



## Effective incomplete contracts and milestones in market-distant R&D collaboration

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### ABSTRACT

R&D outsourcing is often conducted during the early, market-distant stages of the innovation process. However, the main obstacle to this potentially efficient interfirm specialization is the high danger of moral hazard. Most organizational mechanisms fail to control that type of opportunism because of information asymmetries, even ex post. In the theory of incomplete contracts, this problem is mitigated by assigning the control rights to the supplier. To date, empirical studies have mainly investigated the interfirm distribution of the control rights. However, we do not know yet which concrete control right is crucial with regard to supplier opportunism, which is the decisive dependent variable. Our study addresses this research gap. For the first time, we extend the empirical focus from biotechnology and pharmaceutical firm alliances to a cross-industry sample of 113 collaboration cases. The results show the effectiveness of contracts that ex ante assign patent ownership rights to the supplier. The findings are also relevant for management practice because the majority of practitioners do not use this contract type yet, although there is no sign of an effective alternative.

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### 1. Introduction

R&D outsourcing is prevalent (Arora and Gambardella, 2010; Calantone and Stanko, 2007; Ceccagnoli et al., 2010; Chesbrough, 2003; Chiesa et al., 2004; Gans and Stern, 2003; Gilson et al., 2009; Hagedoorn and Duysters, 2002). It also concerns the early, market-distant stages of innovation processes, in which the external suppliers deliver R&D results that are patentable but not yet marketable to end customers. This type of collaboration often occurs with biotechnology firms and pharmaceutical companies (Arora and Gambardella, 1994a,b; Arora et al., 2001: 45–89; Festel et al., 2010; Pisano, 1990; Pisano and Mang, 1993; Rothaermel and Boeker, 2008; Rothaermel and Deeds, 2004; Scherer, 2010).<sup>1</sup> However, market-distant R&D outsourcing is confronted with a high moral hazard danger that is caused by the strong information asymmetries of hidden action and hidden information between suppliers and buyers.<sup>2</sup> Buyers could not detect opportunistic withholding of

relevant supplier efforts, not even ex post. Therefore, the suppliers of market-distant R&D services have ample leeway for opportunism (Aboody and Lev, 2000; Sampson, 2007).<sup>3</sup> This problem is aggravated by the fact that uncertainty prevents a complete contractual anticipation of the supplier duties.

Principally, one might ask why manufacturers of final products outsource market-distant R&D at all if they cannot evaluate the quality of the supplier's work. However, there is no doubt that specialization benefits also exist in R&D. In order to realize these benefits, it is necessary to control the moral hazard danger. Otherwise, buyers would have reason to refrain from outsourcing, or an already initiated collaboration could become ineffective without detection.

the potential supplier in the research field that seems to be the most relevant for the planned R&D process. Our analysis starts at the point in time when the collaboration partners have identified each other. The danger of hold-up (Klein et al., 1978) exerted by the buyer (principal) will only be considered insofar as it influences the supplier's motivation to act opportunistically.

<sup>3</sup> The paper will not depict the basic traits of new institutional economics with its main sub-theories of property rights theory, transaction cost economics, and agency theory. There are several established introductions into this system of theories. The focus of Williamson (1985), for example, is on transaction cost theory. Arrow (1985) describes the foundations of agency theory. An overview of the whole system of theories is given, for example, by Furubotn and Richter (2000), Ménard and Shirley (2008), and Milgrom and Roberts (1992).

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<sup>1</sup> Pharmaceutical companies often outsource the initial phase of drug discovery to small biotechnology firms. The identified drugs must undergo a long process of development, testing, and regulatory approval before a new drug can be launched into the market.

<sup>2</sup> We will not deal with the selection of suitable suppliers and the related problem of adverse selection (Akerlof, 1970) that results from hidden characteristics. This problem can be addressed by credible signals (Spence, 1973) like the patent record of

Due to various reasons, traditional governance mechanisms fail.<sup>4</sup> Behavior monitoring cannot overcome the information asymmetries. Intrinsic motivation possibly exists but is not manageable. Self-enforcing contracts (Klein, 1985; Kronman, 1985) that are based on the hostage of reputation also fail due to information asymmetries. The question of moral hazard control becomes even more problematical under the further specified conditions that define the precise case that we will investigate by our empirical study.

We deliberately do not consider the mechanisms of relational contracting and equity shares because they are less relevant due to frequent change of contract parties. We also exclude from our survey royalty agreements in the original collaboration contract because they would require a precise definition of the royalty basis that typically does not exist yet at market-distant R&D stages. Thus, we focus on a specific case of R&D collaboration. However, we do so because of two reasons. First, this case is especially problematical for theorists as for managers. Second, it is not a rare case as our pilot study and the response rate of our main study show.

From the perspective of organization theory, it seems that in our case the model of incomplete contracts could provide effective instruments for supplier opportunism control. The basic model was developed by Grossman and Hart (1986) and Hart and Moore (1988). Aghion and Tirole (1994) applied it to R&D alliances. Incomplete contracts are inevitable if the activities of the parties are to some extent either unpredictable (Pisano, 1990), indescribable, or unobservable (Tirole, 1999). A consequence of incompleteness is that third parties, including courts, cannot verify to what extent the contract parties fulfilled their duties (Hart, 1987: 754). The major conclusion of the theoretical model is the contractual allocation of property rights (control rights) to the party that has the stronger marginal ability to influence the collaboration output. In the beginning of an innovation process, this is – according to the model – the technology supplier. The model predicts that the assignment of the control rights leads to the required “effort of the research unit” (Aghion and Tirole, 1994: 1188).

Despite several empirical studies in this field, some questions remain unsolved. To date, the assignment of several control rights to the R&D supplier was confirmed for a considerable share of biotechnology alliances (Haeussler and Higgins, 2009; Higgins, 2007; Lerner and Merges, 1998). Some studies also examine the impact of the contract design on different dependent variables, such as knowledge spillover (Haeussler and Higgins, 2009) or milestone achievements (Lerner et al., 2003). However, we do not know yet which concrete control right is critical for the control of moral hazard. Answers to these questions are relevant for theory and practice. Theorists get to know how their model can be realized in an effective way with regard to the dependent variable of opportunism that is crucial in new institutional economics and in the model of incomplete contracts especially. Practitioners should be interested in reliable controls of moral hazard that help realizing the efficiency potential of market-distant R&D outsourcing. We address the research gap based on a study that examines 113 cross-industry cases.

Our empirical results show that in a minority of the cases, supplier opportunism is effectively controlled by a mechanism that is based on the in-principle-assignment of *patent* ownership rights to the supplier in the original contract ( $t_0$ ). According to these rights, the supplier receives actual ownership shares in a generated patent (in  $t_1$ ) in case it has contributed to the patented invention between  $t_0$  and  $t_1$ . The supplier can use these actual ownership shares for

enforcing a continuous share in the innovation return that is generated when the buyer sells final products. By opportunism, the supplier would endanger the market success of those final products. The crucial feature of the in-principle assigned patent ownership rights ( $t_0$ ) is that they are enforceable in court in  $t_1$ . Therefore, the supplier is motivated to refrain from opportunism. The positive effect is also evident in the supplier's relative contribution to generated patents. Other control rights (regarding the R&D process and the marketing of its results) are typically not enforceable in court and can therefore not motivate in that way (Kloyer, 2011).

Apart from this main finding, we also show that milestone-dependent payments are superfluous, if their only purpose is motivating suppliers against opportunism. In that regard, they are ineffective. We conducted this additional test because, in accordance with theoretical reasoning (Bower et al., 2002), the majority of interviewees in our pilot study regarded milestone-dependent payments as a crucial incentive against opportunism. Apparently, many practitioners consider outcome monitoring (Wathne and Heide, 2000: 43) as effective in market-distant as in market-near R&D collaboration. As far as we know, our study is the first one that examines the opportunism control effect of patent ownership rights and milestones in incomplete R&D collaboration contracts.

The article is organized as follows: Section 2.1 describes the specific danger of moral hazard in market-distant R&D collaboration. Section 2.2 will explain why we exclude several traditional governance mechanisms from the survey. In Section 2.3, we will depict why our study focuses on the specific control right type of patent ownership. Section 2.4 will deal with the practice tool of milestone-dependent payments. The empirical study will be presented in Sections 3 and 4. Discussion and conclusion follow in Section 5.

## 2. Theory

### 2.1. Moral hazard in market-distant R&D collaboration

The mental process of generating innovative ideas is not transparent at the market-distant stages of an R&D project (*hidden action* (Arrow, 1985; Furubotn and Richter, 2000)). Therefore, external suppliers of market-distant R&D services have an ample leeway for deliberately withholding efforts without the risk of being detected. Such behavior is to be classified as opportunism. It is a form of “self-interest seeking with guile” (Williamson, 1975: 6) as well as of “shirking or evasion of obligations” (Wathne and Heide, 2000: 38). Moreover, it is a form of passive opportunism (Masten, 1988). The resulting management problem is the opportunism danger of *moral hazard* (Holmstrom, 1979).<sup>5</sup>

One might ask whether the problem of opportunistic withholding of efforts is that relevant. However, there are several *potential motives for opportunism* in contract R&D: increasing the profits by reducing the efforts, preparation of own competitive activities, and selling non-specific parts of the generated knowledge to a competitor. Moreover, the motivation of R&D suppliers to behave opportunistically can increase if they anticipate the danger of buyer opportunism, i.e., the danger of *hold-up* (Klein et al., 1978). In market-distant R&D collaboration, the hold-up-danger is severe. The supplier must often make one-sided, buyer-specific investments at the beginning of the relationship (e.g., into laboratory equipment or qualification of employees) that are not completely compensated by the specific investments of the buyer. This leads to a one-sided dependence after contracting. An opportunistic buyer

<sup>4</sup> For an overview of governance approaches, see Baker (1992), Campbell (2006), Eisenhardt (1985), Hennart (1993), Laffont and Martimort (2002), Ouchi (1979, 1980), and Wathne and Heide (2000).

<sup>5</sup> From the perspective of game-theory, the impossibility to detect opportunism means that a buyer cannot distinguish between cooperation and defection (Wathne and Heide, 2000, p. 45).

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