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When Should RD&E and Marketing Collaborate? The Moderating Role of Exploration–Exploitation and Environmental Uncertainty

Roger Calantone and Gaia Rubera

Collaboration between research, development, and engineering (RD&E) and marketing has traditionally been regarded as beneficial for new product performance (NPP). However, some studies have pointed out the drawbacks of excessive collaboration. Because collaboration simultaneously presents costs and benefits that vary with conditions, a contingent view of managerial practices suggests that the optimal level of integration should vary according to some factors that indicate when high levels of collaboration are preferable to lower levels. Although the literature on the many different factors that may impact the desirable level of collaboration is abundant, only a few studies have investigated the role of the peculiar characteristics of the new products being developed. This is at odds with several calls for future research on the role of the characteristics of the new product. This paper investigates the moderating role of an explorative versus an exploitive innovation program. It also controls for the moderating role of environmental uncertainty, which has been traditionally considered a moderator of the relationship between RD&E–marketing collaboration and new product program performance.

The paper also investigates how a firm's innovation posture—a cultural trait—influences both directly and indirectly, via marketing's technical knowledge, RD&E–marketing collaboration. Indeed, several scholars have recognized that cultural differences create the main barrier between RD&E and marketing. Hence, a firm's culture should have an impact on the cultural barriers between the two departments. Further, the firm's innovation posture affects the extent to which the departments have to share resources and exchange information. In their seminal work, Gupta, Raj, and Wilemon argue that resource dependency is the main factor affecting the integration achieved between RD&E and marketing. Hence, an analysis of a firm's innovation posture is required to gain a deeper understanding of the antecedents of the collaboration between the two departments.

The antecedents and effects of RD&E–marketing collaboration are tested in a sample of 80 companies operating in the U.S. auto industry through partial least squares. The paper shows that the extent to which a company develops explorative rather than exploitative innovations is a better moderator than environmental uncertainty in the relationship between RD&E–marketing collaboration and new product program performance. This contradicts much previous literature and sheds light on a partially neglected construct in the new product development literature. Second, the paper demonstrates that firms with a more aggressive innovation posture tend to develop greater collaboration between RD&E and marketing. Also, the marketing department tends to have a better understanding of the RD&E processes and capabilities in companies with an aggressive innovation posture than in companies with a defensive one.

The Amalgamation of RD&E with Marketing

In the field of new product development (NPD) research, scholars focused increased attention on the collaboration between RD&E and marketing as one of the main phenomena that affect new product performance (NPP) (e.g., Kahn, 1996; Moenaert, Souder, DeMeyer, and Deschoolmeester, 1994; Song and Xie, 2000; Souder, 1988). In spite of considerable investigation, there are still gaps in the literature that this work endeavors to fill.

First, collaboration between RD&E and marketing has traditionally been regarded as beneficial for NPP. Collaboration is defined as a mutual understanding, a common vision, collective goals, and resource sharing between two departments (Kahn, 1996). However, some studies have pointed out the drawbacks of excessive

Address correspondence to: Roger Calantone, Department of Marketing, Eli Broad Graduate School of Management, Michigan State University, N370 Business Complex, East Lansing, Michigan 48824. E-mail: rogercal@msu.edu. Tel: 517-432-6400.

collaboration (Griffin and Hauser, 1996; Gupta, Raj, and Wilemon, 1986; Kahn and Mentzer, 1998; Maltz and Kohli, 2000; Souder, 1988). Because collaboration simultaneously presents costs and benefits that vary with conditions, a contingent view of managerial practices suggests that the optimal level of integration should vary according to some factors that indicate when high levels of collaboration are preferable to lower levels. Although the literature on the many different factors that may impact the desirable level of collaboration is abundant (e.g., Griffin and Hauser, 1996; Gupta et al., 1986; Parry and Song, 1993; Ruekert and Walker, 1987), only a few studies have investigated the role of the peculiar characteristics of the new products being developed. This is at odds with several calls for future research on the role of the characteristics of the new product (e.g., Cooper and Kleinschmidt, 1991; Danneels, 2002; Song, Montoya-Weiss, and Schmidt, 1997). This paper investigates the moderating role of an explorative versus an exploitive innovation program. It also controls for the moderating role of environmental uncertainty, which has been traditionally considered a moderator of the relationship between RD&E–marketing collaboration and new product program performance (Bstieler, 2005; Calantone, Garcia, and Drodge, 2003).

Second, the effect of a firm's innovation posture has not been investigated thus far. This paper contends that a firm's innovation posture is a potentially relevant antecedent of the collaboration between RD&E and marketing. Innovation posture is a firm's orientation toward innovation and defines the reigning culture toward introducing new products in an organization (Hurley and Hult, 1998). The closest concept to innovation posture analyzed in the previous literature is the type of strategy, which has been typically based on the classification proposed by Miles and Snow (1978). However, scholars point out that a firm's orientation and strategy are two related yet distinct concepts, with the latter being a part of the former (see, for instance, Frambach, Prabhu, and Verhallen, 2003; Homburg, Korhmer, and Workman, 2003; Morgan and Strong, 1998). There are two reasons why it is relevant to investigate the role of a firm's innovation posture on the collaboration between RD&E and marketing. First, several scholars have recognized that cultural differences create the main barrier between RD&E and marketing (Dougherty, 1992; Griffin and Hauser, 1996; Maltz and Kohli, 2000). Hence, a firm's culture should have an impact on the cultural barriers between the two departments. Second, the firm's innovation posture affects the extent to which the departments have to share resources and exchange information. In their seminal work, Gupta et al. (1986) argue that resource dependency is the main factor affecting the integration achieved between RD&E and marketing. Hence, an analysis of a firm's innovation posture is required to gain a deeper understanding of the antecedents of the collaboration between the two departments.

This paper contributes to the NPD literature in two relevant ways. First, it shows that the real moderator in the relationship between RD&E–marketing collaboration and new product program performance is the extent to which a company develops explorative rather than exploitative innovations. Environmental uncertainty—which has traditionally been considered a moderator—has no moderating effect once controlled for the nature of the innovation program (explorative versus exploitative). These results are robust to different types of analyses and model specifications. Second, it demonstrates that firms with a more aggressive innovation posture tend to develop greater collaboration between RD&E and marketing. Also, marketing tends to have a better understanding of the RD&E processes and capabilities in companies with an aggressive innovation posture than in companies with a defensive one.

BIOGRAPHICAL SKETCHES

Dr. Roger Calantone is the Eli Broad chaired university professor of business at the Eli Broad College of Business at Michigan State University, chair of the Marketing Department, and codirector of the Institute for Entrepreneurship. He continues to research and publish in innovation strategy, product development, and pricing.

Dr. Gaia Rubera is the assistant professor of marketing at Eli Broad College of Business at Michigan State University. Her research interests focus on esthetic innovation, creativity, organizational structures that foster innovation, globalization, and marketing strategy. She has published in *Journal of Service Research, Marketing Letters*, and other journals.

Theoretical Framework

This paper has two main purposes. First, it analyzes the effect of RD&E–marketing collaboration on new product program performance and the existence of some contingencies—either internal or external—that increase the value of collaboration. Second, it analyzes how a firm's innovation posture influences both directly and indirectly, via marketing's technical knowledge, RD&E–marketing collaboration. Collaboration is defined as a mutual understanding, a common vision, collective goals,

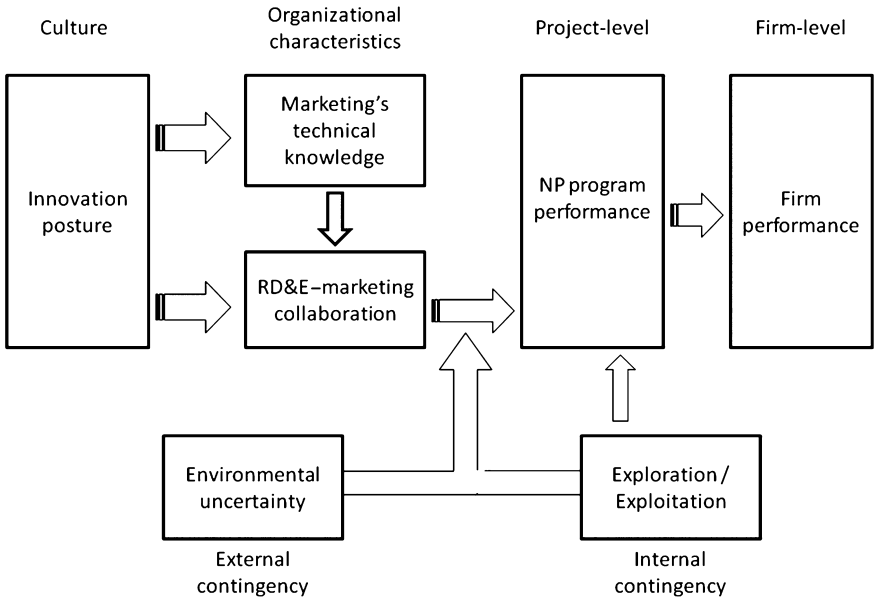

Figure 1. The Theoretical Model

and resource sharing between two departments (Kahn, 1996).

The theoretical framework is depicted in Figure 1. A firm's cultural trait—in our case, firm's innovation posture—determines organizational characteristics—in our case, the extent of collaboration between RD&E and marketing's technical knowledge, which in turn influences the performance of the product program. Product program performance refers to the success of the entire portfolio of NPD projects in which a firm is involved in a certain period of time.

Scholars attribute a key role to the integration of the different functions involved in the NPD process (e.g., Calantone and Di Benedetto, 1988; Gupta et al., 1986; Souder, 1988). The vast majority of these studies focused on the interface between RD&E and marketing (for an extensive review, see Griffin and Hauser, 1996). Continuing in this tradition, the paper analyzes the integration between marketing, which acquires, develops, and eventually transfers to the rest of the organization the market knowledge, and RD&E, which acquires, develops, and eventually transfers to the rest of the organization the technological knowledge. Indeed, NPD consists of bringing together two main components—market and technological knowledge—that allow a firm to develop technologies related to customer needs (Danneels and Kleinschmidt, 2001; Li and Calantone, 1998). Therefore, collaboration between marketing and RD&E can be considered a strategic resource: firms with higher integration are better able to exploit their technological capabilities by defining new features consistent with the market's requirements, which should lead to better product program performance (Li and Calantone, 1998; Song and Parry, 1997). Consistent with the existing literature, this paper argues that just the RD&E–marketing collaboration has a direct effect on product program performance, while marketing technical knowledge has an indirect one, fully mediated by collaboration.

However, previous research has found that collaboration between RD&E and marketing can have some downsides. Most interaction activities do not promote performance success, but rather overburden personnel with too many meetings and stress (Kahn, 1996; Kahn and Mentzer, 1998). Also, an excess of cohesion has been found to harm the NPD process by limiting objective criticism (Sethi, Smith, and Park, 2001; Souder, 1988) or by generating myopia and premature elimination of options (Swink, 2000). Because of this, some scholars have proposed a contingent view of RD&E–marketing collaboration according to which the level of collaboration should differ from firm to firm (Griffin and Hauser, 1996). This paper adopts a contingency perspective and contends that the effect of collaboration on product program performance depends on some contingencies. It analyzes an external contingency, environmental uncertainty, and an internal contingency—the extent to which the firm is involved in exploration versus exploitation processes.

Previous literature contends that firms operating in environments with different levels of uncertainty should have different levels of collaboration (Carroad and

Carroad, 1982; Gupta et al., 1986). A better understanding of the effects of RD&E–marketing collaboration and NPP necessitates considering the main reason why marketing and RD&E collaborate: to combine two critical pieces of knowledge for new product success—technical and market—that otherwise would be separate (Danneels and Kleinschmidt, 2001; Li and Calantone, 1998). Many scholars have observed that the need for integrating knowledge heavily depends on the nature of the product innovation program the firm is pursuing (Atuahene-Gima, 1995; Kleinschmidt and Cooper, 1991; Song and Montoya-Weiss, 1998; Veryzer, 1998). Hence, another possible moderator of the relationship between RD&E–marketing collaboration and new product program performance is investigated, namely the fact that a firm is developing more explorative or more exploitive product innovations. Indeed, the knowledge necessary to develop these two disparate types of innovation is quite different (Jansen, Van Den Bosch, and Volberda, 2006). Because of its nature internal to the NPD process, exploration/exploitation is supposed to also have a direct impact on the product program performance. Finally, product program performance is supposed to influence firm's performance.

Exploration Versus Exploitation Projects

NPD projects can be classified along a continuum: at one extreme, there are exploitative projects, in which a firm refines existing competencies to generate new products; at the other extreme, there are explorative projects, in which a firm searches and develops new competencies to generate new products. Exploration implies firms' behaviors characterized by search, discovery, experimentation, risk taking, and development of new competencies, while exploitation implies refinement, implementation, efficiency, production, and selection (March, 1991). Exploitation projects rely on a firm's existing learning curve by strengthening its current competences (Kyriakopoulos and Moorman, 2004).

The exploration/exploitation framework has been extensively used to study product innovation. In her seminal work, Leonard-Barton (1992) found that those core capabilities that are at the basis of a firm's success can turn into core rigidities, which may lead to inertia in the face of environmental changes. Core capabilities embodied in people, technical/managerial systems, and culture facilitate the development of projects closely aligned with these capabilities, but at the same time make more difficult for the organization to align with changing environmental requirements. Hence, firms face the dilemma of utilizing and maintaining their capabilities (i.e., exploitation), and yet avoiding the dysfunctional flip side by renewing and replacing them (i.e., exploration) in order to avoid what Levitt and March (1988) called *competency trap* and Levinthal and March (1993) *success trap*.

According to the learning literature, both exploration and exploitation projects are essential for organizations, but they compete for scarce resources so that firms must make choices between the two (March, 1991). On the one hand, exploration of new alternatives reduces the speed at which existing competences are improved; on the other hand, improvements in existing competences make exploration less attractive (Levitt and March, 1988). Levinthal and March (1993) contend that firms should pursue both exploration and exploitation: whereas an excess of exploitation may lead to competency trap, obsolescence, and paucity of novel ideas, an excess of exploration may suffer the costs of experimentation without reaping the benefits of deploying existing competencies.

While the exploration/exploitation dichotomy might remind the incremental/radical dichotomy, the two constructs are different. Indeed, exploitation and exploration reflect firms' investment decisions (Chandy and Tellis, 1998). Hence, they have to be considered as the antecedents of new products that might have different level of newness (Atuahene-Gima, 2005). Also, scholars do not agree that exploration necessarily leads to radical innovations, and exploitation necessarily leads to incremental innovations. For instance, Kyriakopoulos and Moorman (2004) point out that, even though apparently similar, the concepts of exploitation/exploration and product newness are different. The authors argue that a firm may be engaged in exploration projects that lead to incremental innovations if the firm decides to serve the same customers by using new knowledge. Alternatively, a firm can target a new segment by deploying current knowledge and skills. Hence, while the level of innovativeness of a new product is defined from a market perspective, the extent to which a firm is engaged in exploitative (or explorative) projects is defined from a firm perspective and depends on whether or not the firm does (or does not) rely on its current knowledge and skills. In a similar way, Abernathy and Clark (1985) argue that firms can exploit existing technical competences either to target existing markets or new ones. In the latter case, the innovation can be defined radical for consumers, but it is based on an exploitation process. Also, Rothwell and Gardiner (1988) suggest that firms can exploit existing technological competences to create new products (new market products in their definition) or to improve existing products (minor details in their definition). Garcia and Calantone (2002) make the example of the switch from analog to

digital technologies in the copy machine industry. While this innovation required firms to explore new competencies, it did not represent a radical innovation. Hence, even though exploration is more likely to lead to radical than to incremental innovations, the two concepts are theoretically distinct (Garcia and Calantone, 2002; Kyriakopoulos and Moorman, 2004).

Hypotheses

Innovation Posture

Product innovation posture is a reflection of a firm's commitment to developing and marketing products that are new to the firm and/or the market (Li and Atuahene-Gima, 2001). Innovation posture defines the firm's overall orientation as reflected in its risk profile and its competitive stance (Dröge and Calantone, 1996). Following Mintzberg (1973), an innovation posture is defined as the result of both past actions and strategic directions that lead present and future actions.

We clarify here some differences between innovation posture and other similar constructs. First, innovation posture is a slightly different concept from a firm's willingness to cannibalize: The latter considers just the firm and its relationship with its own product or "the extent to which a firm is prepared to reduce the actual or potential value of its investments" (Chandy and Tellis, 1998, p. 475); innovation posture "captures the relative (rather than absolute) aggressiveness in strategy" (Dröge and Calantone, 1996, p. 558), and hence presents a competitive dimension that willingness to cannibalize does not have. Second, although innovation posture and exploration/exploitation seem to be similar constructs, they refer to two different levels, and hence must be kept separate. Innovation posture is a firm-level trait, whereas exploitation and exploration are project-level strategies (Kyriakopoulos and Moorman, 2004). Hence, a firm's innovation posture creates the context within which project-level innovation strategies occur.

An aggressive innovation posture leads a firm to frequently introduce new products (regardless of the type of competencies used to introduce them) before competitors do the same. A defensive innovation posture leads a firm to introduce a small number of products per year, with a few changes and as a competitive reaction to competitors' offerings (Miles and Snow, 1978). Three elements of the innovation posture are relevant to define how the RD&E–marketing collaboration and the marketing's technical knowledge change between aggressive and defensive firms.

First, innovation posture is seen as a culture that develops an organizational climate that creates a unifying comradeship, enthusiasm, and devotion among employees (Amabile, 1997; Hurley and Hult, 1998). The various functional areas of an aggressive firm are guided by a unique desire to innovate, which fosters reciprocal understanding and collaboration. Second, aggressive firms have a greater need of market and technology information to reduce the risk of new product failure than defensive firms (Gupta et al., 1986). Siguaw, Simpson, and Enz (2006) contend that more innovative firms reduce their needs by encouraging and facilitating knowledge transfer across functions to foster cooperation and understanding among all functional areas and direct them toward innovation. As Sivadas and Dwyer (2000, p. 33) argue, "Innovators need some mechanism to connect departmental 'thought worlds' so that insights possessed by individual departments can be combined to develop new products." Thus, an aggressive innovation posture requires the firm to force employees to work together even across functions. Third, more aggressive firms are more tolerant of internal conflicts in support of creativity (Dyer and Song, 1998). Miles and Snow (1978) report that more innovative firms engage in high levels of interaction and frequent cross-functional contacts than less aggressive firms. On the other hand, less innovative firms tend to limit the number of interactions between functions. Hence, we hypothesize that:

H1: More aggressive firms develop more RD&E–marketing cooperation.

H2: The more aggressive a firm, the higher marketing's technical knowledge.

Marketing's Technical Knowledge

Disharmony between RD&E and marketing is the rule and not the exception (Griffin and Hauser, 1996). According to Dougherty (1992), the friction between the two departments is due to the fact that each department constitutes a different "thought world," that is *"a community of persons engaged in a certain domain of activity who have a shared understanding about that activity*." Each community develops its own interpretative schemes through which information is selectively filtered. Because of specialization, different departments are likely to better understand certain issues and to ignore others. Thus, even though RD&E and marketing are sincerely concerned with the success of the new product, they tend to develop their own perspective on

the NPD process and its goals. RD&E people emphasize product specifications; want to exploit new technologies and build "neat" new products. Marketing people are focused on customer needs and are concerned with the impact that the new product has on the firm's relationship with customers (Maltz and Kohli, 2000). Given the differing education and training, the two groups use somewhat dissimilar language, which makes the communication even more difficult (Griffin and Hauser, 1996). Hence, different perspectives, goals, and languages make collaboration between RD&E and marketing very challenging.

We contend that marketing's technical knowledge enhances the collaboration between RD&E and marketing. Indeed, Demsetz (1991) identifies the prerequisite for collaboration between different specialists as the presence of common knowledge between them. According to Grant (1996), for integration mechanisms to be effective, different functions have to share common knowledge and have a mutual understanding of what is going on in the other function. Hence, collaboration between RD&E and marketing should be enhanced when marketing has a good understanding of what RD&E's problems are. We hypothesize that:

H3: Marketing's technical knowledge has a positive effect on RD&E–marketing cooperation.

Marketing—RD&E Collaboration

Academics agree on that integration between RD&E and marketing improves NPP (Calantone and Di Benedetto, 1988; Griffin and Hauser, 1996; Gupta et al., 1986; Jassawalla and Sashittal, 1998; Song and Parry, 1997). *It is now accepted that, all else being equal, more integration between marketing and RD&E leads to better new product performance* (Leenders and Wierenga, 2002). Indeed, a firm's competitive advantage when launching a new product is based not only on better technological features than those of rivals but also on the consumer's perception that the firm's product has a higher value than its cost (Li and Calantone, 1998; Ruekert and Walker, 1987). Because of this, integration between marketing—where the market knowledge is acquired, developed, and eventually transferred to the rest of the organization—and RD&E—where the technological knowledge is acquired, developed, and eventually transferred to the rest of the organization—can be considered a strategic resource: firms with higher integration are better able to exploit their technological capabilities by defining new features consistent with consumer needs (Li and Calantone, 1998; Song and Parry, 1997). Successful new product developers have better knowledge of user applications, technological trends, and market segments, and are better able to combine this knowledge (Dougherty, 1990). Previous research has found that higher integration leads to a shorter development process, cost reductions, higher profitability, improved quality, faster time to market, and eventual commercial success (Ayers, Dahlstrom, and Skinner, 1997; Griffin and Hauser, 1996; Song et al., 1997). Managers agree that cooperation between marketing and RD&E improves the performance of the NPD program. Marketing managers attribute almost 14% of the product development performance to the cooperation with RD&E, and RD&E managers say cooperation contributes 11% (Kahn, 1996). Hence, we hypothesize that:

H4: RD&E–marketing cooperation has a positive effect on the new product program performance.

Environmental Uncertainty

Classical contingency theory argues that the optimal organizational design does not exist, but a firm must adapt its collaborative mechanisms to the contingencies of the external environment (Galbraith and Nathanson, 1973). Environmental uncertainty has been indicated as one of the most relevant contingent factors because organizations have higher information processing needs in uncertain environments than in normal situations (Gupta et al., 1986). In rapidly changing environments, RD&E and marketing need to frequently exchange information in order to keep pace with technological and market changes (Ruekert and Walker, 1987). Conversely, the need for information exchange and processing is reduced when the firm competes in environments with low uncertainty. Hence, the role of collaboration between RD&E and marketing is more important when environmental uncertainty is high. Furthermore, organization scholars have found that firms tend to overcome the challenge of environment uncertainty by creating specialization, which in turn emphasizes the distance between the two "thought worlds" (Burns and Stalker, 1961; Lawrence and Losch, 1967). Collaboration is more necessary under these conditions to bring together technological and market knowledge (Gupta et al., 1986). In summary, higher information processing needs and departmental specialization are the two conditions that make the effect of collaboration on new product program performance greater when firms compete in uncertain environments than in other situations. Thus, we hypothesize that:

H5: The strength of the positive relationship between RD&E–marketing cooperation and new product program performance increases as environmental uncertainty increases.

Explorative–Exploitative New Product Introductions

Exploratory innovations are necessary to minimize the risk of obsolescence and find new profitable markets (Jansen et al., 2006). Introducing exploratory innovations allows companies to meet new customer needs or create new markets, and generate above-normal returns (Levinthal and March, 1993). Conversely, firms that go on exploiting existing products and markets have lower performance because they remain trapped in obsolete capabilities (Leonard-Barton, 1992) that, over time, are no longer successful (Uotila, Maula, Keil, and Zahra, 2009). Hence, we hypothesize that:

H6: Firms developing explorative innovations have better product program performance than firms developing exploitative innovations.

Explorative innovations are riskier and more complex than exploitative ones (Benner and Tushman, 2003; Danneels, 2002). The former requires the development of a large amount of new knowledge: consumer demand is latent; product requirements are unarticulated and market opportunities are often unspecified and unclear; they often require intensive technological development; and there is high market, technology, and competitor uncertainty (Jansen et al., 2006; Veryzer, 1998). Exploitative innovations, on the contrary, require the redeployment of existing knowledge in new products (Danneels, 2002; Gopalakrishnan and Damanpour, 1994). At the light of these differences, we contend that RD&E–marketing integration should have a more positive impact on new product program performance when firms develop explorative products than when they develop exploitative products.

The combination of high uncertainty and lack of relevant previous experience typical of explorative projects tends to increase the amount of interdependence—and, therefore, the need to share information, expertise, and other resources—across functions (Olson, Walker, Ruekert, and Bonner, 2001). Furthermore, because employees have less experience when exploring new competencies, they perceive the development task as more challenging and tend to perceive themselves as more dependent on other functional specialists (Olson, Walker, and Ruekert, 1995). According to the resource dependence perspective, integration should be stronger when each department strongly relies on another's area of expertise, information, and other resources (Ruekert and Walker, 1987), thus suggesting that collaboration between RD&E and marketing is more beneficial for explorative than for exploitative products. Hence, we hypothesize that:

H7: RD&E–marketing cooperation has a more positive impact on new product program performance when the firm is involved in explorative versus exploitative innovation programs.

Method

This section describes the sample and measures.

Sample

This study focuses on the new product program of firms in the highly competitive automotive parts supply industry. Consistent with past research, we suggest that successful companies within an industry are likely to exhibit characteristics that allow them to achieve superior levels of innovativeness relative to other firms in the industry, given the constraints of their markets (Calantone, Vickery, and Drodge, 1995; Cooper and Kleinschmidt, 1993; Yap and Souder, 1994). In analysis at the business unit level, in almost any competitive (nonoligopolistic) industry, it has been observed that managers will report widely variant perceptions of threats, opportunities, and outcomes they face. Thus, to balance or equalize sources and types of environmental uncertainty, the data collection effort is focused within a single industry.

The U.S. auto industry is among the nation's largest manufacturing industries. Together with its suppliers and dealers, it is a cornerstone of the U.S. industrial base. It is estimated that the auto industry as a whole performs over 10% of the nations' corporate RD&E—the most by any U.S. industry. Recently, the auto industry is moving toward greater and more rapid technological innovation in response to global competition, consumer demand, and environmental concerns. As a result, pressures on automotive parts suppliers are growing. Original equipment manufacturers (OEMs) are driving supplier consolidation by pushing suppliers to provide entire component systems, along with investing in innovation and quality design leadership. Additionally, as OEMs are shifting new component development and design responsibility to suppliers in an effort to shorten development cycle time, they simultaneously demand cost reductions. Thus,

conditions in the automotive parts supply industry are increasingly turbulent for most suppliers.

A random sample of 250 industrial firms in the automotive industry was drawn by a commercial e-mail list firm. The list was filtered several times to ensure the final list identified the proper manager or person responsible. Presurvey e-mails solicited participation in the study and confirmed that the company actively developed new components or systems. For each firm, the RD&E manager was asked to complete a questionnaire concerning his/her perceptions of NPD program innovativeness within the business unit. After follow-up e-mails, we received 80 valid responses, yielding a response rate of 32%.

Measures

Firm Innovation Posture ($\alpha = .81$). The scale of firm innovation posture is derived from Miller and Friesen (1983). The scale is made up of seven items, which assess the extent to which the firm is particularly innovative in terms of the rate and novelty of new products that are introduced, and the extent of risk taken by key executives.

Marketing's Technical Knowledge ($\alpha = .86$). The scale is based on the discussion in Ruekert and Walker (1987). The scale is made up of three items, which assess the extent to which marketing has an understanding of the RD&E process, product policies, limitations, and capabilities

RD&E–Marketing Collaboration ($\alpha = .91$). The scale is adopted from Cooper (1983). The scale is made up of six items, assessing the extent to which there is cooperation between RD&E and marketing during the whole NPD process and in the different phases of the process. In order to be sure that the managers' answers were consistent with our conceptualization of collaboration, we explained to them what we mean by collaboration before they filled in the questionnaire.

Environmental Uncertainty ($\alpha = .77$). The scale of environmental uncertainty is derived from Miller and Friesen (1983). The scale is made up of five items, which assess the amount and unpredictability of change in customer tastes, production or service technologies, and the modes of competition in the firm's principal industries.

Exploration Versus Exploitation Innovation Programs. The measure is derived from Rothaermel and Deeds (2004). A firm's exploration innovation program is a count variable of its projects (internal and external via alliances and licensing) that focuses on the upstream activities of the value chain. Conversely, a firm's exploitation projects are a count variable of its projects (internal and external) that focuses on the downstream activities of the value chain. As scarce resources are assigned between these two activities, as one increases, the other decreases. Thus, the variable is formulated as:

$$(\#\ \text{radical projects upstream} / \#\ \text{line extensions and projects downstream}) * 10.$$

New Product Program Performance ($\alpha = .806$). Product program performance is measured with a 4-item scale. The new program return on investment (ROI) is calculated by using 10k and other reports available at the time. We also collected two measures of the quality of the new products: one was based on the Harris Brand Quality Index or equivalent for that firm; the second was derived from JD Power. Finally, we asked companies to assess the quality of their products compared with their competitors'.

Firm Performance. Firm performance is measured as Tobin's Q. Data were collected from Compustat and calculated Tobin's Q based on the approach in Dutta, Narasimhan, and Rajiv (1999).

Results

We used partial least squares (PLS) to test our model. PLS simultaneously estimates the measurement and the causal model. However, Hulland (1999) suggests interpreting the model in two stages: the psychometric properties of the variables and the goodness of the measurement model first, and then the assessment of the structural model.

Measurement Model

All factor loadings on the intended latent variable are significant and bigger than .7 (Fornell and Larcker, 1981), and the squared-multiple correlations supports the existence of item reliability. The average variance extracted from each variable is bigger than .50 (Bagozzi and Yi, 1988), thus supporting the existence of convergent validity. Finally, discriminant validity is evaluated by comparing the average variance extracted (AVE) of each construct and the variance shared between such constructs and other constructs in the model. This comparison revealed that there is discriminant validity (see Table 1).

Table 1. Discriminant Validity

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Environmental uncertainty	0.56								
2. Exploration/exploitation	0.18	1.00							
3. NP program performance	0.21	0.39	0.67						
4. RD&E–MKTG collaboration	0.08	–0.20	–0.28	0.68					
5. RD&E–MKTG collaboration × Exploration/exploitation	–0.23	–0.24	–0.29	0.01	0.39				
6. RD&E–MKTG collaboration × Exploration/exploitation	–0.23	–0.41	–0.28	0.05	0.20	0.66			
7. Firm performance	0.10	0.92	0.29	–0.23	–0.16	–0.32	1.00		
8. MKTG technical knowledge	0.09	–0.08	–0.20	0.63	0.07	0.08	–0.09	0.79	
9. Firm innovation posture	0.36	0.08	–0.09	0.49	0.01	–0.06	0.08	0.48	0.54

MKTG, marketing; NP, new product; RD&E, research, development, and engineering.

Structural Model

Main Effects. The results are presented in Table 2 and in Figure 2. H1 contends that firms adopting a more aggressive innovation posture generate higher collaboration between marketing and RD&E. We found support for H1 ($\beta = .24$; $t = 4.52$). Also, in support of H2, marketing has greater technical knowledge when it is in an aggressive firm than when it is in a defensive firm ($\beta = .48$; $t = 11.87$). The fact that the marketing department has significant technical knowledge facilitates collaboration between marketing and RD&E ($\beta = .51$; $t = 12.63$), in support of H3.

H4 contends that collaboration between RD&E and marketing has a positive impact on the product program performance. We found that collaboration between the two departments has a negative effect on product program performance ($\beta = -.28$; $t = 5.93$). Hence, H4 has to be rejected.

According to H6, the product program performance increases as a firm pursues more explorative than exploitative innovations. We found support for this hypothesis ($\beta = .68$; $t = 19.03$). Finally, we found that product program performance has a positive effect on firm performance ($\beta = .69$; $t = 20.87$).

Interaction Effect. H5 argues that collaboration between RD&E and marketing is more beneficial when the environmental uncertainty is high rather than low. In order to test this hypothesis, we standardized the RD&E–marketing collaboration and environmental uncertainty measures, and created an interactive term as a latent construct with items that are the product terms of each pair of items. Contradicting H5, the interaction effect is not significant ($\beta = -.05$; $t = .76$). Hence, the effect of marketing–RD&E collaboration does not depend on environmental uncertainty.

H7 maintains that the impact of marketing–RD&E collaboration on product program performance is bigger when a firm develops explorative rather than exploitative innovations. We adopted the same procedure described earlier to create the interaction term between marketing–

Table 2. Results of the Partial Least Squares Analysis

	Hypothesis	Main Effects Model	Moderated Effects Model
Firm innovation posture –> RD&E–MKTG collaboration	H1	.24* (4.52)	.24* (5.61)
Firm innovation posture –> MKTG technical knowledge	H2	.48* (11.87)	.48* (10.69)
MKTG technical knowledge –> RD&E–MKTG collaboration	H3	.51* (12.63)	.51* (11.54)
RD&E–MKTG collaboration –> NP program performance	H4	–.28* (5.93)	–.14* (4.71)
Exploration/exploitation –> NP program performance	H6	.66* (27.86)	.67* (28.11)
Environmental uncertainty –> NP program performance	H7	.06 (1.9)	.06 (1.89)
New product program performance.–> Firm performance	H8	.69* (19.14)	.69* (20.87)
Environmental uncertainty × RD&E–MKTG collaboration. –> NPP performance			–.05 (.76)
Exploration/exploitation × RD&E–MKTG collaboration. –> NPP performance			–.17* (3.94)
R^2 new product performance		.08	.67*
R^2 firm performance		.47*	.48*

* $p < .05$.
MKTG, marketing; NP, new product; RD&E, research, development, and engineering.

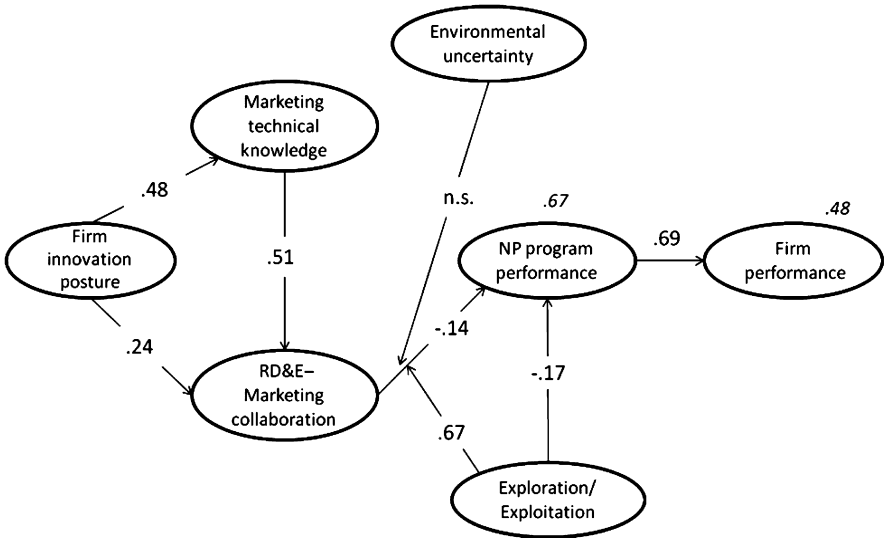

Figure 2. Results

RD&E collaboration and the nature of the innovation program. The effect of this interaction term on product program performance is negative ($\beta = -.17$; $t = 3.93$). Contradicting H7, the collaboration between RD&E and marketing is more positive when firms develop exploitative innovations than when they develop explorative innovations. To evaluate if including the interaction effect significantly improves the predictive power of the model, we computed the effect size of interaction as $f = (R^2_{\text{FULL}} - R^2_{\text{MAIN}})/(1 - R^2_{\text{FULL}}) = 1.79$, which can be considered significant (Cohen and Cohen, 1983). Also, the increase in R^2 attributable to the interaction effect (delta $R^2 = .59$) is statistically different from zero at the 0.05 level (Cohen and Cohen, 1983).

Robustness Analysis. Three types of robustness analysis are conducted: (1) we controlled for possible endogeneity; (2) we tested the interaction effects with two different analyses (ordinary least squares [OLS] and ANOVA); and (3) we used alternative model specifications.

Endogeneity. Firms might choose their level of collaboration and the level of exploration/exploitation in their projects only in conditions that are advantageous to performance. For instance, companies may select a certain degree of exploration/exploitation of their projects in a certain year, depending on the level of environmental uncertainty in the same year. Hence, we ran a Durbin–Wu–Hausman test in Stata to control for endogeneity. In order to do that, we had to abandon the latent variables approach and create averaged scales of our constructs. Collaboration and exploration/exploitation were considered as two endogenous variables, while innovation posture and environmental uncertainty (and marketing's technical knowledge in the case of collaboration) were considered exogenous variables. Please note that posture and uncertainty have no effect on exploration versus exploitation, thus providing a first indication that endogeneity is not a relevant issue in our data. In any case, the Durbin–Wu–Hausman test failed to reject the null hypothesis ($\chi^2 = 1.25$; $p > .05$), thus indicating that endogeneity does not bias our results.

Interaction effects with OLS and ANOVA. We adopted an alternative approach to test the interaction effects in our model through OLS. To do that, we created averaged construct scores. The results remained totally consistent. In order to further corroborate our results, we used a different approach and split the sample in two groups according to the median value of the exploration–exploitation variable. We also created two other groups by splitting the sample according to the median value of environmental uncertainty. Table 3 reports the results of an ANOVA analysis in which we compared the effect of cooperation on program performance in (1) a group of firms involved in exploitation projects and in a group of firms involved in exploration project; and (2) in a group of firms that perceived the environmental uncertainty to be low and in a group of firms that perceived the environmental uncertainty to be high. The results show that the effect of cooperation is bigger for companies involved in exploitative rather than explorative projects ($\beta = 18.79$; $p < .001$), while there is no difference when

Table 3. Results of the ANOVA Analysis—Effects of Cooperation on New Product Program Performance

	Beta (*t*-value)
Intercept	32.27 (5.00)**
Cooperation	−1.93 (−2.17)*
Exploration–exploitation (exploration reference group)	18.79 (7.14)**
Environmental uncertainty (low uncertainty reference group)	−3.22 (−1.22)

** $p < .001$; * $p < .05$.

the sample is split according to the level of environmental uncertainty ($\beta = -3.22$; $p < .001$). Hence, both the OLS and the ANOVA analyses corroborate the results of the PLS analysis.

Different model specifications. We checked the robustness of our results for H7 in alternative model specifications. First, we removed the interaction effect between cooperation and environmental uncertainty, which is not significant, from the model and treated uncertainty like a control variable. The interaction effect between cooperation and exploration–exploitation remained almost the same ($\beta = -.18$, $t = 2.54$). Second, we removed environmental uncertainty from the model. Also, in this model, the interaction effect between cooperation and exploration–exploitation remained negative ($\beta = -.19$, $t = 2.87$). Hence, results are robust to different alternate model specifications.

Conclusion and Implications for Managers

This paper offers three main implications about (1) the effect of the firm's innovation posture on the collaboration between RD&E and marketing; (2) the moderating effect of the new product program nature; and (3) the moderating role of environmental uncertainty.

Firm's Innovation Posture

First, the paper analyzed the effects of firms' innovation posture on the cooperation between RD&E and marketing. The analysis showed that a more aggressive innovation posture enhances cooperation not only in a direct way but also in an indirect way by improving marketing's understanding of RD&E processes and capabilities. Different mind-sets, cultures, and languages represent the main barrier to a fruitful collaboration between the two departments (Dougherty, 1992). Hence, real collaboration requires that marketing develops a clear understanding of the capabilities and limitations of the RD&E department. The frequency with which an aggressive firm innovates may enhance the collaboration in two different ways. On the one hand, frequent new product introductions force marketing to have a greater knowledge of the technical competencies of the firm because the marketing department has to emphasize them during the new product launch. The marketing department becomes aware of how the technological know-how the firm possesses can be applied to introduce new products. In this way, the marketing department is able to understand how customer needs can be satisfied through the technical knowledge existing within the firm. In a similar way, the frequency with which aggressive firms introduce new products may facilitate the collaboration between RD&E and marketing because the RD&E department receives more frequent feedback on what the market wants and can develop new technologies that are more consistent with customer needs.

The Moderating Role of Explorative–Exploitative Innovation Programs

Firms can develop new products either by using their existing technological or customer knowledge, or by exploring new solutions far removed from the current capability endowment (Kyriakopoulos and Moorman, 2004). The analysis showed that strong collaboration between RD&E and marketing when firms are pursuing explorative innovation programs has a negative impact on new product program performance. It seems that when companies develop new products that require different market or technological knowledge, it is preferable to keep the RD&E and marketing separate, rather than having them collaborate together. This is a surprising result, which contradicts previous NPD literature (Olson et al., 1995, 2001; Ruekert and Walker, 1987). March argues that organizational units involved in the exploration process should be kept separate from the rest of the organization, in an effort to guarantee them the freedom to develop new competencies (Levinthal and March, 1993). Only when new competencies are developed should these units be reintegrated within the organization to transfer their knowledge to other units. This theory may explain our results. A sequential NPD process, in which RD&E develops new competencies and creates new products, and then the marketing educates consumers about the benefits of the new product, seems to be preferable to a NPD process in which RD&E and marketing collaborates for the entire process.

The Moderating Role of Environmental Uncertainty

Scholars have traditionally considered environmental uncertainty to be a key moderator of the effect that collaboration between RD&E and marketing has on NPP (Gupta et al., 1986; Ruekert and Walker, 1987). Our results, however, show that environmental uncertainty has no significant role when controlling for the moderating role of explorative–exploitative new product introductions. While this result might be due to possible omitted variables in our study, it also suggests a revision of the previous literature in the sense of paying more attention to internal factors than to external ones. The need to develop new knowledge, and the fact that the nature of the new knowledge to be developed changes across different NPD processes, is the key variable to consider.

In summary, our paper suggests to managers that the level of collaboration between RD&E and marketing does not necessarily need to be high. There are situations in which it is better to keep the two departments separate during the NPD process. In particular, we forewarn managers of the necessity of creating loose collaboration between RD&E and marketing when the firm is involved in explorative NPD processes.

Future Research Directions

In this paper, collaboration is defined as a mutual understanding, a common vision, collective goals, and resource sharing. Such conceptualization implies that there is a soft dimension (e.g., mutual understanding) and a hard dimension of collaboration (e.g., information sharing). Future research could investigate whether the two dimensions have differing effects and how much variance of the new product program performance is explained by each dimension. Also, it would be interesting to analyze whether environmental uncertainty and explorative–exploitative innovation programs have a moderating effect on one of the two dimensions or both (or none).

Danneels (2002) distinguishes NPD projects according to the technological and market competencies that a firm must explore/exploit during the project. It might be the case that a firm explores technological (market) competencies and in the same project exploits market (technological) competencies. Future research could investigate whether the moderating effect of exploration/exploitation varies according to the type of competencies that a firm explores.

Finally, our paper analyzes collaboration between RD&E and marketing during the entire development process. Future research should consider whether the negative moderating effect of an explorative–exploitative innovation program occurs solely in the early phase of the development process (e.g., when the RD&E department develops brand new competencies to introduce new products or the marketing department plans to enter completely new markets) or during the entire development process. Levinthal and March's (1993) argument seems to suggest RD&E and marketing must be kept separate only at the beginning of the NPD process, but future research is necessary to clarify this point.

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Appendix. Measures

Constructs and Item Measures	Factor Loadings
Environmental uncertainty	
a. Our firm must rarely change its marketing to keep with the market and competitors	.694
b. The rate at which products/services are getting obsolete in the industry is very slow (e.g., basic metal, like copper)	.786
c. Actions of competitors are quite easy to predict	.758
d. The product/service technology is not subject to very much change and is well established	.756
Firm innovation posture	
a. The rate, relative to competitors, of new product/service introduction by the firm has increased very much	.622
b. The rate of change in your methods of production or rendering services has accelerated rapidly	.668
c. Risk taking by key executives of the firm in seizing and exploring "chancy" growth opportunity has increased very much	.727
d. In dealing with its competitors, the firm resorts much more to a live and let live philosophy*	.769
e. Seeking of unusual, novel situations by senior executives to problems via the use of "idea men," brainstorming, etc. has become much more common	.672
f. In general, the top managers of my firm believe that owing to the nature of the environment, bold, wide-ranging acts are necessary to achieve the firm's objective	.848
g. When confronted with decision-making situation involving uncertainty, my firm typically adopts a cautious, "wait-and-see" posture in order to minimize the probability of making a mistake*	.816
Marketing technical knowledge	
a. The marketing department understands RD&E process	.919
b. The marketing department understands company's new product policies	.919
c. The marketing department knows RD&E's limitations and capabilities	.819
Marketing–RD&E collaboration	
Overall, there is total cooperation between RD&E and marketing	
a. Overall	.837
b. In new product development	.806
c. In value analysis/value engineering programs	.854
d. In setting production levels	.792
e. In sales forecasting	.846
f. In setting territory goals	.797
Product program performance	
a. New program ROI	.874
b. Perceived quality (Harris Brand Quality Score)	.752
c. Objective quality (JD Power)	.845
d. Our products are generally of higher quality: tighter specifications, or stronger or more durable than competitors'. (self-report)	.791

* Reverse-coded item.