The Impact of Product Innovativeness on the Link between Development Speed and New Product Profitability

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A review of the literature reveals that the relationship between development speed and new product profitability is not as strong and straightforward as conventional wisdom suggests. A number of studies show positive results, others show mixed results, and some present no evidence of a relationship. In other words, the valence of the link between development speed and new product profitability is unclear at this time. Therefore, this study investigates whether or not speeding new products to market has positive or negative effects on new product profitability. Prior research shows that product innovativeness influences both development speed and new product profitability. This raises the question of whether increasing speed is equally successful in improving profitability across new products that differ in their degree of innovativeness. Therefore, this study also investigates the moderating effect of product innovativeness on the relationship between development speed and new product profitability. The results from a survey-based study of 233 manufacturers of industrial products in the Netherlands reveal an inverted U-shaped relationship between development speed and new product profitability. The findings also show that the optimal point is different for two new product types—product improvements and line additions—that vary in their innovativeness. These results provide an onset for the development of a decision tool that helps managers to determine how much to spend on accelerating the development of individual new products and how they should allocate that spending across products in their new product portfolio.

“There are two kinds of firms—the quick and the dead.”
Andy Grove, former president of Intel

Introduction

New product development (NPD) speed is critical because product life cycles are shrinking and because obsolescence is occurring more quickly than in the past while competition also has intensified (Filippini, Salmaso, and Tessarolo, 2004). To grow, it has become imperative for firms to move new products to market faster. Firms such as Gillette, Merrill Lynch, Honeywell, and Xerox are often cited as examples of firms that compete on development speed. Firms that succeed in speeding new products faster to market than competitors can obtain first-mover advantages (Dröge, Jayaram, and Vickery, 2000). These advantages stem from the firm's competitive start over rivals and are expected to result in dominant market positions (Smith and Reinertsen, 1991). Specifically, development speed and new product profitability are believed to be causally related.

On closer examination however, the relationship between development speed and new product profitability does not seem to be as strong and straightforward as conventional wisdom suggests. A number of studies show positive results (e.g., Lynn, Skov, and Abel, 1999), some demonstrate mixed results (e.g., Ittner and Larcker, 1997), and others present no evidence of a relationship between development speed and new product profitability (e.g., Griffin, 2002). In other words, the valence of the relationship between development speed and new product profitability is unclear at this time. Therefore, the present study's primary objective is to offer consensus on the theoretical and empirical question of whether or not speeding new products to market has positive or negative effects on new product profitability.

Looking at the relationship between development speed and new product profitability requires taking into account potential moderators (Suarez and Lanzolla, 2005). One of these moderators is product innovativeness because prior research suggests that innovativeness influences both development speed (Griffin, 2002) and new product profitability (Robinson, 1990). Nearly all empirical results show that more innovative new products are associated with slower development speeds (Ali, Krapfel, and LaBahn, 1995) and higher new product performance (Robinson, 1990), and vice versa. This raises the question of whether increasing development speed is uniformly successful in improving profitability across new products that differ in their degree of innovativeness (Ali, 2000). Therefore, the present study's secondary objective is to broaden the theory on NPD acceleration by focusing on the moderating effect of product innovativeness on the relationship between development speed and new product profitability.
To accomplish both objectives this study reviews the innovation and marketing literatures and derives fresh insights about the link between development speed and new product profitability and about the moderating impact of product innovativeness on this relationship. Two hypotheses are derived from the theory on NPD acceleration and are tested using a sample of 233 manufacturers of industrial products in the Netherlands. The results reveal an inverted U-shaped relationship between speed and profitability. In addition, the findings show that the optimal point is dissimilar for two new product types—product improvement and line additions—that vary in their innovativeness. On the basis of these results a tentative decision tool is developed to help better manage the speed–profitability trade-off.

The rest of the article is structured as follows. The next section presents the development of the hypotheses, followed by an explanation of the research methodology and presentation of the results. Then a discussion of the results and their implications is provided, along with a proposal for a tentative decision tool. The final section discusses the study's limitations and directions for further research.

Hypotheses

The Effect of Development Speed on New Product Profitability

Development time is defined as the elapsed time from the beginning of idea generation—when the firm decided to develop a new product—to market introduction. This definition is consistent with the notion of product development time (Lilien and Yoon, 1990), innovation time (Mansfield, 1988), total time (Griffin, 1993), and lead time (Clark, 1989). This definition implies that development time can be reduced by increasing the new product's development speed. Therefore, development speed is defined as the ability to minimize the time it takes from the beginning of idea generation to market introduction (Dröge, Jayaram, and Vickery, 2000).

An extensive theoretical and empirical literature has examined the advantages and disadvantages associated with increases in development speed. Several studies report that firms should speed new products to market (see the review by Kalyanaram, Robinson, and Urban, 1995). At the same time, other empirical studies have found that speeding new products to market can have disadvantages (see the review by Golder and Tellis, 1993). Rather than repeating all the findings here, the present study briefly points to the main advantages and disadvantages.

The advantages can be classified as follows:

1. consumer-related advantages with regard to the first choice of profitable segments and positions (Niedrich and Swain, 2004)
2. advantages related to the occurrence of positive network effects
3. advantages related to the high switching costs for early adopters (Kardes and Kalyanaram, 1992)
4. cost reductions through economies of scale and experience effects (Rosenau, 1990)
5. advantages related to pricing freedom (Smith and Reinertsen, 1991)
6. distribution advantages with regard to the choice of the best distributors
7. advantages related to technological standard setting (Golder and Tellis, 1993)
8. supply-based advantages related to preempting scarce resources and suppliers (Lee et al., 2000).

These advantages are assumed to be sustainable through the growth stage and into the maturity stage of the product life cycle, resulting in a strong share position and substantial returns (Kalyanaram, Robinson, and Urban, 1995).

The disadvantages can be classified as follows:

1. higher costs due to Crawford's (1992) hidden costs of accelerated NPD, such as the risk of trivial innovation driving out more profitable breakthrough innovations
2. higher costs as a result of the required investments in technology (Golder and Tellis, 1993)
3. elevated costs due to more thorough concept and prototype testing (Lee et al., 2000)
4. consumer-based disadvantages related to the inability to exploit opportunities arising from shifts in consumers' preferences and purchase criteria as the market develops (Zhang and Markman, 1998)
5. disadvantages related to being locked in on first-generation technology, which prevents firms from
taking advantage of the latest technology (Golder and Tellis, 1993).

(6) disadvantages related to possible positioning and pricing mistakes inherent with accelerated NPD (Lee et al., 2000).

These disadvantages are assumed to have an adverse effect on the new product's profitability as the market evolves (Boulding and Christen, 2003).

The preceding review describes the advantages and disadvantages of increasing development speed. Credible arguments can be made for and against each perspective. To reconcile both perspectives the present study proposes an inverted U-shaped relationship between development speed and new product profitability. This means that for each new product developed by a particular firm under specific competitive conditions, there is an optimal development speed that maximizes new product profitability (see Figure 1).

To the left of the optimal point increasing development speed improves new product profitability. In this region firms benefit from, for example, the first choice of profitable segments, scale and experience effects, the formation of favorable buyer awareness and preferences, and the preemption of resources (e.g., Rosenau, 1990; Smith, 1999). Hewlett-Packard is an example of a firm that has reported significant increases in development speed accompanied with lower development costs, improved product quality, and increased new product profitability. Gupta, Brockhoff, and Weisenfeld (1992) believed, however, that most firms operate on the right side of the optimal point. This means that speeding becomes counterproductive for new product profitability. Arguments related to the hidden costs of accelerated NPD, growing market uncertainties, and higher technological risks support decreasing new product profits in this region (Crawford, 1992). An example is Chrysler, which rushed the Neon to market before sufficient road tests were completed. Chrysler had to recall the car twice within the first month of sale. This resulted in dampened consumer and dealer enthusiasm for the Neon (Bayus, 1997).

The proposition that there is an optimal point in the relationship between development speed and new product profitability for each new product developed by a particular firm under specific competitive conditions is consistent with results from analytical models in which the relationship between development time and development cost is approximated by a U-shaped function (Bayus, 1997). Assuming constant sales this scenario implies that development speed has an inverted U-shaped relationship with new product profitability. Thus,

H1: Development speed has an inverted U-shaped relationship with new product profitability.

The Moderating Effect of Product Innovativeness

Product innovativeness is most frequently used as a measure of the degree of newness of a new product (Griffin, 2002). The most often used typology of new products, the Booz Allen Hamilton (1982) typology categorizes them along two perspectives: newness to the market and newness to the developing firm. Here both viewpoints are briefly explained (see Danneels and Kleinschmidt, 2001 for an extensive review).

The market perspective draws on the extant literature on innovation adoption and diffusion to understand how customers perceive product newness. Within this view researchers have focused on the impact of new product attributes on customers' decisions to adopt (e.g., Rogers, 1995), on the timing of the adoption, and on the change in established behavior patterns that the new product requires (e.g., Gatignon and Robertson, 1991). Research from the firm side draws on the literature examining organization–environment relationships and the resource-based theory of the firm. Researchers have focused on newness as familiarity regarding the interplay between the firm and its environment (e.g., Souder and Song, 1998) and on newness as the degree of fit between the new product and the firm's existing marketing or technological resources and capabilities (e.g., Song and Parry, 1997).

In line with this thinking, product innovativeness is defined as the extent to which the new product is new to the target market and to the developing firm. As such, product innovativeness reflects (1) the degree of information search, behavioral change, and learning effort required by customers in the target market to adopt the new product; and (2) the firm's knowledge of and experience with similar NPD projects in the past. This definition is used to classify the arguments that underpin this study's assumption that the effect of development speed on new product profitability is different under dissimilar new product innovativeness conditions. The reasons are shown in Table 1. It is important to recognize, however, that not all researchers agree or employ definitions of product innovativeness that include newness to the firm; in fact, some argue against such definitions.

The market perspective uses the concept of strategic window to argue that product innovativeness influences the development speed at which new product profitability is maximized. Prior research suggests namely that by taking little time to develop a more innovative new product, a firm risks facing a not-yet-open strategic window (Ali, 2000). The reason is that in the early stages of the product life cycle a more innovative new product produces incompatibility with customers' existing way of doing business and increases perceived risks due to customers'
inexperienced with the product. For example, the response from customers to Apple's Newton personal data assistant (PDA) was dismal, and the product was ultimately withdrawn from the market. Conversely, research suggests that taking a long time to develop a less innovative product cause firms to face an already closed strategic window, because customers are knowledgeable and experienced with the product category (Lambert and Slater, 1999). Customers are already exposed to existing products, and they are unlikely to postpone their purchase decision to await minor improvements. Also, competitors may already have introduced comparable improvements by then (Niedrich and Swain, 2004). This is what happened to Philips when it entered a well-developed cellular phone market after Nokia, Motorola, Ericsson, and Siemens. This line of reasoning suggests that the development speed maximizing new product profitability is lower for more innovative new products—otherwise the strategic window is not yet open—than for less innovative new products—or else the strategic window is already closed. Thus, H2a: The development speed that maximizes new product profitability is lower for more innovative new products than for less innovative new products.

The firm perspective uses the hidden cost approach to argue that product innovativeness influences the maximum profitability firms attain by speeding new products to market. The literature suggests namely that taking a short amount of time to develop a more innovative new product raises the risk of making a mistake in the development of the product (Crawford, 1992). This may result in technical limitations or costly design flaws that reduce the new product's profitability. Being too quick with such a product also requires that a new market must be developed. This might result in making costly mistakes in launching the new product. For example, the firm may use ineffective promotional appeals to communicate the product's benefits (Lee et al., 2000). The development of a less innovative new product may, in contrast, be easily planned and implemented (LaBahn, Ali, and Krapfel, 1996). Taking too long to develop such a product results in overly loose schedules, which in turn yield unfocused efforts and lapses of attention during the NPD process (Lukas and Menon, 2004), adding to the development costs of the new product. Taking too long also raises the costs of launching such a new product, because it becomes more difficult to differentiate the product in ways that are attractive to the established market (Niedrich and Swain, 2004). For example, Apple was faced with higher marketing costs when iTunes for Windows was launched into a market already crowded with similar services for Windows users, like MusicMatch, BuyMusic.com, and Napster. This line of reasoning suggests that the maximum profitability attained by speeding new products to market is lower—due to higher development and marketing costs—for more innovative than for less innovative new products—due to lower development and marketing costs. Thus, H2b: The maximum profitability achieved by speeding new products to market is lower for more innovative new products than for less innovative new products.

Methodology

Sample and Data Collection

Estimating the inverted U-shaped relationship requires speed and profitability data on multiple completed NPD projects. The present study opted to use a cross-sectional research design to collect this data. The sample consisted of 600 manufacturers of industrial products in the Netherlands with independent research and development (R&D), production, and marketing—sales departments in the primary metal, fabricated metal, machinery equipment, electrical equipment, transportation equipment, and measuring instruments industries (standard industrial classification [SIC] codes 33–38). Through a telephone presurvey 528 firms were identified with (1) a new product that had been in the market for more than 12 months to ensure they had sufficient data on the resulting performance; (2) a new product that was representative of the firm's product development program; and (3) a knowledgeable informant from the NPD team. A rating scale (anchored at 1=not representative and 5=very representative) measured the representativeness of the new product. The mean response was 4.05 (s.d.=.74), thus showing the representativeness of the new product selected for the firm's product development program. To make sure the appropriate respondents were interviewed, they were asked to rate themselves on their knowledgeability of the respondents.

A total of 344 (65.2 percent) knowledgeable informants willing to cooperate with the research received a personalized letter explaining the purpose of the study, along with a questionnaire and a preaddressed, postage-paid envelope. Nonrespondents received a reminder letter and a second questionnaire. These efforts yielded 233 usable responses, giving a response rate of 44.1 percent (67.7 percent of those who received a questionnaire). T-tests indicated no significant differences in the mean responses on any construct across respondents with different functional backgrounds (e.g., R&D, marketing) and across firms from different industries. A time-trend extrapolation procedure was used to test for nonresponse bias (Armstrong and Overton, 1977). The underlying rationale is that late respondents are more similar to nonrespondents than to early respondents. Therefore, the data set was divided into quartiles based on the number of days between the initial mailing and receipt of the
completed questionnaire. In comparing early (first-quartile) and late (fourth-quartile) respondents by means of t-tests, no significant differences emerged in the mean responses on any construct. Together these results suggest that respondent bias, industry bias, and nonresponse bias were not problematic. Table 2 shows the sample characteristics.

Measure Development and Pretesting

A pool of items was generated for each construct using literature search and interviews with academics and practitioners. Pretests of these items occurred in two phases: (1) face-to-face interviews with four academics; and (2) face-to-face interviews with eight NPD managers. At each stage, participants identified items that were confusing, tasks that were difficult to respond to, and any other problems they encountered. Problematic items were revised or eliminated, and new ones were developed. By the end of the second phase of pretesting the practitioners reported no concerns, and the questionnaire was ready for final administration.

Measures

The measurement of development speed and new product profitability can be undertaken in two ways. First, speed and profitability may be gauged objectively either by asking respondents to report absolute values or via secondary sources. Second, speed and profitability may be measured subjectively via respondents who are asked to assess the respective performance dimensions relative to competitors, objectives, or past performance. In the present study subjective measures were used for several reasons. First, subjective measures have the advantage of facilitating comparisons among different NPD projects of firms in different industries (Atuahene-Gima and Ko, 2001). Second, subjective measures have shown to be correlated to objective measures of product innovation (e.g., Ancona and Caldwell, 1992; Zahra and Covin, 1993). Third, objective (i.e., certifiable by a third party) measures were virtually impossible to obtain. Fourth, subjective measures have often been used in prior developmental speed (e.g., Sherman, Souder, and Jenssen, 2000) and new product profitability (e.g., Ali, 2000) studies.

Using the subjective approach development speed, which was described to respondents as the ability to minimize the time it takes from the beginning of idea generation to market introduction, was measured using two items based on Dröge, Jayaram, and Vickery (2000). Respondents were asked to rate how well the new product they selected had performed on development speed (1) relative to similar products that their firm developed in the past; and (2) relative to competitors that had developed similar products (see Appendix). The scale was anchored by 1=very much slower and 5=very much faster. The correlation between the items was positive (r=.47 and significant (p<.01), and therefore the construct was formed by averaging the responses to both items. Similarly, two items adapted from Griffin and Page (1996) were used to measure new product profitability. Respondents were asked how satisfied they were with the new product's performance with regard to (1) the degree to which the new product met profit goals; and (2) the degree to which the new product met margin goals. The scales were anchored by 1=not at all satisfied and 5=highly satisfied. The correlation between the items was positive (r=.38 and significant (p<.01). Thus, the construct was formed by averaging both responses. From a content validity perspective it might be argued that using single-item indicators for both speed and profitability is more appropriate in testing the hypotheses, because the interitem correlations of .47 and .38 are not very high. To check this, the regressions also were estimated using single-item indicators. The results were similar to the ones reported in Tables 3 and 4. Multiple-item measurement is, in general, preferred over single-item measurement. Therefore, the multiple-item constructs were used to test the hypotheses.

The self-typing approach was used to measure product innovativeness (see Appendix). Respondents were asked to assign the selected new product to one of the categories from Booz Allen and Hamilton’s (1982) typology. This typology classifies new products by the level of newness in relation to both the market and the firm. The categories respondents could choose from were (1) a new product line (i.e., a new product that, for the first time, allows a firm to enter an existing product category); (2) an addition to an existing product line (i.e., a new product that supplements one of the firm's established product lines); and (3) a product improvement (i.e., a new product that provides improved performance or greater perceived value to customers and replaces one of the firm's existing products). Together these three categories account for 77 percent of all new products introduced in the marketplace (Griffin, 1997). The response frequencies were 18 (7.7 percent) new product lines, 93 (39.9 percent) additions to existing product lines, and 122 (52.4 percent) product improvements. The analysis focuses on additions to existing product lines and on product improvements. The reason is that the size of the new product line category was too small to be included in the test for moderating effects (Aiken and West, 1996).

The self-typing approach was used to measure innovativeness for several reasons. First, this approach is logically appealing and effective. Second, objective measures on product innovativeness were impossible to obtain. Third, the self-typing approach has been proven to be reliable and valid in related research domains (e.g., James and Hatten, 1995). Finally, the self-typing approach has often been used in prior innovation studies (e.g., Kleinschmidt and Cooper, 1991). The self-typing approach is not without shortcomings, however. A first limitation is possible variance among respondents' perceptions of the innovativeness of the new product (Garcia and Calantone,
A second drawback is the lack of external confirmation of respondents’ answers (McDaniel and Kolari, 1987). Given the nature of the sample it was almost impossible to obtain external confirmation of the respondents’ self-typing. A third limitation is that respondents may tend to overstate the innovativeness of their new product. In comparison to previous research, the response frequencies provide no indication that this happened. A fourth limitation is that the self-typing approach does not allow for continuous variable statistical analyses (Griffin, 1993), which is why subsample analyses were used to test the hypotheses. Still, the results must be interpreted with these limitations in mind.

As control variables two firm characteristics—R&D expenditures as percentage of sales and firm size as number of employees—and one market characteristic—market turbulence—were measured by means of one item each. These firm and market characteristics have a recognized influence on new product performance (Henard and Szymanski, 2001).

Results

To test H1 multiple regression analysis was used with a linear and squared term for development speed as well as the control variables as independent variables. The constructs were mean-centered to overcome potential problems due to multicollinearity (Aiken and West, 1996). The squared term was included to test for the proposed inverted U-shaped relationship between speed and profitability. This type of relationship is supported if the coefficient of the linear development speed variable is positive and the coefficient for the squared term is negative (Aiken and West, 1996). Table 3 reveals that the model explains 47 percent of the variance in new product profitability. Hierarchical regression analyses also were applied to test the hypotheses. The first models only included the linear term for development speed and the control variables. The quadratic term pertaining to development speed was added in the second models. The results of the F-tests of the change in the adjusted $R^2$ indicate that the inclusion of the squared term yielded, without exception, better specified models than the models without the squared term. Therefore, only the results from the models with the squared term included are reported. Dummy variables also were included to test for unobserved industry effects, none of which were found. So only the results from the models without the dummy variables are reported.

The results reveal that the linear effect of development speed on new product profitability is positive ($b=1.15$) and that the quadratic effect on new product profitability is negative ($b=-0.21$). These findings support the inverted U-shaped relationship predicted in H1 (see Figure 2). When the first partial derivative with respect to development speed is set equal to zero, new product profitability peaks at $3.22$ when development speed equals $2.74$. The results further show that R&D expenditures ($b=0.10$) have a positive effect and market turbulence a negative ($b=-0.16$) effect on new product performance.

To test H2a and H2b the same regression equation was tested for the subsamples of product improvements and product line additions, as suggested by Sharma, Durand, and Gur-Arie (1981). The use of the self-typing approach does not allow for continuous variable statistical analyses. Table 4 reveals that the models explain between 41 and 52 percent of the variance in new product profitability.

In both regressions the results support the inverted U-shaped relationship between development speed and profitability, because the linear effects are positive ($b=1.22$ and $b=0.82$, respectively) and the quadratic effects are negative ($b=-0.20$ and $b=-0.17$, respectively). A Chow test was used to test for the equality between the sets of coefficients in the two regressions. The results ($F_{(5,205)}=15.19; p<.05$) indicate that separate equations must be estimated for product line additions and product improvements (Pindyck and Rubinfeld, 1998). Testing subsets of coefficients is, however, not the same as testing for the equality of coefficients between the two regressions. Therefore, a series of t-tests also was performed between the coefficients. These tests revealed that the coefficients, including the linear and quadratic development speed coefficients, were indeed significantly different. When the partial derivative with regard to development speed is set equal to zero in each equation, this significant difference expresses itself in the fact that new product profitability is maximized when development speed is $3.05$ for product improvements and $2.41$ for product line additions. The results further show that new product profitability peaks at $3.57$ for product improvements and at $2.75$ for product line additions (see also Figure 3). Together, these findings provide support for H2a and H2b with regard to product improvements and product line additions. The other new product types in Booz Allen and Hamilton’s (1982) typology were not included in the present study’s test for moderating effects. The results therefore cannot be generalized to these categories. The results further show that R&D expenditures have positive ($b=0.10$ and $b=0.12$, respectively) effects on new product profitability for both types of new products. Market turbulence has a negative effect ($b=-0.45$) on product profitability for line additions only.

Discussion and implications

This study makes several contributions. First, it offers a consensus on the theoretical and empirical question whether or not speeding new products to market has positive or negative effects on profitability. Second, it
broadens the theory on NPD acceleration by incorporating product improvements and line additions in the speed–profitability relationship. Here are the key results:

- Development speed has an inverted U-shaped relationship with new product profitability.
- Profit maximization occurs at a higher development speed for product improvements than for additions to existing product lines.
- The maximum profitability achieved by speeding new products to market is higher for product improvements than for line additions.

These empirical results lead to several implications for managers. First, the results suggest that the inverted U-shaped relationship between development speed and new product profitability is common for manufacturers of industrial products. This implies that an initial increase in development speed boosts new product profitability but that additional increases become detrimental after a certain point. Managers need to anticipate this pattern and make a careful analysis of the trade-off between speed and profitability to ensure that dedication to NPD acceleration does not outstrip the new product’s profitability.

Second, the finding that profit maximization occurs at a higher speed and that the maximum profitability is higher for product improvements than for line additions enables managers to form different expectations about the profitability impact of speeding new products to market that differ in their degree of innovativeness. These expectations can help managers to correctly assess the expected payoffs from acceleration investments in products that differ in innovativeness. Finally, the results can be used as an onset for the development of a decision tool that enables managers to predict the development speed at which new product profitability is maximized. These predictions help managers to determine how much to spend on accelerating the development of individual new projects and how they should most profitably allocate that spending across different new products in their portfolio.

A tentative decision tool

Such a decision tool can be built using data of completed NPD projects. In this tool new product profitability is a function of factors relating to new product characteristics: what the firm does to accelerate NPD, development speed, new product profitability, and market characteristics. Most of these factors can be observed, for example, new product profitability and the costs to accelerate NPD. Other factors can only be estimated (cf. Thomas, Reinartz, and Kumar, 2004). In particular, development speed is partly a function of the amount spend on accelerating NPD. Once all these factors have been estimated and the weightings indicating their relative importance have been assigned, managers can manipulate the tool by plugging in different numbers for the factors they control—particularly investments in accelerating NPD—to see at which speed new product profitability is maximized.

An examination of a simple ongoing NPD project for which a manager wants to determine the optimal investment amount in accelerating NPD can illustrate how such a tool works. It is assumed that new product profitability (NPP) is only determined by development speed (DS) and that speed is affected by how much the firm invests in accelerating NPD (IAD). In estimating development speed it is necessary to control for diminishing returns on the investments in accelerating NPD over time (cf. Thomas, Reinartz, and Kumar, 2004). To simulate that effect the square of the investment factor is subtracted. Then the weighting coefficients \(c_1, c_2, b_1, b_2\) are applied, and the starting intercept \(a_1, a_2\) points are set. This yields two equations:

\[
\begin{align*}
\text{NPP} &= a_1 + c_1 \cdot \text{DS} - c_2 \cdot \text{DS}^2 \\
\text{DS} &= a_2 + b_1 \cdot \text{IAD} - b_2 \cdot \text{IAD}^2
\end{align*}
\]

To work out the weightings of the coefficients, managers can run historical numbers for profitability, speed, and investments derived from similar NPD projects the firm has completed in the past. Unfortunately, these numbers were not available from the study. Therefore, the results shown in Table 3 are substituted into equation 1. Equation 2 is estimated by using the firm’s R&D expenditures (i.e., percent of sales) as a proxy for investments in accelerating NPD. This procedure yields the following results:

\[
\begin{align*}
\text{NPP} &= 1.65 + 1.15 \cdot \text{DS} - 0.21 \cdot \text{DS}^2 \\
\text{DS} &= 2.58 + 0.13 \cdot \text{IAD} - 0.02 \cdot \text{IAD}^2
\end{align*}
\]

The next step is to predict what happens to the profitability of the ongoing project if the investments in accelerating NPD are changed. To obtain alternate profitability estimates, different investment values can be
plugged in. After repeating this procedure several times, the investment value that maximizes profitability is revealed. The highest development speed is achieved with an investment of 3.3 percent of sales, but maximum new product profitability occurs when only 1.6 percent is spent on accelerating NPD.

This example is of course a very simple application of the decision tool managers can use to determine the optimal investment in accelerating NPD. Three complicating factors in practice are that (1) a measure of product innovativeness needs to be incorporated into the decision tool, because the results indicate that innovativeness has an impact on the effectiveness of investments in accelerating NPD; (2) the optimal amount to be invested in each product in the NPD portfolio must be estimated before allocation decisions across NPD projects can be made; and (3) more precise product-related (i.e., innovativeness), firm-related (e.g., marketing expenses), and market-related (e.g., competition) variables need to be included in the tool. Encouragingly, it is not necessary for managers to invest huge amounts in gathering data to implement the tool; instead, they can rely on previously collected information. Their allocation choices, in turn, will provide clear profit-linked goals for which managers can be held accountable.

**Directions for future research**

The study’s results, as well as its limitations, provide several opportunities for future research. First, future research could conduct a single-industry study to rule out possible confounding effects due to unmeasured industry-level factors. Second, research could benefit from using multiple respondents to enable a more thorough analysis of validity and measurement error issues. Third, researchers should attempt to collect objective measures of development speed and new product profitability to replicate the results, because subjective measures are not always a perfect surrogate. Fourth, future research may consider using data on multiple new products in a firm’s NPD portfolio that cover all new product types in Booz Allen and Hamilton’s (1982) typology. Fifth, researchers should avoid problems associated with classifications by using a multidimensional scale to measure product innovativeness to avoid selection and range effects (Garcia and Calantone, 2002). Sixth, researchers also should try to collect data on new product innovativeness from the market perspective. Finally, researchers could attempt to collect historical data to build and test the decision tool. All of these directions require large data collection efforts, which will provide important new insights on the important phenomenon of accelerating NPD.

**References**


Biographical sketches

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Figure 1. The Relationship between Development Speed and New Product Profitability

![Graph showing the relationship between development speed and new product profitability with an optimal point.](image)

Figure 2. The Effect of Development Speed on New Product Profitability

![Graph with a quadratic equation: $Y = 1.15X - 0.21X^2 + 1.65$, $\text{Adj. } R^2 = 0.47$ $(n = 233)$.](image)

Figure 3. The Effect of Development Speed on New Product Profitability for Product

![Graph with two equations: for product improvements, $Y = 1.23X - 0.50X^2 + 1.71$, $\text{Adj. } R^2 = 0.53$; for product line additions, $Y = 0.82X - 0.17X^2 + 1.76$, $\text{Adj. } R^2 = 0.41$.](image)
Table 1. The Impact of Innovativeness on the Link between Speed and New Product Profitability

<table>
<thead>
<tr>
<th>Results of Taking Too Little Time in the Development of More Innovative New Products</th>
<th>Results of Taking Too Much Time in the Development of Less Innovative New Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Perspective Strategic Window</td>
<td>A strategic window that is not yet open due to incompatibility</td>
</tr>
<tr>
<td>Firm Perspective Development Costs</td>
<td>Lower profitability because of higher costs due to hidden costs of accelerated NPD and testing mistakes</td>
</tr>
<tr>
<td>Firm Perspective Marketing Costs</td>
<td>Lower profitability because of higher costs related to new market development and possible marketing mistakes</td>
</tr>
</tbody>
</table>

Table 2. Sample Characteristics (n=233)

<table>
<thead>
<tr>
<th>SIC Code</th>
<th>Number of Employees</th>
<th>Sales in Million Euros</th>
<th>Functional Background Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>33: Primary Metal</td>
<td>28</td>
<td>11–50</td>
<td>38</td>
</tr>
<tr>
<td>34: Fabricated Metal</td>
<td>24</td>
<td>51–100</td>
<td>74</td>
</tr>
<tr>
<td>35: Machinery Equipment</td>
<td>68</td>
<td>101–250</td>
<td>39</td>
</tr>
<tr>
<td>36: Electrical Equipment</td>
<td>55</td>
<td>251–500</td>
<td>32</td>
</tr>
<tr>
<td>37: Transportation</td>
<td>55</td>
<td>&gt;500</td>
<td>31</td>
</tr>
<tr>
<td>38: Measuring Instruments</td>
<td>39</td>
<td>&gt;250</td>
<td>25</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3. The Effect of Development Speed on New Product Profitability

<table>
<thead>
<tr>
<th>New Product Profitability</th>
<th>Development Speed</th>
<th>Development Speed²</th>
<th>R&amp;D Expenditures</th>
<th>Firm Size</th>
<th>Market Turbulence</th>
<th>Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>( b )</td>
<td>1.15</td>
<td>-0.21</td>
<td>0.10</td>
<td>0.06</td>
<td>-0.16</td>
<td>1.65</td>
</tr>
<tr>
<td>( \beta )</td>
<td>0.78</td>
<td>-0.43</td>
<td>0.17</td>
<td>0.10</td>
<td>-0.21</td>
<td></td>
</tr>
<tr>
<td>( p )</td>
<td>**</td>
<td>**</td>
<td></td>
<td></td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

\[ R^2 \] = 0.49

\[ \text{Adjusted } R^2 \] = 0.47

\[ F\text{-value} \] = 43.61

\( p < .05 \).

\( p < .01 \).

Table 4. The Effect of Development Speed on New Product Profitability for Product Improvements and Product Line Additions

<table>
<thead>
<tr>
<th>Product Improvements ((n=122))</th>
<th>Product Line Additions ((n=93))</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Product Profitability</td>
<td>New Product Profitability</td>
</tr>
<tr>
<td>( b )</td>
<td>( \beta )</td>
</tr>
<tr>
<td>Development Speed</td>
<td>1.22</td>
</tr>
<tr>
<td>Development Speed²</td>
<td>-0.20</td>
</tr>
<tr>
<td>R&amp;D Expenditures</td>
<td>0.10</td>
</tr>
<tr>
<td>Firm Size</td>
<td>0.01</td>
</tr>
<tr>
<td>Market Turbulence</td>
<td>-0.08</td>
</tr>
<tr>
<td>Constant</td>
<td>1.71</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.54</td>
</tr>
<tr>
<td>( \text{Adjusted } R^2 )</td>
<td>0.52</td>
</tr>
<tr>
<td>( F\text{-value} )</td>
<td>27.23</td>
</tr>
</tbody>
</table>

\( *p < .05 \).

\( **p < .01 \).

\( p < .05 \).

\( p < .01 \).