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R&D, MARKETING INNOVATION, AND NEW PRODUCT PERFORMANCE:

A MIXED METHODS STUDY

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Drs. Grimpe, Sofka, and Chatterjee dedicate this research to their co-author Mukesh Bhargava, who passed away before the manuscript was completed. Mukesh brought us together on this project. We will cherish forever his graciousness, concern for others, and his wonderful sense of humor, none of which he lost even as he battled his illness to the last day. Mukesh was truly one of a kind.

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ABSTRACT

This article investigates the relationship between investments in marketing innovation, i.e. the way in which technologically unchanged products are designed, priced, distributed, and/or promoted, and a firm's new product performance. Marketing innovation, such as calorie-based packaging or unusual distribution channels, may lead to new products. However, it is unclear whether they pay off, particularly when the firm follows a dual strategy, i.e. investing in both innovative marketing and R&D at the same time. We draw from theory on competence development as well as diffusion of innovation and argue that pursuing a dual strategy lowers performance, an effect that we attribute to the role of complexity in innovation. Based on a mixed methods study that integrates a dataset of 866 firms from a representative set of industries in Germany and extensive interview evidence, we find empirical support for our hypotheses. Our research contributes to the emerging stream of literature that seeks to better understand the role of marketing in firms' innovation processes.

PRACTITIONER POINTS

- This article investigates the role of marketing innovation in a firm's overall innovation strategy.
- We find that following a dual strategy, i.e. investing in both innovative marketing and R&D at the same time, has dissynergistic effects and decreases innovation performance.
- The negative effects are particularly strong for small firms and firms in high-tech industries.

Keywords: Marketing innovation, technological innovation, new product performance, mixed methods study

INTRODUCTION

Existing research frequently stresses the ability of firms to introduce new products as a cornerstone of competitive advantage (e.g., Spender and Grant, 1996; Katila, 2002) and highlights investments into research and development (R&D) as a way to create such new products that embody technological novelty (e.g., Helfat, 1994). However, little attention has been paid to new products that do not result from R&D investments but rather from novel marketing strategies. Anecdotal evidence of such *marketing innovation* is plentiful: It includes calorie-based packaging (e.g. "100 calorie packs") or purpose-based packaging (e.g. "Lunchables" as pre-packaged lunches for parents to give to their school kids) of otherwise unchanged food products. Innovative store designs, for example of Starbucks, have generated important competitive advantages. Pre-paid and flat-rate pricing have proven to be crucial for the performance of telecommunication service providers. The same is true for music, news, and book publishers which have found effective and profitable ways to distribute their content digitally. In that sense, the novelty of marketing innovation originates exclusively from the way in which technologically unchanged products are designed, priced, distributed, and/or promoted – the often quoted "4 Ps" of the marketing mix (Waterschoot and Van Den Bulte, 1992).

While prior literature has often stressed the complementary nature of firm R&D and marketing to commercialize and advertise new products (e.g., Song et al., 2005; King et al., 2008), we seem to know little about marketing innovation as a source of new products itself. Hence, in this study we investigate the role of marketing innovation for achieving new product performance, defined as the sales with new products. Comparing the effectiveness of investments into marketing innovation with those into technological innovation, we are particularly interested

in firms that pursue a dual strategy, i.e. firms that invest into both types of innovation at the same time.

The conceptual framework of Danneels and Kleinschmidt, 2001 is particularly fitting for our theoretical reasoning because it distinguishes between a firm-level perspective of product innovativeness and a customer perspective. Innovativeness at the firm-level originates from the degree to which a firm is familiar with market and/or technology environments as well as the fit with existing resources. The customer perspective of product innovativeness, though, rests on attributes of the innovation, adoption risks as well as required behavioral changes (Danneels and Kleinschmidt, 2001). We draw from both firm-level theory on competence development (Danneels, 2002; Danneels, 2008) as well as diffusion of innovation theory (e.g. Rogers, 2003) for customer-level arguments, and we suggest that combining technological with marketing innovation harms innovation performance.

We attribute the dis-synergistic effect of a dual strategy to the role of complexity in innovation. This complexity is greater if new products embody both technological and marketing innovation. At the firm-level, simultaneous innovation by R&D and marketing increases the risk of conflict between the functions especially on account of resource constraints (Danneels, 2008). At the customer-level, complexity as a result of innovation in both technology and marketing domains implies higher effort for customers to evaluate the new product which they may wish to avoid (Dawes et al., 1989). As a consequence, higher complexity adversely impacts customer adoption and slows the diffusion of an innovation (Rogers, 2003). In sum, both firm- and customer-level arguments suggest that the effectiveness of investments into R&D for performance decreases in the presence of investments into marketing innovation, and vice-versa. Additionally, we explore the dis-synergistic effect between technological and marketing

innovation in more detail and argue that the trade-off between them is particularly pronounced for (a) small firms, which are especially challenged by legitimacy and resource constraints relative to large firms, and (b) for firms in high-tech (versus low-tech) industries, owing to more rapid technological change and greater uncertainty in the high-tech environment.

We test our hypotheses using a mixed methods design that integrates a sample of 866 firms in Germany representing a cross-section of industries and an extensive interview study with R&D, product and innovation managers that provide detailed insights into the role of marketing innovation for performance. Our quantitative study is at the firm-level, i.e. dedicated to explaining firm-level innovation performance through firm-level investments. Within this quantitative part, customer-level mechanisms are assumed to affect the overall performance of the firm's product innovation portfolio. We rely on the qualitative part of our study to examine the presence of customer-level effects. Hence, the mixed methods study addresses both the firm- and the customer-level. We find that the average firm does not benefit from pursuing the dual strategy. Moreover, we find evidence that especially small and high-tech firms are better off when investing in one type of innovation, marketing or technology, but not both at the same time.

Our research contributes to the literature in at least two ways. First, we focus on investments into marketing innovation as an innovation strategy which is separate from technological innovation. Existing studies linking technological R&D with marketing envision the latter primarily as supportive of the former (as an exploitation strategy), not as a source of new products in itself. We find that innovative product design, packaging, pricing, promotion and distribution strategies can be an important source of new product performance even if the new products are not based on technological innovation. In fact, investments in marketing

innovation have at least the same potential to create superior innovation performance as R&D investments do. What is more, we investigate the interrelationships between technological and marketing innovation, suggesting a dis-synergistic effect. In that sense, we contribute to an emerging stream of literature that seeks to better understand the role of marketing for new product performance (Griffin and Hauser, 1996; Song et al., 2005; Drechsler et al., 2013).

Second, we adopt a contingency view and identify two important boundary conditions for the dis-synergistic relationship between technological and marketing innovation: firm size and industry affiliation. Our study suggests that firms must be cautious about a dual strategy that pursues both types of innovation simultaneously, especially in case of legitimacy deficits and resource limitations (as for smaller firms) or if the industry is characterized by rapid change and technological uncertainty (as for firms in high-tech industries).

THEORY AND HYPOTHESES

Prior literature often defines the path to generating new products with superior value to customers rather narrowly. Most studies more or less explicitly conceptualize a knowledge production function with R&D investments as the crucial input (for a comprehensive review see Ahuja et al., 2008). Thus, innovation opportunities for technological innovation typically stem from scientific discovery and R&D effort. This can occur within a firm's own laboratory but is frequently developed by applying research generated by other organizations such as universities or suppliers (e.g., Laursen and Salter, 2006; Köhler et al., 2012). In this context, marketing has traditionally been viewed as a mechanism for exploiting technologically novel products commercially (for a recent review see Krasnikov and Jayachandran, 2008). Another stream of literature questions the overly strong technology focus of firms and asks for greater market orientation via a stronger focus on customers and competitors when firms set and develop

strategy (e.g., Day, 1994; Slater and Narver, 1998; Slater and Narver, 1999). In this conceptualization, the marketing function is the driving force behind identifying promising market opportunities, and all other firm functions, such as R&D, follow its lead (Calantone and di Benedetto, 1988; Danneels, 2002; Morgan et al., 2009). The marketing function provides links with customers to build durable relationships with them, thereby enabling a more accurate prediction of changes in customer behavior (Day, 1994).

More recent studies envision an interplay between R&D and marketing. Market research is conducted to understand customer behavior, including the identification of latent and emerging needs, and to study competitors to predict their moves (Calantone and di Benedetto, 1988; Griffin and Hauser, 1996; Slater and Narver, 1998; Slater and Narver, 1999). A multitude of techniques has been developed to support market research, including ethnographic research, lead user studies, or panels of futurists (Mohr et al., 2009). R&D is charged with developing the corresponding products, and marketing subsequently enables the value capture of R&D's development efforts (Griffin and Hauser, 1996; Song et al., 2005; Webb et al., 2011). Prior research has also found the status of the marketing function within the organization to be an important factor for marketing's contribution to firm performance (Drechsler et al., 2013).

In the following, we deviate from the perspective of marketing adding value to the innovation process only through its role in the direction and subsequent commercialization of technology-driven inventions by explicitly separating the innovative from the non-innovative marketing activities of a firm. In that sense, we narrow the definition of marketing innovation to "the implementation of new marketing methods involving significant changes to a firm's marketing mix in product design or packaging, product placement, product promotion or pricing" (OECD, 2005).

As a result, marketing innovation processes are fundamentally different. Knowledge gathered from customers and competitors in the process of market research does not only identify market opportunities and direct firm R&D towards them but leads to innovation opportunities in itself. In that sense, market research plays a decisive role in creating marketing innovation (Moorman et al., 1993) because innovative marketing solutions are typically based on thoughtful market research, combined with a firm's expertise in areas such as advertising, customer management, or sales. New technologies can facilitate marketing innovation, e.g., the ability to sell books electronically or digital supermarket displays enabling flexible pricing, but the novelty advantages from marketing innovation may erode quickly if competitors start adopting such practices.

Hypotheses

The notion that product innovations can emerge from both the technology and marketing domains is not new (Danneels and Kleinschmidt, 2001). While extant literature has frequently stressed the complementary nature of firm R&D and non-innovative marketing (e.g., Song et al., 2005; King et al., 2008), we suggest that R&D and *innovative* marketing are dis-synergistic in their contribution to new product performance. In other words, we argue in the following that firms pursuing a dual strategy will perform worse than those focusing on either technological or marketing innovation at a certain point in time. We follow the conceptualization of Danneels and Kleinschmidt, 2001 who distinguish between a firm-perspective on the innovativeness of new products (i.e. resource fit and familiarity) and a customer perspective (i.e. adaptation). The combination of investments into R&D and innovative marketing increases the complexity of managing the necessary competencies at the firm-level as well as the complexity of resulting new products for customers. A system can be described as more complex if it comprises an

increasing number of elements in which the interaction between these elements is difficult to predict (Simon, 1962; Anderson, 1999). The complexity of innovations in particular has been described based on the dispersion of their underlying knowledge (Dougherty and Dunne, 2011).

To elucidate the effects of complexity at the firm-level, we adopt a framework developed by Danneels (2002) for classifying competences which explain product innovation outcomes. He introduces two types of so-called first-order competences, i.e. a firm's existing technology for producing goods as well as competencies for serving existing customer groups (i.e. knowledge of customer needs, brands, distribution). However, product innovations emerge from changes in technology or marketing through so-called second-order competences (Danneels, 2008). Second-order competencies encompass the identification, evaluation and incorporation of new technologies as well as new customer competences (Danneels, 2002). The former relates directly to our concept of technological innovation while the latter relates to marketing innovation. We will build on the second-order competencies framework but focus our discussion on potential friction between technological and marketing innovation (Danneels, 2002; Danneels, 2008).

In this regard, investments in technological and marketing innovation at the firm-level draw from the same pool of slack resources within the firm (Danneels, 2008). Both the feasibility of a technological experiment as well as the acceptance of new marketing techniques are by definition ex-ante hard to predict or uncertain. Even if such experimentation is successful, returns are more likely to occur with significant time delays. Hence, both technological and marketing innovation stretch and compete for scarce firm resources both in financial terms but also in the attention that top management can devote to them (Ocasio, 1997). What is more, both types of innovation have considerable potential to create conflict within the firm because they make existing assets and routines obsolete (Danneels, 2008). Firms which invest in technological

or marketing innovation in isolation are more likely to be able to draw on information on existing technologies or customers respectively (Danneels, 2002). This makes it easier to arrive at predictions about potential outcomes of technological or marketing experiments and communicate their value. Hence, the potential for conflict is lower.

Firms pursuing a dual strategy may also lack the ability to leverage existing expertise. They are more likely to experience capacity constraints when they screen opportunities. The screening of technological opportunities requires expertise in science and engineering while marketing opportunities are much more likely rooted in market research as well as interaction with customers and competitors. Given the distinct origins of opportunities for technological and marketing innovation, few firms can afford to invest in both consistently and build a critical mass of prior related knowledge for identifying opportunities. Hence, the average quality of the screening of new opportunities may decrease and firms are more likely to miss important trends (Koput, 1997). The result is that the average product innovation project takes longer (Danneels, 2002) or is of lower quality relative to a more focused innovation effort.

At the customer-level, we draw from the theory of diffusion of innovations (Rogers, 2003) to argue that customers face greater complexity when they assess the value of a product that combines technological and marketing novelty. Customers associate uncertainty with new products because it is ex-ante, i.e. before the product has been bought and consumed, not fully observable to what extent a new product will be valuable. As a result, uncertainty is related to lower customer adoption and slower diffusion of an innovation. New products characterized by technological and marketing novelty render a customer's decision making and value assessment even more complex because customers need to aggregate uncertainty across two different

domains instead of just one. Reluctance to adopt such products has been described as "feature fatigue" among customers (Thompson et al., 2005).

Early adoption is typically limited to customers who can tolerate uncertainty about the eventual value of a new product to them. Rogers refers to this adopter category as "innovators", who have high social status and financial liquidity which helps in absorbing failures of complex innovations (Rogers, 2003). We argue, however, that even such innovators may be more reluctant to adopt a new product that combines technological and marketing novelty because the uncertainty that stems from technological and marketing novelty concerns very different elements of a customer's value assessment that complicates aggregation. In this case, the customer's assessment becomes less specific and more abstract. Moreover, the aggregation of information across domains is difficult and requires effort (Dawes et al., 1989) which potential customers would like to avoid. Interestingly, while customers may show higher levels of adoption intention for innovations that are more complex, they are found to actually adopt innovations with lower complexity (Arts et al., 2011).

An example can illustrate dis-synergistic relationships between investments in technological and marketing innovation. Tesla Motors is an innovative producer of electric cars. While the company invests heavily in technological innovation through R&D, e.g. for batteries, it has also invested in a novel distribution system, i.e. marketing innovation, which does not rely on car dealerships but operates own showrooms and a 'factory-direct' selling method (Putros, 2014). Competitors like BMW sell electric vehicles through existing dealerships (Kurylko, 2016). Dis-synergies emerge for Tesla at the firm-level because it has to devote attention to both technological setbacks (e.g. combustible batteries) as well as legal challenges from the product markets (e.g. lawsuits for violating franchising laws in the US) (Putros, 2014). At the customer-

level, BMW trains existing dealers to sell its innovative electric car and therefore benefits from existing customer knowledge and trust of these dealerships (Kurylko, 2016). Tesla, though, requires its potential buyers to judge its technologically innovative cars in a largely unfamiliar sales environment.

In sum, both firm- and customer-level mechanisms imply that pursuing a dual strategy will adversely affect new product performance, relative to the less complex case of either type of innovation offered in isolation. Therefore, we propose:

Hypothesis 1 (H1): There is a dis-synergistic effect between investments into technological and marketing innovation on new product performance.

Firm size

Adopting a contingency view, we focus on the size of the firm as a factor moderating the relationship between the combination of technological and marketing innovation and new product performance. We suggest that the dis-synergistic effect is stronger for small firms compared to large firms for two reasons. First, our firm-level discussion suggests that resource availability is an important mechanism for friction between investments in technological and marketing innovation (Danneels, 2008). Large and established firms with proven marketing and R&D capabilities are likely to find it easier combining technological and marketing innovation effectively. Lower firm size may imply higher resource constraints (Rao et al., 2008), and pursuing both technological and marketing innovation at the same time could overstretch the resources of small firms. Ocasio (1997) suggests management attention to be one of the most important resources of the firm. Thus, small firms with limited personnel capacity will find managing combinations of technological and marketing innovation especially challenging, potentially leading to errors and adversely affecting new product performance.

Second, our customer-level arguments suggest increased complexity originating from a combination of technological and marketing novelty to negatively influence the adoption decision. Small firms have often times been viewed as lacking legitimacy (Rao et al., 2008). Legitimacy can be defined as "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed systems of norms, values, beliefs, and definitions" (Suchman, 1995: 574). The lack of legitimacy of small firms can also be characterized as a liability of smallness. Higher legitimacy reduces the uncertainty perceived by a customer about buying the product of a particular firm. It also facilitates the aggregation of information across domains since legitimacy reduces the effort to gather and process information about both the firm and the product innovation.

Similar customer-level mechanisms linking firm size with adoption decisions can be found in the literature on brand equity (Ailawadi et al., 2003). Products from larger firms are likely to have greater awareness or familiarity among customers in the market; greater product (brand) familiarity leads to higher customer-based brand equity (Keller, 1993). Greater brand equity and reputation, in turn, tend to reduce perceived uncertainty and thereby increase the likelihood of adoption (Keller, 1993; Ailawadi et al., 2003), consistent with diffusion theory (Rogers, 2003). The CTO of a small software company provides us with an example. He describes how his company had sold technologically advanced software with an innovative pricing model ('freemium') to B2B customers. At the customer level, clients were mostly confused by the pricing model. At the firm-level, the company had increased the complexity of its pricing structure to different clients for different services, making it extremely costly for a small firm with limited resources to accommodate customers when technological difficulties from the new software emerged. Therefore, we propose:

Hypothesis 2 (H2): There is a dis-synergistic effect between investments into technological and marketing innovation on new product performance and this effect will be stronger for small firms compared to large firms.

High-tech industries

We next suggest that the industry affiliation of the innovating firm, as a conduit for the nature of technological development, is an important contingency to consider. In particular, we argue that the greater magnitude of uncertainty faced by firms in high-tech industries implies that marketing and technology innovation exhibit a stronger dis-synergistic effect for these firms relative to firms in low-tech industries.

At the firm-level, both investments in technological and marketing innovation make existing assets as well as routines within a firm obsolete and are therefore a source of conflict (Danneels, 2008). The risks from conflict are particularly high when the outcomes of investment decisions are difficult to predict. Hence, dis-synergistic effects from conflicts are likely to increase with the level of uncertainty of both technological and marketing innovation. High-tech industries share the common characteristics of high technological uncertainty, market uncertainty, and competitive volatility (Moriarty and Kosnik, 1989). The rapidly changing competitive landscape aggravates the situation facing firms in high-tech industries. Resources need to be quickly redeployed, creating additional friction and conflicts between R&D and innovative marketing. In more stable, low-tech environments, firms can draw from their familiarity with technologies or markets and build on an established fit with existing resource endowments. Hence, investment decisions into product innovations can be more reliably explained and communicated within a firm. High-tech industries lack this predictability which increases the risk for conflict and this risk is compounded once a firm decides to follow a dual

strategy of combining technological with marketing innovation. Accordingly, firm-level mechanisms predict that the dis-synergistic effects of technological and marketing innovation are particularly strong in high-tech industries.

From a customer perspective, product life cycles in high-tech industries are typically short (Pisano and Wheelwright, 1995), and the product-market environment tends to be relatively dynamic and turbulent. Uncertainty in the adoption of any particular product innovation springs from "not knowing whether the technology – or the company providing it – can deliver on its promise to meet specific needs" (Moriarty and Kosnik, 1989: 8). This in turn leads to higher sensitivity to complexity in the customer's decision making as product innovations in high-tech imply a higher level of uncertainty due to ex-ante unknown innovative features, materials or functions. Given this ex-ante higher level of uncertainty in adoption decisions of customers in high-tech industries, we expect them to be particularly sensitive to additional complexity induced by combinations of technological as well as marketing innovation.

A top marketing manager from a health care company provides us with examples of such dis-synergies. She describes the potential for conflict at the firm-level in high-tech industries originating from established incentive and reputation structures for technological excellence, e.g. in the creation of new chemicals. Investments in marketing innovation are largely considered as a distraction. At the customer-level, though, she highlights risks from discrediting a novel marketing approach, e.g. a brand extension, by combining it with an unproven or error-prone technology.

In sum, both firm- and customer-level arguments suggest the performance of innovations combining technological and marketing novelty in a high-tech context to be lower than in a low-tech context. Our third hypothesis reads as follows:

Hypothesis 3 (H3): There is a dis-synergistic effect between investments into technological and marketing innovation on new product performance and this effect will be stronger for firms in high-tech industries compared to firms in low-tech industries.

DATA AND METHODS

Empirical strategy

Ideally, one would like to test our hypotheses at the firm- and customer-level, i.e. by tracking new product performance as well as the relative contributions of investments in technological and marketing innovation for each product. We are not aware of a dataset which would provide information at this detailed level across a meaningful number of firms with different sizes and from different industries, i.e. the prerequisite for testing hypotheses 2 and 3. Instead, we follow Vergne (2012) and adopt a mixed methods approach which combines qualitative fieldwork with quantitative analyses.

Qualitative analysis. For the qualitative part we rely on 10 semi-structured interviews with decision makers on both technological and marketing innovation in German firms. Typical job titles of our respondents include manager of business development, head of business intelligence, head of marketing excellence, director of R&D and strategic development or CEO. We gained access to the respondents based on readings of trade journals and other professional magazines describing product innovations. We select firms and interview partners from a variety of industries and firm sizes reflecting the comparative hypotheses 2 and 3. The qualitative insights allow us to gain a more comprehensive understanding of the types of marketing innovation in firms as well as its interaction with technological innovation at customer- and firm-levels.

Quantitative analysis. We complement the interviews by a quantitative study in which we test our hypotheses using data from the "Mannheim Innovation Panel" (MIP), which is the German

contribution to the Community Innovation Survey (CIS) of the European Union focusing on innovation activities at the firm level. The quantitative analyses use aggregated information at the firm level. Hence, we make the explicit assumption that a firm's average success with new products as well as its average investments in technological and marketing innovation are valid proxies of our theoretical constructs. Using the firm-level average reduces the variance in our empirical model because it reduces the influence of extreme products with excessively large technological or marketing innovation components. Hence, this induces a downward bias to our estimation results in the sense that it makes it less likely to find empirically significant results. The qualitative findings can help putting the quantitative findings into context.

The methodology and questionnaire used for compiling our data comply with CIS standards and follow the Oslo manual of the OECD (OECD, 2005). CIS surveys target the decision makers for a firm's innovation activities. Typical respondents are CEOs, heads of innovation management units or R&D departments. Decision makers provide direct, importance-weighted measures for a comprehensive set of questions on innovation inputs, processes and outputs (Criscuolo et al., 2005). Several contributions to recent management, strategy and innovation literature have relied on the self-reported information provided by CIS surveys (e.g., Grimpe and Kaiser, 2010; Leiponen and Helfat, 2011).

CIS surveys are unique compared to most other surveys because of their multinational application for more than a decade within the European Union member states. Experience and feedback cycles with regard to quality management and assurance are extensive. First, CIS surveys are subject to substantial pre-testing and piloting in various countries, industries and firms with regards to interpretability, reliability and validity (Laursen and Salter, 2006). The questionnaire contains detailed definitions and examples to increase response accuracy. Second,

the questions are regularly tested for response accuracy and data are compared to other databases. Third, a comprehensive non-response analysis provides no evidence of any systematic distortions between responding and non-responding firms (Rammer et al., 2005). Fourth, a scientific advisory board periodically reviews all questionnaire items. As a result, the German CIS data are generally considered to be of high quality (Eurostat, 2009).

The core of our dataset stems from the MIP survey conducted in 2007 covering the three years prior to the survey. The 2007 MIP questionnaire is the first one containing questions on a firm's marketing innovations. Firms were surveyed again in 2008. We draw the dependent variable on innovation performance from the following observation year (t+1). This limits the coverage of our dataset to firms which participated in both surveys (2007 and 2008), but provides clarity in interpretation by eliminating potential simultaneity issues. We complement this dataset with industry concentration data for the year 2005 provided by the German Monopolies Commission. After dropping incomplete observations, we end up with a final sample of 866 firm observations. The survey data allow us to generate proxy variables across firms of different sizes and industries which can test our theoretical predictions.

Variables

Dependent variable. Researchers have used a variety of constructs for measuring innovation performance (for an overview, see OECD, 2005). They range from innovation inputs such as R&D expenditures to a broad range of output measures such as the number patents or new products. We adopt the latter approach. However, the existence of a novel product is hardly a good predictor for the economic performance of an innovation. It is the market acceptance that turns a novelty into a successful product innovation. In that sense, we follow prior literature based on CIS data and take the sales the firm achieved with new products normalized by the

firm's total sales as our measure for innovation performance in *t*+1 (Laursen and Salter, 2006; Grimpe and Kaiser, 2010; Leiponen and Helfat, 2010; Klingebiel and Rammer, 2014; Klingebiel and Adner, 2015).[1] While innovation performance measured in this way may not necessarily be connected with general firm profitability, we chose this measure to reflect the outcome of investments in technology and marketing innovation. Moreover, general firm profitability may also be influenced by many other factors unrelated to a firm's innovation activities. It is important to keep in mind that our dependent variable captures the sum of sales achieved with both marketing innovations and technological innovations that the firm had introduced.

Focal variables. The focal variables are the investments of firms into marketing innovation and technological innovation. To measure investments in marketing innovation, the survey first asks for the firm's total marketing expenditure in 2006 based on the following definition:

> Marketing expenditures include all internal and external expenditures for advertisement (incl. trade marketing), for the conceptual design of marketing strategies, market and customer research, and the installation of new distribution channels. Pure selling costs do not count as marketing expenditures.

The survey then provides respondents with a detailed definition of marketing innovation:

> A marketing innovation is the implementation of a new marketing method which your enterprise has not used before. It involves significant changes in product design or packaging, product placement, product promotion or pricing and must be part of a new marketing concept or strategy that represents a significant departure from the firm's existing marketing methods. Please note that seasonal,

[1] CIS data distinguish between products new to the firm and those new to the market. We use the sales of products new to the firm. This measure includes products that are new to the market and is, therefore, the more comprehensive construct. Moreover, the correlation between the two figures is high (0.52), and sales of firm novelties equal sales of market novelties for more than 34 percent of firms in the sample.

> regular and other routine changes in marketing instruments are not marketing innovations.

Respondents are subsequently asked to indicate whether their firm had introduced a marketing innovation in any of the following areas: product design, advertising/brands, sales channels, and pricing policy. If yes, respondents are instructed to estimate the share of their marketing expenditures dedicated to marketing innovation. We use this information to calculate a firm's investment in marketing innovation as a share of total sales. We are aware that this operationalization defines the novelty of a firm's marketing innovations from the perspective of the firm.[2] These marketing innovations may be new to the firm but not necessarily to the customer since other firms may have introduced similar marketing innovations before. Yet, there is likely some novelty from the customers' perspective as they may not have seen a firm or firms in this industry use this marketing innovation.[3] If this situation would be present in our sample, it would reduce the odds of finding significant main and interaction effects of marketing innovation because the customers would not face conditions of increased novelty or increased complexity respectively. Hence, our operationalization of marketing innovation can be considered conservative since it induces a downward bias in all estimation results.

Investment in technological innovation is correspondingly calculated as the firm's expenditure on R&D in 2006 as a share of total sales. This information is also taken from the survey.

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[2] It is virtually impossible to objectively define how novel a product needs to be in order to qualify as an innovation. CIS surveys circumvent this problem by leaving it to the responding firm to indicate whether they introduced an innovation that is new to the firm or new to the market. In that sense, a product innovation based on innovative marketing can in fact be considered an innovation which is new to the firm even if other firms may have introduced a similar marketing innovation.

[3] A vending machine for Bose headphones in airports, for example, can be regarded as a new channel to Bose, but customers had not seen vending machines of this brand or this product type before. We thank an anonymous reviewer for pointing this out.

Control variables. Several other factors have been identified in the literature as influencing a firm's innovation performance (for an extensive review see Ahuja et al., 2008). Based on questionnaire information, we include the firm's age (number of years since foundation, in logarithmic form), its number of employees (also in logarithmic form), whether it is part of a company group, and whether it also engages in process innovation (the last two operationalized as dummy variables). We control for different degrees of internationalization through the share of exports over total sales. Moreover, we include a firm's investments into non-innovation related marketing as a percentage of sales to account for a firm's general marketing effort. Besides their association with new product performance, these control variables may also be related to investments into R&D and innovative marketing. Particularly export-intensive firms, for example, have frequently been shown to considerably invest into R&D in order to sustain their export advantage (e.g., Salomon and Jin, 2010).

We also introduce several control variables at the industry level. First, differences in the level of competitive intensity may influence investment decisions for innovation (e.g., Aghion et al., 2005). The German Monopolies Commission calculates a Herfindahl-Hirschman index on the degree of market concentration in Germany. We add its 2005 values at the three-digit NACE industry level to the model.[4] Second, we include industry expenditures in marketing as a share of industry sales to control for industry-level differences in marketing effort. This measure is calculated at the two-digit NACE industry level and based on projected data from the MIP survey, since the firms in the survey are drawn as a stratified random sample and can therefore be considered as representative for Germany (for a detailed description see Rammer et al., 2005). Third, we add six industry dummy variables at the grouped two-digit NACE level to capture any

[4] NACE stands for "Nomenclature statistique des activités économiques dans la Communauté Européenne" and is similar in structure to the SIC or NAICS classification systems.

remaining industry effects: low-tech manufacturing, medium high-tech manufacturing, high-tech manufacturing, distributive services, knowledge-intensive services and technological services. These industry dummy variables are at a higher aggregation level than the continuous industry level variables (competition and prevalence of marketing) described before and do therefore not cause multicollinearity concerns. Finally, we control for regional differences within Germany by including a dummy variable indicating whether a firm is located in eastern Germany, since these firms have been found to differ significantly from firms located in western Germany following reunification (e.g., Czarnitzki, 2005).

Model

Our dependent variable – the share of sales accounted for by new products in t+1 – is censored between 0 and 100, which requires a Tobit regression model. We estimate separate Tobit models to test our hypotheses. As a baseline, we estimate a model that only includes our control variables and subsequently a model including the firm's innovative marketing and R&D investments. We add a multiplicative interaction term of innovative marketing and R&D investments to a separate model and finally split the sample by firm size and industry affiliation. In splitting the sample by firm size, we follow Eurostat, the statistical office of the European Union, which defines small firms as those with less than 50 employees.[5] For the split based on whether the firm belongs to a high-tech versus low-tech industry, we assign all firms belonging to high and medium-high tech manufacturing and knowledge-intensive and technological services (based on NACE classification) to the high-tech group, while the other firms (in low and medium-low tech manufacturing and distributive services) form the low-tech group.

[5] See http://europa.eu/legislation_summaries/enterprise/business_environment/n26026_en.htm

Moreover, we estimate several models as robustness checks. First, as an alternative to the number of employees we use a threshold of total firm sales of 10m Euros for the split sample regressions for firm size. Second, we estimate a model that includes the dependent variable at *t*-3 as an additional control variable. Including the lagged dependent variable allows controlling for some stable unobserved factors. Third, we re-estimate the models excluding two consumer goods industries (NACE 15: food and drinks; NACE 16: tobacco) since marketing innovation could be a predominant phenomenon in those industries. Fourth, multi-product firms may use technological innovations for one product while marketing innovations might be used for another which would jeopardize our reasoning on the combination of technological and marketing innovation. For this reason, we use survey information on whether marketing innovation actually occurred in connection with the introduction of (technologically) new products. Survey respondents were asked to provide this information in a follow-up question. We re-estimate the models using the reduced sample of firms which indicated this to be the case. Finally, since Tobit models are non-linear, the correct interpretation of interaction effects requires the calculation of their marginal effects. We follow the procedure suggested by Wiersema and Bowen (2009) and report marginal effects in order to test the hypotheses.

RESULTS

Qualitative evidence

Table 1 provides a detailed overview and representative quotes from our interviews in the field. All respondents reported examples of marketing innovations. Most marketing innovations originate from changes in the product design, e.g. creating product bundles, novel pricing or delivery strategies. A manager in charge of business development for an energy provider presents a fitting example:

> Offering more flexible delivery to new customers with temporary energy demands is a small part of our overall revenues but it allows us to set higher prices in an otherwise standardized business. In this sense, adding new delivery options to our portfolio gives us new strategic options.

Some respondents had dedicated organizational units for marketing innovation while others made investment decisions triggered by customer requests. Particularly smaller and service firms can be found in the latter group. Other interview partners emphasized competitive pressures as well as limited technological or regulatory opportunities in their particular sectors as reasons for investments in marketing innovation. A statement from the CEO of a small provider of gaming services exemplifies these pressures well:

> Our business faces substantial regulation in terms of which products we can offer legally since they qualify as gambling. Return customers are crucial for our success but subscriptions are not allowed by law. Hence, we have become very innovative in offering products with new price structures, e.g. start bonuses, and advertising to maximize the return rate of existing customers.

When we ask the interview partners about the relationship between R&D and marketing innovation in their firm, only firms which rely strictly on technological process innovations, e.g. acquiring new IT infrastructure, report no conflicts. Most respondents comment on dis-synergies at the firm-level. They mention differences in mental models and incentives between R&D engineers and innovative marketing functions. The head of marketing excellence of a large health care company tells us for example:

> Our drive for more marketing excellence has required change management. We have experienced power fights and incentive clashes in some units. For somebody who is incentivized to produce a certain number of molecules every year, customer inputs and marketing are a distraction.

Larger firms have comparatively more structured processes in place to manage these conflicts. They typically refer to business development committees which, irrespective of whether the opportunities emerge from R&D, marketing or a combination of both, compare performance potentials and set priorities. Two of the interviewed companies had dedicated units for marketing innovation.

At the customer-level, several respondents highlighted the risk-aversion of their companies to combine too many novel elements in a new product which could harm the company's brand or reputation. The CTO of a small start-up firm described his experience with combining a novel software product with innovative pricing like this:

> Freemium is apparently not a model that works for B2B customers. Our B2B customers didn't understand it and demanded a simple pricing model.

Besides, two respondents recalled customer-level experiences in which the customer feedback for products which combined technological and market novelty was disappointing. In one case the firm had overestimated the technological novelty vis-à-vis existing products. In the other case, customers found the novel delivery method of a new product too confusing. In both cases the firms reacted with relying on proven technologies or existing marketing methods. The head of business intelligence of a large consumer goods producer shared one example:

> We had a new product which was supposed to be calibrated with a novel tablet app for the end consumer at home. The feedback was not good. For that reason we have shifted the distribution technology back to existing retailer channels. The risk of tarnishing our reputation was too high.

Managers from high-tech firms emphasized the technological roots of their companies but were also particularly aware of the limitations of novel technologies for creating innovation performance. They mention marketing innovation as the untapped performance potential for

creating and capturing value from their stock of technologies. Firms in low-tech sectors, though, had ex-ante much lower expectations from R&D investments which were typically directed at process improvements or incremental innovation. Hence, there were fewer trade-offs with marketing innovation which had to be managed. One manager from a low-tech firm indicated that marketing innovation in the form of a new outer design actually provided an opportunity to make incremental technological innovation more visible to the customer.

In sum, the interviews from the field support the importance of marketing innovations for firms of many industries for new product performance. In line with our hypotheses, there is some indication that smaller firms and those from high-tech sectors are less prepared to manage potential conflicts with technological innovations. The quantitative study can help to understand whether these relationships also hold in a representative sample of firms.

[Table 1 about here]

Descriptive results of the quantitative study

The average firm in our sample is 20 years old and has 345 employees. Table 2 provides descriptive statistics for the full sample, for firms with and without investments in marketing innovation, as well as for small versus large firms and high-tech versus low-tech firms. We test for mean differences between the two groups as an initial empirical step. Firms in our sample derive an average of 21% of their sales from new products. Innovation performance is significantly higher for firms that invest in marketing innovation and also for firms in high-tech (versus low-tech) industries, as one might expect, but there is no difference between small and large firms. The average firm spends 2% of its sales on marketing overall but only 0.4% on marketing innovation, with the remainder going into non-innovative marketing. Among firms investing in marketing innovation, small (versus large) firms and firms in high-tech (versus low-

tech) industries spend significantly more on overall marketing and also on marketing innovation. R&D investment of the average firm in our sample is 5% of sales. Interestingly, R&D investment (as a percentage of sales) does not differ significantly between firms that invest in marketing innovation and those that do not. Small firms spend significantly more on R&D than do large firms. Not surprisingly, firms in high-tech industries spend significantly (on average, 8 times) more on R&D than those in low-tech industries.

[Table 2 about here]

Table 3 shows the distribution of firms performing technological and/or marketing innovation. Most firms invest in both types of innovation activities at the same time, though substantial fractions of the sample only perform technological or marketing innovation. Tables 4 and 5 show the distribution for small firms and for high-tech firms. Again, a majority invests in both types of innovation. Chi-square tests confirm for all tables that the number of firms performing both activities is significantly higher than we would expect if the two types of investment were independent, i.e. if there was no statistically significant association between the two types of investment. These descriptive findings reject the idea that small firms or firms in high-tech might focus entirely on one type of innovation while large firms or firms in low-tech adopt a more "generalist" approach with investments in multiple types of innovation.

[Tables 3, 4 and 5 about here]

Table 9 in the appendix shows bivariate correlations and collinearity statistics. We do not find an indication of collinearity problems in our data by any conventional standard (e.g., Belsley et al., 1980).

Regression results

Main results. Table 6 shows the results of the Tobit regression models. We estimate seven models with different specifications. All of them include our set of control variables, whose effects turn out to be largely consistent across the specifications. We describe the results for the control variables for all models at the end of this section. Model 1 only includes our control variables. Model 2 is our baseline model which includes the firm's investments into innovative marketing and R&D. As expected, we find that both variables are significantly and separately positively associated with new product performance. Although R&D investments have frequently been shown to be an important determinant of new product performance, the results indicate that investment in marketing innovation has a separate, large impact on performance (the marginal effects on the expected value of new product performance conditional on it being larger than zero are 1.558 and 0.279 for marketing innovation and R&D, respectively). This finding supports our baseline expectation for a positive association between marketing innovation and new product performance that is separate from technological innovation.

Model 3 includes the interaction between marketing innovation and R&D investments. We find that the interaction effect is significant and negative, thus lending support to hypothesis 1. The marginal effect (i.e. the secondary moderating effect, cf. Wiersema and Bowen, 2009) equals –0.075.[6] Investments in technological and marketing innovation are hence dis-synergistic with regard to new product performance.

Models 4 and 5 analyze split-samples of small firms (having less than 50 employees) and large firms (with 50 or more employees), respectively. According to our results, the negative

[6] Wiersema and Bowen (2009) suggest plotting the secondary marginal effect to determine whether it is significant for all observations in the sample. We find this to be confirmed except for very few observations for which the marginal effect is not statistically different from zero. The results are shown in Figure 1 the appendix.

interaction between technological and marketing innovation seen in Model 3 only holds true in the case of small firms (Model 4). The marginal effect equals –0.098 and is significant. It turns out to be larger for small firms compared to the full sample. There is no significant interaction effect for larger firms. These results support hypothesis 2.

We next turn to Models 6 and 7 for a sample split on the basis of firms in high-tech industries (Model 6) and firms in low-tech industries (Model 7). The interaction between marketing innovation and technological innovation is negative and highly significant in the case of high-tech industries (the marginal effect is –0.102 and significant); for low-tech industries, the coefficient is not statistically significant. Thus, our results support hypothesis 3.

Moreover, we test the difference in coefficients between the subsamples by using seemingly unrelated estimations and by interacting the moderators (small firm and high-tech firm dummy variables) with the interaction term. While we find the coefficients to be significantly different from each other in the small/large firm sample split, we do not find a significant difference in the high-tech/low-tech firm sample split. As a consequence, we have to qualify the results for hypothesis 3.

[Table 6 about here]

Control variables. Model 1 shows a positive and significant association between a firm's investment in non-innovative marketing and new product performance, indicating a high importance of general marketing effort. However, this relationship turns insignificant (but remains positive) once the regression models include our measure of marketing innovation investments. This result qualifies prior findings (Drechsler et al., 2013) in that the role of marketing in new product development is only relevant for new product performance when it concerns significant changes in the firm's marketing mix. Firm age is generally negatively

associated with innovation performance, while firm size (in terms of employees) has a positive effect. High international orientation of the firm (measured as the share of exports in overall sales) is positively associated with innovation performance, as is having an Eastern Germany location. The effects of firms being part of a group and being a process innovator turn out to be insignificant. Competitive intensity (as measured by the Herfindahl-Hirschman index) and the general marketing intensity of the industry both show positive and significant effects on innovation performance, suggesting that higher product-market concentration as well as higher marketing orientation at the industry level are associated with higher new product performance of firms. Regarding the industry effects, firms in high-technology manufacturing and technology-oriented services show higher new product performance, as one would expect.

Consistency and sensitivity checks. Tables 7 and 8 show the results of our consistency checks. Using a sample split at a level of 10m Euros of firm sales does not alter our results. Moreover, the results remain robust if we include the lagged dependent variable even though the sample drops quite sharply to 343 observations. Excluding firms from consumer goods industries (NACE 15, 16) from our sample also produces consistent results. Finally, Table 8 shows results for the reduced sample of firms which indicated that marketing innovation occurred in connection with technological innovation. Again, we find the results to be consistent.

[Tables 7 and 8 about here]

In auxiliary regressions, available from the authors upon request, we provide two further consistency checks. First, we restrict the sample to firms with a low degree of diversification, indicated by a share of sales greater than 75% that stems from only one product or product category. Second, we use the firm's credit rating, compiled by the German credit rating agency "Creditreform" as an alternative measure of resource constraints. We split the sample along the

median and the 75% percentile of the credit rating to distinguish between firms with a low rating (i.e. resource constrained) and a high rating (i.e. not resource constrained). Both consistency checks provide fully consistent results.

DISCUSSION

Prior studies have largely concentrated on general marketing investments as a way to appropriate the returns from technological innovation (e.g., Griffin and Hauser, 1996; Krasnikov and Jayachandran, 2008). We deepen our understanding of how the marketing function itself may generate new products or services, how marketing innovation affects new product performance, and its interaction with R&D. To do so, we isolate the investments in marketing innovation. Aside from anecdotal evidence – for example, the "100 Calorie Packs" – little is known about firms' efforts to introduce marketing innovations. Our research is one step in the direction of obtaining a clearer understanding of firms' marketing innovation activity and has several implications for management research and practice.

We find that investments in marketing innovation have at least the same potential to create superior innovation performance as R&D investments do. Studies that focus exclusively on technological innovation as a source of competitive advantage (e.g., Helfat, 1997) may therefore not capture the full picture of a firm's innovation activities. This implies that findings derived from studies on technological innovation cannot be simply transferred to marketing innovation. However, a key finding of our study is the negative interaction between technological and marketing innovation which suggests that some firms do not benefit from pursuing a dual strategy. At the firm level, we draw from literature on second-order competencies for changing existing technologies and marketing approaches (Danneels, 2002; Danneels, 2008). We argue that some firms are more likely to experience resource constraints

and potential conflicts when they invest in both second-order competences (technology and market) simultaneously. Drawing from theory on the diffusion of innovations (Rogers, 2003) for a customer-level argument, we attribute the negative interaction effect to the role of complexity in innovation and argue that the complexity of a firm's new products increases if their novelty originates from both technological and marketing innovation. Complexity requires higher effort on behalf of the customers in assessing the value of an innovative product. Besides, customers have difficulties aggregating uncertainty from different domains. As a result, there is a negative effect on a customer's perceived value, leading to lower new product performance.

THEORETICAL IMPLICATIONS

Our research holds several implications for theory based on several aspects. Our study design allows us to examine a variety of firms and industries. We are not bound by patent statistics favoring technological innovation (e.g. Ceccagnoli, 2009) or single industry studies with peculiar technological and appropriability conditions such as in pharmaceuticals (e.g. Nerkar and Roberts, 2004). Both the qualitative fieldwork and the quantitative study based on survey data allow us to substantiate the theoretical argument that technological and marketing innovation are distinct from each other. While they may both improve a firm's new product performance separately, pursuing a dual strategy that combines technological and marketing innovation leads to dis-synergistic effects for certain firms. These firms are better off when focusing on one of the two as a source of innovation rather than combining both. This is a major distinction from existing literature that sees marketing per se as a tool for commercializing technological innovation as a result R&D investment.

Moreover, we find contingencies such as firm size and industry affiliation to be important. Small firms with limited resources and legitimacy suffer especially when they try to

combine technological and marketing innovation. This provides a link to the entrepreneurship literature (e.g., Brush et al., 2001; Hewitt-Dundas, 2006). Based on our findings, small firms are better off when focusing primarily on technological or marketing innovation instead of following a dual strategy.

Firms in high-tech industries face the challenge of high uncertainty and turbulence. In such settings, resource conflicts between technological and marketing innovation are more likely to occur, and customers do not reward novelty based on both marketing and technological innovation because of greater complexity. This particular finding is a strength of our empirical setting, which allows the comparison of various industries and is not confined to a single industry context. It is of particular relevance because many firms in high-tech sectors, such as pharmaceutical or medical instruments, which have traditionally derived innovation from technological and scientific discovery, move increasingly towards more customer-centric models of creating value. They explore new opportunities for designing distribution channels or structuring prices (e.g. Michel, 2014). Our findings show that those investments in marketing innovation are particularly likely to result in friction with technological innovation activities. Such friction may stem from conflicts over budgets or new approaches to innovation which make existing assets or procedures obsolete. Hence, our results can provide an impetus for more work on more nuanced theory on how high-tech firms can build competencies for developing new markets and accessing new customers.

MANAGERIAL IMPLICATIONS

Several recommendations for management practice follow from these theoretical insights. A firm would be short sighted in neglecting the potential for innovation originating from its marketing department. Innovative product design, packaging, pricing, promotion and distribution strategies

can be a promising source of new product performance even if the new products are not based on technological innovation. Prudent managers would need to compare the potential of innovation originating from R&D as well as marketing, and invest more heavily in innovation activities in the department with the higher potential. Neither is per se superior to the other when it comes to creating successful innovation. However, a strategy primarily focusing on one or the other will outperform a dual strategy that splits resources between the two, if resources are limited and/or uncertainty is high, which is the likely situation facing small firms and firms in high-tech industries.

FUTURE RESEARCH

This research takes an initial look at the role of marketing innovation in the relationship between a firm's R&D investment and new product performance. While we have demonstrated that marketing innovation is an important driver of innovation performance, particularly when not combined with technological innovation, we need to acknowledge several limitations of our study. Our research does not provide deep insights into how firms successfully introduce marketing innovations, how they may be effectively protected against imitation, and at which point in the life cycle of the firm's product portfolio they should be introduced.

We have suggested that if new products resulting from marketing innovation are based on existing technology, firms may effectively slow down the pace of technology evolution (Suarez and Lanzolla, 2007) in order to appropriate the value from technology resources (Mizik and Jacobson, 2003) that may otherwise have become obsolete. While marketing innovation could thus serve as an instrument to extend technology-based first-mover advantages (Lieberman and Montgomery, 1988; Lieberman and Montgomery, 1998), further research is needed to develop a better understanding of the appropriate timing in the introduction of such innovations. This issue

is particularly important since marketing innovation could actually become very risky in case a firm stays with a technology for too long, thereby losing the opportunity to switch to a more advanced technology that might subsequently allow further marketing innovation. In order to investigate these questions, we would need longitudinal data, which would permit a more nuanced understanding of the interaction between marketing and technological innovation, in terms of the conditions under which the two may be synergistic rather than dis-synergistic. Along these lines, the consideration for factors interacting with the imitability and timing conditions for technological and/or marketing innovation such as suggested by Danneels (2012) could be particularly promising. Within the theoretical reasoning of this study, marketing innovation is defined along changes in marketing mix decisions (the "4Ps"). Such changes can permit the implementation of new segmentation, targeting, and positioning ("STP") strategies which may ultimately allow the more successful positioning of technologically novel products in product markets, i.e. lead to synergistic relationships. This particular interaction between innovative marketing decisions and R&D is outside the scope of what we can cover in this study empirically and theoretically. However, we encourage dedicated studies which are designed to capture this particular aspect of synergy. Future research may also explicitly examine the direct and interactive effect of marketing innovation on "crossing the chasm" between the early adopters and the rest of the market, which frequently determines the success or failure of innovations (Moore, 2002).

Finally, further work also needs to be done to improve the measure of marketing innovation which in this study captures the total amount spent on marketing innovation (as defined in the CIS survey), without specifics on how the money was spent. As noted, the topic of marketing innovation is under-researched. There is an opportunity to better understand what

unique resources and capabilities marketing innovation entails, especially in contrast to traditional marketing, and what roles marketing innovation and traditional marketing play together in influencing the firm's new product performance.

REFERENCES

Aghion, P., N. Bloom, R. Blundell, R. Griffith and P. Howitt. (2005). Competition and innovation: an inverted-u relationship. *Quarterly Journal of Economics*(May), 701-728.

Ahuja, G., C.M. Lampert and V. Tandon. (2008). Moving Beyond Schumpeter: Management Research on the Determinants of Technological Innovation. *Academy of Management Annals* 2, 1 - 98.

Ailawadi, K.L., D.R. Lehmann and S.A. Neslin. (2003). Revenue Premium as an Outcome Measure of Brand Equity. *Journal of Marketing* 76(4), 1-17.

Anderson, P. (1999). Perspective: Complexity Theory and Organization Science. *Organization Science* 10(3), 216-232.

Arts, J.W., R.T. Frambach and T.H.A. Bijmolt. (2011). Generalizations on consumer innovation adoption: A meta-analysis on the drivers of intention and behavior. *International Journal of Research in Marketing* 28(2), 134-144.

Belsley, D.A., E. Kuh and R.E. Welsh (1980). *Regression diagnostics: Identifying influential data and sources of collinearity*. New York.

Brush, C.G., P.G. Greene and M.M. Hart. (2001). From initial idea to unique advantage: the entrepreneurial challenge of constructing a resource base. *Academy of Management Executive* 15(1), 64-78.

Calantone, R.J. and A. di Benedetto. (1988). An integrative model of the new product development process - An empirical validation. *Journal of Product Innovation Management* 5(3), 201-215.

Ceccagnoli, M. (2009). Appropriability, Preemption, and Firm Performance. *Strategic Management Journal* 30(1), 81-98.

Criscuolo, C., J.E. Haskel and M.J. Slaughter (2005). Global Engagement and the Innovation Activities of Firms. In: *NBER Working Paper*. Cambridge, MA.

Czarnitzki, D. (2005). Extent and Evolution of the Productivity Deficiency in Eastern Germany. *Journal of Productivity Analysis* 24(2), 209-229.

Danneels, E. (2002). The dynamics of product innovation and firm competences. *Strategic Management Journal* 23(12), 1095-1121.

Danneels, E. (2008). Organizational antecedents of second-order competences. *Strategic Management Journal* 29(5), 519-543.

Danneels, E. (2012). Second-order competences and Schumpeterian rents. *Strategic Entrepreneurship Journal* 6(1), 42-58.

Danneels, E. and E.J. Kleinschmidt. (2001). Product innovativeness from the firm's perspective: its dimensions and their relation with project selection and performance. *Journal of Product Innovation Management* 18(6), 357-373.

Dawes, R.M., D. Faust and P.E. Meehl. (1989). Clinical versus actuarial judgment. *Science* 243(4899), 1668-1674.

Day, G.S. (1994). The capabilities of market-driven organizations. *Journal of Marketing* 58(4), 37-52.
Dougherty, D. and D.D. Dunne. (2011). Organizing Ecologies of Complex Innovation. *Organization Science* 22(5), 1214-1223.
Drechsler, W., M. Natter and P.S.H. Leeflang. (2013). Improving marketing's contribution to new product development. *Journal of Product Innovation Management* 30(2), 298-315.
Eurostat (2009). *Fifth community innovation survey: Synthesis of quality reports*. Luxembourg: Office for Official Publications of the European Communities.
Griffin, A. and J.R. Hauser. (1996). Integrating R&D and marketing: A review and analysis of literature. *Journal of Product Innovation Management* 13(3), 191-215.
Grimpe, C. and U. Kaiser. (2010). Balancing internal and external knowledge acquisition: the gains and pains from R&D outsourcing. *Journal of Management Studies* 47(8), 1483-1509.
Helfat, C.E. (1994). Firm-specificity in corporate applied R&D. *Organization Science* 5(2), 173-184.
Helfat, C.E. (1997). Know-How and Asset Complementarity and Dynamic Capability Accumulation: The Case of R&D. *Strategic Management Journal* 18(5), 339-360.
Hewitt-Dundas, N. (2006). Resource and capability constraints to innovation in small and large plants. *Small Business Economics* 26, 257-277.
Katila, R. (2002). NEW PRODUCT SEARCH OVER TIME: PAST IDEAS IN THEIR PRIME? *Academy of Management Journal* 45(5), 995-1010.
Keller, K.L. (1993). Conceptualizing, Measuring, and Managing Customer-Based Brand Equity. *Journal of Marketing* 57(1), 1-12.
King, D.R., R. Slotegraaf and I. Kesner. (2008). Performance Implications of Firm Resource Interactions in the Acquisition of R&D-Intensive Firms. *Organization Science* 19(2), 327-340.
Klingebiel, R. and R. Adner. (2015). Real options logic revisited: The performance effects of alternative resource allocation regimes. *Academy of Management Journal* 58(1), 221-241.
Klingebiel, R. and C. Rammer. (2014). Resource allocation strategy for innovation portfolio management. *Strategic Management Journal* 35(2), 246-268.
Köhler, C., W. Sofka and C. Grimpe. (2012). Selective search, sectoral patterns, and the impact on product innovation performance. *Research Policy* 41(8), 1344-1356.
Koput, K.W. (1997). A Chaotic Model of Innovative Search: Some Answers, Many Questions. *Organization Science* 8(5), 528-542.
Krasnikov, A. and S. Jayachandran. (2008). The Relative Impact of Marketing, Research-and-Development, and Operations Capabilities on Firm Performance. *Journal of Marketing* 72(4), 1-11.
Kurylko, D.T. (2016). BMW perseveres with i3 in tough environment for EVs. In: *Automotive News*. Detroit.
Laursen, K. and A. Salter. (2006). Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal* 27, 131-150.
Leiponen, A. and C.E. Helfat. (2010). Innovation objectives, knowledge sources, and the benefits of breadth. *Strategic Management Journal* 31(2), 224-236.
Leiponen, A. and C.E. Helfat. (2011). Location, Decentralization, and Knowledge Sources for Innovation. *Organization Science* 22, 641-658.

Lieberman, M.B. and D.B. Montgomery. (1988). First-Mover Advantages. *Strategic Management Journal* 9, 41-58.
Lieberman, M.B. and D.B. Montgomery. (1998). First-mover (dis)advantages: Retrospective and link with the resource-based view. *Strategic Management Journal* 19, 1111-1125.
Michel, S. (2014). Capture More Value. *Harvard Business Review* 92(10), 78-85.
Mizik, N. and R. Jacobson. (2003). Trading off between value creation and value appropriation: The financial implications of shifts in strategic emphasis. *Journal of Marketing* 67, 63-76.
Mohr, J.J., S. Sengupta and S.F. Slater (2009). *Marketing of High-Technology Products and Innovations*. Upper Saddle River, NJ: Pearson Prentice Hall.
Moore, G.A. (2002). *Crossing the chasm: Marketing and selling disruptive products to mainstream customers*. New York: Harper Collins.
Moorman, C., R. Deshpandé and G. Zaltman. (1993). Factors Affecting Trust in Market Research Relationships. *Journal of Marketing* 57(1), 81-101.
Morgan, N., D. Vorhies and C. Mason. (2009). Market Orientation, Marketing Capabilities, and Firm Performance. *Strategic Management Journal* 30(8), 909-920.
Moriarty, R.T. and T.J. Kosnik. (1989). High-tech marketing: concepts, continuity, and change. *Sloan Management Review* 30(4), 7-17.
Nerkar, A. and P.W. Roberts. (2004). Technological and product-market experience and the success of new product introductions in the pharmaceutical industry. *Strategic Management Journal* 25(8/9), 779-799.
Ocasio, W. (1997). Towards an Attention-based View of the Firm. *Strategic Management Journal* 18, 187-206.
OECD (2005). *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*. Paris: Organisation for Economic Co-operation and Development.
Pisano, G.P. and S.C. Wheelwright. (1995). The new logic of high tech R&D. *Harvard Business Review* 73(5), 93-105.
Putros, K. (2014). Tesla Motor: Burning up the Road to Domination or Doom. *Ivej Publishing Case*(9B13A050).
Rammer, C., B. Peters, T. Schmidt, B. Aschhoff, T. Doherr and H. Niggemann (2005). *Innovationen in Deutschland. Ergebnisse der Innovationserhebung 2003 in der deutschen Wirtschaft*. Baden-Baden: Nomos.
Rao, R.S., R.K. Chandy and J.C. Prabhu. (2008). The Fruits of Legitimacy: Why Some New Ventures Gain More from Innovation Than Others. *Journal of Marketing* 72(4), 58-75.
Rogers, E. (2003). *Diffusion of Innovations*: Simon and Schuster.
Salomon, R. and B. Jin. (2010). Do leading or lagging firms learn more from exporting? *Strategic Management Journal* 31(10), 1088-1113.
Simon, H.A. (1962). The architecture of complexity. *Proceedings of the American Philosophical Society* 106(6), 467-482.
Slater, S.F. and J.C. Narver. (1998). Customer-Led and Market-Oriented: Let's Not Confuse the Two. *Strategic Management Journal* 19(10), 1001.
Slater, S.F. and J.C. Narver. (1999). Market-oriented is more than being customer-led. *Strategic Management Journal* 20(12), 1165-1168.
Song, M., C. Droge, S. Hanvanich and R. Calantone. (2005). Marketing and technology resource complementarity: an analysis of their interaction effect in two environmental contexts. *Strategic Management Journal* 26(3), 259-276.

Spender, J.-C. and R.M. Grant. (1996). Knowledge and the firm: An overview. *Strategic Management Journal* 17(Winter Special Issue), 5-9.
Suarez, F.F. and G. Lanzolla. (2007). The role of environmental dynamics in building a first mover advantage theory. *Academy of Management Review* 32(2), 377-392.
Suchman, M.C. (1995). Managing Legitimacy: Strategic and Institutional Approaches. *Academy of Management Review* 20(3), 571-610.
Thompson, D.V., R.W. Hamilton and R.T. Rust. (2005). Feature Fatigue: When Product Capabilities Become Too Much of a Good Thing. *Journal of Marketing Research* 42(4), 431-442.
Vergne, J.-P. (2012). Stigmatized Categories and Public Disapproval of Organizations: A Mixed-Methods Study of the Global Arms Industry, 1996–2007. *Academy of Management Journal* 55(5), 1027-1052.
Waterschoot, W.v. and C. Van Den Bulte. (1992). The 4P classification of the marketing mix revisited. *Journal of Marketing* 56(4), 83-93.
Webb, J., R. Ireland, M. Hitt, G. Kistruck and L. Tihanyi. (2011). Where is the opportunity without the customer? An integration of marketing activities, the entrepreneurship process, and institutional theory. *Journal of the Academy of Marketing Science* 39(4), 537-554.
Wiersema, M.F. and H.P. Bowen. (2009). The use of limited dependent variable techniques in strategy research: Issues and methods. *Strategic Management Journal* 30, 679-692.

TABLES

Table 1: Qualitative evidence from the field

Respondent	*Representative quotes on marketing innovation*	*Representative quotes on the relationship between technological and marketing innovation*
Head of marketing excellence of a large health care company	We have a long tradition of R&D but innovation from marketing is now a big topic for us. Part of it is due to new competitors from fast moving consumer goods sectors entering the broader health and wellness market based on excellent marketing competencies. We have just recently created a dedicated marketing unit for analysing marketing opportunities arising from established products, some of which are decades old. Our most typical approach for creating novel offerings is to extend brand equity from existing products to new ones.	*Dis-synergy firm-level* Our drive for more marketing excellence has required change management. We have experienced power fights and incentive clashes in some units. For somebody who is incentivized to produce a certain number of molecules every year, customer inputs and marketing are a distraction. *Dis-synergy customer-level* We are a traditional company with long-term perspectives, strict compliance codes and a valuable reputation. This makes us generally risk averse when it comes to combining new technologies with new marketing.
Director of R&D & strategic development of a large chemical company	We have started working with designers who design products for the customers of our customers. The resulting products demonstrate to our immediate customers how they can profitably apply our products. It's a proof of concept and effective promotion.	*Dis-synergy firm-level* Business development is supposed to serve as an interface between technological development and market demands. Budgets for business development are a contentious point in our firm. Most of the time, those budgets are taken from the research budget. We have two types of R&D engineers based on their skills of engaging with customers. Some work only internally because they are not open for market impulses. But I have also a group of engineers who can very effectively communicate with customers almost like in a marketing of technology. I have learned over the years to spot those people.
Head of business intelligence of a large consumer goods producer	Online markets allow us to experiment and create new offerings by changing variables such as pricing or delivery options. Many of our new marketing approaches do not require new technologies.	*Dis-synergy customer-level* We had a new product which was supposed to be calibrated with a novel tablet app for the end consumer at home. The feedback was not good. For that reason we have shifted the distribution technology back to existing retailer channels. The risk of tarnishing our reputation was too high. *Dis-synergy firm-level* Our "New Ventures" division is increasingly handling most of our innovative marketing. Our company is overall successful doing what it does already. We run into bureaucratic barriers and office politics when suggesting innovative approaches throughout the firm. The situation changes completely when the top management gets involved. That's the only way for us get things done.
Manager of business development at medium-sized energy provider	Our market is highly regulated but we have created new products based on changes in delivery. Offering more flexible delivery to new customers with temporary energy demands is a small part of our overall revenues but it allows us to set higher prices in an otherwise standardized business. In this sense, adding new delivery options to our portfolio gives us new strategic options.	*No synergy effects* We use new technologies when infrastructure needs replacement or for improving the efficiency of our operations but it's a slow process. For the latter we have separate teams and established committees. The new contract option is largely driven by our sales unit. It did not require technological changes.

Respondent	*Representative quotes on marketing innovation*	*Representative quotes on the relationship between technological and marketing innovation*
CEO of a small provider of gaming services	Our business faces substantial regulation in terms of which products we can offer legally since they qualify as gambling. Return customers are crucial for our success but subscriptions are not allowed by law. Hence, we have become very innovative in offering products with new price structures, e.g. start bonuses, and advertising to maximize the return rate of existing customers.	*No synergy effects* When we try something new, it comes from the marketing side. Our investment into new technologies is for example in the form of IT severs for improving the efficiency of our processes, e.g. database management. We use it to test marketing initiatives and their success.
Senior consultant of small, specialized energy consultancy	We have changed the design of our services due to customer feedback. For one thing, we have moved towards offering complete packages of services. We also changed the timing of our services from ex-post regulatory due diligence to pro-active consulting.	*Dis-synergy customer-level* R&D in our line of business is largely the creation of algorithms for forecasting models. Typically we rely on external software houses for these algorithms. However, I was personally involved in a strategic project in which we had identified a new market segment for which we had redesigned our services. We also developed our own dedicated algorithm for this service. It did not turn out well. The customers preferred using existing algorithms from other providers which could be relatively easily tweaked. This rendered our research effort futile. *Dis-synergy firm-level* I have individual performance targets and they do not include new technology. I can change a product following customer demands and decide about an algorithm later. Small size and flat hierarchies are a strategic choice of our firm since the beginning. I advocate for having dedicated people who can research new algorithms but it is an ongoing debate how this fits with our organizational structure. We work almost like freelancers under a single roof.
Chief Technology Officer of software start-up firm	We had launched a new software product with a “Freemium” pricing strategy to our B2B customers. They would get basic functionality for free but were charged for more advanced features and functionality.	*Dis-synergy customer-level* Freemium is apparently not a model that works for B2B customers. Our B2B customers didn’t understand it and demanded a simple pricing model. *Dis-synergy firm-level* We wanted to target too many different groups of customers and offered a lot of different pricing models to B2B and B2C customers. At the same time, the software turned out to be not quite ready and demanded a lot of extra development effort. We got bogged down completely because we had to manage the software development and the different pricing models at the same time. We had to declare bankruptcy and we are now trying to relaunch the software product with a very clear customer focus and simple pricing model.

Respondent	*Representative quotes on marketing innovation*	*Representative quotes on the relationship between technological and marketing innovation*
Head of business unit at a large automotive supplier (low-tech)	When you look at our products you don't easily see the technological features. We thought it would be important to find a way to underline our products' features because we do not only sell performance but also safety and confidence. As a consequence, we started to change the outer design of our product that has nothing to do with the product's performance but that is actually visible to the customer.	*Synergy customer-level* The new outer design was mainly driven by the marketing department. They learned about the importance for customers to actually perceive the product's performance. Our technological innovation processes are very incremental. Every year we make small improvements that are easy to understand for customers. The new outer design provides a nice opportunity to show our customers that we have included new features and improved the product.
Manager product planning at large automotive supplier (high-tech)	We mostly rely on technological innovation. Our products are sold because of the technological features. But these features are also highly specified by the OEMs [original equipment manufacturers]. The only marketing innovation we recently introduced was a new distribution organization based on product systems instead of individual components.	*No synergy effects* Our new distribution system helped to increase efficiency and response times but it didn't make our new products more attractive to our customers per se.
Senior product manager at a development bank	Our bank is very engaged in financing small and medium sized enterprises. When the financial crisis hit those firms, we started offering new types of credit facilities and loans, for example to finance innovation activities in the firms. At the same time, we chose to promote these new products in a quite different way in order to reach SMEs that we had never worked with before.	*Dis-synergy customer-level* The financial crisis put particularly SMEs under high pressure and many were struggling to survive. They knew that they needed money to invest but many were also confused about the new credit products we offered to them and our promotion strategy. Some thought that these products were not meant for them.

Table 2: Descriptive statistics and tests on mean differences

Variable	Full sample		Firms w/ inv. in mkt. innov.		Firms w/o inv. in mkt. innov.			Firms <50 empl.		Firms ≥50 empl.			High-tech firms		Low-tech firms		
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	T-test	Mean	Std. Dev.	Mean	Std. Dev.	T-test	Mean	Std. Dev.	Mean	Std. Dev.	T-Test
Share of sales w/ new prod. in t+1	21.35	24.03	23.67	24.11	18.86	23.73	***	21.38	25.68	21.33	22.44		26.49	25.49	15.14	20.52	***
Share marketing exp. of sales	1.98	3.74	2.84	4.66	1.06	2.02	***	2.39	4.38	1.62	2.99	***	2.34	4.33	1.56	2.81	***
Share innov. mkt. exp. of sales	0.38	1.07	0.74	1.40	0.00	0.00	***	0.54	1.39	0.24	0.62	***	0.48	1.27	0.26	0.77	***
Share non-innov. mkt. exp. of sales	1.60	3.09	2.11	3.75	1.06	2.02	***	1.85	3.53	1.38	2.60	**	1.86	3.55	1.30	2.38	***
Share R&D exp. of sales	5.01	13.05	4.69	9.97	5.35	15.70		6.89	15.10	3.27	10.54	***	8.32	16.75	1.00	2.73	***
Firm age (years)	20.47	17.76	20.99	18.23	19.90	17.24		16.11	11.03	24.48	21.46	***	18.70	14.48	22.60	20.87	***
No of employees	345	2572	511	3547	165	382	**	18	11	645	3540	***	330	3258	362	1341	
Share exports of sales	22.90	26.51	23.06	26.01	22.74	27.07		14.86	22.85	30.30	27.49	***	25.47	27.26	19.81	25.26	***
Location East Germany (d)	0.35	0.48	0.32	0.47	0.38	0.49	**	0.46	0.50	0.25	0.43	***	0.37	0.48	0.32	0.47	
Firm is part of group (d)	0.37	0.48	0.39	0.49	0.34	0.48		0.13	0.34	0.59	0.49	***	0.36	0.48	0.38	0.48	
Process innovation (d)	0.54	0.50	0.61	0.49	0.47	0.50	***	0.48	0.50	0.60	0.49	***	0.54	0.50	0.54	0.50	
Herfindahl index (*1000)	4.85	9.07	5.08	9.45	4.60	8.64		4.79	9.94	4.91	8.19		5.16	8.69	4.47	9.50	
Industry marketing int. (ratio)	1.31	0.61	1.37	0.64	1.24	0.58	***	1.40	0.59	1.22	0.62	***	1.42	0.45	1.18	0.75	***
Low-tech manuf. (d)	0.36	0.48	0.35	0.48	0.37	0.48		0.32	0.47	0.40	0.49	**			0.80	0.40	
Medium high-tech manuf. (d)	0.20	0.40	0.19	0.39	0.21	0.41		0.16	0.36	0.24	0.43	***	0.36	0.48			
High-tech manuf. (d)	0.13	0.34	0.16	0.36	0.11	0.31	**	0.14	0.35	0.13	0.34		0.24	0.43			
Distributive services (d)	0.09	0.29	0.09	0.29	0.09	0.29		0.09	0.29	0.09	0.28				0.20	0.40	
Knowledge-intens. services (d)	0.05	0.23	0.05	0.22	0.06	0.24		0.05	0.21	0.06	0.24		0.10	0.30			
Technological services (d)	0.16	0.37	0.16	0.37	0.15	0.36		0.24	0.43	0.08	0.27	***	0.29	0.45			
No. of obs.	866		449		417			415		451			474		392		

(d) dummy variable; ** p<0.05, *** p<0.01

Table 3: Firms performing technological and/or marketing innovation (all firms)

			Firm invests into marketing innovation		
			No	Yes	Total
Firm invests into technological innovation	No	Obs.	195	144	339
		Row %	*57.5*	*42.5*	*100.0*
		Column %	*46.8*	*32.1*	*39.2*
	Yes	Obs.	222	305	527
		Row %	*42.1*	*57.9*	*100.0*
		Column %	*53.2*	*67.9*	*60.9*
	Total	Obs.	417	449	866
		Row %	*48.2*	*51.9*	*100.0*
		Column %	*100.0*	*100.0*	*100.0*

Pearson chi2(1) = 19.6***

Table 4: Firms performing technological and/or marketing innovation (firms <50 employees)

			Firm invests into marketing innovation		
			No	Yes	Total
Firm invests into technological innovation	No	Obs.	114	75	189
		Row %	*60.3*	*39.7*	*100.0*
		Column %	*51.8*	*38.5*	*45.5*
	Yes	Obs.	106	120	226
		Row %	*46.9*	*53.1*	*100.0*
		Column %	*48.2*	*61.5*	*54.5*
	Total	Obs.	220	195	415
		Row %	*53.0*	*47.0*	*100.0*
		Column %	*100.0*	*100.0*	*100.0*

Pearson chi2(1) = 7.4***

Table 5: Firms performing technological and/or marketing innovation (high-tech firms)

			Firm invests into marketing innovation		
			No	Yes	Total
Firm invests into technological innovation	No	Obs.	77	57	134
		Row %	*57.5*	*42.5*	*100.0*
		Column %	*34.4*	*22.8*	*28.3*
	Yes	Obs.	147	193	340
		Row %	*43.2*	*56.8*	*100.0*
		Column %	*65.6*	*77.2*	*71.7*
	Total	Obs.	224	250	474
		Row %	*47.3*	*52.7*	*100.0*
		Column %	*100.0*	*100.0*	*100.0*

Pearson chi2(1) = 7.8***

Table 6: Tobit results for the share of sales with new products

	Model 1 Full sample	Model 2 Full sample	Model 3 Full sample	Model 4 Firms < 50 empl.	Model 5 Firms ≥ 50 empl.	Model 6 High-tech firms	Model 7 Low-tech firms
Control variables							
Share non-innov. mkt. exp.	0.96***	0.30	0.41	0.57	0.37	0.14	1.17
	(0.31)	(0.35)	(0.35)	(0.51)	(0.53)	(0.42)	(0.66)
Firm age (years, log)	-5.44***	-5.30***	-5.29***	-10.64***	-2.96**	-5.91***	-4.75**
	(1.34)	(1.29)	(1.29)	(2.61)	(1.41)	(1.74)	(1.90)
No of employees (log)	2.27***	2.38***	2.48***	3.73	1.09	2.17**	3.01***
	(0.77)	(0.74)	(0.74)	(2.25)	(1.12)	(1.01)	(1.10)
Share exports of sales	0.20***	0.17***	0.17***	0.25***	0.13***	0.18***	0.15**
	(0.04)	(0.04)	(0.04)	(0.07)	(0.05)	(0.06)	(0.06)
Location East Germany (d)	9.10***	6.10***	6.38***	5.09	6.03**	4.50	8.28**
	(2.19)	(2.16)	(2.16)	(3.32)	(2.94)	(2.90)	(3.21)
Firm is part of group (d)	2.98	3.23	3.09	1.48	3.82	2.15	4.84
	(2.38)	(2.30)	(2.29)	(4.76)	(2.49)	(3.06)	(3.45)
Process innovation (d)	2.75	2.11	2.04	1.42	2.82	2.26	0.55
	(1.98)	(1.92)	(1.91)	(3.19)	(2.35)	(2.55)	(2.89)
Herfindahl index (*1000)	0.18	0.18	0.18	0.18	0.26	0.22	0.15
	(0.11)	(0.11)	(0.11)	(0.17)	(0.14)	(0.15)	(0.15)
Ind. marketing int. (ratio)	5.85***	5.18***	4.98***	3.95	5.01**	5.40	4.92**
	(1.79)	(1.73)	(1.73)	(3.02)	(2.06)	(3.57)	(1.97)
Low-tech manuf. (d)							8.71**
							(4.00)
Med. high-tech manuf. (d)	6.95**	5.34**	5.35**	3.46	6.34**	-2.94	
	(2.75)	(2.67)	(2.66)	(4.87)	(3.01)	(3.87)	
High-tech manuf. (d)	12.19***	9.86***	9.62***	11.33**	6.87	0.98	
	(3.30)	(3.21)	(3.20)	(5.31)	(3.94)	(4.28)	
Distributive services (d)	-8.94**	-8.81**	-8.75**	-29.87***	2.04		
	(4.08)	(3.93)	(3.92)	(7.85)	(4.53)		
Knowl.-intens. services (d)	-3.93	-4.03	-3.89	-2.97	-3.88	-11.62**	
	(4.83)	(4.67)	(4.65)	(8.19)	(5.45)	(5.42)	
Technological services (d)	17.77***	8.43***	8.42***	6.01	11.70**		
	(3.06)	(3.23)	(3.22)	(4.60)	(4.98)		
Focal variables							
Share innov. mark. exp. of sales		2.58**	4.12***	4.69***	2.10	5.67***	0.47
		(1.01)	(1.21)	(1.57)	(2.30)	(1.52)	(2.17)
Share R&D exp. of sales		0.54***	0.59***	0.72***	0.36***	0.58***	1.74***
		(0.08)	(0.08)	(0.12)	(0.12)	(0.09)	(0.64)
Int. innov. mark. * R&D			-0.09**	-0.13**	0.29	-0.12**	0.06
			(0.04)	(0.05)	(0.28)	(0.05)	(0.51)
Constant	-3.23	-1.56	-2.37	8.62	-0.99	8.82	-15.88**
	(5.66)	(5.48)	(5.48)	(10.39)	(8.13)	(8.43)	(7.90)
Sigma	27.29***	26.35***	26.26***	29.10***	23.46***	26.25***	25.84***
	(0.80)	(0.77)	(0.77)	(1.34)	(0.88)	(0.98)	(1.21)
Pseudo R2 (Aldrich-Nelson)	0.21	0.25	0.26	0.34	0.19	0.25	0.19
N	866	866	866	415	451	474	392
LR Chi2	199.9	250.47	255.45	174.87	91.23	135.55	77.77
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Coefficients are shown; standard errors in parentheses; (d) dummy variable; ** p<0.05, *** p<0.01

Table 7: Tobit results for the share of sales with new products (consistency checks)

	Model 8 Firms < 10m EUR sales	Model 9 Firms ≥ 10m EUR sales	Model 10 with lagged dependent var.	Model 11 NACE 15, 16 excluded
Control variables				
Share non-innov. mkt. exp. of sales	0.70	0.18	0.42	0.41
	(0.54)	(0.49)	(0.42)	(0.36)
Firm age (years)	-7.61***	-4.01***	-3.52**	-5.61***
	(2.66)	(1.40)	(1.75)	(1.32)
No of employees (log)	1.3	2.18**	1.84	2.52***
	(2.07)	(0.97)	(0.99)	(0.76)
Share exports of sales	0.33***	0.09**	0.09	0.17***
	(0.08)	(0.05)	(0.06)	(0.04)
Location East Germany (d)	4.64	9.19***	9.92***	6.43***
	(3.45)	(2.82)	(2.78)	(2.23)
Firm is part of group (d)	8.23	0.52	5.60	2.97
	(5.29)	(2.40)	(3.13)	(2.35)
Process innovation (d)	0.95	3.62	-0.83	2.07
	(3.33)	(2.26)	(2.49)	(1.96)
Herfindahl-Hirschman index (*1000)	0.16	0.17	0.07	0.18
	(0.18)	(0.13)	(0.13)	(0.11)
Industry marketing intensity (ratio)	5.31	4.07**	3.96	4.65***
	(3.12)	(2.04)	(2.22)	(1.75)
Medium high-tech manuf. (d)	0.62	8.24***	6.34	4.17
	(5.29)	(2.88)	(3.34)	(2.73)
High-tech manuf. (d)	11.46**	7.97**	4.64	8.66***
	(5.75)	(3.71)	(4.04)	(3.26)
Distributive services (d)	-29.61***	-1.48	-15.78***	-10.16**
	(8.67)	(4.22)	(5.38)	(4.00)
Knowledge-intens. services (d)	-6.02	1.94	-4.05	-5.25
	(7.12)	(6.92)	(7.73)	(4.73)
Technological services (d)	5.8	11.71**	2.91	7.36**
	(4.68)	(5.16)	(4.61)	(3.29)
Lagged dependent variable			0.43***	
			(0.05)	
Focal variables				
Share innov. marketing exp. of sales	4.45***	2.73	2.49	4.02***
	(1.60)	(2.23)	(1.91)	(1.24)
Share R&D exp. of sales	0.69***	0.36***	0.34***	0.59***
	(0.12)	(0.13)	(0.09)	(0.08)
Interaction innov. marketing * R&D	-0.12**	0.29	-0.11**	-0.09**
	(0.05)	(0.28)	(0.06)	(0.04)
Constant	4.26	-0.21	-7.77	-0.04
	(10.43)	(7.27)	(7.71)	(5.69)
Sigma	29.51***	23.24***	21.46***	26.48***
	(1.41)	(0.86)	(0.95)	(0.79)
Pseudo R2 (Aldrich-Nelson)	0.34	0.19	0.42	0.26
N	394	472	343	834
LR Chi2	167.15	97.33	205.05	243.03
P-value	0.00	0.00	0.00	0.00

Coefficients are shown; standard errors in parentheses; (d) dummy variable; ** p<0.05, *** p<0.01

Table 8: Tobit results for the subsample of firms which indicated that marketing innovations were introduced in connection with technological innovations (consistency checks)

	Model 12 Full sample	Model 13 Firms < 50 empl.	Model 14 High-tech firms
Control variables			
Share non-innov. mkt. exp. of sales	-0.52	0.28	-0.62
	(0.50)	(0.80)	(0.58)
Firm age (years, log)	-3.40**	-7.96**	-4.50**
	(1.63)	(3.62)	(2.25)
No of employees (log)	-0.14	7.07**	0.63
	(0.96)	(3.18)	(1.33)
Share exports of sales	0.16***	0.20**	0.09
	(0.05)	(0.09)	(0.07)
Location East Germany (d)	5.94**	2.50	6.03
	(2.96)	(4.56)	(4.05)
Firm is part of group (d)	5.43	16.78**	3.58
	(3.05)	(6.65)	(4.22)
Process innovation (d)	1.87	0.68	3.80
	(2.61)	(4.33)	(3.48)
Herfindahl index (*1000)	0.16	0.07	0.09
	(0.13)	(0.19)	(0.16)
Ind. marketing int. (ratio)	7.50***	6.97	4.87
	(2.17)	(4.04)	(4.66)
Med. high-tech manuf. (d)	6.23	3.78	1.68
	(3.56)	(6.32)	(5.10)
High-tech manuf. (d)	5.08	5.27	2.40
	(3.98)	(6.53)	(5.55)
Distributive services (d)	-6.93	-41.83***	
	(5.77)	(15.67)	
Knowl.-intens. services (d)	2.27	12.13	-5.90
	(6.80)	(25.82)	(7.77)
Technological services (d)	6.84	5.79	
	(4.36)	(6.04)	
Focal variables			
Share innov. mark. exp. of sales	3.81**	4.20**	7.08***
	(1.48)	(1.90)	(1.95)
Share R&D exp. of sales	0.68***	0.79***	0.71***
	(0.14)	(0.16)	(0.14)
Interaction innov. mark. * R&D	-0.11	-0.15**	-0.20***
	(0.06)	(0.07)	(0.07)
Constant	7.05	-0.16	15.93
	(7.15)	(14.87)	(10.76)
Sigma	24.06***	25.24***	24.09***
	(0.94)	(1.59)	(1.23)
Pseudo R2 (Aldrich-Nelson)	0.24	0.36	0.22
N	394	163	222
LR Chi2	106.49	76.81	55.79
P-value	0.00	0.00	0.00

Coefficients are shown; standard errors in parentheses; (d) dummy variable; ** p<0.05, *** p<0.01

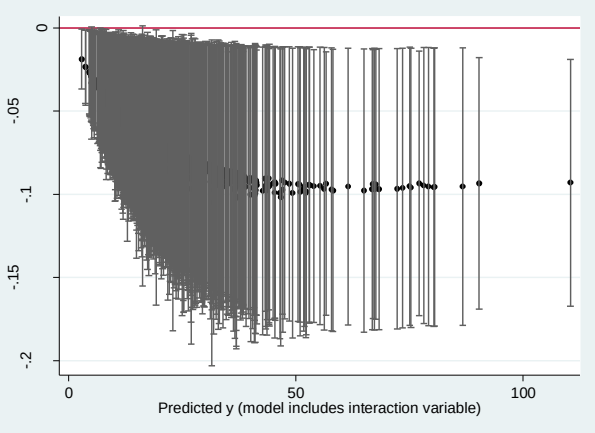
APPENDIX

Table 9: Correlation table

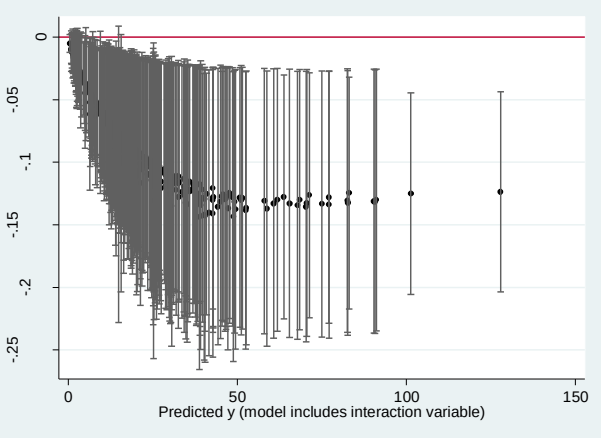
	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1)	Share innov. mkt. exp. of sales	1.00															
(2)	Share R&D exp. of sales	0.16***	1.00														
(3)	Share non-innov. mkt. exp. of sales	0.50***	0.16***	1.00													
(4)	Firm age (years, log)	-0.08	-0.08**	0.02	1.00												
(5)	No of employees (log)	-0.15***	-0.14***	0.09	0.20****	1.00											
(6)	Share exports of sales	-0.02	0.00	0.05	0.09**	0.33***	1.00										
(7)	Location East Germany (d)	0.06	0.21***	-0.04	-0.26***	-0.25***	-0.18***	1.00									
(8)	Firm is part of group (d)	-0.08**	-0.10***	0.10**	0.10**	0.52***	0.23***	-0.19***	1.00								
(9)	Process innovation (d)	0.00	0.01	0.00	0.01	0.15***	-0.02	-0.01	0.09***	1.00							
(10)	Herfindahl-Hirschman index (*1000)	-0.02	-0.02	0.00	-0.04	0.03	0.03	0.00	0.06	0.02	1.00						
(11)	Industry marketing intensity (ratio)	0.13***	0.16***	0.02***	-0.02	-0.15***	0.06	0.06	-0.07**	-0.06	0.03	1.00					
(12)	Medium high-tech manuf. (d)	-0.04	-0.03	0.07	0.00	0.11***	0.29***	-0.10***	0.06	0.00	0.01	-0.07**	1.00				
(13)	High-tech manuf. (d)	0.01	0.05	0.02	-0.03	-0.01	0.18***	0.00	0.08**	-0.04	0.26***	0.30***	-0.20***	1.00			
(14)	Distributive services (d)	-0.06	-0.11***	-0.04	0.03	0.03	-0.18***	-0.03	0.03	0.01	0.04	-0.29***	-0.16***	-0.12***	1.00		
(15)	Knowledge-intens. services (d)	-0.04	-0.08	-0.02	0.00	-0.01	-0.19***	0.05	-0.02	0.05	-0.10***	-0.15***	-0.12***	-0.09***	-0.08**	1.00	
(16)	Technological services (d)	0.20***	0.42***	0.00***	-0.10***	-0.26***	-0.22***	0.13***	-0.14***	0.01	-0.13***	0.16***	-0.22***	-0.17***	-0.14***	-0.10***	1.00
	VIF	1.39	1.32	1.38	1.11	1.66	1.41	1.20	1.42	1.04	1.10	1.29	1.33	1.43	1.26	1.16	1.62
	Mean VIF	1.32															
	Condition number	17.64															

** p<0.05, *** p<0.01

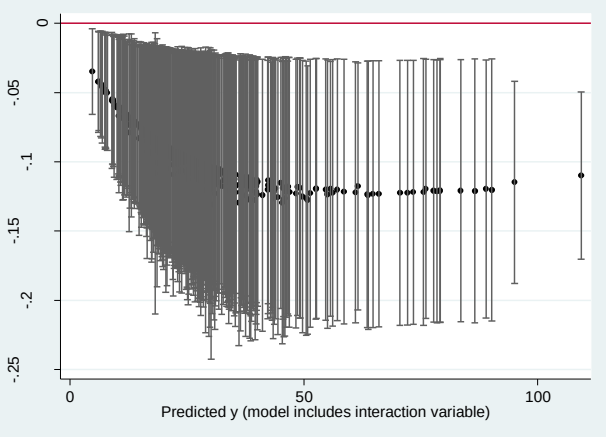
Figure 1: Secondary moderating effects



(a) full sample



(b) small firms



(c) high-tech firms

Note: Graphs show the secondary moderating effects (Wiersema and Bowen, 2009) at each observation for the interaction of technological innovation and marketing innovation in the three samples. The graphs also indicate the 95 percent confidence interval for each moderating effect. With few exceptions, the confidence interval does not intersect with the horizontal axis, indicating that the moderating effect is in fact significantly different from zero.