishing to cannibalize successful existing products, but instead bringing in new products when the profit-generating capabilities of their existing products has been diminished. As this feedback effect is nonsimultaneous, the model is recursive. Thus, unbiased estimates of the effect of product introductions on firm profit rate can be obtained without incorporating instrumental variable estimates for new product introductions.

5.2. Profit-Rate Persistence

Profits in this market appear to display little, if any, persistence. The estimated autoregressive coefficient in Model 1.1 (0.06) is both small in magnitude and statistically insignificant.[8] This estimated effect is below what we, and others, observe for ROA persistence across the spectrum of publicly traded firms (i.e., around 0.6). However, this finding is consistent with the PC industry being very dynamic with ease of competitor entry and exit. Low persistence is not unique to a few firms in our sample, but rather a common characteristic across the firms. PC manufacturers had their profit rates buffeted throughout the period. This lack of persistence serves to highlight some of the unique characteristics of the PC marketplace. Firms in the industry have been unable to erect isolating mechanisms and barriers to imitation that restrict the dissipation of abnormal returns. As a point of comparison,

[7] See, for example, Hausman (1978) and Maddala (2001) for discussions of the Hausman test and its properties. We also tested for possible effects of growth on product introductions. We found no evidence of either a contemporaneous or lagged effect of firm growth on product introductions.

[8] The first stage R^2 in obtaining the instrumental variable estimate for ΔROA_{it-1} is 0.4. This is well above the value where issues pertaining to instrumental variable estimation in the presence of "weak instruments" come into play, i.e., where R^2 is less than the inverse of the sample size (Bound et al. 1995). As such, the finite-sample bias associated with the instrumental variable estimator will be minimal. Further support for the use of the Anderson-Hsiao estimation procedure is provided by Arrellano (1989), who notes that the method can be expected to produce "well determined estimates" of the autoregressive parameter.

consider that the persistence for firms in the pharmaceutical industry averages around 0.75. Advantage is short-lived for PC firms.

A possible reason for a lack of profit persistence may stem from the role of new product introductions. In particular, the persistence parameter may not be a constant, but instead it may vary depending on new product introductions. To allow for this possibility, we expand Equation (1) to allow the autoregressive coefficient to vary systematically depending on firm product introductions, i.e., $\phi = \phi_0 + \phi_1$ Intro$_{it}$. Model 1.2 in Table 1 presents the estimation results with this interaction term. We see no evidence that persistence does in fact depend on new product introductions. The estimated effects for persistence (0.25) and the interaction term (−0.46) are individually, and jointly, statistically insignificant.

5.3. Asset Growth

As we discussed previously, a firm's market value increases not just with increases in its profitability, but also (as long as it has a positive profitability to cost of capital spread) with increases in size. As such, another way that new product introductions can affect firm value is through an impact on size.[9] Here, too, we see positive effects of new product introductions. As reported in Model 1.3, the estimated effects for both current (0.63) and lagged new product introductions (1.21) are positive and statistically significant. The fact that asset growth exhibits positive persistence (0.22) suggests that the effects of product introduction on growth will persist a bit beyond one year, and decay fairly rapidly beyond this point. As a sensitivity check, we also explored the relationship between new product introductions and another size measure, sales growth. This analysis provided results consistent with those observed in Model 1.3. We find that both current and lagged new product introductions are positively associated with sales growth, with the lagged effect being of greater magnitude.

5.4. The Effect of New Product Introductions on the Components of ROA

The results reported in Table 1 show that new product introductions influence business performance through two of the three drivers of business performance we considered. That is, new product introductions influence profit rate and asset growth, but do not influence profit rate persistence. Having found that new product introductions influence profit rate, we now turn our attention to empirically isolating the source(s) of this association. That is, we empirically assess why the observed associations found in Model 1.1 exist. We do so by splitting operating income, the numerator in the ROA measure, into separate components and assessing which components are or are not influenced by new product introductions. We first separate operating income into two fundamental elements, operating income gross of SG&A ("gross operating income," simply sales less cost of good sold) and SG&A expenses, and report the empirical results for this separation in Table 2. We then further decompose SG&A into some of its primary components, in particular, we separate out advertising expenditures and R&D expenditures from SG&A expenditures, and report the results in Table 3.

As shown in Tables 2 and 3, we use two different kinds of analyses to expand our understanding of the phenomenon. One form of analysis considers the effects of new product introductions on operating income component *intensities* (operating income component/assets). The second form of analysis estimates the effects of new product introductions on *growth rates* of the operating income components. The two separate analyses provide an enhanced picture of how the introduction of new products influences profit rate.

Gross Operating Income. Interestingly, we see no evidence from the estimation of Model 2.1 in Table 2 that new product introductions have a positive effect on gross operating return, i.e., gross operating income/assets. Both current and lagged new product introductions are estimated to have

[9] It would be interesting to assess which asset components are most affected by new product introductions. We are, however, limited in our ability to undertake this type of analysis as missing values are reported in the Compustat database for a number of asset components for a number of firms and years. Nonetheless, and not unexpectedly, we find strong evidence that firms are increasing their inventories in the wake of an introduction, and this is one source of asset growth.

Table 2 The Effects of New Product Introductions on Income Components

	Model 2.1 Gross operating return	Model 2.2 Gross operating income growth	Model 2.3 SG&A intensity	Model 2.4 SG&A growth
New product introductions$_t$	−0.04 (−0.26)	0.21 (0.57)	−0.85 (−4.37)	−0.33 (−1.74)
New product introductions$_{t-1}$	−0.14 (−1.13)	0.49 (1.44)	−1.29 (−7.15)	−0.25 (−1.39)
Dependent variable$_{t-1}$	0.53 (2.18)	0.12 (1.13)	−0.20 (−1.42)	0.02 (1.60)
N	109	105*	109	109
F-statistic, *P*-value	[1.65, 0.059]	[2.14, 0.00]	[3.65, 0.0001]	[2.73, 0.0007]

Note. Each model also includes annual dummy variables not reported here (*t*-statistic in parentheses).
Definitions. Gross operating return: (Sales$_t$–Cost of good sold$_t$)/assets$_t$. SG&A intensity: Selling, general, and administrative expenditures$_t$/assets$_t$. Gross operating income growth: log(sales$_t$–cost of good sold$_t$)–log(sales$_{t-1}$–cost of good sold$_{t-1}$). SG&A growth: log(selling, general, and administrative expenditures$_t$)–log(selling, general, and edministrative expense$_{t-1}$).
*The number of observations in the gross operating income equation differs from the gross operating return equation because of the presence of negative gross operating income, which generates missing data once logarithms are taken.

small (−0.04 and −0.14, respectively) and statistically insignificant effects on gross operating return. Model 2.2 shows that new product introductions exhibit some positive (albeit statistically insignificant) association with growth in gross operating income. However, while new product introductions may influence the numerator in the gross operating return measure, they also influence asset growth, and, as such, the denominator in the measure; see Model 1.3 in Table 1. The net result is that there is no significant impact of new product introductions by the firms in our sample on gross operating return.

Table 3 Effects of New Product Introductions on SG&A Components

	Model 3.1 "Other" SG&A intensity	Model 3.2 "Other" SG&A growth	Model 3.3 R&D intensity	Model 3.4 R&D growth	Model 3.5 Advertising intensity	Model 3.6 Advertising growth
New product introductions$_t$	−1.29 (−6.28)	−1.89 (−5.65)	0.04 (0.91)	0.54 (1.44)	−0.09 (−2.35)	−2.84 (−3.95)
New product introductions$_{t-1}$	−0.66 (−4.24)	−0.73 (−2.65)	−0.32 (−5.61)	−0.30 (−0.83)	−0.10 (−3.34)	−0.04 (−0.07)
Dependent variable$_{t-1}$	0.13 (0.71)	0.43 (4.52)	0.69 (3.68)	0.06 (0.43)	0.21 (0.77)	0.05 (0.40)
N	98	98	106	106	98	98
F-statistic, *P*-value	[4.09, 0.0001]	[4.83, 0.0001]	[4.20, 0.0001]	[1.22, 0.259]	[2.64, 0.001]	[3.26, 0.0001]

Note. Each model also includes annual dummy variables not reported here (*t*-statistic in parentheses).
Definitions. "Other" SG&A intensity: (Selling, general, and administrative expenditures$_t$–research and development expenditures$_t$–advertising expenditures$_t$)/assets$_t$. R&D intensity: Research and development expenditures$_t$/assets$_t$. Advertising intensity: Advertising expenditures$_t$/assets$_t$. "Other" SG&A growth: log(gross SG&A expenditures$_t$)– log(gross SG&A expenditures$_{t-1}$). R&D expenditure growth: log(research and development expenditures$_t$)–log(research and development expenditures$_{t-1}$). Advertising expenditure growth: log(advertising expenditures$_t$)–log(advertising expenditures$_{t-1}$).

SG&A. Combined with the results for gross operating return, Models 2.3 and 2.4 show that the positive effect of new product introductions on profit rate arises through an impact on SG&A. Model 2.3 shows that current and lagged new product introductions are associated with decreases in SG&A intensity (−0.85 and −1.29, respectively). While its role is often overlooked or excluded from analysis, SG&A plays an important part in firm profitability, as the median SG&A intensity for our data is 0.4, compared to median gross operating return of 0.5. Model 2.4 shows that some of this decrease in SG&A intensity might be coming from firms cutting back on SG&A growth in the wake of product introduction; SG&A expenditure growth is negatively related, although the coefficients are not significant, to both current and lagged new product introductions. Any cutbacks in SG&A growth would have an accentuated effect on SG&A intensity, as product introductions also generate an increase in asset growth (Model 2.3). While these results cannot pinpoint the effect on SG&A growth, clearly SG&A is not growing as rapidly as assets when a product introduction occurs (and, indeed, may even be declining), so SG&A intensity and product introductions will be negatively correlated.

As shown in Table 3, we can gain some insight into the underlying sources of the SG&A association with new product introductions by separately analyzing some of the components of SG&A. In particular, we separate SG&A into R&D expenditures, advertising expenditures, and "Other" SG&A expenditures (i.e., SG&A expenditures other than R&D and advertising). Analysis of the advertising measure, which includes the cost of both media advertising and promotional expenditures, while not inclusive of all marketing expenditures, can be expected to provide fundamental insights into the interactions taking place between new product introductions and marketing activities.

Other SG&A Expenditures. We see from Model 3.1 a strong negative relationship between Other SG&A expenditure intensity (SG&A expenditures other than advertising and R&D) and both current (−1.29) and lagged new product introductions (−0.66). The reason for this negative relationship is that not only is a firm's asset base growing with new product introductions, but firms are also decreasing the growth in their other SG&A expenditures, as is shown by Model 3.2. This decrease is most dramatic at the time of the introduction (−1.89), but continues into the subsequent year as well (−0.73).

R&D. One reason that the effect of new product introductions is more substantial for Other SG&A than for SG&A is that firms are not cutting back on R&D expenditure growth in the wake of a new production introduction. That is, we see from Model 3.4 that the estimated effects for both current and lagged new product introductions on R&D growth (0.54 and −0.30, respectively) are statistically insignificant.

We see from Model 3.3 that while current R&D intensity is unrelated to new product introductions—the estimated effect is 0.04 and statistically insignificant—R&D intensity is negatively associated with lagged introductions—the estimated effect is −0.32 and highly significant. While Model 3.4 perhaps suggests that firms increase contemporaneous R&D expenditure growth with new product introductions (i.e., the estimated effect of 0.54 has a t-statistic of 1.44), its effect on R&D intensity is counterbalanced by the positive contemporaneous effect on asset growth. These offsetting influences explain the absence of a contemporaneous association between R&D intensity and new product introductions. The absence of an effect (or perhaps even a negative effect) of lagged new product introductions on R&D growth reported in Model 3.4, combined with the positive lagged effect of new product introductions on asset growth, accounts for the significant negative association between R&D intensity and lagged new product introductions.

Advertising. Counter to the conventional wisdom that new product introductions require an increase in advertising, Model 3.5 shows that both current and lagged new product introductions have statistically significant negative effects on advertising intensity, −0.09 and −0.1, respectively. Indeed, Model 3.6 shows that new product introductions have a negative contemporaneous association with advertising expenditure growth. As such, contemporaneous to a product introduction, PC firms tend to both cut back advertising growth and increase in size. This accounts for the significant negative contemporaneous association between advertising intensity and new product introductions reported in Model 3.5. We see no association between lagged product introductions and advertising growth (i.e., the coefficient −0.04 in Model 3.6 is small and insignificant), but asset growth is positively correlated with lagged new product introductions. This increase in size, therefore, seems to account for the negative lagged effect of new product introductions on advertising intensity.

6. Discussion

Our results indicate that new product introductions in the PC industry influence two of the three core drivers of firm value, profit rate, and firm size (as reflected in asset growth), but not profit-rate persistence. As such, our analyses support Hypotheses 1 and 3, but not Hypothesis 2.

The lack of an effect of new product introductions on profit persistence is not so surprising in the context of the industry we study. Sustaining above-normal profits from any source would be difficult to achieve in an industry like the PC industry, in which frequent technological advances and disruptive new product introductions by competitors are the norm. We find that profits from new products are reinvested into building up the firm's asset base. As long as the firm has a positive profit rate to cost of capital spread, this growth induced by new product introductions will increase market value. Market value is additionally enhanced as new product introductions increase profit rates for a two-year period. Particularly in industries with low rates of profitability, activities that enhance return are of fundamental importance in influencing firm value.

Our empirical finding that the introduction of new products enhances firm profitability by increasing firm size and profit rates is important because of the lack of solid evidence elsewhere in the literature. At the same time, these results are not all that surprising. What is surprising, however, is what our results say about the manner by which new product introductions increase firm profit rates. Our analysis shows that new product introduction activity enhances profitability through reduced SG&A expenditure intensity, and not through gross operating return.

New products introduced into the PC market increase sales, but also come at an increased cost. These effects appear to "cancel out" so that operating profit margin remains about the same. However, our results show that new products in this industry have lower selling expenses than the older, more established products. The decrease in SG&A intensity induced by new product introductions indicates, for example, that firms do not have to spend as much on advertising and other marketing activities to sell new products as opposed to older products.

A number of factors can account for this reduction in advertising intensity in the presence of a new product introduction. Certainly, new product introductions are commonly viewed as "news" and receive "free" media attention (e.g., important new pharmaceuticals often receive more press attention; Angell 2000). This attention from alternative sources lessens the need for paid promotional activities by a firm. Further, rather than incurring the additional expenses associated with selling its older products to new customers, a firm has lower SG&A expenses by selling new products to its current customers. Consistent with Grossman and Shapiro (1984), advertising in the PC industry may be informative rather than persuasive, suggesting that firms targeting current customers with new generations of an existing product will have less advertising expenditure than firms attempting to expand their customer bases.

A possible alternative explanation for our findings is that a reduction in advertising is justified by generally increasing brand reputation and stature over time. This, however, does not appear to be the case. When we include a firm longevity variable (i.e., the number of years the firm has been in the PC industry at the time of the introduction) in our advertising equations, its effect is small and insignificant (−0.0005, with a t-statistic of −0.37). Further, the estimated effects of product introductions are indistinguishable from those reported in Table 3.

Another possibility is that our findings result from a commoditization of PC products. That is, due to the inherent characteristics of this industry—i.e., short product life cycles, a rapid pace of technological change, and increasing competitive pressure due to reduced margins—the way PC companies maintain profits is to cut advertising but not R&D. While all such industrywide trends would be captured by the annual dummy variables in our models and thus not affect the estimated coefficients for product introductions, it is also the case that the data do not support a commoditization hypothesis. Under this view, we would expect to see declining advertising intensity, but not R&D intensity, over time. Our data, however, show just the opposite: Mean advertising intensity does not decline over time (which is consistent with the overall industry pattern in Figure 2), while mean R&D intensity shows a systematic decline.[10] The effects of product introductions on advertising reported in Models 3.5 and 3.6 stem not from a general industry trend, but rather are tied to firm-specific product introductions.

Some characteristics of the PC industry help to explain why this phenomenon is present in this industry. In particular, this industry combines rapid technological development with the existence of buyers who know what is available (Langlois 1992). Technologically advanced, or at least technologically competitive, new products thus have a ready demand from knowledgeable and discriminating customers. Because customers are able to tell the difference between new and older products, older products with out-of-date technology are more difficult to sell. Moore (1995) and others contend that in technology-based industries characterized by rapid growth, technological advancement, and buyers empowered by choice and access to information, the appropriate marketing strategy is to supply, and not court, the customers. Demand creation is not needed, i.e., it is assumed that the product is indeed demanded, so the firm should "just ship" products. Instead, it is products that lag behind the technology frontier, or that fail to have an obvious reason for being, that require more demand-creating marketing activities.

7. Conclusion

The PC industry has been one of the most innovative sectors of the economy and one of the most competitive. Quality-adjusted prices have fallen at a rate of 25% per year. Imitators with low prices have few barriers to entry. In such a market environment, it is natural to question how firms are able to realize tangible financial rewards from their new product activities. We find that firms in the PC industry achieve financial rewards from their new product introductions because this activity allows them to increase in size and increase their profit rate through lowered SG&A intensity. More specifically, we find that new product introductions influence profit rate and asset growth, but not profit-rate persistence.

Caution should be exercised in generalizing our findings beyond the specific industry, time period, and data sample used in this study. These limitations, however, suggest various directions for future research. In particular, future studies might attempt to generalize our results to other industry settings, including dynamic as well as more stable product technologies and products in the maturity and decline stages of their industry life cycle. In addition, recent signs of a slowdown in the PC industry raise the question of whether firms will continue to be able to rely on new products to lower their selling and advertising expenditures (e.g., Hannon 2001). Thus, continuing to increase our understanding of how and why firms benefit from new product activity is an important area for future research.

[10] Specifically, a regression of advertising intensity on time gives a time-parameter estimate of 0.00009 with an insignificant t-value of 0.08. A regression of R&D intensity on time gives a time-parameter estimate of –0.007 with a significant t-value of −3.91.

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Accepted by Christopher S. Tang; received August 2001. This paper was with the authors 2 months for 2 revisions.