



## Complements and substitutes in profiting from innovation— A choice experimental approach

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### ABSTRACT

The ability of firms to effectively use mechanisms that support them in profiting from technological innovation is key to outperforming competitors. Yet, such mechanisms have, for the most part, been studied in isolation, without accounting for interactions between them. We address this gap by developing a conjoint-based method to study such interactions, and by applying it to analyze interactions between product-related patents and three other appropriability mechanisms. To this end, we conduct and analyze a series of discrete choice experiments with 319 managers within a leading international communications equipment company. As a result, we find the number of product-related patents to be complementary to the overall size of the patent portfolio and complementary—with an interesting exception—to contributions to open standards. We also find indications of a substitutive interaction with lead time advantages. Hence, the effectiveness of patents seems to be leveraged by controlled diffusion of the underlying technologies and by the size of the firm's patent portfolio, a finding that may contribute to explaining the patent paradox. Theoretical and managerial implications are discussed.

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### 1. Introduction

The question of how firms can profit most from technological innovation plays a central role in the management literature (Rumelt, 1984; Teece, 1986). Among the various appropriability mechanisms that support firms' value appropriation, scholars tend to focus on lead time advantages, complementary assets, patents, and secrecy (Arora and Ceccagnoli, 2006; Cohen et al., 2000; Dechenaux et al., 2008; Levin et al., 1987).

Extant empirical research provides us with a solid understanding of the effectiveness of these appropriability mechanisms (e.g., Cohen et al., 2000; Harabi, 1995; Levin et al., 1987; Sattler, 2003, for an overview). These studies consistently found that, in most industries, firms perceive patents as rather ineffective in supporting them to profit from innovation. Yet, firms' patenting activities increase steadily, an apparent contradiction that has been termed the patent paradox (Hall and Ziedonis, 2001). Most

of the extant research, however, analyzed appropriability mechanisms in isolation. In practice though, a firm makes use of a whole bundle of appropriability mechanisms, the effectiveness of which may be affected by interactions between them (Laursen and Salter, 2005; Graham and Somaya, 2006). Indeed, management theory emphasizes the importance of complementarities or substitutabilities between a firm's assets (e.g., Milgrom and Roberts, 1990).

In this paper, we address this gap by devising and applying a method to analyze interactions between appropriability mechanisms. We complement existing work by taking a choice-experimental survey approach, conducting discrete choice experiments (also called choice-based conjoint analysis) with 319 managers within a leading international communications equipment company. That is, we analyze complementarities and substitutabilities between product-related patents and other appropriability mechanisms as perceived by employees responsible for managing value appropriation. In so doing, we rely on respondents' ability to correctly assess the effectiveness of appropriability mechanisms (as do all survey-based studies, e.g., Cohen et al., 2000; Levin et al., 1987). The advantage of this approach is that it avoids the methodological challenge of disentangling the effects of potential interactions from those of confounding factors (Athey

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and Stern, 1998), in particular, omitted variables.<sup>1</sup> Furthermore, our research design offers participants a more realistic setting by prompting them to assess profiles of appropriability mechanisms rather than asking for the perceived effectiveness of each one separately.

We study interactions between product-related patents and three other appropriability mechanisms: lead time, contributions to open (but not royalty-free) standards, and the firm's overall patent portfolio. We included "contributions to open standards" in this list since the deliberate diffusion of an innovation, and thus the waiving of exclusivity, has recently been identified as potentially facilitating profit from innovation (e.g., Harhoff et al., 2003; Henkel, 2006; Pisano, 2006; Simcoe et al., 2009). Thus, we study profiting from innovation not only from selling products but also from outlicensing the underlying inventions in the context of standards (cf. Arora and Ceccagnoli, 2006). We furthermore distinguish between patents related to a given product and the firm's overall patent portfolio since the latter may have an independent effect on the product's protection. Given that this paper is not about formally testing a theory and derived hypotheses, we take an exploratory approach.

Results show that survey participants do perceive various complementarities and substitutabilities between patents and other appropriability mechanisms. The number of product-related patents is, for firms with low and medium performance in appropriating value, perceived to be complementary to the size of the patent portfolio overall—but, interestingly, only for high levels of both mechanisms, not for intermediate levels. Furthermore, the number of product-related patents is seen as complementary to contributions to open standards (with an interesting exception: the combination of high levels of patenting with high levels of standard contributions is perceived as not beneficial). Also, there are indications of a substitutive interaction with lead time advantages, for firms with good appropriation capabilities.

Our study makes three contributions. First, we contribute methodologically through the development of a method—based on contributions by King et al. (2000)—that tests for interaction effects in discrete choice experiments, which allows to study perceived complementarities and substitutabilities between appropriability mechanisms. Second, we contribute to the literature on profiting from innovation (originating with Teece, 1986) by explicitly addressing interactions between appropriability mechanisms. We find that patenting in conjunction with contributions to open standards (in which patents are licensed under "RAND" conditions—"reasonable and non-discriminatory") is highly effective in capturing value, as conjectured earlier (Bekkers et al., 2002; Leiponen, 2008; Simcoe et al., 2009). Furthermore, amassing large patent portfolios increases the effectiveness of product-related patents protection, and thus constitutes another way to leverage the effectiveness of patents. If respondents in earlier surveys, when rating the effectiveness of patents for protecting a given innovative product, related only to patents covering the focal product (rather than to the firm's overall patent portfolio), then this finding contributes to explaining the patent paradox. Third, we contribute to the strategy literature that discusses the importance

of management competence in integrating and coordinating firms' assets and capabilities (Holcomb et al., 2009; Sirmon et al., 2007; Teece, 2007). We show that managers indeed perceive multiple interactions between mechanisms that have to be taken into account to optimize profiting from innovation.

## 2. Interaction effects in profiting from innovation

Several appropriability mechanisms are discussed in the literature on profiting from innovation, which work by increasing the innovator's bargaining power or the overall value created. In our context, the communications equipment industry, the most relevant appropriability mechanisms are product-related patents, the innovator's overall patent portfolio, diffusion of an invention, lead time, and complementary assets, as we explain in the following.<sup>2</sup> Since the design of the conjoint experiment depends on which interaction effects shall be observed, we derive in the following which interactions are likely relevant in the present setting.

### 2.1. Patents

Legal property rights offer the owner the possibility to exclude others from using its property by enforcing the right in court. Patents and utility models are exclusion rights that protect technical inventions, while other legal exclusion rights such as copyright and trademarks protect non-technical intellectual property (IP) (with the exception that copyright covers software as well). For innovative, technical firms, patents are the most prominent exclusion right and the traditional core of companies' IP management. The classical function of patents is to prevent imitation of the invention. Due to patent protection, firms hold a technological advantage on time and thus enjoy a stronger bargaining position. Besides this traditional function, patents are exploited through strategic usages, giving rise to strategic motives to patent (Cohen et al., 2000). Firms use patents to block competitors, to signal technological competence, and as a measure to control R&D departments. Firms may patent to amass large patent portfolios to deter legal attacks, and also use their patents as bargaining chips in cross-licensing agreements (Cohen et al., 2000; Hall and Ziedonis, 2001). Particularly in complex product industries where firms inevitably infringe patents, patents are used to deter legal attacks (Hall and Ziedonis, 2001) or become tools to negotiate a settlement in case a suit is filed (Somaya, 2003). These usages of patents drive filing numbers and thus contribute to the patent paradox (Hall and Ziedonis, 2001; Hall, 2005). They also give patents a value independent of the underlying invention. Thus, in our analysis we make the important distinction between product-related patents that protect inventions used in the focal product (including patents that cover direct substitutes to such inventions) and the firm's overall patent portfolio, which is used for purposes of cross-licensing or deterrence.

A large patent portfolio also supports offensive usage of patents. Extant research suggests that a firm's patent portfolio influences its

<sup>1</sup> While complementarity between two factors favors a positive correlation between their levels (or positively correlated movements over time in the case of panel data), such correlation may also be caused by omitted variables that affect both factors in the same direction. For this reason, some studies of complementarities explicitly restrict themselves to showing an implication of complementarity, namely, positive correlations between the respective factors (e.g., Arora and Gambardella, 1990). Furthermore, real world data tend to conflate cost and effectiveness, since returns to scope in procuring two factors also favor a positive correlation between their levels. The notion of complementarity, however, commonly refers to the marginal value of factors rather than their cost.

<sup>2</sup> This list accords well with rankings of relative effectiveness obtained from empirical studies (e.g., Sattler, 2003). Not included in these rankings is "diffusion," which we include here because of the network-good character of the focal product and because of recently acknowledged benefits of "open innovation." Secrecy and the complexity of design matters less in the industry we study, since technology not "revealed" by contributing it to open standards is typically distributed as compiled software code and thus requires little decision making regarding secrecy. The level of secrecy of an invention is, by its nature—and so in a less interesting way—substitutive to patenting since the latter requires disclosure of the invention (e.g., Horstman et al., 1985). Trademarks matter little in the focal industry since the number of relevant firms is limited and buyers are professionals who are aware of each firm and its reputation.

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