Capturing the Most Value from Innovation – Strategy Choices of R&D and Marketing Managers

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Abstract

Profiting from technological innovation requires both the development of new products and the capture or appropriation of profits from them. For new product development, the interplay of marketing and R&D has been intensively researched. In contrast, on the issue of capturing value, which is emphasized by top management and finance, it has been largely neglected. To fill this gap, we study choices by marketing and R&D managers regarding activities aimed at appropriating profits from new products. We study, in detail, how managers perceive the effectiveness of product-related patents, overall patent portfolio size, marketing, sales and services quality, lead time, and contributions to open standards. We conducted discrete choice experiments with 143 managers working in R&D or marketing functions in upper and middle management in a leading communication equipment firm, and analyzed the resulting data by comparing marginal effects of rank-ordered mixed logit models between the two groups. We find that choices of R&D and marketing functions on how to capture the most value differ strongest on the most important mechanism, "lead time advantages." Top management needs to consider these diverging perceptions when formulating business strategies.

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"*SAP's announcement that it aims at 'better aligning product innovation with customer needs' raises serious questions. We are worried about a stronger focus on innovation, possibly higher R&D costs and less focus on margins,*" a bank analyst wrote, explaining a "reduce" rating. After the announcement of SAP's strategy change its shares slumped 2.5% while the overall market gained 0.9%. (Reuters 2010)

1. Introduction

Top management and financial analysts emphasize the importance of margins for firm performance and, thus, concentrate on firms' capabilities to capture or appropriate value. Marketing, in contrast, concentrates on the creation of customer value—among others by aligning product innovation with customer needs[1]—which is less accountable for firm performance (O'Sullivan and Abela 2007). Thus, top management sometimes perceives marketing as a mere cost center instead of an investment (Brown 2005, Verhoef and Leeflang 2009). To stem the decline of its influence in firms (Sheth and Sisodia 2005, Verhoef and Leeflang 2009), marketing was advised to talk in the language of finance to top management to secure support for its projects (McAlister et al. 2007, Srivastava et al. 1999). An alternative approach for marketing to stem its decline in influence is proposed in this paper. Regarding strategies on how to capture value from technological innovation marketing can add valuable customer knowledge that other functions, in particular R&D, are lacking. As top management should appreciate this input, marketing might emphasize its contribution to value capture besides its traditional role in value creation to regain recognition.

Both value creation and value capture are required for innovation to be commercially successful. To this end, it is evident that the functions of marketing and R&D need to cooperate. Recent empirical studies support this view, showing a complementary effect of marketing and R&D capabilities on firm performance (Dutta et al. 1999; Lin et al. 2006).

[1] The American Marketing Association AMA (2007) defines "marketing" as follows: "Marketing is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large".

Accordingly, a large body of scholarly literature in marketing, innovation management and strategic management covers the relationship between firms' R&D and marketing functions. Most of this literature focuses on collaboration between these functions in the new product development process (for overviews, see Gerwin and Barrowman 2002, Griffin and Hauser 1996, and Troy et al. 2008). In such collaboration, marketing employees identify customer needs and communicate product benefits, while R&D staff develop technology and implement it in innovative products. Consequently, extant research largely addresses the interface between R&D and marketing functions, particularly differences and frictions between them in new product development processes and thus in value creation.

However, the existing literature on the cooperation between marketing and R&D largely neglects issues related to profiting from innovation[2]. This omission is surprising considering the broad attention that this topic receives in general. Recent empirical research shows that stock markets react favorably when firms shift their focus from value creation to value appropriation (Mizik and Jacobson 2003), again emphasizing the importance of value appropriation.

We address this gap by investigating R&D and marketing managers' choices on how firms can best profit from their innovations and thus capture value. More precisely, we compare the perceptions of marketing and R&D managers of the effectiveness of various mechanisms that support value appropriation. Most frequently studied among these so-called appropriability mechanisms are patents, lead time advantages, sales and service quality, brand, advertising, and network effects (e.g., Cohen et al. 2000, Dechenaux et al. 2008, Levin et al. 1987). We focus on the five mechanisms that are most relevant in the industry that we study, namely, product-related patents, the overall patent portfolio, sales and services quality, lead time, and contributions to open standards (exploiting network effects).

We discuss both groups' thought worlds and the amount of control that each group exerts on the various appropriability mechanisms. Based on these considerations, and drawing on social identity and attribution theory, we derive hypotheses of whether and how marketing and R&D managers' perceptions

[2] We use the terms value capture, value appropriation and profiting from innovations as synonyms.

of appropriability mechanisms differ. For example, we hypothesize that marketing managers view the effectiveness of sales and service quality for value appropriation higher than R&D managers do.

In order to test our hypotheses, we conducted discrete choice experiments with 143 employees working in upper and middle management in a leading communication equipment firm. In these experiments, participants are presented with three hypothetical firms characterized by the levels of five appropriability mechanisms, and have to choose which firm will profit most and which will profit least from its innovation. We fit the obtained data with a rank-ordered mixed logit model to deduce respondents' preferences. To facilitate a group comparison in this nonlinear model, we develop and implement a simulation approach that allows us to assess group differences in average marginal effects for each appropriability mechanism.

Our results are partly in line with predictions, partly surprising. Contradicting our hypotheses, we find no significant differences between marketing and R&D in the perception of product-related patents, contributions to open standards, and marketing, sales, and service efforts. Even more surprising, marketing perceives the effectiveness of an average-size patent portfolio to be higher than R&D does. Most noteworthy are our results concerning lead time. Lead time advantages, both being the first mover and being an early follower (the base category being "late follower"), are considered significantly more effective by R&D than by marketing. This finding is crucial in light of the fact that lead time is, on average, considered the most effective appropriability mechanism (see Sattler 2003 for an overview), and that marketers' customer orientation should give them a superior understanding of market entry timing (cf. Chandy et al. 2006, Golder and Tellis 1993, Shankar et al 1998, Shankar et al 1999). As different views of R&D and marketing originate from different thought worlds, these complementary perspectives on the same problem should improve quality of top managements' strategy formulation.

Our study contributes to several streams of literature. First, we contribute to the literature on firm strategy that highlights the importance of value appropriation (Mizik and Jacobson 2003, Hauser et al. 2006), showing where and how marketing and R&D managers' perceptions differ in this respect. Second, we add to the literature on profiting from innovation in innovation management. Most empirical studies of

the effectiveness of appropriability mechanisms draw on surveys of R&D managers; however, since marketing managers, who can be expected to have a more accurate perception of this mechanism than R&D managers, rate lead time less highly, our findings suggest that these studies overestimate the effectiveness of lead time. Third, our findings add to the emerging literature on micro-foundations of strategic management theories such as the resource-based view and dynamic capabilities (Abell et al. 2008, Lippman and Rumelt 2003, Teece 2007). We show that cognitive biases between managers in different functions exist, resulting from different thought worlds and different levels of control over appropriability mechanisms. Fourth, our findings have implications for the position of the marketing function within the organization and its self-conception. Recent research holds that the influence of marketing in the firm and its recognition by top management is in decline (Verhoef and Leeflang 2009). Putting a stronger emphasis on marketing's knowledge of and contribution to value appropriation may help stem this loss of influence. Finally, we make a methodological contribution by developing and implementing a simulation method to perform comparisons between groups in nonlinear econometric models.

2. Theory and Hypotheses

In this section, we introduce the appropriability mechanisms that we study. We then discuss which function controls each mechanism and compare both functions' thought worlds. Based on these considerations, we derive hypotheses as to how each function should perceive effectiveness of the individual appropriability mechanisms.

2.1. Appropriability Mechanisms

Firms do not automatically profit from developing new products that create customer value. They have to appropriate a preferably large share of the created value by translating it into earnings. Simply speaking, if the created value establishes the size of the pie, value appropriation means determining the share of the pie

(Gulati and Wang 2003). Teece's (1986) seminal paper tackled the question of why some firms do not profit from their innovations. He identifies the timing of market entry, the appropriability regime, and a firm's access to complementary assets as the main determinants of its ability to appropriate value. The appropriability regime is defined by the nature of the technology under consideration and the efficacy of legal mechanisms of protection. Complementary assets such as sales and service organizations are needed to successfully commercialize the innovation. Building upon these determinants of profiting from innovation, the literature on innovation management studies several mechanisms that support firms in appropriating value, so-called appropriability mechanisms (Cohen et al. 2000, Levin et al. 1987). These mechanisms support value appropriation by enhancing the innovator's bargaining power or leveraging the value created by technological innovation. Appropriability mechanisms that are most relevant for the communication equipment industry—which is our empirical setting—are: exclusion rights; lead time advantages; favorable complementary asset positions in marketing, sales, and service; and contributions to open standards.[3] We discuss these mechanisms and their relevance in the following.

Exclusion rights are legal property rights that allow the owner to exclude others from using its property through judicial proceedings. Patents and utility models are exclusion rights that protect technical inventions, while other legal exclusion rights such as copyright, brands, and trademarks protect nontechnical intellectual property (with the exception of copyright, which also covers software). For innovating technical firms, patents are the most prominent exclusion right. The classic purpose of patents is to prevent imitation of the invention. Due to patent protection, firms hold a temporary technological advantage and thus enjoy a stronger bargaining position. Besides this traditional function, patents are exploited in other ways, often labeled as "strategic" usages (e.g. Ziedonis 2004). In particular, firms patent to amass large patent portfolios to deter legal attacks and use their patents as bargaining chips in cross-licensing agreements (Cohen et al. 2001, Hall and Ziedonis 2001). Thus, in our analysis we make the important distinction between product-related patents—those that protect inventions used in the product under consideration—and the firm's overall patent portfolio that is used for cross-licensing or deterrence.

[3] Brand recognition matters less, since the market is a business-to-business market in which all relevant players enjoy a high reputation.

Lead time advantages result if an innovator is faster than its competitors in bringing an invention to the market. In other strands of literature this effect is discussed as first-mover advantages, pioneering advantage, or time-to-market advantages (Lieberman and Montgomery 1988, 1998). Being first on the market temporarily enhances the firm's bargaining power due to lower competition. However, the value created by technological innovation might also be enhanced due to successful preemption of the most favorable market space (Bohlmann et al. 2008). Furthermore, lead time advantages may be exploited to build additional competitive advantages in complementary assets (Dechenaux et al. 2008) or learning-curve advantages (Fehrshtman et al. 1990).

In the context we study, complementary assets needed to appropriate value from an invention are: marketing, sales, and service activities that manage customer relationships; sales channels; and advertising. Superior access to relevant complementary assets and superior quality of these assets compared to those of competitors enhances the company's value appropriation capabilities by increasing customers' use value or decreasing costs relative to competitors.

Contributions to open standards are somewhat new in a list of appropriability mechanisms. Recent insights made in innovation management practice and research shake the established doctrine that exclusion of others is a precondition of value appropriation (Arrow 1962, Liebeskind 1996). Firms may also profit by practicing "open innovation" and outlicensing their technologies (Chesbrough 2003). They may even profit by freely revealing innovation-related information, benefiting indirectly from the fact that others adopt the innovation (Harhoff et al. 2003). Such indirect benefits may be due to informal R&D collaboration, reputation building, standard setting, and increased demand for complements (e.g., Allen 1983, von Hippel 1988, Henkel 2006), or may arise because the innovator reassures its customers that it will not exploit them monopolistically down the road (Shepard 1987, Farrell and Gallini 1988, Economides 1996). Diffusion of inventions may also create royalty income and thus support value appropriation directly. In the communication equipment industry, companies regularly and voluntary reveal important product-related inventions by contributing them to open standards (cf. Rysman and Simcoe 2008), usually under the roof of standard setting organizations such as IEEE, IETF, ITU-T, and

ETSI. We thus include contributions to open standards as an appropriability mechanism in our experimental setting.

2.2. Departmental Control of Appropriability Mechanisms

In order to discuss which function, marketing or R&D, controls each appropriability mechanism, we need to precisely define each term. As we are interested in the perceptions of managers affiliated with either department, we follow the functional rather than the activity based understanding of the terms (Workman et al. 1998). Keeping with the literature on the R&D/marketing interface (e.g., Griffin and Hauser 1996) that employs rather broad definitions, "marketing" is assumed to comprise sales and service functions. Similarly, the term "R&D" comprises innovation management and intellectual property (IP) management.

The management of patents, both of those pertaining to a specific product and of the patent portfolio overall, is clearly in the realm of R&D-related functions, particularly of R&D in the narrower sense and of IP management. In contrast, marketing, sales, and service activities are controlled by the marketing function as defined above. The remaining two appropriability mechanisms are controlled by both functions jointly. Lead time increases, for example, when marketing identifies market opportunities earlier and when R&D develops new products faster. Similarly, contributing to open standards requires suggestions from R&D regarding suitable technologies as well as input from marketing regarding product features that should be differentiated and those that should be standardized.

2.3. Departmental Thought Worlds

Management's answer to the complexity of firm tasks is interdepartmental division of labor. However, the building of specialized knowledge in each department has a downside in that each develops its own thought world. As Dougherty (1992, p. 182) defines, "a thought world is a community of persons engaged in a certain domain of activity who have a shared understanding about that activity." Dougherty (1992) develops two categories of thought world differences that are relevant at the R&D/marketing interface. She differentiates between the information that departments possess, their "funds of knowledge," and the

system of procedures, judgments, and methods that the departments use to process information, their "systems of meanings." Homburg and Jensen (2007) discuss the similarity between this categorization and the differentiation concept developed by Lawrence and Lorsch (1969, p. 11), pointing out that both concepts emphasize cognitive orientation and knowledge. We look at both aspects in the following.

Differences in the cognitive orientation of R&D and marketing functions are well documented (see Griffin and Hauser 1996 for an overview). With respect to organizational issues, marketing employees have a higher tolerance for ambiguity and accept a higher degree of bureaucracy overall and organizational structure within the department than do R&D personnel (c.f. Saxberg and Slocum, 1968). Furthermore, R&D employees were shown to exhibit a high loyalty to their scientific profession, while marketing personnel were more loyal to their firm (Gupta et al. 1986, Lorsch and Lawrence 1965). With respect to the technology-market link, differences are particularly pronounced (Dougherty, 1992). Marketing employees focus on the market, explore current customer needs, and identify future trends. In contrast, R&D functions concentrate on scientific advances and development of new technology. In the same vein, marketing personnel favor the short time horizon of incremental projects, while R&D personnel prefer far-reaching projects with a long time horizon (Gupta et al. 1986, Lorsch and Lawrence 1965).

These differences in cognitive orientation lead to different stocks of knowledge that the two functions build upon. The market orientation of marketing functions leads to an accumulation of knowledge on customer needs, customer willingness to pay, and future trends. The technology orientation of R&D leads to a stock of knowledge on the technological frontier and a higher degree of experience in implementation issues. Furthermore, the divergences in cognitive orientation lead to differences in recruitment (Griffin and Hauser 1996). R&D personnel are drawn from science and engineering schools that emphasize scientific methods, technical problem solving, and technical knowledge. In contrast, marketing professionals are mostly hired from business schools that teach general problem solving and decision making under high uncertainty.

2.4. Social Identity Theory and Attribution Theory

Before employing social identity theory and attribution theory for deriving our hypotheses, we briefly discuss both concepts in more general terms.

The concept of collective self-esteem is anchored in social identity theory (e.g. Taifel and Turner 1979), which is primarily concerned with a person's motivation to maintain a social identity. The theory proposes that persons strive to create or maintain high collective self-esteem (Pelham and Swann 1989, Luhtanen and Crocker 1992). A strategy to achieve a positive social identity is to discriminate against or derogate members of the outgroup relative to the ingroup or, more generally, favorably value the ingroup with the relevant comparison group, which leads to an ingroup bias (Crocker and Luhtanen 1990, Aberson et al. 2000). This ingroup bias should positively affect the valuation of those appropriability mechanisms that are controlled only by the focal function or that are closer to the thought world of this function.

Attribution theory yields the same predictions. A large body of social psychology literature focuses on self-serving attributions, with the robust finding that positive outcomes tend to be attributed to internal causes while negative outcomes are attributed to external causes (e.g. Weiner et al. 1971, Bradley 1978). In particular, self-serving attributions were found to play a role in managers' explanation of organizational performance (e.g. Staw et al. 1983, Clapham and Schwenk 1991). In the context of an ingroup and an outgroup, self-serving attribution should positively affect the perception of ingroup causes. Thus, members of a particular function should perceive effectiveness of an appropriability mechanism as higher if this mechanism is controlled by the respective function.

2.5. Differing Perceptions of Appropriability Mechanisms

By interpreting the above discussion regarding control and thought worlds in light of social identity theory and attribution theory, we derive hypotheses about differences in perception that we expect marketing and R&D personnel to have regarding the appropriability mechanisms we study.

The management of product-related patents as well as the overall patent portfolio is controlled by R&D functions. Also, patents are related to technology with hardly any relation to the market orientation

of marketing functions. We thus expect R&D managers to perceive the effectiveness of product-related patents, as well as that of the overall patent portfolio, as higher than marketing managers do.

R&D and marketing functions control contributing product-related inventions to open standards jointly. R&D functions manage the work in standardization bodies and coordinate joint development with other firms, while marketing managers suggest which product features should be differentiated and which should be standardized in order to create the most customer value. R&D managers perceive collaborating with other firms to share technology as a (not always welcome) necessity to secure interoperability of the created product, while marketing managers deem the customer benefits of standardized products as crucial. Thus we expect that marketing managers should perceive contributions to open standards as more valuable than R&D managers do.

Lead time advantages are an outcome of the product-development process that is controlled by both R&D and marketing. Considerations of the respective thought worlds, however, predict differences in perception between the two functions. In the marketing thought world, it is believed that customers need to understand the benefits they will obtain from new products before sales can be generated. On the other hand, R&D managers see pushing the technological frontier as the core of their profession. Thus, we expect R&D managers to perceive lead time as more effective for value appropriation than marketing managers do.

Marketing, sales, and service efforts, in contrast, are the core task of marketing managers and the essential center of their thought world. Thus, we expect marketing managers to have a higher valuation of marketing, sales, and service efforts than R&D managers have. Table 1 summarizes our theoretical predictions.

-- Insert Table 1 about here --

3. Data and Method

3.1. Sample

As our empirical setting we chose one specific firm in the enterprise communications industry. This industry is particularly apt for our study because patents, openness, lead time advantages, and complementary assets all play important roles in supporting value appropriation.

We identified all employees in this firm who manage appropriability mechanisms in marketing, sales, services, R&D, IP management, standardization, and general management. We included only permanent employees and excluded secretaries, students, and trainees. We ended up with 1,475 out of more than 10,000 employees that met our criteria. From 1,475 invited employees, 422 participated in the survey, yielding a response rate of 28.6%. From these 422 persons, 319 completed at least one experiment. We had to drop the experiments of 29 persons that we could not accurately assign to either R&D or marketing functions. Of the remaining 280 survey participants, 143 indicated that they work in upper or middle management. These respondents are of interest in our study. Table 2 presents their demographics by groups, with 67 R&D managers and 76 marketing managers.

-- Insert Table 2 about here --

3.2. Choice Experiments

To test our hypotheses about diverging strategic choices of R&D and marketing managers, we conducted discrete choice experiments. Doing so allows us to capture nonlinear effects and trade-offs between individual appropriability mechanisms. It also avoids the shortcomings of Likert scale survey questions (on which most earlier studies of appropriability mechanisms relied, e.g. Cohen et al. 2000, Levin et al. 1987) such as biased answers due to individual response styles (e.g. Stening and Everett 1984) and a potential inflation of importance. Most importantly, our experimental setting comes closer to real-world managerial choices about firm strategies that are also choices about bundles of appropriability mechanisms.

In the experiment, each respondent is repeatedly (10 times) shown three cards, each of which describes one firm. All firms sell a particular type of product (a so-called private branch exchange, or enterprise communication system), which is typical for the industry we study. The competing products are technologically fully equivalent. However, the firms differ by their endowments and capabilities in appropriability mechanisms, as explained below. For each set of cards, the respondent was then asked to assess which of the three firms would appropriate the most value from its technological innovation and which would appropriate the least.

An important issue in choice experiments is making them as realistic as possible while also keeping them manageable by respondents. To make sure that we only included relevant appropriability mechanisms at realistic levels, we conducted 20 in-depth interviews with employees in functions ranging from marketing, sales, and services to R&D, standardization, product management, and IP management. Interviewees confirmed that the patent portfolio, product-related patents, lead time advantages, marketing, sales, and services, and contributions to open standards are all relevant and that we did not miss other more important appropriability mechanisms for this industry. We used each of these five appropriability mechanisms at three different levels as summarized in Table 3.

-- Insert Tables 3 and 4 about here --

To restrict the number of choice sets to 10 we relied on an efficient fractional-factorial design generated by computerized search (Yu et al. 2009).[4] We used five versions of the resulting design randomly assigned to survey participants where the order of choice sets and the order of appropriability mechanisms were randomly varied to avoid biases. Table 4 shows the designs used. Figure 1 shows a choice experiment as presented to the survey participants.

[4] The design was generated using the software package NGene 1.0 by ChoiceMetrics, Ltd.

We conducted four pre-tests, one each with a manager dealing with R&D, IP, marketing, and standardization. The pre-tests confirm that the number of choice tasks, though burdensome, is manageable and that the attribute levels and experimental descriptions are realistic and understandable.

-- Insert Figure 1 about here --

3.3. Estimation

By asking survey participants to identify the best and the worst of the three hypothetical firms, we obtained a complete ranking of alternatives for every choice set. A model to analyze rank-ordered data econometrically was first introduced by Beggs et al. (1981) and Chapman and Staelin (1982). It is based on exploding the data describing *k* ranks in one choice set into *k*-1 independent choices. The ranking over three alternatives is thus decomposed, or exploded, into a choice of the best alternatives out of all three, and a subsequent choice of the second-best alternative out of the remaining two. As a second step, Beggs et al. (1981) as well as Chapman and Staelin (1982) pooled the exploded data and fitted McFadden's (1974) conditional logit model.

However, unobserved preference heterogeneity among respondents making multiple choices leads to correlation among error terms, violating the assumption of independence of irrelevant alternatives (IIA) required for a conditional logit model (Layton 2000). Mixed logit models (also called random coefficient models), a generalization of conditional logit models, do not require the IIA assumption (Revelt and Train 1998, Brownstone and Train 1999, McFadden and Train 2000). Following Srinivasan et al. (2006) we model the utility of an alternative *k* in choice set *s* for respondent *q* as a linear additive function of the alternative's characteristics, described by the vector X_{qsk}, and the vector of coefficients β. As the respondents' ranking of three alternatives is exploded into two implicit choices, $m = 1, 2$ denotes the implicit choice:

$$U_{qsmk} = \beta X_{qsk} + \omega_{qk} + \varepsilon_{qsmk}$$

In a mixed logit model, a respondent's perceived utility is influenced by two error terms, ω_{qk} and ε_{qsmk} (Calfee et al. 2001). The terms ε_{qsmk} capture residual errors that are—as in a standard logit model—assumed to be independently and identically distributed and to follow an extreme value distribution. In contrast, the terms ω_{qk} capture the individual-specific unobserved influence on respondent q's evaluation of alternative k, thus allowing correlations across all (implicit) choices of respondent q (Srinivasan et al. 2006).

The probability that respondent q selects alternative k from choice set s in implicit choice m conditioned on individual-specific influences ω_{qk} and the visible alternatives of the set C^m in the (implicit) choice set m is then given by:

$$prob_{qsm}\{k \in C^m \mid \omega_{qk}, \forall k' \in C^m\} = \frac{\exp[\beta X_{qsk} + \omega_{qk}]}{\sum_{k' \in C^m} \exp[\beta X_{qsk'} + \omega_{qk'}]}$$

The conditional probability of obtaining the observed rank order of respondent q for choice set m is then computed as the product of the implicit choice situations. Finally, the unconditioned probability is derived and estimated using maximum likelihood technique.[5]

Each alternative presented to respondents contains five attributes, each at one of three possible levels. We dummy coded each attribute into two dummy variables indicating the deviation from the reference value. To ensure convenient interpretation of coefficient estimates, we used the value with the (presumably) lowest benefit as reference for each attribute. These values are made up of having only a few patented product-related inventions, possessing a small patent portfolio, making acceptable marketing, sales, and service efforts, being among the late followers to market, and having only a few product-related inventions contributed to open standards. Table 3 shows all attributes and their levels.

[5] We estimated the model with the mixlogit STATA command, implemented by Hole (2007) using 1,000 halton draws to simulate the likelihood function.

3.4. Group Comparison

To test for differences between groups, we estimate models for the two groups separately. However, as we employ nonlinear models, we cannot simply test for equality of the coefficients across the groups. As Allison (1999) points out, differences in the estimated coefficients of two nonlinear models are not meaningful even if significant. Because the size of an estimated coefficient is scaled by residual variation, traditional tests confound coefficient magnitude and residual variation. Thus, if the amount of residual variation differs between the two models, comparing coefficients across models is inconclusive.[6]

To overcome this identification problem, Allison (1999) proposes to test for equality of residual variation between the models. This is done by comparing two coefficients that are known to be equal in both groups, an approach that is in many situations not applicable. Hoetker (2007) proposes a different solution; namely, to compare ratios of coefficients across the models so that the residual variation has no impact in the comparison. However, if one is interested not in ratios but in differences between coefficients, the normalizing coefficient must again be known to be equal among groups. In our case we do not possess this knowledge (cf. Williams 2009).

We therefore follow an alternative approach recently proposed by Long (2009). As predicted probabilities are not scaled by unobserved heterogeneity, he proposes to compare predicted probabilities between groups to analyze group differences. However, since predicted probabilities depend on all variables jointly, there is no single test for differences between groups in the effect of one variable. Rather, one needs to determine differences between groups with respect to a focal variable for different levels of all other variables.

To capture differences between groups in the effect of a particular dummy variable, we start by determining this variable's marginal effect for each group separately. To this end, we calculate the difference in predicted probabilities that hypothetical firm A in a given choice set is chosen as best when the dummy variable is switched from 0 to 1. The size of this effect depends on the other characteristics of firm A and of those of the two firms it is competing with. We calculate the size of the marginal effect of

[6] This identification problem persists when only one model is estimated with interaction terms for testing for group differences. This approach artificially forces the residual variations in both groups to be identical, cf. Allison (1999).

the focal variable for all possible profiles of firm A and of the other two firms, yielding $3^4 \times 3^5 \times 3^5 =$ 4,782,969 values. As the marginal effect of the variable is not scaled by residual variance, we can base group comparisons on it. Figure 2 shows the average marginal effect of being among first movers separately for both groups. For each group, we sorted the 4.8 mio. marginal effects into five "probability ranges" by the probability that firm A is chosen as best when the dummy variable equals 1 (0% - 20%, 20% - 40%, etc.), and calculated averages for each range.

-- Insert Figure 2 about here --

To assess if the differences in average marginal effects between the groups are significantly different from zero, we rely on a simulation approach to measure the variance of the marginal effects (King et al. 2001, Zelner 2009). The marginal effects are calculated from the coefficient estimates of the rank-ordered mixed logit estimation, which follow a normal distribution described by its mean estimate and standard error. We make multiple random draws from the distribution of each coefficient and repeat the calculation of the marginal effect for each simulated coefficient vector[7] to obtain confidence intervals. To assess the significance of a difference of an average marginal effect in a probability range for two groups, we calculate the differences in average marginal effects for each simulated coefficient vector in both groups. In correspondence to Figure 2, Figure 6 shows the difference between the two groups in average marginal effects for being among first movers and its 90% confidence interval for each probability range. The left-hand graph shows these differences for the dummy variable that captures the deviation from "being among last followers" to "being among early followers." The right-hand graph shows differences for the dummy variable that captures the deviation from "being among last followers" to "being among first movers."

-- Insert Figure 3-7 about here --

[7] Because calculating the average marginal effects consumes an extreme amount of computing time, we use only 100 simulated coefficient vectors.

4. Results

Table 5 shows our estimation results, with coefficient estimates and average marginal effects (averaged over all probability ranges). Model 1 is estimated based on choices made by R&D managers only, while Model 2 is fitted to choice data from marketing managers.

We first take a look at the relative importance of the appropriability mechanisms in both models based on average marginal effects. As commonly done in conjoint analysis, we define the importance of an appropriability mechanism as the difference between the highest average marginal effect of one of its levels and its lowest marginal effect, normalized in such a way that the sum of all importance values equals 100%. As for each appropriability mechanism, the marginal effect of the least preferred level is zero by construction, the non-normalized importance value is the average marginal effect of the most preferred level of this appropriability mechanism. These importance values are then normalized by dividing them by their sum. As an example, consider the patent portfolio in Model 1. The average marginal effect of the patent portfolio equals 0.021 for an average patent portfolio and 0.143 for a large patent portfolio. Thus, the most preferred level is a large portfolio, with an average marginal effect of 0.143. Dividing 0.143 by the sum of all average marginal effects of the respective most preferred attribute (large patent portfolio, nearly all product-related inventions patent protected, nearly all product-related inventions contributed to open standards, among first movers to market, and excellent marketing, sales, and service quality) yields an importance value of the appropriability mechanism patent portfolio of 15.9%. Lead time advantages constitute the most important appropriability mechanisms as perceived by R&D managers, with an importance value of 30.6%. Marketing, sales, and service quality is a close second, reaching an importance value of 27.9%. The patent portfolio comes in third with 15.9%, fourth product-related patents (15.4%), and last open standard contributions (10.2%). The relative importance of appropriability mechanisms obtained from choice experiments with marketing managers differ. In Model 2, marketing, sales, and service efforts is the most important appropriability mechanisms with 28.7%, followed by lead time advantages with 22.8%. The patent portfolio ranks third with 17.5%, contributions to open standards fourth with 17.2%, and product-related patents last with 13.8%.

-- Insert Table 5 about here --

We now determine for each 20% probability range if differences in the perceptions of R&D and marketing managers are significant. Results are shown in Figures 3 to 7. The difference between the two groups with respect to marginal effects of a switch from the base level of the respective focal variable to the middle level is depicted on the left-hand side of each figure. For example, Figure 3 addresses the marginal effect of a switch from a small to an average patent portfolio on the left, and from a small to a large patent portfolio on the right. The differences between R&D and marketing apparent in Figure 3 are surprising. While the valuation of a large patent portfolio does not differ between groups, R&D personnel find an average patent portfolio to be significantly less valuable than marketing personnel do, contradicting our hypothesis. Figure 4 shows group differences regarding product-related patents. For both levels, we find no significant differences in valuation of product-related patents between R&D and marketing functions. With respect to contributions to open standards (Figure 5), we also find no significant differences between the two groups. In contrast, for lead time advantages (Figure 6) we do find differences as hypothesized. R&D managers consider lead time advantages significantly more effective for value appropriation than marketing functions do. These differences in perceptions are significant for both coded levels over all probability ranges we analyze. Differences between the two groups regarding marketing, sales, and service efforts (Figure 7) are again not significant.

5. Conclusion

Analyzing marketing managers' and R&D managers' perceptions of five appropriability mechanisms, we found differences in the valuation of lead time advantages and patent portfolio size. R&D managers consider lead time as significantly more effective than marketing managers do, both moderate ("among early followers") and strong lead time advantages ("among first movers"). Marketing managers perceive

effectiveness of an average-size patent portfolio as significantly higher than R&D managers do, while no differences exist in the valuation of a large patent portfolio. Surprisingly, and most contrary our expectations, we found no significant differences for the valuation of product-related patents, marketing, sales, and service efforts, and contributions to open standards.

The large difference we found for lead time advantages is somewhat surprising because marketing and R&D control this mechanism jointly, and so the argumentation based on control of appropriability mechanisms suggests that differences between the two groups in the valuation of this mechanism should be small. It is highly relevant because lead time is robustly found to be among the most effective mechanisms for supporting value appropriation (e.g. Arundel 2001, Cohen et al. 2001, Levin et al. 1987, Sattler 2003). While our results confirm this finding on average, the difference in importance as perceived by R&D managers (30.6%, first rank) and marketing managers (22.8%, second rank) is considerable. Our interviews provided evidence that marketers also see drawbacks in being first to market, a view that is emphasized by recent contributions to marketing literature (Chandy et al. 2006, Golder and Tellis 1993, Shankar et al 1998, Shankar et al 1999). First movers have to commit large resources to explore and build markets. Second movers can take advantage of these efforts, identify superior previously overlooked product positions and outperform pioneers.

If we assume that marketing managers have a superior understanding of market-related issues, then the above discrepancy has two implications. First, R&D managers might pursue gains in lead time to an inefficiently high extent at the expense of other mechanisms. Second, as extant empirical studies concentrated on R&D managers, these studies may have overestimated the impact of lead time advantages.

The difference in perception of an average-size patent portfolio is also striking, in particular in light of the fact that no significant differences exist for a large patent portfolio. Marketing managers find an average patent portfolio to be nearly as effective as a large one, while R&D managers nearly perceive it as irrelevant. This discrepancy can potentially be explained by thought world differences. Marketing personnel realize that patents are necessary, but lack detailed insights into which inventions are patented

and which are not. R&D personnel, in contrast, discern individual inventions and perceive a forgone protection potential if a patentable invention remains unpatented. This nonlinearity, which our choice-based method allowed us to identify, should imply that marketing managers oppose an increase in patenting activity, seeing it as ineffective if it exceeds a certain level.

Surprisingly, we find no differences in the perception of product-related patents and marketing, sales, and service efforts as suggested by the control arguments we advanced. Overall, control arguments apparently are not very powerful in explaining differences between marketing and R&D managers' perceptions. A possible explanation is that decades of cross-functional team membership in new product development processes enables the managers in our firm to have a less biased view on mechanisms controlled by other functions. For contributions to open standards, the difference between marketing and R&D has the expected sign, but is insignificant.

Differing views between the two functions may lead to tensions if both are involved in the decision making process. However, to the extent that these different views originate from different thought worlds—as is the case for the valuation of lead time advantages—they reflect complementary perspectives on the same problem. While potentially creating conflict and hampering decision making, such different perspectives can improve the quality of decisions (Boone and Hendriks 2009, Homburg and Jensen 2007). From a theoretical perspective, Brunswik (1955) states that in uncertain environments decision makers, possessing limited knowledge about reality, make inferences based on a set of cues they process. Including more persons with different views in the decision making process can thus improve the quality of inferences made (Kim and McLeod 1999). In our case, this implies that top management should not fail to include marketers in the formulation of business strategies on how to capture value, in particular since we assume marketers to have superior knowledge about the effectiveness of some appropriability mechanisms.

Our study makes several contributions to theory. First, we show—to the best of our knowledge for the first time—that R&D and marketing functions have diverging perceptions on how to profit from technological innovation and capture value. While differences in marketing's and R&D's perception of

value creation have been heavily researched, differences with respect to value capture have been largely neglected. This paucity of research cannot be justified by lack of relevance, value capture being a topic that is emphasized by top management and finance. Furthermore, recent contributions show that stock markets honor when firms shift their strategic focus from value creation to value appropriation (Mizik and Jacobson 2003). Research on the R&D/Marketing interface on value appropriation thus appears worthwhile.

Second, extant empirical studies in innovation management on the relative effectiveness of appropriability mechanisms relied on key informants in R&D functions. Since the views of R&D and marketing differ most strongly for a mechanism (lead time) on which marketing should have superior knowledge, these studies could have produced biased results.

Third, we show that different thought worlds and, to a lower degree, different levels of control over appropriability mechanisms explain different strategy choices by marketing and R&D managers. Thus, theories and concepts in strategic management that do not take managers' cognitive biases into account could have come themselves to biased conclusions. Only recently a strand of literature in strategic management emerged (e.g. Teece 2007) that investigates the micro-foundations of strategy theories basing on insights of behavioral sciences. We add to this literature by identifying two sources of cognitive biases in strategy formulation.

Fourth, the topic of value appropriation we analyzed plays only a minor role in marketing's self-conception, while it is much emphasized by top management and finance. Recent research holds that the influence of marketing in the firm and its recognition by top management is in steep decline (Verhoef and Leeflang 2009). Putting a stronger emphasis on marketing's knowledge of and contribution to value appropriation may help to stem this loss of influence.

Finally, we developed a method to facilitate correct group comparisons in a choice experimental approach. In this method based on recent contributions by Long (2009) and King et al. (2001), we compare differences in average marginal effects of dummy-coded attributes in predefined probability

ranges between two groups and assess their significance. This method allows to exploit the advantages of choice experimental approaches for group comparisons.

Our study has several limitations. First, we conducted the survey in one firm. This is because our approach requires us to design the choice experiments in a realistic manner, which implies that they are somewhat specific to the industry under study.[8] Depending on the size of this industry, the number of firms for which the survey is suited is thus limited (in our case, to about 10). Hence, in order to obtain a number of responses sufficient for statistical analysis, one needs a considerable number of participants from each firm. However, obtaining such a commitment from several firms is difficult, due to both time requirements and the need to build trust. Potential biases due to firm-specific effects are mitigated by the fact that the firm we studied is international, with respondents from five continents and 10 countries. Still, we have to be cautious about making inferences. A promising avenue for further research is to generalize our results, carve out industry differences, and test for mediating and moderating environmental effects.

Second, we included only a limited set of appropriability mechanisms in our study. While we used qualitative analysis to make sure that the mechanisms we included were the most important ones, it would be interesting to know which other mechanisms the two functions have diverging opinions on.

Third, our experiments are necessarily a simplified model of a managerial choice situation. In our survey, participants had to choose between three profiles of appropriability mechanisms, ignoring their cost. In real life, managers have a much wider choice of profiles, but need to consider cost, resources, and time required to create each. We think that an explicit integration of these items would make choice experiments unfeasible. However, one needs to keep in mind that our results, as do those of earlier studies, concern the effectiveness of appropriability mechanisms, not their efficiency.

Fourth, we chose to compare only two groups, R&D and marketing managers, and defined the two functions rather broadly. A promising avenue for further research would be to delve deeper into

[8] This is true in particular for the mechanism related to "openness." In our context, the relevant instance of openness is "contributions to open standards," while e.g. in the software industry "contributions to public open source projects" would be germane. Furthermore, extending the study to related industries such as mobile telephony equipment would reduce precision of our results (as it does in standard Likert-type surveys on the topic) since it is hard to control for specificities of the respective industry.

differences between all functions related to value appropriation and differentiate between functions like sales, services, marketing, manufacturing, development, and patent management. Furthermore, in light of the differences we found between R&D and marketing with respect to mechanisms they control jointly, it seems worthwhile to study the interface between R&D and marketing on value appropriation in more detail.

For managerial practice our study implies that strategy formulation on how to profit from technological innovations should benefit from combining views of marketing and R&D functions. As years of research advocated the integration of R&D and marketing in new product development processes, such integration is also called for in formulating strategy for value appropriation. More generally, we would advise marketers to bring their influence to bear on questions of how to profit from technological innovation and capture value.

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Tables and Figures

Table 1: Predictions regarding perceptions of effectiveness

Argumentation based on:	**Control**	**Thought Worlds**
Appropriability mechanism:		
Patent portfolio	R&D	R&D
Product-related patents	R&D	R&D
Contributions to open standards	-	Marketing
Lead time advantages	-	R&D
Marketing, sales and service efforts	Marketing	Marketing

Table 2: Demographics of R&D and marketing functions

	R&D Managers	Marketing Managers
Number	67	76
Main activity (percent):		
Software development	.45	0
Hardware development	.09	.02
IP management	.05	0
Standardization	.02	0
Sales	0	.22
Services	.02	.21
Marketing	0	.34
Management	.24	.2
Other	.14	.01
Experience (5-point Likert scale):		
Software	3.93	2.19
Hardware	2.4	1.84
IP	2.9	2.16
Standards	2.99	2.27
Sales	2.12	3.58
Services	3.13	3.9
Marketing	2.15	3.74
Management	2.15	4.22
Educational background (percent):		
Computer Science	.27	.08
Electrical Engineering	.43	.27
Mechanical Engineering	0	.02
Physics	.09	0
Mathematics	.05	.01
Business Administration	.09	.35
Law	0	0
Psychology	0	.02
Other	.07	.25
Tenure (percent):		
Industry Experience (years)	21.99	19.57
Middle Management	.6	.7
Director	.33	.16
Vice-President	.08	.14
Executive level	.003	0

Table 3: Attributes and attribute levels

Attribute	Attribute levels
Patent Portfolio	Small patent portfolio Average patent portfolio Large patent portfolio
Product-related inventions which are patented	Some product-related inventions patented Half of all product-related inventions patented Nearly all product-related inventions patented
Contributions to open standards	Only a few contributions to open standards Some contributions to open standards Many contributions to open standards
Time to market	Among late followers to market Among early followers to market Among first movers to market
Marketing, sales & service quality	Average marketing, sales & service quality Good marketing, sales & service quality Excellent marketing, sales & service quality

Table 4: Choice sets[a]

Survey Type 1				Survey Type 2				Survey Type 3				Survey Type 4				Survey Type 5			
1	pp	2	1	0	4	lt	1	0	1	8	os	2	0	0	1	os	0	1	2	4	pn	1	2	1
	pn	2	0	2		pn	1	2	1		pp	0	2	0		pp	2	1	0		ss	0	2	1
	os	0	1	2		pp	1	0	1		lt	2	0	1		pn	2	0	2		os	1	2	0
	lt	0	1	2		os	1	2	0		ss	0	2	0		lt	0	1	2		pp	1	0	1
	ss	2	1	0		ss	0	2	1		pn	0	0	2		ss	2	1	0		lt	1	0	1
2	pp	2	0	1	1	lt	0	1	2	3	os	1	0	1	10	os	0	0	2	3	pn	2	1	1
	pn	1	1	1		pn	2	0	2		pp	0	1	2		pp	2	1	0		ss	2	0	1
	os	2	1	0		pp	2	1	0		lt	2	1	0		pn	0	0	0		os	1	0	1
	lt	1	0	1		os	0	1	2		ss	2	0	1		lt	1	2	0		pp	0	1	2
	ss	1	1	1		ss	2	1	0		pn	2	1	1		ss	0	0	2		lt	2	1	0
3	pp	0	1	2	6	lt	2	0	0	4	os	1	2	0	8	os	2	0	0	9	pn	0	0	0
	pn	2	1	1		pn	0	2	0		pp	1	0	1		pp	0	2	0		ss	1	2	0
	os	1	0	1		pp	0	0	2		lt	1	0	1		pn	0	0	2		os	0	2	1
	lt	2	1	0		os	0	0	2		ss	0	2	1		lt	2	0	1		pp	0	2	0
	ss	2	0	1		ss	2	0	0		pn	1	2	1		ss	0	2	0		lt	0	2	0
4	pp	1	0	1	5	lt	0	1	2	10	os	0	0	2	3	os	1	0	1	10	pn	0	0	0
	pn	1	2	1		pn	2	1	2		pp	2	1	0		pp	0	1	2		ss	0	0	2
	os	1	2	0		pp	1	0	2		lt	1	2	0		pn	2	1	1		os	0	0	2
	lt	1	0	1		os	2	1	0		ss	0	0	2		lt	2	1	0		pp	2	1	0
	ss	0	2	1		ss	0	1	2		pn	0	0	0		ss	2	0	1		lt	1	2	0
5	pp	1	0	2	2	lt	1	0	1	7	os	1	2	1	9	os	0	2	1	8	pn	0	0	2
	pn	2	1	2		pn	1	1	1		pp	1	2	1		pp	0	2	0		ss	0	2	0
	os	2	1	0		pp	2	0	1		lt	0	2	2		pn	0	0	0		os	2	0	0
	lt	0	1	2		os	2	1	0		ss	1	0	2		lt	0	2	0		pp	0	2	0
	ss	0	1	2		ss	1	1	1		pn	1	2	0		ss	1	2	0		lt	2	0	1
6	pp	0	0	2	3	lt	2	1	0	9	os	0	2	1	4	os	1	2	0	1	pn	2	0	2
	pn	0	2	0		pn	2	1	1		pp	0	2	0		pp	1	0	1		ss	2	1	0
	os	0	0	2		pp	0	1	2		lt	0	2	0		pn	1	2	1		os	0	1	2
	lt	2	0	0		os	1	0	1		ss	1	2	0		lt	1	0	1		pp	2	1	0
	ss	2	0	0		ss	2	0	1		pn	0	0	0		ss	0	2	1		lt	0	1	2
7	pp	1	2	1	7	lt	0	2	2	5	os	2	1	0	6	os	0	0	2	6	pn	0	2	0
	pn	1	2	0		pn	1	2	0		pp	1	0	2		pp	0	0	2		ss	2	0	0
	os	1	2	1		pp	1	2	1		lt	0	1	2		pn	0	2	0		os	0	0	2
	lt	0	2	2		os	1	2	1		ss	0	1	2		lt	2	0	0		pp	0	0	2
	ss	1	0	2		ss	1	0	2		pn	2	1	2		ss	2	0	0		lt	2	0	0
8	pp	0	2	0	8	lt	2	0	1	2	os	2	1	0	7	os	1	2	1	5	pn	2	1	2
	pn	0	0	2		pn	0	0	2		pp	2	0	1		pp	1	2	1		ss	0	1	2
	os	2	0	0		pp	0	2	0		lt	1	0	1		pn	1	2	0		os	2	1	0
	lt	2	0	1		os	2	0	0		ss	1	1	1		lt	0	2	2		pp	1	0	2
	ss	0	2	0		ss	0	2	0		pn	1	1	1		ss	1	0	2		lt	0	1	2
9	pp	0	2	0	9	lt	0	2	0	1	os	0	1	2	5	os	2	1	0	7	pn	1	2	0
	pn	0	0	0		pn	0	0	0		pp	2	1	0		pp	1	0	2		ss	1	0	2
	os	0	2	1		pp	0	2	0		lt	0	1	2		pn	2	1	2		os	1	2	1
	lt	0	2	0		os	0	2	1		ss	2	1	0		lt	0	1	2		pp	1	2	1
	ss	1	2	0		ss	1	2	0		pn	2	0	2		ss	0	1	2		lt	0	2	2
10	pp	2	1	0	10	lt	1	2	0	6	os	0	0	2	2	os	2	1	0	2	pn	1	1	1
	pn	0	0	0		pn	0	0	0		pp	0	0	2		pp	2	0	1		ss	1	1	1
	os	0	0	2		pp	2	1	0		lt	2	0	0		pn	1	1	1		os	2	1	0
	lt	1	2	0		os	0	0	2		ss	2	0	0		lt	1	0	1		pp	2	0	1
	ss	0	0	2		ss	0	0	2		pn	0	2	0		ss	1	1	1		lt	1	0	1

[a] pp: Patent Portfolio
pn: Product-related inventions which are patented
os: Contributions to open standards
lt: Time to market.

Table 5: Estimation results[a]

Model specification	Model 1 – R&D Manager Rank-ordered mixed logit (robust SE)			Model 2 – Marketing Manager Rank-ordered mixed logit (robust SE)		
Dependent variable: Firm ranking	**Coeff. (SE)**	**AME**	**AME 90% CI**	**Coeff. (SE)**	**AME**	**AME 90% CI**
Average patent portfolio	.199 (.258)	.021	-.021 .057	.815*** (.210)	.100	.052 .129
Large patent portfolio	1.377*** (.229)	.143	.103 .180	1.108*** (.186)	.132	.095 .168
Half of all product-related inventions patented	-.032 (.348)	-.003	-.058 .052	-.283 (.321)	-.030	-.094 .028
Nearly all product-related inventions patented	1.332*** (.312)	.138	.083 .182	.833** (.290)	.104	.044 .156
Some contributions to open standards	.294 (.196)	.030	-.005 .065	.567** (.201)	.068	.027 .110
Many contributions to open standards	.894*** (.240)	.091	.046 .136	1.086*** (.232)	.130	.079 .180
Among early followers to market	2.540*** (.245)	.246	.201 .276	1.230*** (.222)	.143	.102 .179
Among first movers to market	2.840*** (.307)	.274	.216 .325	1.458*** (.222)	.172	.124 .216
Good marketing, sales & service quality	1.464*** (.241)	.144	.095 .178	1.510*** (.238)	.178	.121 .218
Excellent marketing, sales & service quality	2.510*** (.395)	.250	.193 .313	1.851*** (.281)	.216	.171 .270
Persons / Observations	67	3,315		76	2,655	
LL	-808.2			-758.5		
LR (p-value)	176.56 (0.000)			121.79 (0.000)		

[a] Robust standard errors are in parentheses. AME: average marginal effect. Simulations for estimating coefficients and calculating predicted probabilities for the mixed logit models were done using 1,000 Halton draws. Simulations used to calculate confidence intervals of average marginal effects were done using 100 random draws of coefficients.

* $p < 0.1$; ** $p < 0.01$; *** $p < 0.001$

Figure 1: Choice experiment as presented to survey participants

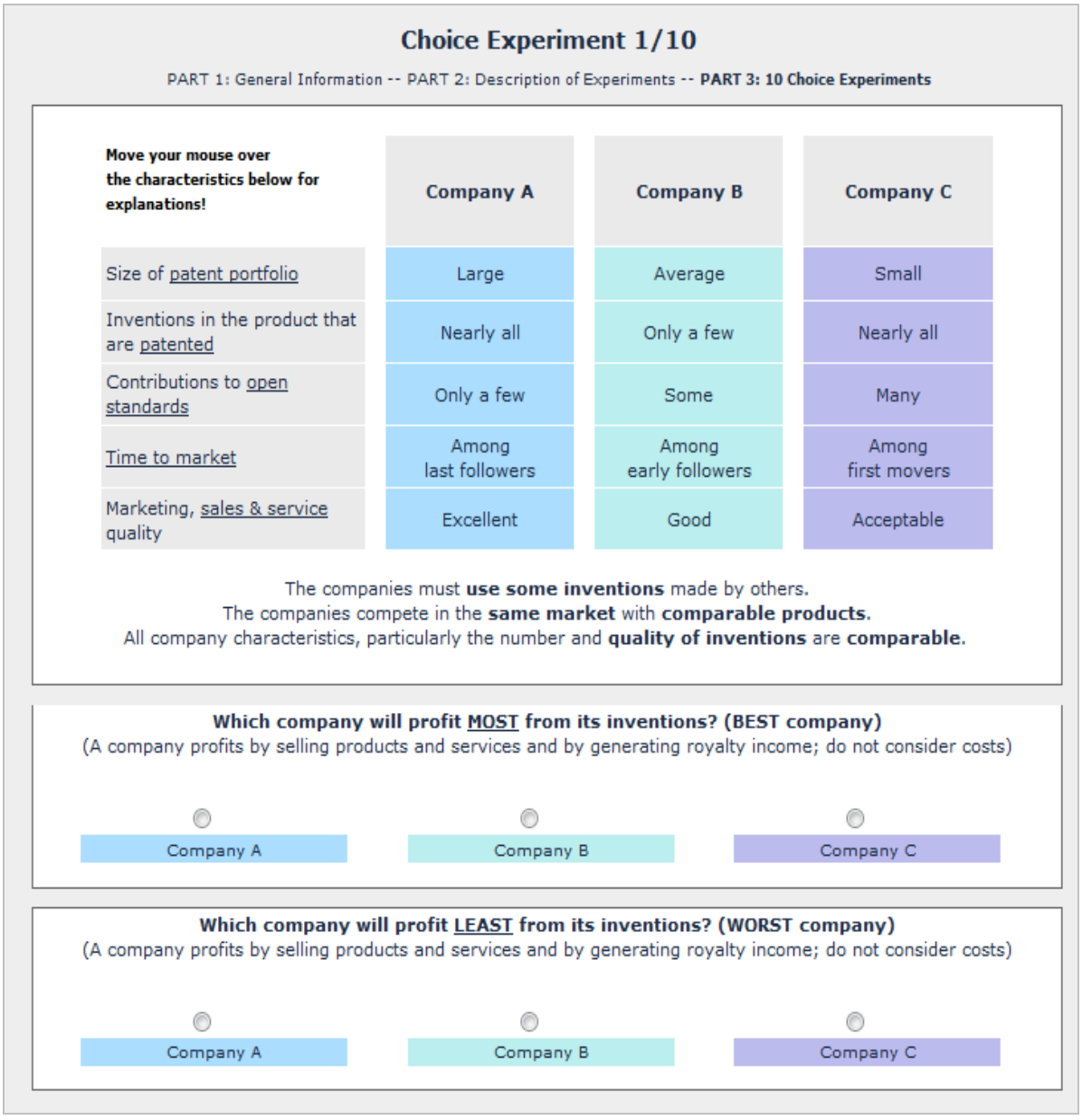

Figure 2: Average marginal effects of "Among early followers to market" by groups, with 90% confidence intervals

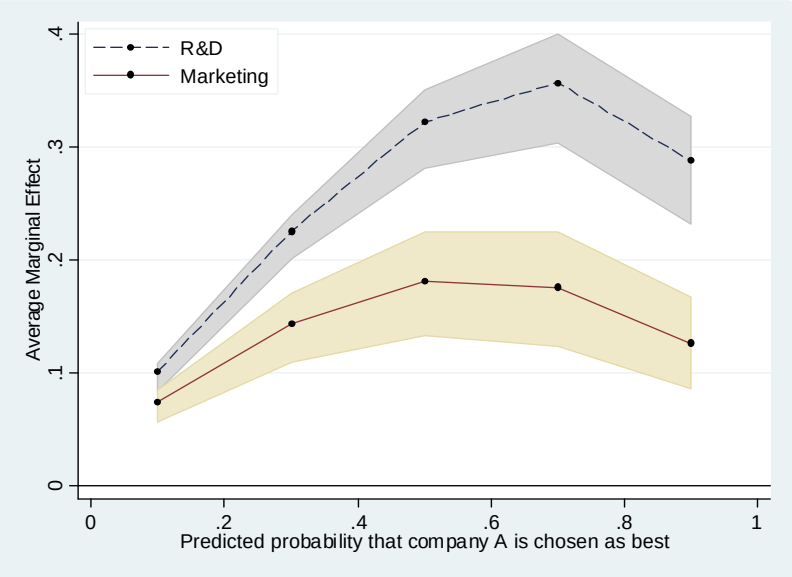

Figure 3: Group differences in average marginal effects: Patent portfolio size

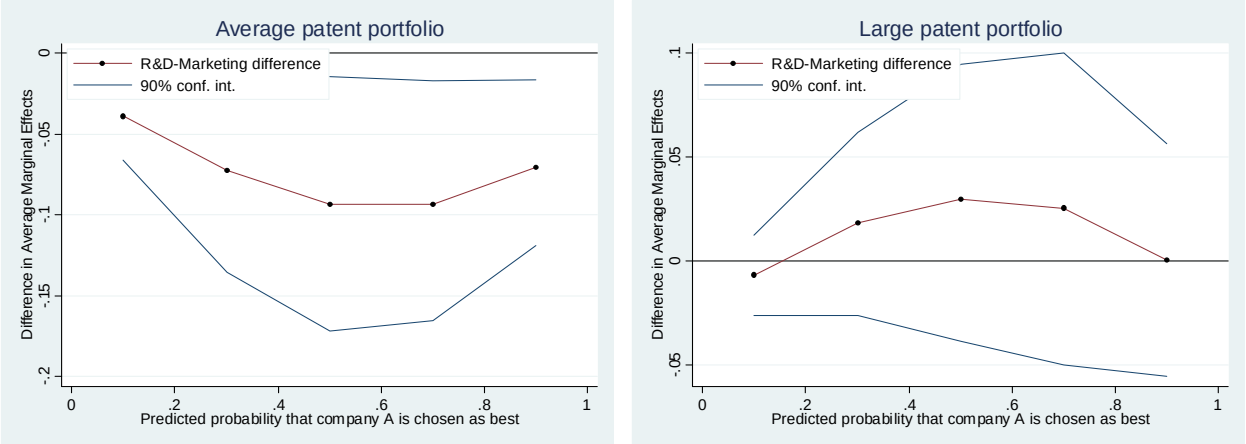

Figure 4: Group differences in average marginal effects: Product-related patents

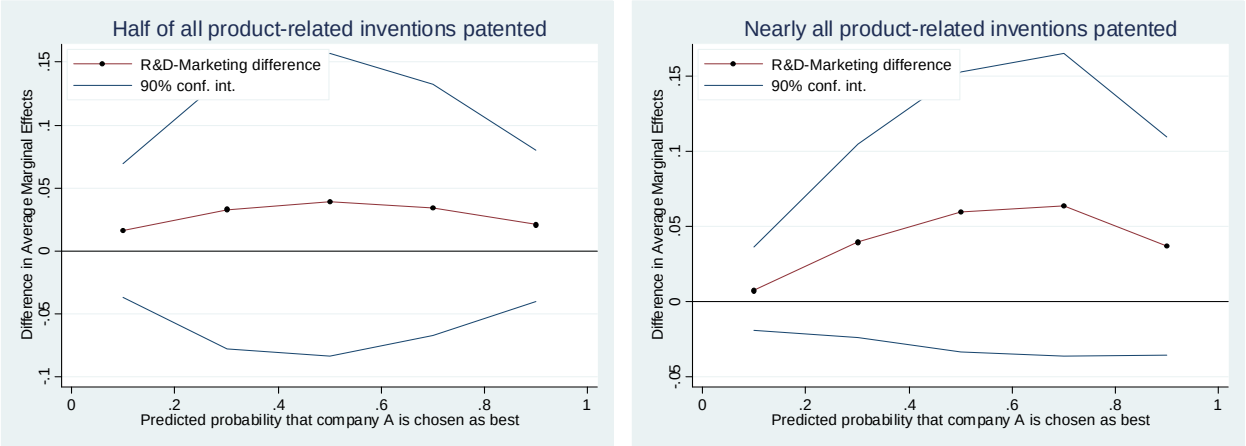

Figure 5: Group differences in average marginal effects: Contributions to open standards

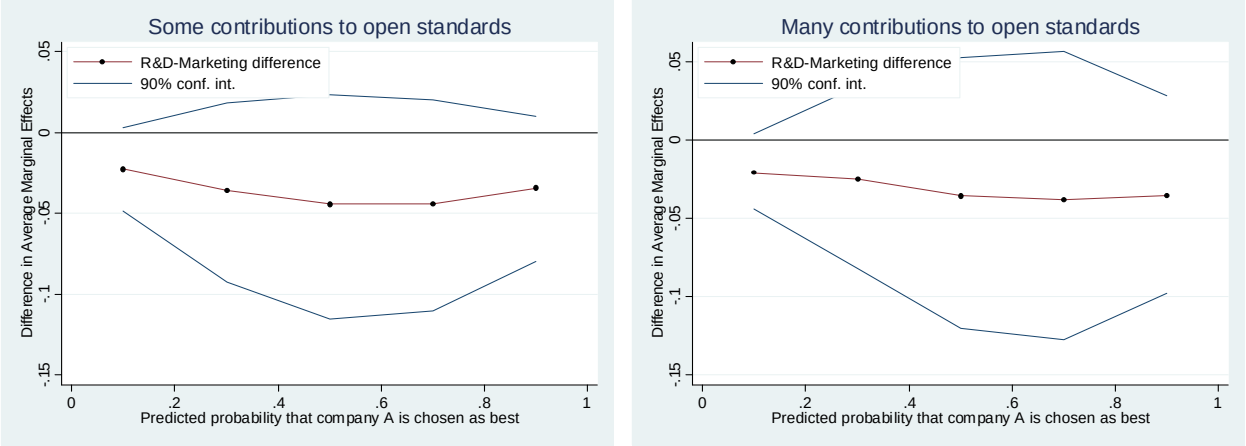

Figure 6: Group differences in average marginal effects: Lead time advantages

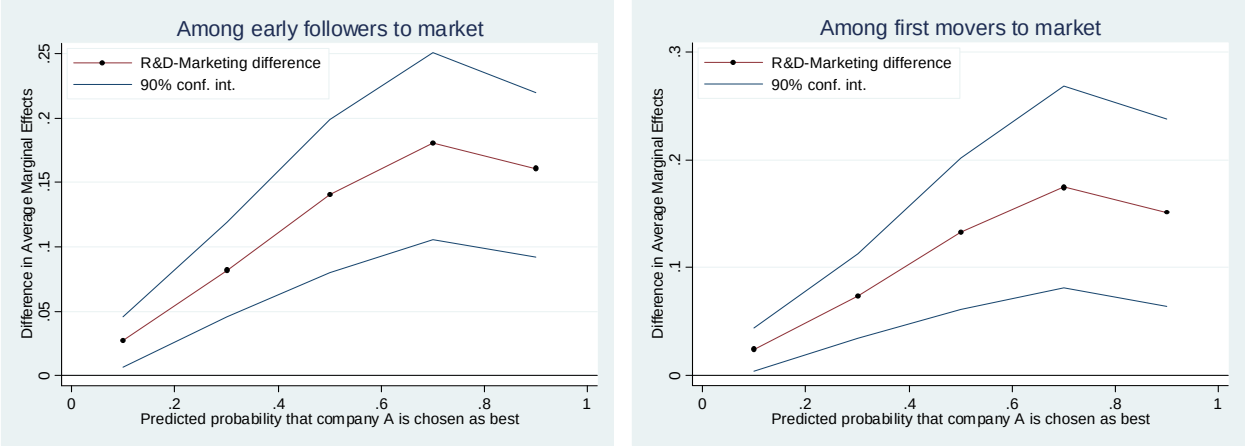

Figure 7: Group differences in average marginal effects: Marketing, sales and service efforts