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Exploring Mediating and Moderating Influences on the Links among Cycle Time, Proficiency in Entry Timing, and New Product Profitability*

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Development cycle time is the elapsed time from the beginning of idea generation to the moment that the new product is ready for market introduction. Market-entry timing is contingent upon the new product's cycle time. Only when the product is completed can a firm decide whether and when to enter the market to exploit the new product's window of opportunity. To determine the right moment of entry a firm needs to correctly balance the risks of premature entry and the missed opportunity of late entry. Proficient market-entry timing is therefore defined as the firm's ability to get the market-entry timing right (i.e., neither too early nor too late). The literature has produced divergent evidence with regard to the effects of development cycle time and proficiency in market-entry timing on new product profitability. To explain these disparities this study (1) explores the mediating roles of development costs and sales volume in the relationships among development cycle time, proficiency in market-entry timing, and new product profitability, respectively; and it (2) explores the moderating influence of product newness on the relationship between development cycle time and development costs and that of new product advantage on the link between proficiency in market-entry timing and sales volume. The results from a survey-based study of 72 manufacturers of industrial products in the Netherlands suggest that development costs mediate the relationship between development cycle time and new product profitability and that sales volume mediates the link between proficiency in market-entry timing and new product profitability. In addition, the findings indicate that new product advantage strengthens the positive relationship between proficiency in market-entry timing and sales volume. The results provide no evidence for a moderating effect of product newness. These results have important implications because to maximize new product profitability managers need to distinguish between costs and demand side effects of development cycle time and market-entry timing on new product profitability. Keeping this distinction in mind should help them to better determine the relative profit impact of investments in cycle time reduction or improved entry timing. Moreover, the findings suggest that highly advantaged products that enter the market at the right time may have a highly attenuated sales volume. It also implies that new products with lower advantage may have very little leeway in hitting the "sweet spot" in market. The message is that "doing the right thing" (i.e., to develop a highly advantaged

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new product) may be at least as important as correctly balancing the risks of premature entry and the missed opportunity of late entry.

Introduction

Most literature reviews conclude that short development cycle time and optimal market-entry timing are sources of competitive advantage that result in larger market shares and higher new product profitability (e.g., Kessler and Chakrabarti, 1996; Szymanski, Troy, and Bharadwaj, 1995). Several studies have shown that the faster the firm completes the product development cycle, the greater is its likelihood of surpassing competitors in the marketplace (e.g., Chen, Reilly, and Lynn, 2005; Langerak and Hultink, 2005). The emphasis on cycle-time reduction is based on the belief that the largest market share, and hence greatest new product profitability, is achieved by the firm that first introduces the product in the marketplace, with the implication being that firms should always speed new products to market (e.g., Kalyanaram, Robinson, and Urban, 1995; Robinson and Min, 2002; VanderWerf and Mahon, 1997).

This line of reasoning is not without controversy. The literature has produced divergent evidence with regard to the effects of development cycle time and market-entry timing on new product profitability. Several cycle-time studies have found that faster speed to market is associated with increased new product profitability (Calantone and Di Benedetto, 2000; Calantone, Vickery, and Dröge, 1995; Langerak and Hultink, 2006), whereas other studies have found that cycle-time reduction has an adverse effect on profitability (Adams-Bigelow and Griffin, 2005; Griffin, 2002). An explanation for these disparities in findings may be that prior studies overlooked firm specific cost implications of accelerating new product development (NPD) while investigating the impact of cycle time on new product profitability (Bayus, Jain, and Rao, 1997). Likewise, a number of studies on market-entry timing shows that pioneers outsell late movers (e.g., see Kalyanaram et al., 1995 for an overview), whereas others reveal that late movers outsell pioneers (e.g., see Golder and Tellis, 1993 for an overview). An explanation may be that past research focused on the order of market entry instead of the moment of market entry in relation to the new product's window of opportunity. As such, these studies may have failed to consider the sales implications of the new product's strategic window. Pioneers might not generate revenues because they enter the market when the strategic window is not yet open, whereas followers might not generate sales volume because they enter the market when the strategic window is already closed (Ali, 2000).

To explore these explanations the present study views development cycle time and market-entry timing as two related, but distinct, temporal aspects of NPD. Development cycle time is defined as the elapsed time from the beginning of idea generation to the moment that the new product is ready for market introduction (Griffin, 2002). Market-entry timing is contingent upon the new product's cycle time. Only when the product is completed can a firm decide

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whether and when to enter the market to exploit the new product's window of opportunity. To determine the right moment of entry, a firm needs to correctly balance the risks of premature entry and the missed opportunity of late entry (Lilien and Yoon, 1990). Proficient market-entry timing is therefore defined as the firm's ability to get the market-entry timing right (i.e., neither too early nor too late).

The firm's ability to determine the new product's optimal cycle time and the right moment of market entry should, of course, become manifest in the new product's profitability (Kerin, Varadarajan, and Peterson, 1992). Development costs and sales volume are important determinants of new product profitability, but they seem to contribute through different elements of the equation. Past experimental, modeling, and case-study research suggest that cycle time affects new product profitability though its curvilinear effect on development costs (Bayus, 1997; Gupta et al., 1992; Murmann, 1994). In contrast, prior empirical studies suggest that proficiency in market-entry timing affects new product profitability through its impact on sales volume, because timing affects market share (e.g., Boulding and Christen, 2003; Kalyanaram et al., 1995).

As far as this study could discover, past research on the impact of cycle time and proficiency in entry timing on new product profitability has not examined these mediating roles of development costs and sales volume. The first objective is therefore to explore the mediating roles of development costs and sales volume in the relationships among development cycle time, proficiency in market-entry timing, and new product profitability.

Exploring the mediating roles of development costs and sales volume requires taking potential moderators into account (Min, Kalwani, and Robinson, 2006). Two of these moderators are product newness to customers (hereafter referred to as product newness) and new product advantage. Past research suggests that product newness is related to both cycle time (Ali, Krapfel, and LaBahn, 1995) and development costs (Griffin, 2002) and that new product advantage influences the market-entry timing decision (Shankar, Carpenter, and Krishnamurthi, 1998) and the new product's sales volume (Li and Calantone, 1998). These findings raise the question of whether the effects of cycle time on development costs and of proficiency in entry timing on sales volume are different across new products that differ in newness and advantage. Therefore, the second objective is to explore the moderating influence of product newness and new product advantage on the relationships between development cycle time and development costs and between proficiency in market-entry timing and sales volume.

To accomplish these objectives this study reviews the innovation and marketing literatures to derive new insights about the mediated impact of development cycle time and proficiency in market-entry timing on new product profitability and about the moderating influences of product newness and new product advantage on these relationships. Six hypotheses are derived from theory and are tested using a cross-sectional sample of 72 manufacturers of industrial products in the Netherlands.

The rest of this article is structured as follows. The next section presents the model and the hypotheses. The research methodology is then presented, followed by the results and their implications. The final section discusses directions for further research.

Hypotheses

The complete model, shown top left in Figure 1, reveals that development cycle time and proficiency in market-entry timing are expected to have a main effect on development cost and sales volume, respectively. Furthermore, development costs and sales volume are expected mediate the effects of cycle time and proficiency in entry timing on new product profitability. Finally, the main effects of cycle time and proficiency in market-entry timing are expected to be moderated by product newness and new product advantage, respectively.

The Main Effect of Development Cycle Time on Development Costs

Development cycle time, defined as the elapsed time from the beginning of idea generation when the firm decided to develop a new product to the moment the product is ready for market introduction, is consistent with the notion of time to market (Messica and Mehrez, 2002), innovation time (Mansfield, 1988), total time (Griffin, 1993), and lead time (Clark, 1989). There are different viewpoints with regard to the effect of development cycle time on development costs (cf. Kessler and Chakrabarti, 1996). Traditionally, development cycle time has been positively correlated with development costs (Clark and Fujimoto,

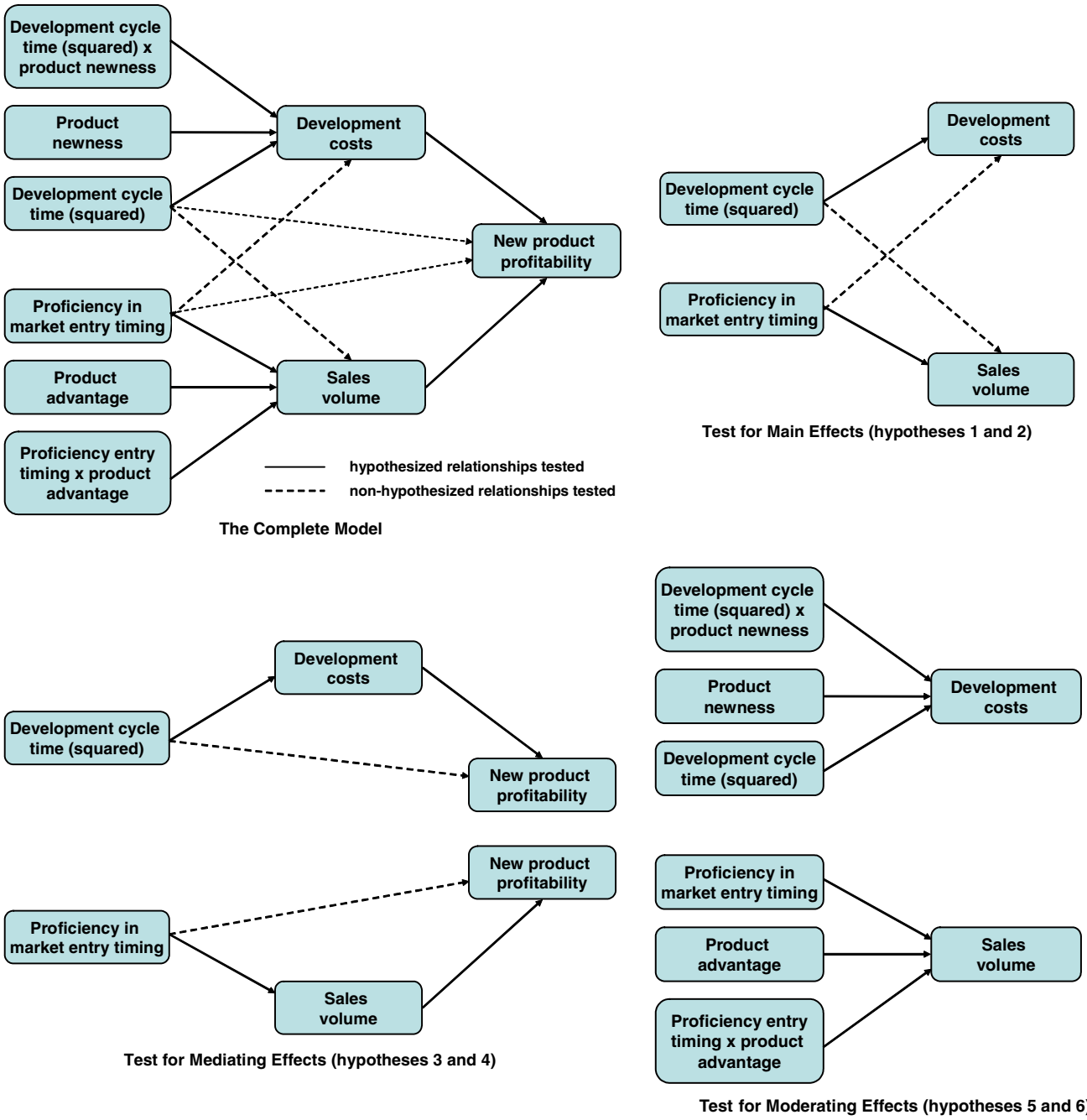

Figure 1: The Procedure Used to Test the Hypotheses

1991). Development costs include all financial requirements and associated human resources needed to develop a new product (Kessler and Bierly, 2002). However, to shorten a new product's cycle time, firms may commit more manpower, materials, and equipment to the development project, which increases the development costs (Kessler and Chakrabarti, 1996). Other researchers have contended that shortening cycle time brings about increased strategic flexibility (Brown and Eisenhardt, 1995) and a higher level of self-consciousness among new product team members (Clark, 1989). This results in an increased efficiency of resources and, hence, lower costs (Kessler and Bierly, 2002). Along this line of reasoning, development cycle time has been linked with increased coordination and subsequent reductions in costly work redundancy, errors, and recycling (e.g., Meyer, 1993; Rosenau, 1988). Moreover, faster development results in less time to spend funds and thus provides a cap on person-hours (Kessler and Chakrabarti, 1996).

Other researchers have proposed a U-shaped relationship between cycle time and development costs (e.g., Gupta et al., 1992). Shortening cycle time to below the minimum of the U-shaped curve means increasing costs because of higher coordination costs (Kessler and Chakrabarti, 1996), additional expenses for overtime work (Murmann, 1994), errors that arise from skipping process steps, and having players on speeded up teams chew up the firm's support resources (Crawford, 1992). Thus, an overly tight schedule burns resources because it pushes the new product team to the limit of its resources and capabilities (Kessler and Chakrabarti, 1996). Similarly, lengthening the new product's cycle time above the function's minimum increases costs because of losing know-how, motivation, and the occurrence of additional set-up costs (Murmann, 1994). Thus, an overly loose schedule wastes resources because of dissipated efforts and lapses of attention (Kessler and Chakrabarti, 1996).

To account for both possibilities this study proposes a U-shaped relationship between development cycle time and new product development costs. This means that some firms may experience increasing costs when accelerating development, and others may experience cost savings when allocating extra resources to shorten the new product's development cycle. This proposition is consistent with results from experimental analyses (Gupta et al., 1992), analytical modeling (Bayus, 1997), and case-study analyses (Murmann, 1994). Surprisingly, little survey-based evidence exists about the U-shaped function. Thus, the following is proposed:

H1: Development cycle time has a U-shaped relationship with development costs.

The Main Effect of Proficiency in Market-Entry Timing on Sales Volume

Proficiency in market-entry timing is defined as the firm's ability to get the market-entry timing right. This is realized by correctly balancing the risks of premature entry and the missed opportunity of late entry (Lilien and Yoon, 1990). This definition is consistent with the concepts of move timing (Lee et al., 2000) and entry timing (Ali et al., 1995). Experimental research suggests that proficient market-entry timing is positively associated with demand advantages related to customers' preferences, memory, learning, and judgments that influence the way they choose and then repurchase a new product (Boulding and Christen, 2003). Carpenter and Nakamoto (1989), for example, showed that customers develop stable positive preferences for new products that enter the market at the right time. Often such a product becomes the standard for the category that influences how customers evaluate other products (Kardes and Kalyanaram, 1992). These preferences are the foundation for a new product's sales volume. Another advantage of proficient market-entry timing is that it allows firms to occupy the most attractive market position that results in a high sales volume (Lane, 1980). Proficient entry timing also enables firms to generate additional sales by locking in customers in categories that have high switching costs (Shankar et al., 1998). Together these advantages suggest that correctly balancing the risks of premature entry and the missed opportunity of late entry is a fundamental requirement to generate new product sales. This study found no empirical research about the effect of proficient market-entry timing on sales volume. Therefore, the following is proposed:

H2: Proficiency in market-entry timing has a positive effect on sales volume.

Development costs and sales volume are two important elements in the new product profitability equation (Bayus, 1997). Theory suggests that development cycle time and proficiency in market-entry timing contribute to new product profitability through the cost and demand side of this equation, respectively. On the cost side, cycle time influences new product profitability through its effect on development costs (e.g., Gupta et al., 1992). On the demand side, proficiency in entry timing affects new product profitability through its impact on sales volume (e.g., Bayus et al., 1997). This study found no evidence that suggests that cycle time is related to sales volume or that proficiency in entry timing has an effect on development costs. Therefore, no hypotheses with regard to these effects are formulated, although they will be tested for.

The Mediating Effect of Development Costs

Past empirical research investigating the effect of development cycle-time reduction on new product profitability has not taken development costs into account. This might explain why some studies find a

positive relationship (e.g., Calantone and Di Benedetto, 2000; Lynn, Skov, and Abel, 1999), others find mixed results (e.g., Ittner and Larcker, 1997), still others find negative results (Adams-Bigelow and Griffin, 2005; Griffin, 2002), and most studies report no evidence of a link between cycle time and new product profitability (e.g., Dröge, Jayaram, and Vickery, 2004; Meyer and Utterback, 1995). The results from game theoretical modeling underline the importance of considering the role of development costs, because firms have different cost structures. These cost structure differences imply that cycle-time reduction decisions are likely to have a different impact on new product profitability (Bayus et al., 1997). It is argued therefore that development costs act as a go-between in the relationship between cycle time and new product profitability. This role of development costs fine-tunes experimental (Gupta et al., 1992), simulation (Bayus, 1997), and case (Murmann, 1994) evidence that cycle time has a U-shaped link with development costs and that development costs negatively impact new product profitability. Thus, the following is proposed:

H3: The effect of development cycle time on new product profitability is mediated by development costs.

The Mediating Effect of Sales Volume

Research investigating the influence of proficient market-entry timing on new product profitability has, as far as this study could find out, not taken sales volume into account. Game theoretical modeling underlines the significance of considering sales volume because new products are asymmetric in their revenue potentials (Bayus et al., 1997). These asymmetries originate from differences in new products' windows of opportunity in terms of the length of the life cycle, the time to peak sales, and the change in prices over time (Bayus, 1997). These asymmetric sales functions lead different entry timing decisions to have a different impact on new product profitability. Based on this line of reasoning this study posits that sales volume acts as a go-between in the relationship between the proficiency in market-entry timing and new product profitability. Thus, the following is proposed:

H4: The effect of proficiency in market-entry timing on new product profitability is mediated by sales volume.

The Moderating Effect of Product Newness

Although cycle time is expected to have a U-shaped relationship with development costs, this effect is likely to be more marked for products with a higher degree of newness. Product newness represents the degree to which the new product is compatible with existing consumption patterns of customers (Atuahene-Gima, 1996). Past research suggests that product newness is important for development cycle time and costs. Olson, Walker, and Ruekert (1995) show, for example, that new product teams encounter greater difficulty and take more time when developing products with a higher degree of newness. In addition, the development tasks are more uncertain and risky, which increases the need for coordination that leads to higher costs (Sheremata, 2000). Similarly, de Brentani (2001) suggests that highly new products require more efforts, time, and resources. Griffin (2002) also points out that higher newness increases development time and costs because of greater new product complexity. Together these findings suggest that product newness may attenuate the U-shaped relationship between development cycle time and new product development costs. Therefore, the following is proposed:

H5: Product newness attenuates the U-shaped relationship between development cycle time and development costs.

Past research reveals that product newness also has a curvilinear link with new product profitability (Kleinschmidt and Cooper, 1991). It was already hypothesized that product newness moderates the link between cycle time and development costs and also that development costs mediate the effect of cycle time on new product profitability. Keeping sales volume constant, there are no grounds, as far as this study could discover, to presume that product newness or the interaction between newness and cycle time should impact new product profitability, after controlling for their influence through development costs. That is why no hypotheses are formulated with regard to these effects.

The Moderating Effect of Product Advantage

Although proficiency in market-entry timing is presumed to increase sales volume, this positive effect is expected to be stronger for new products of higher

advantage. Product advantage refers to the customer's perception of product superiority with respect to quality, cost-benefit ratio, technological innovativeness, or function relative to existing products (Montoya-Weiss and Calantone, 1994). Empirical evidence suggests that product advantage is important for new product trial and adoption. Holak and Lehmann (1987) found, for example, that product advantage is positively associated with customer purchase intentions. Similarly, Horsky (1990) showed that the sales potential of the new product depends on the benefits that the product provides to customers. Li and Calantone (1998) also found that new product advantage positively affects market performance. Together these findings suggest that product advantage amplifies the positive impact that entering the market at the right moment, in view of the new product's window of opportunity, has on sales volume. Therefore, the following is proposed:

H6: Product advantage strengthens the positive relationship between proficiency in market-entry timing and sales volume.

Prior research reveals that product advantage also has a positive effect on new product profitability (Henard and Szymanski, 2001). Earlier it was hypothesized that new product advantage moderates the link between proficiency in entry timing and sales volume and also that sales volume mediates the effect of proficiency in entry timing on new product profitability. Keeping development costs constant, there is, as far as this study could discover, no reason to assume why product advantage and the interaction between advantage and proficiency in entry timing should impact new product profitability, after controlling for their influence through sales volume. Thus, no hypotheses are formulated with regard to these effects.

Methodology

This study used a cross-sectional research design to collect the data required for testing the hypotheses. The sample consisted of 275 manufacturers of industrial products in the Netherlands in the primary metal, fabricated metal, machinery equipment, electrical equipment, and transportation equipment industries (standard industrial classification [SIC] codes 33 to 37). Through a telephone presurvey 183 firms were identified with (1) a new product that had been in the market for more than 12 months to ensure sufficient data on performance; (2) a new product that was representative of the firm's product development program; and (3) a knowledgeable key informant from the NPD team. A rating scale measured the representativeness of the new product (anchored 1 = not representative and 7 = very representative). The mean response was 5.30 ($\sigma = 1.21$), showing that the new product selected was representative of the firm's NPD program.

A total of 123 (67.2%) knowledgeable informants willing to cooperate received a personalized letter explaining the purpose of the study, a questionnaire, and a preaddressed, postage paid return envelope. Nonrespondents received a reminder letter and a second questionnaire. These efforts yielded 72 usable responses, a response rate of 39.3% (58.5% of those who received the questionnaire). T-tests indicated no significant differences in the mean responses on any construct across respondents with different functional backgrounds (e.g., research and development [R&D], marketing) and across firms from different industries. Time-trend extrapolation was used to test for nonresponse bias (Armstrong and Overton, 1977). In comparing early (first quartile) and late (fourth quartile) respondents using t-tests, no significant differences emerged in mean responses on any construct. Together these results suggest that respondent, industry, and nonresponse biases were not problematic. Table 1 provides sample characteristics.

Table 1: Sample Characteristics

Industry (SIC[a] Code)		Employees		Sales (euros × 106)		Background Respondents	
Primary Metal (33):	8	11 to 50:	6	5 to 20:	28	R&D Manager:	16
Fabricated Metal (34):	29	51 to 100:	29	21 to 40:	21	Engineering:	18
Machinery Equipment (35):	21	101 to 250:	23	41 to 60:	11	New Business Manager:	15
Electrical Equipment (36):	6	251 to 500:	13	61 to 100	11	Product Manager:	13
Transportation (37):	8	>500:	1	>100	1	Marketing/Sales:	10
N	72		72		72		72

[a] SIC, standard industrial classification.

Measure Development and Pretesting

A pool of potential items was generated for each construct using the literature and interviews with academics and practitioners. Pretests of initial items occurred in two phases: (1) face-to-face interviews with three academics; and (2) face-to-face interviews with eight NPD managers. At each stage, participants identified confusing items, 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.

Measurement Approach and Limitations

Constructs can be measured in different ways. They may be gauged objectively either by asking respondents to report absolute values or via secondary sources, or they may be measured subjectively by asking respondents to assess the constructs relative to competitors, objectives, or past performance. This study used subjective data to test the hypotheses for several reasons. First, subjective measures have the advantage of facilitating comparisons across NPD projects of firms from different industries (Atuahene-Gima and Ko, 2001). Second, subjective measures have been shown to be correlated to self-reported objective measures of product innovation (e.g., Ancona and Caldwell, 1992; Zahra and Covin, 1993). Third, secondary (i.e., certifiable by a third party) data were impossible to obtain for some of the constructs (i.e., proficiency in market-entry timing). Fourth, subjective measures have often been used in prior development cycle time (e.g., Sherman et al., 2000) and new product profitability (e.g., Ali, 2000) studies.

The use of subjective measures for testing the hypotheses is not without shortcomings. A first limitation is the lack of external validation of respondents' assessments (Venkatraman and Ramanujam, 1987). Given the nature of the sample it was almost impossible to obtain secondary data. Alternatively, within-method triangulation was used by also asking respondents to report objective values on cycle time and new product profitability (Jick, 1979). The correlations between the subjective and objective measures were positive and significant. A second drawback that remains is possible common method bias. To assess this potential problem Harman's one-factor method was applied (Podsakoff and Organ, 1986). The results indicated that the first factor did not account for a majority of the variance and that there was no general factor in the unrotated factor structure. A final shortcoming is that subjective measures are subject to respondent memory clarity and that respondents are likely to overrate their responses. Venkatraman and Ramanujam (1987) showed, however, that managers tend to be less biased in their assessments than researchers have tended to give them credit for.

Measures

Proficiency in market-entry timing was measured subjectively using one newly developed item and one item adapted from Griffin and Page (1996), respectively (see Appendix for all measures). The correlation between the items was positive ($r = 0.53$; $p < 0.01$). Development cycle time was measured subjectively and objectively using single items from Sherman et al. (2000) and Griffin (2002), respectively. The correlation between the items was positive ($r = 0.41$; $p < 0.01$). When subjected to a factor analysis the items pertaining to proficiency in entry timing and cycle time loaded onto two distinct factors with eigenvalues greater than 1.

Sales volume was measured subjectively using two items drawn from Griffin and Page (1996). The correlation between the items was positive ($r = 0.60$; $p < 0.01$). Development costs were measured subjectively using two items adapted from Gupta et al. (1992) and Griffin and Page (1996), respectively. The correlation between the items was positive ($r = 0.46$; $p < 0.01$). New product profitability was measured subjectively and objectively using single items adapted from Griffin and Page (1996) and based on Cooper and Kleinschmidt (1987), respectively. The correlation between the items was positive ($r = 0.54$; $p < 0.01$) and well within the range reported in other studies using subjective and self-reported objective measures of performance (e.g., Robinson and Pearce, 1988). When subjected to a factor analysis the items pertaining to sales volume, development costs and new product profitability loaded onto three distinct factors with eigenvalues greater than 1.

New product advantage was measured subjectively using four items from Atuahene-Gima (1996). The

reliability coefficient was 0.72. Product newness also was measured subjectively using four items adapted from Atuahene-Gima (1995). The reliability coefficient was 0.86. When subjected to a factor analysis the items pertaining to product newness and advantage loaded onto two distinct factors with eigenvalues greater than 1.

Based on the previous evidence the constructs were formed, where applicable, by averaging the responses to each item in a particular scale. From a content validity perspective it might well be argued that using single-item indicators is more appropriate in testing the hypotheses, because the interitem correlations for the two item constructs were not very high. To check this the regressions were also estimated using single-item indicators. The results were similar to the ones reported in the results section. Multiple-item measurement is, in general, preferred over single-item measurement. Therefore, the multiple-item constructs were used to test the hypotheses.

Data Analysis

The sample size of 72 new products precludes using structural equation modeling to test all hypotheses simultaneously. Thus, multiple regression was used to test for the main effects of development cycle time and proficiency in market-entry timing (H1 and H2). To test for the mediating effects of development costs and sales volume (H3 and H4) three regression equations were estimated, as recommended by Baron and Kenny (1986). Finally, moderated regression analysis was applied to test for the moderating effects of product newness and product advantage (H5 and H6).

Results

As is true with all research, the methodology used imposes compromises in the results. This study used subjective measures suffering from the previously discussed shortcomings to test the hypotheses. Moreover, the composition of the sample of manufacturers of industrial products in the Netherlands implies that no claims are made about the generalizability of the results beyond this context. The results described in the following sections must be interpreted with these limitations in mind.

Table 2: Main Effects of Cycle Time and Proficiency in Entry Timing

	Equation 1: Development Costs	Equation 2: Sales Volume
Constant	4.481	3.888
Development Cycle Time	**−0.375****	−0.111
Development Cycle Time^2	**0.133***	0.142
Proficiency in Market-Entry Timing	0.068	**0.438****
R^2	0.423	0.198
Adjusted R^2	0.398	0.164
F-Value	**16.839****	**5.696****
N	72	72

* $p<0.05$.
** $p<0.01$.

Results Related to Main Effects of Development Cycle Time and Proficiency in Entry Timing

To test for the main effects of development cycle time and proficiency in market-entry timing two separate regression equations were estimated because development costs and sales volume were not significantly correlated ($r=-0.14$; $p=0.24$). The approach is graphically represented on the top right of Figure 1. The results, shown in Equation 1 of Table 2, reveal that the linear ($b=-0.375$; $p<0.01$) and quadratic ($b=0.133$; $p<0.05$) effects of development cycle time on development costs are negative and positive, respectively. These findings support the proposed U-shaped relationship between development cycle time and development costs (Aiken and West, 1996). When the first partial derivative with respect to cycle time is set equal to zero, development costs reaches its minimum at 3.69 when development cycle time equals 1.41. The results further show that proficiency in market-entry timing has no significant effect on development costs. Together the findings provide support for H1. The results of Equation 2 show that proficiency in market-entry timing ($b=0.438$; $p<0.01$) has a positive effect on sales volume. The linear and quadratic terms of development cycle time are not significant. These findings provide support for H2.

Results Related to Mediating Effect of Development Cost

To test for the mediating effect of development costs, shown bottom left in Figure 1, a set of three regression equations was estimated as recommended by Baron

Table 3: Mediating Effect of Development Costs

	Equation 1: Development Costs	Equation 2: New Product Profitability	Equation 3: New Product Profitability
Constant	4.475	4.593	2.411
Development Costs	—	—	**−0.510****
Development Cycle Time	**−0.453****	**0.384****	0.054
Development Cycle Time^2	**0.117***	**−0.161***	0.115
R^2	0.434	0.151	0.174
Adjusted R^2	0.420	0.130	0.142
F-Value	**30.997****	**7.050****	**5.469****
N	72	72	72

* $p<0.05$.
** $p<0.01$.

Table 4: Mediating Effect of Sales Volume

	Equation 1: Sales Volume	Equation 2: New Product Profitability	Equation 3: New Product Profitability
Constant	−0.133	4.673	2.500
Sales Volume	—	—	**0.509****
Proficiency in Market-Entry Timing	**0.477****	**0.215***	0.036
R^2	0.168	0.045	0.325
Adjusted R^2	0.157	0.033	0.308
F-Value	**15.553****	**3.773***	**19.052****
N	72	72	72

* $p<0.05$.
** $p<0.01$.

and Kenny (1986). The first equation in Table 3 tests the effect of the independent variables on the mediating variable. The results show that development cycle time ($b=-0.453$; $p<0.01$) and development cycle time squared ($b=0.117$; $p<0.05$) have negative and positive effects on development costs, respectively. The second equation of Table 3 tests the effect of the independent variables on the dependent variable. The results show that the linear term ($b=0.384$; $p<0.01$) has a positive and the squared ($b=-0.161$; $p<0.05$) term of development cycle time a negative effect on new product profitability. The third equation tests whether the mediator influences the dependent variable while controlling for the direct effect of the independent variables. The results indicate that this condition is satisfied because development cost ($b=-0.510$; $p<0.01$) has a negative effect on new product profitability, whereas development cycle time and cycle time squared have no significant effects on new product profitability. Taken together, this pattern of results shows that development costs completely mediate the link between development cycle time and new product profitability. Therefore, H3 is supported.

Results Related to Mediating Effect of Sales Volume

To test for the mediating effect of sales volume (see bottom left in Figure 1) again three regression equations were estimated. The results in Table 4 show that in Equation 1 proficiency in market-entry timing has a positive relationship with sales volume ($b=0.477$; $p<0.01$). In Equation 2, proficiency in entry timing has a positive relationship with new product profitability ($b=0.215$; $p<0.01$). In Equation 3 sales volume has a positive effect on new product profitability ($b=0.509$; $p<0.01$), whereas proficiency in entry timing has no significant effect on new product profitability. Together this pattern of results indicates that the relationship between the proficiency in market-entry timing and new product profitability is fully mediated by sales volume. Therefore, H4 is supported.

Results Related to Moderating Effect of Product Newness

To test for the moderating effect of product newness (see bottom right in Figure 1), hierarchical regression analyses was used. Prior to creating the interaction term, the constituent variables were mean centered to eliminate multicollinearity (Aiken and West, 1996). The results, shown in Table 5, show that in Equation 1 the linear ($b=-0.453$; $p<0.01$) and quadratic ($b=0.117$; $p<0.01$) effects of cycle time are negative and positive, respectively. Equation 2 reveals that the effects of the linear and quadratic terms of cycle time remain significant. Product newness has no significant on development costs. The incremental R^2 is also not significant. The results of the third equation reveal that the interaction terms between cycle time and product newness are not significant. Thus, there is no support for H5. An additional test for the presence of possible main effects revealed that product newness and the interactions between product newness and the linear and squared terms of development cycle time have no significant effects on new product profitability. No mediated-moderation effects of product newness were found.

Table 5: Moderating Effect of Product Newness

	Equation 1: Development Costs	Equation 2: Development Costs	Equation 3: Development Costs
Constant	4.475	4.525	4.533
Development Cycle Time	**−0.453****	**−0.445****	**−0.439****
Development Cycle Time^2	**0.117***	**0.120****	**0.124****
Product Newness	—	0.168	0.150
Cycle Time × Product Newness	—	—	−0.030
Cycle Time^2 × Product Newness	—	—	−0.016
R^2	0.434	0.451	0.454
Adjusted R^2	0.420	0.429	0.416
F-Value	**30.997****	**20.552****	**12.120****
R^2 Change	—	0.017	0.003
N	72	72	72

* $p<0.05$.
** $p<0.01$.

Results Related to Moderating Effect of Product Advantage

To test for the moderating effect of product advantage hierarchical regression analyses was used (bottom right in Figure 1). Again the constituent variables were mean centered to eliminate multicollinearity (Aiken and West, 1996). The results, shown in Table 6, reveal that in Equation 1 the proficiency in market-entry timing ($b=0.477$; $p<0.01$) has, as expected, a positive effect on sales volume. The R^2 change between Equation 1 and Equation 2 is not significant. Proficiency in market-entry timing still has a positive effect ($b=0.438$; $p<0.01$), but the impact of product advantage on sales volume is not significant. The results of Equation 3 show that proficiency in market-entry timing ($b=0.419$; $p<0.01$) and the interaction term between proficiency in entry timing and product advantage ($b=0.355$; $p<0.01$) have positive effects on sales volume. To determine the monotonicity of the moderating effect the first partial derivative with regard to product advantage was set equal to zero. The inflection point is reached when the proficiency in market-entry timing equals −0.44. Since this point is outside the range of interest (1–7), this shows that proficiency in market-entry timing has a monotonic positive impact on sales volume over the range of product advantage. Thus, support is found for H6. An additional test for the presence of possible main and mediated-moderation effects of new product advantage revealed that the effects of product advantage and the interaction between proficiency in market-entry timing and new product advantage on new product profitability are, as expected, completely mediated by sales volume.

Table 6: Moderating Effect of Product Advantage

	Equation 1: Sales Volume	Equation 2: Sales Volume	Equation 3: Sales Volume
Constant	−0.133	−0.171	−0.266
Proficiency in Market-Entry Timing	**0.477****	**0.438****	**0.419****
Product Advantage	—	0.237	0.156
Entry Timing × Product Advantage	—	—	**0.355****
R^2	0.168	0.190	0.283
Adjusted R^2	0.157	0.168	0.255
F-Value	**15.553****	**8.899****	**9.877****
R^2 Change	—	0.022	**0.093****
N	72	72	72

* $p<0.05$.
** $p<0.01$.

Discussion and Implications

This study aimed to reconcile the conflicting results with regard to the effects of development cycle time and proficiency in market-entry timing on new product profitability. As such the present study makes two contributions. First, it broadens the theory on two temporal aspects of NPD by hypothesizing, and then testing, the mediating roles of development costs and sales volume in the relationships among cycle time, proficiency in entry timing, and new product profitability. Second, it provides evidence for the moderating influence of new product advantage on the link between proficiency in entry timing and sales volume. This study's key results are as follows (Figure 2):

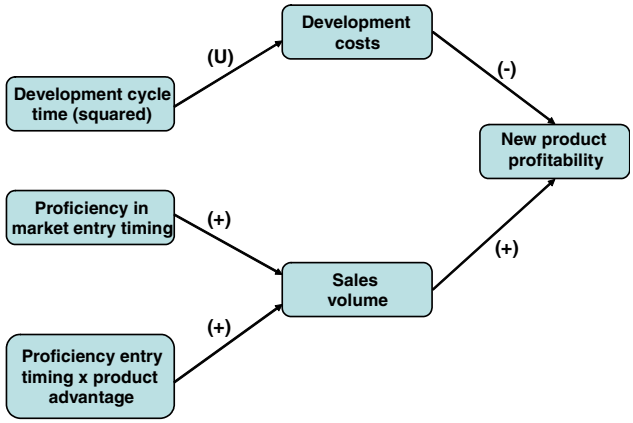

Figure 2: Empirically Derived Model

- Development cycle time has a U-shaped relationship with development costs.
- Development costs mediate the relationship between development cycle time and new product profitability.
- Proficiency in market-entry timing has a positive association with sales volume.
- Sales volume mediates the relationship between proficiency in entry timing and new product profitability.
- Product advantage strengthens the positive relationship between proficiency in market-entry timing and sales volume.

The managerial inferences that can be drawn from the results are based on the documentation of existing practices across a moderate number of manufacturers in the Netherlands. Therefore, these inferences are not necessarily appropriate outside this research context.

First, the results suggest that the U-shaped relationship between development cycle time and development cost may be common for manufacturers of industrial products. Combining this with the finding that development costs mediate the link between cycle time and new product profitability implies that there may be an ''optimum'' cycle time that maximizes new product profitability. Managers may want to anticipate this pattern, and it may behoove them to make a careful analysis of the trade-off among cycle time reduction, development costs, and new product profitability in their particular context. Cycle-time reduction for speed's sake may lead to lower long-run profits. Clearly, additional research assessing the trade-offs between among time to market, development costs, and new product profitability is needed.

Second, the finding that proficiency in market-entry timing is positively related to sales volume implies that carefully balancing the risks of premature entry and the missed opportunity of late entry may be a prerequisite to achieve the new product's market share objectives. The message for managers may be that proficiency in entry timing is at least as important as order of market entry (i.e., pioneering vs. following) to build market share and that the sales volume of a new product that is ahead or behind its strategic window will suffer. Future research should aim to tease apart the sales impact of entry order versus entry timing.

Third, the results suggest that the effects of development cycle time and proficiency in market-entry timing on new product profitability may be mediated by development costs and sales volume, respectively. To maximize profits managers need to distinguish between costs and demand side effects of cycle time and entry timing on new product profitability. Keeping this distinction in mind should help them to better determine the relative profit impact of investments in cycle-time reduction or improved market-entry timing. Future research should continue to break down the cost and demand side effects on new product profitability.

Fourth, this study did not find that product newness moderates the relationship between development cycle time and development cost. This finding is somewhat unexpected because previous research suggests that product newness is associated with longer lead times (Clark and Fujimoto, 1991) and higher development costs (Griffin, 2002). The analysis reveals that product newness may be an antecedent of development costs (at a significance level of 0.065) instead of a moderator influencing the impact of cycle time on development costs. The role of product newness clearly warrants further research.

Finally, this research found that new product advantage strengthens the positive relationship between proficiency in market-entry timing and sales volume. This finding suggests that highly advantaged products that enter the market at the right moment may have a highly attenuated sales volume that is perhaps even greater than expected. However, it also implies that new products with lower advantage may have very little leeway in hitting the ''sweet spot'' in the window of opportunity. The message that comes to management is that ''doing the right thing'' (i.e., to develop a highly advantaged new product) may be at least as important as correctly balancing the risks of premature entry and the missed opportunity of late entry. A more in-depth understanding of the significance of new product advantage is clearly needed (cf. Shankar et al., 1998).

Limitations

The study's results must be interpreted with the following limitations in mind. First, the composition of the sample is such that no claims are made about the generalizability of the results beyond this context. The present findings need further testing using larger and independent samples outside the Netherlands. Second, this study used a single informant to test the hypotheses. Therefore, the potential for common

method variance inflating the relationships cannot be completely discounted, although this bias was not found using Harman's one-factor test. Nevertheless, future research should move toward between-method triangulation to explore the potential impact of common method variance (Jick, 1979). Third, this study used primary data from key informants to test the hypotheses. The informants may have overrated their responses, which could have inflated the relationships. Future research should where possible also collect secondary data to rule out this possibility. Fourth, the results might be confounded due to unmeasured industry-level factors, although these effects were not found using industry dummies in the regressions. To fully discard this possibility, future research could conduct a single-industry study. Fifth, this study used a single new product that was representative of the firm's NPD program. Thus, the potential for selection bias affecting the relationships cannot be ruled out. To avoid this problem future research may consider using data on multiple new products in a firm's portfolio. Finally, this study used data on product newness and product advantage from the firm's perspective. Future research should try to also collect data from the customer's perspective to allow researchers to be more confident of their results. All of these directions require new data collection efforts, but these efforts will provide important new insights on the interplay among development cycle time, proficiency in market-entry timing, and new product profitability.

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Appendix: Items and Descriptive Statistics

	Mean	SD
Objective New Product Development Time Please indicate how long it took to develop the new product that you selected from the beginning of idea generation to the moment that the product was ready for introduction (Griffin, 2002): _____ years and _____ months	16.89	8.72
Subjective New Product Development Time How well has the product you selected performed on product development cycle time (Sherman, Souder, and Jenssen, 2000). Here: 1 = very much shorter and 7 = very much longer. . . . relative to competitors in your industry that have developed similar products?[R]	4.63	1.46
Proficiency in Market-Entry Timing Please indicate your extent of agreement about how well the following statement is an accurate description of the new product that you selected. Here: 1 = strongly disagree and 7 = strongly agree. The new product that you selected: . . . was introduced into the market at the right moment. Please indicate how satisfied you are with the introduction timing of the new product that you selected. Here: 1 = not at all satisfied and 7 = highly satisfied. How satisfied are you with (Griffin and Page, 1996): . . . the timing of the market introduction of the new product you selected?	4.51	1.32
Development Costs Please indicate your extent of agreement about how well the following statement is an accurate description of the new product that you selected. Here: 1 = strongly disagree and 7 = strongly agree. The new product that you selected (based on Gupta, Brockhoff, and Weisenfeld, 1992): . . . exceeded the budget specifications with regard to development cost.[R] Please indicate how satisfied you are with the development costs of the new product that you selected. Here: 1 = not at all satisfied and 7 = highly satisfied. How satisfied are you with (Griffin and Page, 1996): . . . the development costs of the new product you selected?	4.15	1.19
New Product Sales Please indicate how satisfied you are with the performance of the new product that you selected on the indicator mentioned below. Here: 1 = not at all satisfied and 7 = highly satisfied. How satisfied are you with (Griffin and Page, 1996): . . . the degree to which the new product you selected met unit volume goals? . . . the sales volume of the new product that you selected in comparison to competing products?	4.56	1.46
Objective New Product Profitability Please indicate the return on the investment (ROI/IRR [internal rate of return]) for the new product that you selected (Cooper and Kleinschmidt, 1987): _____ ROI/IRR	19.36	6.74
Subjective New Product Profitability Please indicate how satisfied you are with the profitability of the new product that you selected. Here: 1 = not at all satisfied and 7 = highly satisfied. How satisfied are you with (Griffin and Page, 1996): . . . the degree to which the new product you selected met ROI/IRR goals? . . . the degree to which the new product you selected met market share (in units) goals?	4.69	1.42
Product Advantage Please indicate your extent of agreement about how well each of the following statements is an accurate description of the new product that you selected. Here: 1 = strongly disagree and 7 = strongly agree. The new product that you selected (Atuahene-Gima, 1996): . . . offered unique benefits to customers. . . . provided higher quality than competing products.	5.34	1.42

Appendix. (Contd.)

	Mean	SD
. . . was highly innovative.		
. . . replaced inferior products.		
Product Newness	4.81	1.21
Please use the following scale to indicate your extent of agreement about how well each of the following statements is an accurate description of the new product that you selected. Here: 1 = strongly disagree and 7 = strongly agree.		
The new product that you selected (Atuahene-Gima, 1995):		
. . . required advance planning by customers.		
. . . involved high change over costs for customers.		
. . . was difficult for customers to understand or evaluate.		
. . . took time before customers really understood the product's advantages.		