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The joint impact of quality and innovativeness on short-term new product performance ☆

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ABSTRACT

In the last decade a number of conceptualizations of product quality and innovativeness have been suggested, and academics as well as managers have begun to understand that the relationships between quality, innovativeness and new product performance are more complicated than they may initially seem to be. While an innovation-oriented strategy depends on the exploration of new possibilities through search, risk-taking and experimentation, a high quality strategy requires the exploitation of existing certainties through efficiency, standardization and control. In this research, we demonstrate that the interaction effects of quality (objective and subjective) and innovativeness (for the firm and for the customer) on new product performance are different than the isolated impact of these variables. In addition, by focusing on the main and joint impact of these variables on short-term new product performance, we provide valuable recommendations for new product launch decisions.

"The pure and simple truth is rarely pure and never simple."—Oscar Wilde

1. Introduction

In recent years, worldwide corporate innovation investment (EU R&D Investment Scoreboard) and quality investment (ISO Survey of Certifications) have accelerated, growing by 10% and 16% respectively. Accordingly, a substantial number of studies have investigated the impact of product quality and innovativeness on new product performance. Product quality has been analyzed in relation to new product development speed (Lukas & Menon, 2004), price (Brucks, Zeithaml, & Naylor, 2000), brand name (Warlop, Ratneshwar, & Van Osselaer, 2005) or in the emergence of dominant design (Srinivasan, Lilien, & Rangaswamy, 2006). Similarly, the implications of product innovativeness on new product performance have been analyzed with regard to development teams (Sethi, 2000), product preannouncements (Lee & O'Connor, 2003) or entry strategies (Ali, Krapfel, & LaBahn, 1995) among other variables.

Despite such academic efforts, prior research has shown that product quality investments do not achieve their objectives (Rust, Moorman, & Dickson, 2002). However, more importantly, recent findings by Gourville (2006) reveal that innovative products fail at a stunning rate of between 40% and 90%.

There are several reasons that may help explain why quality and innovativeness do not perform as expected. First of all, most of the multidimensional approaches to product innovativeness and product quality have not been applied consistently when studying the performance of new products. Several authors have illustrated this by looking at how firm and customer dimensions of product innovativeness and product quality may provide new insights into these relationships. For example, Gourville (2006) suggests that executives overvalue their innovations, while customers irrationally overvalue existing alternatives. Similarly, Morgan and Vorhies (2001) have analyzed the gap that exists between the quality most firms believe their products to possess, and quality that is perceived by their customers.

An additional explanation for the above-mentioned inconsistent findings may be that the impact of product innovativeness on new product performance depends on the quality of the new product, and vice versa (Cho & Pucik, 2005). While such interaction effects are highly relevant to managers, surprisingly little is known about the joint impact of product innovativeness in combination with other product-related variables, for instance product quality, on new product performance (Henard & Szymanski, 2001). However, there are several reasons to expect that a significant interaction exists between quality and innovativeness. For example, firms that aim at developing a new product that is both innovative and of a high quality often run into difficulties, because the resources and strategies they need to implement an innovation are different from the ones they need to manufacture a high quality product (Lukas & Menon, 2004). While an innovation-oriented strategy depends on the exploration of new possibilities through search, risk-taking and experimentation, a high

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quality strategy requires the exploitation of existing certainties through efficiency, standardization and control (Rust et al., 2002).

A third possible explanation stems from the contention that the determinants of new product performance can have a different impact in the short term than they have in the long term (Henard & Szymanski, 2001). Specifically, managers demand a deeper analysis of the impact of quality and innovativeness on short-term new product performance, because it is difficult for firms to change customer perceptions later after a new product launch has proven to be unsuccessful in the short term (Warlop et al., 2005).

Accordingly, the objective of this research is to analyze the joint impact of product quality and product innovativeness on short-term new product performance. In addition to examining the main effects of these variables on new product performance, we take a closer look at how they interact. Product quality is analyzed on the basis of internal (objective and subjective) dimensions, which are in turn based on the product's intrinsic cues, and which can often be much better controlled by firms developing new products. The different dimensions of product innovativeness as far as the firm (technological and marketing) and the customer (product superiority, compatibility and complexity) are concerned, are measured using the resource-based/organizational learning theory (Danneels & Kleinschmidt, 2001; Garcia & Calantone, 2002) and the diffusion theory respectively (Calantone, Chan, & Cui, 2006). Finally, short-term performance is evaluated for the first two stages of the product life cycle (introduction and growth stage).

We believe this study contributes to existing literature by providing new insights into the relationships between quality, innovativeness and new product performance. From a managerial point of view, this research gives valuable information to managers regarding the way to assign resources among quality and innovativeness in order to increase new product success in the short term. Our study is organized as follows. We begin by presenting the theoretical background and hypotheses, after which we explain the research method and the way we tested our hypotheses. We conclude by discussing the academic and managerial implications of our findings.

2. Product quality and new product performance

At project level, most authors accept Zeithaml's (1988) classification framework of product quality, which describes product quality as either based on extrinsic cues (i.e., external quality) or on intrinsic cues (i.e., internal quality). Although extrinsic cues are product-related, they are not part of the physical product itself. The extrinsic cue approach explains product quality based on the brand, price and country of origin (Warlop et al., 2005). Intrinsic cues cannot be changed without altering the nature of a product. Internal quality is further distinguished as being either objective or subjective in nature (see Fig. 1). Objective product quality indicates whether the product performs as expected, incorporates features customers do not expect, or has a low probability of failing (Curkovic, Vickery, & Dröge, 2000). Subjective product quality assesses quality based on customer perceptions of cues like product image or product design (Creusen & Schoormans, 2005).

Although many studies have investigated the impact of product quality on performance (Buzzell, 2004), only few have paid attention to the various components (e.g., objective, subjective, internal, external). Our study focuses on internal product quality because it has received far less attention than external product quality (Garvin, 1987) and it can often be controlled much better by the developing firm.

2.1. The impact of objective product quality on new product performance

Carbonell, Munuera and Rodriguez (2004) have found that high performance products (i.e., new products that perform as expected) tend to lead to higher market and financial performance and higher levels of customer satisfaction. In addition, Lemmink and Kasper (1994) have demonstrated that, if a new product has a lower probability of failing in a specified period of time, customer satisfaction will be higher. Furthermore, Brucks et al. (2000) have shown that products that incorporate features customers do not expect achieve better results both in financial and market-related terms. Finally, Curkovic et al. (2000) have found that an aggregate measure of objective product quality made up of several dimensions (e.g., reliability, features) had a positive impact on the performance of new products. Based on this evidence, we hypothesize:

H1. Objective product quality has a positive impact on new product performance

2.2. The impact of subjective product quality on new product performance

Subjective product quality refers to the quality of a product based on the way customers perceive cues like product image or product design (Creusen & Schoormans, 2005). It has been demonstrated that individual subjective product quality components have a positive influence on the performance of new products. For example, Lemmink and Kasper (1994) have found that products with a good image enhance customer satisfaction, while Swan, Kotabe, and Allred (2005) argue that other subjective product quality components, for instance an attractive design, have a positive impact on new product profitability. We therefore hypothesize:

H2. Subjective product quality has a positive impact on new product performance

3. Product innovativeness and new product performance

Although researchers are not consistent when it comes to labeling new products, independent of the particular name given to a new product (Krishnan & Ulrich, 2001), they agree that, at project level, innovativeness needs to be measured relative to the firm and its customers (Goldenberg, Lehmann, & Mazursky, 2001). The former

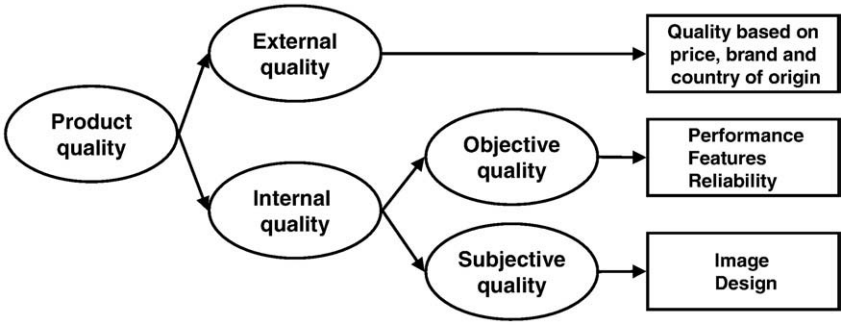

Fig. 1. Product quality framework (adapted from Zeithaml, 1988).

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perspective draws on the resource-based theory of the firm and on organizational learning theory in explaining the level of innovativeness as perceived by a firm. This view focuses on the degree of fit between a new product's requirements and a firm's existing technological or marketing resources and capabilities (Song & Parry 1997). According to Danneels (2002), product innovativeness will be high when there is a low fit between the new product's requirements and the technological and marketing resources of a firm. In addition, the extent to which an organization faces an unfamiliar technological and/or market environment affects the level of product innovativeness for the firm (Hult, Hurley, & Knight, 2004). The way customers perceive product innovativeness draws on existing literature with regard to the adoption and diffusion of innovation to understand how customers perceive product innovativeness (Rogers 1995). The level of innovativeness as perceived by customers has been investigated in several studies (Moreau, Lehmann, & Markman, 2001), through the innovation attributes of product superiority, compatibility and complexity. Fig. 2 summarizes product innovativeness at project level.

3.1. The impact of product innovativeness for the firm on new product performance

The impact product innovativeness for the firm on new product performance has traditionally been explained through the concepts of resource fit and familiarity. For example, Song and Parry (1997) have shown that a low fit between a new product's requirements and a firm's existing competencies has a negative impact on new product performance. Li and Calantone (1998) have found that market newness reduces new product performance, mainly because it is more difficult to understand the needs and wants of new customers. We therefore hypothesize:

H3. Product innovativeness for the firm has a negative impact on new product performance

3.2. The impact of product innovativeness for the customer on new product performance

Literature on the adoption and diffusion of innovation (Rogers, 1995) suggests that product innovativeness for the customer consists of three main product characteristics (product superiority, compatibility and complexity). Following Lee and O'Connor (2003), we define product superiority as the extent to which a new product includes new technologies or features relative to existing products. Ali et al. (1995) have found that product superiority based on unique or novel attributes may have a negative impact on product performance. Product compatibility relates to the degree to which an innovation is consistent with an adopter's behavior patterns, lifestyle and values (Rogers, 1995). Moreau et al. (2001) have shown that low product compatibility has a negative impact on new product performance. Complexity refers to the degree to which an innovation is perceived to be relatively difficult to understand and use. Veryzer and Mozota (2005) have shown that product complexity has a negative impact on customer satisfaction and market performance. We therefore hypothesize:

H4. Product innovativeness for the customer has a negative impact on new product performance

4. The joint impact of product quality and innovativeness on new product performance

4.1. Objective product quality, innovativeness for the firm and new product performance

We have hypothesized earlier that a negative relationship can be expected between product innovativeness for the firm and new product performance. However, it has been demonstrated in previous studies that product innovativeness can also help a firm secure a competitive advantage in the market (Hult et al., 2004). One possible explanation for this may be that product innovativeness for the firm interacts positively with objective product quality on new product performance. Although the development of highly innovative products for the firm usually involves higher levels of uncertainty with regard to technology and market (Krishnan & Ulrich, 2001), it can also provide new ways of commercializing products (Song & Parry, 1997) and incorporate new resources and knowledge from the environment (Li & Calantone, 1998). According to Swan et al. (2005), it is on the basis of the uncertainty that characterizes any new product that a firm can leverage its resources and knowledge to strengthen its functional competitive advantages in terms of product performance. Using a similar reasoning, one may expect product innovativeness for the firm to provide an advantage over competitive offerings (different to the certain condition of less innovative products, where the effects of objective quality on new product performance are similar among products), which might increase the positive effects of objective quality on new product performance. We therefore hypothesize:

H5a. Product innovativeness for the firm strengthens the positive impact of objective product quality on new product performance

4.2. Subjective product quality, innovativeness for the firm and new product performance

The subjective quality of a new product can be viewed as the communicator of the product's image and design (Brucks et al., 2000). The positive effect this can have on new product performance could be increased if it is adequately linked to product innovativeness for the firm. Products that display low levels of innovativeness for the firm rarely include new resources or knowledge from the environment (Danneels, 2002). As a result, customers only perceive the aesthetics or design of a product when evaluating these products and firms developing these products may be perceived by customers as adopting a “cost emphasis”

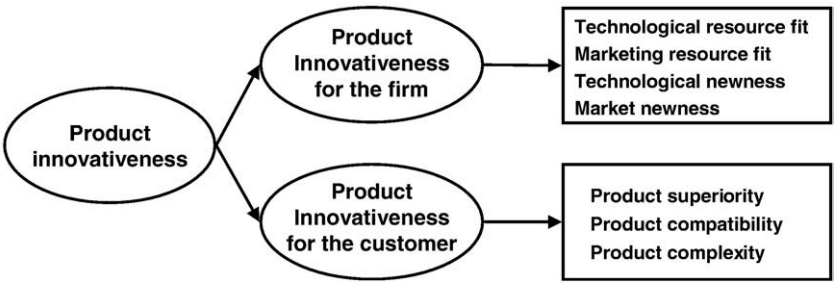

Fig. 2. Product innovativeness (adapted from Danneels & Kleinschmidt, 2001).

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approach, at the expense of their customers' true needs and wants (Rust et al., 2002). In line with this, Yamamoto and Lambert (1994) have found that firms who fail to include new resources and knowledge in a product design achieve lower performance. By contrast, developing highly innovative products involves a combination of resources that are different to those a firm usually employs (Veldhuizen, Hultink, & Griffin, 2006). Customers can perceive this in a positive light, as a way of updating the product, which in turn may improve the positive effect of a product's image and design on its performance. Creusen and Schoormans (2005) describe the important task of product designers to translate this new knowledge into a new design for an innovative product that conveys a highly subjective quality, whereas Swan et al. (2005) discuss how such a new design can improve a new product's image and reputation. Consequently and based on the previous, including these new resources and knowledge, together with subjective quality, can help improve new product performance. In line with these suggestions, we propose:

H5b. Product innovativeness for the firm strengthens the positive impact of subjective product quality on new product performance

4.3. Objective product quality, innovativeness for the customer and new product performance

Customers play a major role in providing input for products characterized by low levels of innovativeness, because they can describe the improvements they need based on their experiences (Rogers, 1995). By contrast, products that are perceived by customers as highly innovative often include unique and unknown attributes (Calantone et al., 2006), discontinuity in terms of user-interface complexity (Gourville, 2006) or low levels of compatibility (Srinivasan et al., 2006). Customers have a negative perception of these products and experience, for instance, discomfort and insecurity, due to unfamiliar product/technology functions. According to Moreau et al. (2001), the way customers perceive a new product and its relative advantage is influenced by prior knowledge. As a result, innovative products only become successful when they are designed to match evolving user needs (Im, Bayus, & Mason, 2003). This is particularly important with respect to product quality. Swan et al. (2005) have found that the positive effect of the objective quality of a product on its performance will not materialize unless the customer's point of view is taken into account. In line with Veryzer and Mozota (2005), we expect that, when potential customers perceive a product as highly innovative, the impact of the objective quality on new product performance will be lower, because it will be more difficult to communicate the unknown attributes and technology in such a way that its potential customers have a clear understanding of its quality and benefits.

H6a. Product innovativeness for the customer weakens the positive impact of objective product quality on new product performance

4.4. Subjective product quality, innovativeness for the customer and new product performance

Earlier, we have argued that, when a new product is perceived by potential customers as highly innovative, there will be a negative impact on its performance, not only directly, but indirectly as well, through its interaction with objective product quality. However, Lee and O'Connor (2003) have suggested that an innovative product may also surprise customers in a positive way. Consequently, including new features or user-product interfaces may also be beneficial to a firm, as customers not only look for products with which they are already familiar, but may also be interested in products that surprise them (Veryzer & Mozota, 2005). In line with this argument, Creusen and Schoormans (2005) have proven that the outside appearance of a product affects the way it is perceived and adopted by (potential) customers. Similarly, a highly innovative product can enhance the positive feelings this product evokes in the minds of its potential customers. Calantone et al. (2006) clearly state that product innovativeness for the customer can be a means of enhancing and effectively communicating the subjective superiority of a product to customers. Accordingly, it is reasonable to assume that, even though customers find it difficult to understand a new product, the interaction with subjective quality can help increase new product performance (Fig. 3).

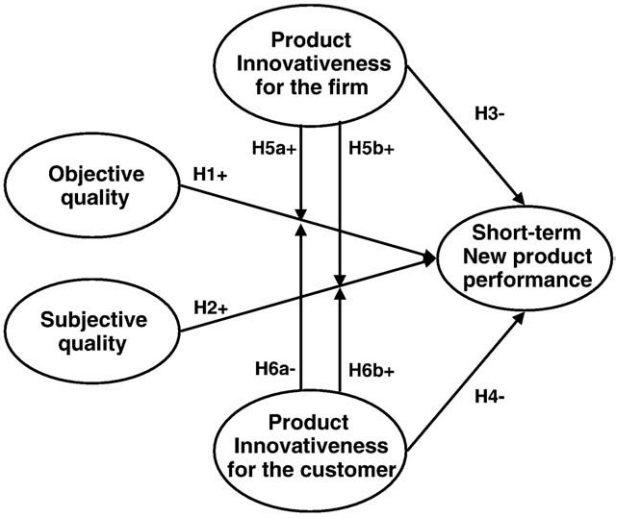

Fig. 3. Conceptual model.

H6b. Product innovativeness for the customer strengthens the positive impact of subjective product quality on new product performance

5. Research method

5.1. Sample and procedure

To test our hypotheses we used a cross-sectional survey methodology. Our research population consisted of 1120 Spanish firms belonging to sectors with high innovation rates[2]: SIC codes corresponding to numbers: 22—textile, 25—furniture, 28—chemical products industry, 30—rubber and plastic products industry, 34—metal products, 35—machinery, 36—electrical and electronic machinery industry. We developed a questionnaire that was pre-tested on ten managers and ten academics. We used the feedback they provided to make several changes in the questionnaire, to improve its clarity and ensure an effective communication with the respondents.

A final version of the questionnaire was developed and mailed to the marketing managers of the firms we had identified. We chose to send the questionnaire to marketing managers because they had a deeper knowledge of the development and launching activities, and also because in most firms it was difficult to identify who the product manager was, due to the fact that this role is usually carried out by the marketing manager. Other researchers have also opted in favor of approaching marketing managers in their studies as the target objective. The questionnaire asked respondents to select an innovative product that was developed and introduced in the market in the last three years (Veldhuizen et al., 2006). The mailing included a cover letter, the questionnaire and a reply-paid envelope. In addition, respondents were offered a free summary of the most relevant findings of the study. Non-respondents were called after two weeks to ask if they had received the questionnaire and to remind them of the value

[2] These sectors were selected according to the innovation rates based on: R&D expenditures, percentage of innovative firms, innovation awards, etc. This information was obtained from a national technological innovation survey and Dun and Bradstreet directory. In addition, our selection of sectors is in accordance with other research in this area.

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Table 1
Sample characteristics (N=110)

SIC code and sectors	Industry distribution (population)		Industry distribution (sample)		Number of employees* (population)		Number of employees* (sample)		Sales volume (x10^6€)* (population)		Sales volume (x10^6€)* (sample)	
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
22. Textile	140	12.5	13	11.8	138	10.5	127	10.0	15,821	7.6	14,250	7.2
28. Chemicals	152	13.6	16	14.6	238	18.2	207	16.3	38,191	18.4	36,200	18.2
30. Plastics	157	14.0	15	13.6	194	14.8	185	14.6	39,851	19.2	38,500	19.3
34. Metals	230	20.5	24	21.8	165	12.6	175	13.8	32,773	15.8	30,250	15.2
35. Machinery	132	11.8	12	10.9	209	16.0	190	15.0	31,957	15.4	30,300	15.2
36. Elec.devices	157	14.0	16	14.6	235	17.9	245	19.3	35,697	17.2	34,250	17.2
25. Furniture	152	13.6	14	12.7	131	10.0	141	11.1	13,539	6.5	15,360	7.7
Total	1120	100	110	100	185	100	170	100	28,353	100	25,990	100

* Mean values are presented for number of employees and sales volume.

of their input. In all, 118 questionnaires were returned, yielding an effective response rate of 11.1%. To check whether the final sample was really developing innovative products, we analyzed each firm individually, using different innovative indicators (number of products launched to the market, awards regarding innovative products, R&D expenditures, etc.) and we compared the results to those of the entire population, finding no significant differences. Because eight of the questionnaires that had been returned were incomplete, the final sample size was 110.

To ensure that the managers who responded were not substantially different from those who did not, we tested non-response bias by comparing early with later respondents (Armstrong & Overton, 1977). The rationale behind this method is that later respondents show a greater resemblance to non-respondents than early respondents. The means of several constructs (e.g., sales volume, company size) were compared, and t-tests revealed no significant differences between the two groups, suggesting that non-response bias was not a major problem.

Table 1 presents the sample composition and summary statistics, including information about the mean number of employees and sales volume. We also checked for the representativeness of the sample. Chi-square distribution analyses revealed no significant differences between our sample and the population it was drawn from in terms of industry distribution, firm age, number of employees and sales volume (Atuahene-Gima, Haiyang, & De Luca, 2006). Because projects were drawn from companies competing in different industries, tests for between-group differences in any of the constructs included in this study were undertaken. Analysis of variance procedures and post-hoc Tukey multiple-comparison tests revealed no significant between-group differences in the averages of our constructs at the 95% confidence significance level. Results of the confirmatory factor-analytic approach to the Harman one-factor test also demonstrated that common method bias was not a serious threat.

5.2. Measure development

Our multi-item scales (Appendix) were predominantly drawn from prior studies. To develop the product quality scales, we reviewed the articles by Brucks et al. (2000), Curkovic et al. (2000) and Garvin (1987), which yielded a total of five items that measure internal product quality in its dual perspective (i.e., objective and subjective). Objective quality was assessed by performance, features and reliability, while subjective quality was measured on the basis of image and design. To measure the various dimensions of product innovativeness for the firm, we adopted the approach suggested by Danneels and Kleinschmidt (2001). Accordingly, we measured technological resource fit, marketing resource fit, technological newness and market newness, with three items each. To measure product innovativeness from the customer's point of view, we adopted the recent terminology suggested by Lee and O'Connor (2003). We selected three items of their product superiority scale to assess product uniqueness (Ali et al., 1995). Following Rogers (1995), we measured compatibility and complexity with two items each. To measure new product performance, we reviewed recent studies (Atuahene-Gima et al., 2006; Huang, Soutar, & Brown, 2004). In accordance with the findings presented in these studies, we identified three dimensions of new product performance that were measured using seven items: market-related performance (market share, volume sales, market penetration), customer-related performance (customer satisfaction, customer loyalty) and profitability-related performance (net income, net profits

Table 2
Scales reliability

	#Items remain	Mean	SD	Eigen value	Lowest t-value	SCR[a]	AVE[b]
Independent variables							
Technological fit	3	2.80	1.02	2.08	7.02	.77	.54
Marketing fit	3	3.23	1.18	2.17	7.55	.81	.60
Technological newness	3	4.00	1.50	2.19	7.81	.82	.60
Market newness	3	3.72	1.48	1.78	6.65	.76	.52
Product superiority	3	4.77	1.45	2.21	7.60	.81	.60
Compatibility	2	3.32	1.79	1.67	8.24	.81	.68
Complexity	2	2.74	2.58	1.73	9.30	.84	.72
Objective quality	3	4.62	1.22	1.73	5.78	.68	.50
Subjective quality	2	5.45	1.26	1.72	8.72	.85	.73
Dependent variables							
Short-term market performance	3	3.28	0.90	2.32	8.52	.86	.68
Short-term customer performance	2	3.90	0.75	1.69	6.00	.70	.52
Short-term financial performance	2	3.43	0.73	1.69	7.37	.75	.61

Fit statistics for measurement model of 31 indicators for 12 constructs: $\chi^2(368)=502.16$ $p=.00$; CFI=.93 TLI=.93 IFI=.93 RMSEA=.05 $\chi^2/df=1.36$.
a Scale composite reliability, b Average variance extracted.

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Table 3
Mean, Standard deviations and correlation matrix

	Mean	SD	1	2	3	4	5
1. Objective quality	4.62	1.22	–				
2. Subjective quality	5.44	1.26	.29***	–			
3. Product innovativeness for the firm	3.43	0.70	−.02	.01	–		
4. Product innovativeness for the customer	3.61	1.21	.14	.06	.31***	–	
5. Short-term new product performance	3.53	0.70	.40***	.28***	−.21**	−.01	–

margin). To focus on short-term new product performance, we asked respondents to evaluate the performance of the new product in the first two stages of its life cycle (introduction and growth stage), as suggested by Lee and O'Connor (2003).

5.3. Scale properties

To refine our measures, we conducted a confirmatory factor analysis (CFA) using LISREL 8.7 to determine the validity and reliability of our measures. As can be observed from Table 2, the results of the twelve factor model provided an acceptable fit ($\chi^2(368) = 502.16$ $p = .00$; CFI = .93 TLI = .93 IFI = .93 RMSEA = .05 $\chi^2/df = 1.36$). The factor loadings of each individual indicator on its respective construct were statistically significant ($p < .001$) establishing convergent validity. The composite reliabilities (Bagozzi & Yi, 1988) and average variance extracted estimates (Fornell & Larcker, 1981) exceeded the .60 and .50 benchmarks, establishing reliable measures. We further assessed the discriminant validity of the latent constructs in two ways. Firstly, as suggested by Anderson and Gerbing (1988), we calculated the 99% confidence intervals around the correlation parameter estimates between all possible pairs of scales, and established that none of these intervals included 1. Secondly, the square of two constructs' correlation was less than the average variance extracted estimates of the two constructs (Fornell & Larcker, 1981). Overall, these results show that our constructs are valid and reliable.

5.4. Product innovativeness and new product performance as second-order factors

We considered product innovativeness for the firm as a second-order construct. It should be noted that the ratings on the items for technological and marketing fit were reversed to capture product innovativeness for the firm, as suggested by Danneels and Kleinschmidt (2001). We also treated product innovativeness for the customer as a second-order construct. The results suggested a good fit for the second-order specification of our measure for product innovativeness for the firm ($\chi^2 = 57.52$, $df = 50$, $p = .22$; $\chi^2/df = 1.15$, GFI = .92; CFI = .98; RMSEA = .03; TLI = .98; IFI = .98) and for our measure of product innovativeness for the customer ($\chi^2 = 17.25$, $df = 11$, $p = .10$; $\chi^2/df = 1.56$, GFI = .96; CFI = .98; RMSEA = .07; TLI = .98; IFI = .98). Similarly, short-term new product performance was seen as a unique second-order construct. The results showed an acceptable fit for our measure of short-term new product performance ($\chi^2 = 22.12$, $df = 11$, $p = .02$; $\chi^2/df = 2.01$, GFI = .95; CFI = .95; RMSEA = .08; TLI = .95; IFI = .95).

Based on the evidence presented above, the constructs were formed by averaging the responses to the items in a particular scale. Table 3 presents the means, standard deviations and correlations among the various constructs.

6. Results

6.1. Regression analyses

We took a hierarchical moderated regression approach to test our hypotheses (Jaccard, Turrisi, & Wan, 1990), in which the dependent variable was short-term new product performance.[3] The mathematical notation of our regression was:

$$Y = \text{b0}$$

$$[\text{control variable}] + \text{b1SV}$$

$$[\text{independent variables}] + \text{b2OQ} + \text{b3SQ} - \text{b4}F.INNOV - \text{b5}C.INNOV$$

$$[\text{interaction terms}] + \text{b6OQ} * \text{F.INNOV} + \text{b7SQ} * \text{F.NNOV} - \text{b8}OQ * C.INNOV + \text{b9}SQ * C.INNOV + \varepsilon i.$$

Where Y = short-term new product performance, SV = sales volume, OQ = objective quality, SQ = subjective quality, F.INNOV = product innovativeness for the firm, C.INNOV = product innovativeness for the customer.

In step 1 of each regression, we included the independent variables (objective quality, subjective quality, product innovativeness for the firm, and product innovativeness for the customer) and sales volume of the firm as the control variable, following the procedure recommended by Jaccard et al. (1990). Step 2 introduced the interaction terms. We first mean-centered the scales of product quality and innovativeness and subsequently created the interaction terms. This technique yields conditional coefficient estimates that help to clarify the results, which reflect the effects of a variable when other variables remain at their mean levels (Irwin & McClelland, 2001). To check for multicollinearity the variance inflation factors (VIFs) were examined. The highest VIF was 1.25, thus far below the cut off value of 10 that indicates problematic multicollinearity.

Table 4 summarizes the results of the regression analyses. After introducing the interactions terms, the results revealed a significant change in the R^2 of .08 ($F = 4.08$ with $p < 0.5$) for short-term new product performance, indicating that our theoretical model with the interaction effects of quality and innovativeness is better able to predict short-term new product performance than a main effects model only.

6.2. Analysis of the interaction terms

To gain a better understanding of the interaction effects, we took the partial derivative of the regression equations, following the procedure suggested by Irwin and McClelland (2001). Short-term new product performance varies according to the level of objective quality, following the equation: ∂performance/∂OQ = b2 + b6 * F.INNOV-b8 * C.INNOV, whereas it follows the equation ∂performance/∂SQ = b3 + b7 * F.INNOV + b9 * C.INNOV, according to the level of subjective quality. Because our variables are mean-centered, a value of zero for F.INNOV and C.INNOV represents the mean level of product innovativeness for the firm and for the customer. We further tested the effects at one standard deviation above and one standard deviation below the mean of F.INNOV and C. INNOV. The impact of objective and subjective quality on performance

[3] Nonlinear effects could also be present. Therefore, we fitted nonlinear models between the independent and dependent variables. However, nonlinear effects fitted worse than the linear models in most of the cases or did not outperform substantially the results obtained in the linear models which let us assume the linear model as most appropriate and parsimonious.

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Table 4
Regression analysis

	Short-term new product performance	
Independent variables	Step 1	Step 2
Intercept	2.84(.49)***	2.71(.47)***
Sales volume (SV)	.09(.04)	.15(.04)
Objective quality (OQ)	.32(.05)***	.36(.04)***
Subjective quality (SQ)	.23(.05)**	.22(.04)**
Product innovativeness for the firm (F.INNOV)	−.19(.09)**	−.18(.09)**
Product innovativeness for the customer (C.INNOV)	−.05(.04)	−.06(.04)
OQ*F.INNOV		.16(.06)**
SQ*F.INNOV		.17(.07)**
OQ*C.INNOV		−.16(.05)**
SQ*C.INNOV		.19(.04)**
R^2 (Adj. R^2)	.26(.22)	.34(.28)
F value	6.50***	6.11***
R^2 change		.08
F Test		4.08**

All significance levels are based on two-tailed tests; number in parentheses are standard error.
Significance levels: ***$p<.01$ **$p<.05$.

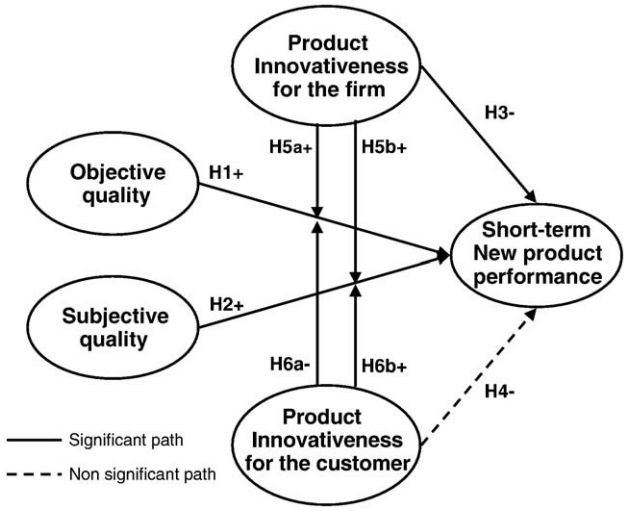

Fig. 4. Impact of product quality and innovativeness on short-term performance.

can be plotted as a function of product innovativeness for the firm and for the customer. As shown in Table 5, the impact of objective quality increases over the range of product innovativeness for the firm, whereas it decreases when product innovativeness for the customer increases. The results also indicate that moderate to higher levels of product innovativeness for the firm and for the customer will help increase the influence of subjective quality on short-term new product performance.

Our results (also depicted in Fig. 4) show that there is a clear impact of objective and subjective product quality on short-term new product performance, which confirms hypotheses H1 and H2. The direct effect of subjective quality on short-term new product performance is lower than that of objective quality, which is consistent with the work of Yamamoto and Lambert (1994), who concluded that certain characteristics of objective product quality, such as the performance of the product have a greater explanatory power than the image of a product.

In addition, we demonstrate that the impact of objective and subjective quality on short-term new product performance should be interpreted together with the effects of product innovativeness for the firm and for the customer. According to our results, product innovativeness for the firm has a negative impact on new product performance in the short term, which supports hypothesis H3. However, this does not mean that firms should abandon the development of such products altogether simply because it involves a high level of product innovativeness. We demonstrate that product innovativeness for the firm can strengthen the positive impact of objective product quality on new product performance, which confirms hypothesis H5a. In addition, we find that product innovativeness for the firm strengthens the impact of subjective product quality on short-term new product performance, supporting hypothesis H5b.

Our results indicate that product innovativeness for the customer is not significantly related to short-term new product performance, which means that hypothesis H4 is rejected. This finding may be explained by the reasoning of Lee and O'Connor (2003), who have suggested that customers who are faced with an innovative product experience positive (surprise and optimism) as well as negative perceptions (discomfort and insecurity). However, our results also suggest that negative perceptions of product innovativeness for the customer are especially relevant when they are linked to objective product quality, which supports hypothesis H6a. Apparently, it is difficult to develop innovative new products with a high objective quality because of the difficulty for customers to integrate familiar and novel features (Swan et al., 2005). The positive perceptions of product innovativeness for the customer are found especially in relation to subjective product quality, which supports hypothesis H6b. This finding confirms that customers not only look for products that fit their needs, but that they are also interested in products that generate a total "experience" (Veryzer & Mozota, 2005). Apparently, when high levels of product innovativeness for the customer are present, firms

Table 5
Impact of objective and subjective product quality on short-term new product performance depending on different levels of product innovativeness for the firm and for the customer

		Product innovativeness for the customer (C.INNOV)		
		LOW	MOD	HIGH
Product innovativeness for the firm (F.INNOV)	LOW	a .19 / b -.08	.10 / .02	.03 / .12
	MOD	.28 / .01	.18 / .11	.08 / .21
	HIGH	.36 / .10	.26 / .20	.17 / .30

$Perf = b_0 + b_1SV + b_2OQ + b_3SQ - b_4F.INNOV - b_5C.INNOV + b_6OQ*F.INNOV + b_7SQ*F.INNOV - b_8OQ*C.INNOV + b_9SQ*C.INNOV$.
$\partial performance/\partial OQ = b_2 + b_6*F.INNOV - b_8*C.INNOV$.
$\partial performance/\partial SQ = b_3 + b_7*F.INNOV + b_9*C.INNOV$.
a (coefficient above the diagonal) = impact of objective product quality (OQ) according to the level of F.INNOV and C.INNOV.
b (coefficient below the diagonal) = impact of subjective product quality (SQ) according to the level of F.INNOV and C.INNOV.

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must carefully consider the consequences with regard to the objective and subjective quality of the product. As argued by Morgan and Vorhies (2001), failing to account for product quality improvements and their relationship with product innovativeness may affect product performance in unexpected ways.

7. Limitations and future research

Our study has several limitations that need to be addressed. First of all, we acknowledge that it would have been desirable if we could have found a better way to measure the various product quality dimensions, but the limited numbers of studies on this subject made this difficult to accomplish. In particular, we have defined subjective product quality solely on the basis of image and design. It may be better to include other aspects to obtain more accurate measurements (Creusen & Schoormans, 2005). Similarly, further research in this area may also benefit from analyzing specific characteristics of objective quality, to provide more meaningful recommendations. Despite these limitations, the dimensions obtained in our research are similar to those found in previous studies (Curkovic et al., 2000; Lemmink & Kasper, 1994). In addition, we based subjective quality and innovativeness for the customer on the perceptions of managers, rather than on those of the customers themselves. Although Waller and Ahire (1996) and Lee and O'Connor (2003) argue that the differences would be small and the discriminant validity between measures was proved in the methodology section of our study, it may be better to use a dyadic approach and ask customers what their perceptions are. The assessment of new product performance can be further improved by including other performance dimensions, for instance technical performance (Carbonell et al., 2004) and process performance (Krishnan & Ulrich, 2001), as well as by considering all the potential relationships between the antecedents and different dimensions of product performance. Finally, our regression analyses leave considerable short-term variance unexplained. Although innovativeness and quality are important determinants of new product performance, we recognize that other types of antecedents are equally valuable to study (Henard & Szymanski, 2001).

In spite of these limitations, the results of this study offer several interesting avenues for future research. Firstly, while we only looked at "product-based quality", it would be interesting to include "manufacturing-based quality" (Rust et al., 2002), to analyze earlier steps in the development process of a product that are not observed by customers but that undoubtedly have an impact on "product-based quality". In addition, we have only considered the impact of product quality on performance, without looking at potential antecedents of product quality, for example technical or distribution-related synergies (Calantone et al., 2006). Based on the time distinction, it could be interesting to analyze these relationships for the long term (Lee & O'Connor, 2003). Although we have justified and proven the existence of a linear negative relationship between innovativeness and new product performance for the type of product we have examined in our research, moderated and radical products, we acknowledge that including incremental products could prove that non-linear relationships are also likely (Goldenberg et al., 2001), which make this an interesting venue for future research. Finally, it should be noted that, while we focused exclusively on endogenous factors, the way customers perceive product innovativeness and quality is affected by many endogenous and exogenous factors, which suggests it may be worthwhile to include factors like innate consumer innovativeness (Im et al., 2003) and the external view of product quality (Warlop et al., 2005) in future research, to bring this important research field forward.

8. Managerial implications

This study provides a number of clear implications for managers. Overall, our results provide a valuable extension to the work of Lukas and Menon (2004), who have shown that a failure to meet quality-related expectations in the initial phases a product's lifecycle is one of the principal reasons why new products fail. However, proving that quality is good business is an extremely difficult proposition, because quality it is the sum of many components (Garvin, 1987). In this sense, the results of our study prove that managers should focus on specific dimensions of quality (i.e., objective versus subjective) to meet customer expectations with regard to product quality. The analysis of these dimensions, in contrast to global measures of quality, can be very valuable for firms, as it can clearly help improve the final new product performance. For example, if a firm is unable to improve the objective quality of its product, perhaps due to technical constraints, it could increase the subjective quality to obtain better results.

Another implication of our research has to do with the trade-off between innovativeness and quality. Usually, managers need to decide the level of innovativeness of their products, as well as having to guarantee the quality of the products involved. This kind of trade-off is very common inside firms, as innovation strategies depend on the exploration of new possibilities, whereas a quality-oriented strategy requires the exploitation of existing certainties through standardization and control. However, both elements, innovativeness and quality, are related to company resources (technology and marketing), which means that managers have to find the most appropriate way to allocate the resources at their disposal (Huang et al., 2004). The results of our study may assist managers in this difficult decision. For example, if a firm encounters difficulties in implementing quality standards, it can move the technological and marketing-related resources to explore new possibilities and, at least to some extent, influence new product performance.

We feel that the main implication of our research is that it would be naïve to look exclusively at the main effects of quality and innovativeness on performance. In this context, failing to consider product quality improvements and their relationships with product innovativeness may mean that the consequences with regard to product performance are ignored (Morgan & Vorhies, 2001). To obtain greater insight into the performance-related consequences of quality and innovativeness, it is important to consider the intricate interaction between them. Consequently, it is important for managers to take these implications into account when they allocate resources to the development of new products. When the goal is to increase short-term new product performance, the focus should be on developing new products with a high level of objective quality, especially when the products involved are new to the firm. When a product is also new to the customer, its subjective quality contributes to its performance, whereas its objective quality has a low impact on its performance. In the end, it will be interesting to look for moderate levels of product innovativeness for the customer, to obtain an optimal effect of both types of quality. These findings are in line with the conclusions presented by Alexander, Lynch, and Wang (2008), who demonstrate that firms should sometimes minimize the extent to which their products are perceived as "really new". The reason is that if consumers perceive that a new technology offers a) new benefits, b) greater uncertainty about those benefits, and c) a greater need to change their behavior to enjoy the benefits, they are less likely to follow up on their possible intention to purchase really new products. However, firms may be sometimes forced to increase product innovativeness for the customer, perhaps to facilitate an early follower strategy, and higher levels of subjective quality could counterbalance the negative effects that product innovativeness may cause. An example is the iPod Mp3 player. Apple was an early follower in the Mp3 market and introduced a highly innovative product for the customer with many new features to distinguish itself from its competitors an attract customers. Although the unfamiliar features have created uncertainty for (potential) customers, the attractive design and subjective quality of the iPod created a positive effect on its market performance.

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Our results are also consistent with the findings presented by Srinivasan et al. (2006) with regard to dominant designs. Based on their research, firms will try to obtain a dominant design in the short term to help them achieve market dominance. The dominant design is the specification (consisting of a single feature or a complement of design features) that defines the product category's architecture. If a firm wants to achieve this objective, it may consider incorporating new technological or market-related knowledge into the product, which will shorten the time needed for a dominant design to emerge. Similarly, if a firm really wants to perform well in the short term, it must look for moderate levels of radical innovation to make the dominant design likely to emerge.

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Appendix

A.1. Product quality[4]

A.1.1. Objective product quality
- The product performs as it is supposed to do
- The product incorporates features customers do not expect
- The probability of product failing is low

A.1.2. Subjective product quality
- The product has an attractive image
- The product has an attractive design

A.2. Product innovativeness for the firm

A.2.1. Technological resource fit
- To what extent were your firm's R&D product development resources, people, and skills more than adequate to handle the development of this product?
- To what extent were your firm's engineering resources, people, and skills more than adequate for the engineering and design work involved in this product?
- To what extent were your firm's production or operation resources, facilities, and people more than adequate for the production of this product?

A.2.2. Marketing resource fit
- To what extent was your existing company's sales force (or your distributors sales force) more than adequate to handle the selling of this product?
- To what extent were your firm's advertising and promotion people, skills, and resources more than adequate for the advertising and promotion of this product?
- To what extent were your firm's marketing research people, skills, and resources more than adequate for the gathering of market information needed for this product?

A.2.3. Technological newness
- To what extent did the technology involved in the development of this product represent a new or different technology for your firm?
- To what extent did the engineering and design work involved in this new product project represent new or different work for your firm—a type of engineering or design work you had not done before?
- To what extent did the production technology and production process represent a new and different one for your firm—a type of production you had not done before?

A.2.4. Market newness
- To what extent was this product aimed at new customers to your firm that you had not sold before?
- To what extent was the market for this product new or different from the market you normally sell into?
- To what extent did this product represent a new product category that your firm had not sold before?

A.3. Product innovativeness for the customer

A.3.1. Product superiority
- The technology this product incorporates was new to the customers
- Customers perceived the product features as novel/unique
- This product offers dramatic improvements in existing product features

A.3.2. Complexity
- The knowledge required to use this product was new to the customers
- Customers needed to learn how to use this new product

A.3.3. Compatibility
- Customer tended to resist adopting this new product
- Customer needed to change their behavior in order to adopt this product

A.4. Short-term new product performance

A.4.1. Market related performance
- Market share performance
- Volume sales performance
- Rate of market penetration

A.4.2. Customer related performance
- Customer satisfaction
- Customer loyalty

A.4.3. Profitability-related performance
- Net income
- Net profits margin

[4] Likert-type scale (1 = strongly disagree to 7 = strongly agree).

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