¿RELATION-SPECIFIC INVESTMENTS AND THE PERFORMANCE OF R&D OUTSOURCING AGREEMENTS

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INTANGIBLE RELATIONSHIP-SPECIFIC INVESTMENTS AND THE PERFORMANCE OF R&D OUTSOURCING AGREEMENTS [1]

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Abstract

We examine the effect of intangible relationship-specific investments—such as trust, formation, and knowledge sharing routines—on the performance of R&D services outsourcing agreements. While we acknowledge that these investments may help to structure the relationship as a self-enforcing agreement, we also argue that they increase appropriability hazards because these investments have the potential of upgrading the provider's absorptive capacity. Using original survey data on R&D outsourcing agreements by 170 European and U.S. firms operating in technology-intensive industries, we find that intangible relationship-specific investments lead to superior performance when outsourcing standardized services. However, these investments are found to be detrimental to performance when the service outsourced is customized to the firm. This suggests that the appropriability hazards originated in these cases may lead partners not to capturing the full potential value that may be generated within the relationship.

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INTRODUCTION

The literature on buyer-seller agreements shows that partners accumulate ever-more valuable resources through relationship-specific investments the longer their relationship endure (Dyer and Hatch, 2006; Dyer and Singh, 1998; Kang, Mahoney and Tan, 2009; Levinthal and Fichman, 1988; Madhok and Tallman, 1998; Ring and Van de Ven, 1994). Such specific investments include not only specialized equipment and expertise (Williamson, 1985), but also trust, personal relationships and specific inter-firm coordination mechanisms (Dyer and Singh, 1998; Levinthal and Fichman, 1988; Mesquita, Anand and Brush, 2008). Previous research shows that these investments play a critical role in the performance of buyer-seller agreements (Asanuma, 1989; Dyer, 1996; Dyer and Singh, 1998; Kim and Mahoney, 2006; Lado, Dant and Tekleab, 2008) and, generally speaking in all kinds of strategic alliances (Ariño and de la Torre, 1998; García-Canal, Valdés-Llaneza and Ariño, 2003; Kale, Singh and Perlmutter, 2000; Parkhe, 1993; Saxenian, 1994; Zajac and Olsen, 1993; Zollo, Reuer and Singh, 2002). By their nature, relationship-specific investments have been found to increase productivity levels (Mesquita et al., 2008) as well as the expectation of future interaction between the parties, thus fostering cooperative behavior (Parkhe, 1993), and prompting partners to turn alliances into relational contracts (Lado et al., 2008) or self-enforcing agreements (Dyer and Singh, 1998). As a consequence, relationship-specific investments help the partners achieve performance levels which cannot be attained by interacting with other partners (Madhok and Tallman, 1998; Mesquita et al., 2008).

Some evidence suggests, however, that relationship-specific investments can be detrimental to alliance performance. Empirical research has shown that relying on trust and relational contracts

can induce opportunistic behavior. For example, Garcia-Canal et al. (2003) showed that in multiparty alliances free- riding reduces the effectiveness of relational investments. Carson, Madhok and Wu (2006) offered evidence indicating that ambiguity and monitoring problems reduce the effectiveness of relational contracts. Finally, Lado et al. (2008) found that strategic alliances involving relationship-specific investments are characterized by varying levels of trust and opportunism. Thus, the possibility of having to deal with differing manifestations of opportunistic behavior is an important drawback of making relationship-specific investments.

Appropriability hazards are one of the main sources of opportunistic behavior in strategic alliances (Kogut, 1988; Oxley, 1997; Teece, 1986). These hazards refer to the risk of suffering the consequences of an unintended leakage of knowledge and assets contributed to the alliance. Appropriability hazards increase as the firm shares proprietary knowledge with its partners (Larsson et al, 1998). For this reason, firms which enter into relational contracts and make relationship-specific investments in the form of knowledge sharing face high appropriability hazards, as the possibility of losing core proprietary knowledge to their partner entails a big risk which can lead to the erosion of the firm's competitive advantage (Kale et al., 2000). These hazards are especially important in the case of R&D outsourcing agreements. As in all types of R&D collaborative agreements, partners in an R&D outsourcing arrangement face the challenge of maintaining the necessary knowledge exchange in order to achieve alliance objectives while avoiding unintended leakage of valuable technology (Oxley and Sampson, 2004a). Thus, the effectiveness of relationship-specific investments may certainly be questioned in the field of R&D outsourcing agreements. However, not all relationship-specific investments generate appropiability hazards to the same extent. Appropriability hazards increase the most when

making relationship-specific investments based on information flows, i.e. intangible relationship-specific investments. Other types of relationship-specific investments, that is, those involving equipment, machinery and plants generate hold-up hazards, but not appropriability hazards. Intangible relationship-specific investments can thus constitute a double-edged sword as they facilitate not only the governance of the agreement, but also undesired knowledge transfers.

In this paper we analyze the impact of intangible relationship-specific investments on the performance of R&D outsourcing agreements. Specifically, we are interested in analyzing the circumstances in which intangible relationship-specific investments lead to superior performance. The growing trend to outsource not only standardized activities but also those considered as more specific or valuable to the firm (Gottfredson, Puryear and Phillips, 2005) makes this research setting especially interesting as partners face a critical dilemma regarding intangible relationship-specific investments. On the one hand, these investments facilitate the transfer of tacit knowledge required to perform the outsourced activities. But, on the other, they can increase the risks of leakage and misappropriation of technological knowledge being exchanged.

However, within a R&D outsourcing agreement, appropriability hazards will depend not only on the level of intangible relationship-specific investments, but also on the level of customization of the service being outsourced. When outsourcing a customized service, the supplier gains access to the client's firm-specific knowledge; thus the risk of the firm suffering an unintended leakage of valuable knowledge related to its core technologies will be increased. Hence, in this paper we examine the level of customization of the service being outsourced together with the level of

intangible relationship-specific investments in the outsourcing agreement, arguing that when outsourcing standardized R&D services intangible relationship-specific investments will facilitate the achievement of superior levels of performance, which will in turn contribute to capturing the full potential value generated within the agreement at a low risk. However, we also argue that when the service being outsourced is customized to the firm, intangible relationship-specific investments may generate negative knowledge spillovers for the firm, and thus conduct to achieve lower levels of performance as these investments increase the provider's absorptive capacity (Cohen and Levinthal, 1990), augmenting the risk of the firm's core technological knowledge being leaked. We examine these arguments using original survey data collected from a representative sample of R&D service outsourcing agreements undertaken by U.S. and European firms. In this regard, we consider as outsourcing agreements all the different modes of governance in which the R&D activity is not fully undertaken internally by the firm. Thus, because of the wide variety of modes of governance available to organize outsourcing agreements, and the difficulty in differentiating a market relationship from a strategic alliance, we consider the different outsourcing options as a continuum defined by occasional outsourcing agreements similar to establishing an arm's- length transaction with the provider, at one end of the spectrum, and outsourcing agreements in which the firm maintains a very close and long-term oriented relationship with its provider (with or without equity participation), at the other. Consequently, we argue that the level of intangible relationship-specific investments made by partners is an indicator of the level of commitment to the relationship, and thus helps distinguish between an arm's-length agreement and a more collaboration-oriented outsourcing agreement.

TANGIBLE AND INTANGIBLE RELATIONSHIP-SPECIFIC INVESTMENTS

For the purposes of this paper, relationship-specific investments are those expenditures in tangible or intangible assets dedicated to a transaction which are (i) not easily redeployable to other transactions with a different partner without losing value, and which (ii) are aimed at either reducing production costs and/or improving the coordination and control of the relationship. Hence, on the one hand, our concept includes Williamson's (1985) four types of asset specificity: site specificity, physical specificity, human specificity and dedicated assets. On the other hand, it also includes all of the expenditures made between the firm and its provider aimed at the development of trust, communication and coordination, and the facilitation of personal relationships between the representatives of each organization (Levinthal and Fichman, 1988; Madhock and Tallman, 1998; Dyer and Singh, 1998). These additional investments may be labeled as "relationship-development specific investments".

Transaction cost economics have traditionally analyzed specific investments as an attribute of the transaction leading to increases in transaction costs (Klein et al., 1978; Williamson, 1985). From this perspective, firms making such investments are exposed to the risk of opportunism on at least two fronts. First, specific investments create what are called hold-up hazards. As transaction-specific assets are of lesser value if dedicated to alternative uses, transaction partners face incentives to appropriate the rents from these specialized investments through *ex post* contractual bargaining or threats of termination (Klein et al., 1978; Masten, 1984; Monteverde and Teece, 1982; Walker and Weber, 1984; Williamson, 1985). A second type of opportunism emerges when a firm reveals valuable knowledge and information to a partner or just facilitates access to it. These knowledge-transfers may take place when partners exchange information in order to improve alliance efficiency levels, generate trust or identify new opportunities for

cooperation. The risk that the partner may make an unintended use of this knowledge and information or, more generally misuse assets contributed to the alliance, is usually called appropriability hazard (Kogut, 1998; Oxley, 1997). Even though these two sources of opportunism may be reduced through the governance form of the alliance (Oxley, 1997; Oxley and Sampson, 2004; Sampson, 2005), previous research shows that problems related to opportunism cannot be eliminated completely (Klein, 1988).

However, relationship-specific investments, especially those specific to the development of the relationship, may nevertheless have a positive effect on the performance of buyer-seller outsourcing agreements. Research shows that as relationship-specific investments, by their nature, increase the expectation of future interaction between the parties involved, they foster cooperative behavior (Parkhe, 1993; Zajac and Olsen, 1993). Such investments are expected to help partners develop a better understanding of each other's cultures and management systems, thus enhancing coordination, and conflict resolution. This knowledge, as well as the trust generated with it, is a valuable asset that may provide partners with a competitive advantage compared with other firms lacking such relational assets and embedded alliances (Dyer and Hatch, 2006; Dyer and Singh, 1998; Madhok and Tallman, 1998; Mesquita et al., 2008). Hence, even though there may be incentives for opportunistic behavior, other relational assets such as trust and knowledge-sharing routines would lose their value and the firm would consequently see its ability to generate relational rents curtailed.

In this paper, in order to analyze the effectiveness of relationship-specific investments on R&D outsourcing agreements, we will focus exclusively on intangible relationship-specific

investments. To do so, we distinguish between specific investments in physical assets (machinery, equipment and plants) and intangible specific assets, such as trust, know-how, expertise, and coordination procedures. We make this distinction because intangible investments are usually based on information exchanges, and so their consequences for the governance of the agreement are different to those of tangible investments. While tangible relationship-specific investments are expected to generate hold-up hazards, those of an intangible nature will not only generate hold-up hazards but mainly appropriability hazards as they imply knowledge-transfers between both organizations.

This distinction between tangible and intangible specific investments is different to the one existing between Williamson's (1985) four types of asset specificity, and "relationship-development specific investments"[2]. Tangible relationship-specific investments would be those specific investments made in order to adapt plants, machinery, or equipment to a specific partner, mainly influencing the production costs achieved within the relationship. These tangible investments would comprise three of Williamson's (1985) types of asset specificity: site specificity, physical asset specificity and dedicated assets (see figure 1). On the other hand, intangible relation specific-investments would entail all of the information-based relationship-specific investments, comprising not only relationship-development specific investments, but also specific know-how and expertise—what Williamson (1985) calls *human specificity*.

One important implication of this distinction is that if we focus exclusively on the side of the supplier, the buyer's attitude towards each type of relationship-specific investment should be

[2] Our distinction between tangible and intangible specific investments is compatible with those included in Kang et al.'s (2009) recent work.

different. Tangible relationship-specific investments do not pose any threat to the buyer beyond the safeguards to be included in the transaction in order to make such investments possible. Intangible relation-investments, however, pose both threats and advantages. On the one hand, as they facilitate knowledge transfer between both organizations, they increase appropriability hazards. On the other hand, they facilitate the governance of the relationship as they facilitate coordination and control. Intangible relationship-specific investments thus constitute a double-edged sword. In the following section we develop a theoretical framework based on transaction cost logic, but incorporating learning and capability development insights, to analyze the circumstances in which intangible relationship-specific investments improve the performance achieved in R&D outsourcing agreements.

HYPOTHESES

In the context of R&D outsourcing agreements, intangible relationship-specific investments are expected to be especially effective due to the tacit nature of innovation activities. Tacit knowledge is difficult to articulate and, as a consequence, more difficult for third parties to understand, being best transferred through close interaction (Kogut and Zander, 1993). Thus, the development of these "soft" or intangible relationship-specific investments is expected to lead to a more effective transfer of the required technological knowledge between partners. Consequently, because R&D activities are subject to organizational learning, intangible relationship-specific investments are expected to help realize the full potential of the value which may be generated by the outsourcing agreement. However, these improvements in transaction effectiveness come at the cost of higher appropriability hazards.

The innovation process, like many other value-adding activities, consists of different and technologically separable stages or services and, as a consequence, many firms outsource some of their R&D activities while retaining others (Afuah, 2001; Harrigan, 1984). Hence, when analyzing the effectiveness of intangible relationship-specific investments, one important factor to consider is the idiosyncratic nature of the R&D service being outsourced, that is, whether the service is customized or not to the firm. Appropriability hazards within a particular R&D outsourcing agreement will depend not only on the level of intangible relationship-specific investments existing between partners, but also on the extent to which the service being outsourced is customized. When outsourcing a customized service, the supplier is necessarily given access to the client's core technologies, thus increasing appropriability hazards.

Thus, when outsourcing customized services, intangible relationship-specific investments may lead to problems of misappropriation or imitation of the firm's valuable technological knowledge which could ultimately result in an erosion of its competitive advantage (Sampson, 2004a). First, intangible relationship-specific investments might end up revealing valuable information to a partner performing activities directly related to the firm's core business. And second, we also expect these investments to contribute to upgrading the provider's absorptive capacity —that is, its ability to identify, assimilate and exploit knowledge, in this case from the client (Cohen and Levinthal, 1990). Thus, as the provider's ability to behave opportunistically will be dependent on its absorptive capacity, we expect that making these "soft" relationally-oriented investments may also increase the risk of the firm's provider becoming a competitor. In other words, revealing valuable information in these cases could imply a potentially risky upgrading of the partner's technological competence (Larsson et al., 1998, Arruñada and Vazquez, 2006). This fact could

explain also why some suppliers are willing to make unilateral commitments in the form of relationship-specific investments (Kang et al., 2009). In this regard, Kang et al.'s (2009) recent work, analyzing why OEM suppliers make unilateral relationship-specific investments without economic safeguards, found that they are more likely to do so when: (i) transactional hazards are mitigated, and (ii) the investment yields sufficient economic values for other transactions with the same exchange partner and for third-party transactions. Thus, from the client's side, these intangible relationship-specific investments can generate negative knowledge spillovers, as they provide room for undesired knowledge transfers between its provider and third parties. As a consequence, the positive effect intangible relationship-specific investments may have on the governance of the agreement is reduced because the shadow of the future when outsourcing customized R&D services is smaller, as it is more difficult to expand the relationship. In fact, these agreements may evolve towards what Hamel (1991) calls learning races. In these races, each firm tries to speed up its learning rate in order to be the first partner capable of leaving the agreement, and in this way becomes the one with the strongest competitive position. In this case, the risk involved will be so high that partners will not be able to rely on trust. Although partners can develop complex contracts when self-enforcing safeguards are not effective (Reuer and Ariño, 2007), the effectiveness of intangible relationship-specific investments on performance will be lower when outsourcing very customized services—as the information exchanged may increase partners' incentives to speed up their learning and abandon the agreement (Khanna, Gulati, and Nohria, 1998). Thus, because firms within an R&D outsourcing agreement may compete and cooperate at the same time, the potential enjoyed by each firm for opportunistic post-agreement development in competition with its estwhile partner will crucially affect its

behavior within the agreement leading in all probability to suboptimal behavior in learning agreements (Khanna et al. 1998).

Therefore, given the appropriability hazards and the risk of the provider becoming the firm's competitor, we propose two different hypotheses regarding the effectiveness of intangible relationship-specific investments on R&D outsourcing agreements, depending on whether the outsourced service is standardized or customized to the firm. The knowledge required in order to outsource a standardized service is not firm-specific, as one of the requisites to vertically disintegrate a value chain is the standardization and simplification of the information needed for the exchange (Jacobides, 2005). Thus, the knowledge transferred in standardized services is expected to have a low strategic value and to remain outside the firms' core competences. As a consequence, the fact of making these intangible or "soft" relationally oriented investments aimed at improving communication and knowledge transfer between partners is not expected to lead to important negative spillover effects. In this context, we expect these investments to constitute an effective contribution to the firm's goal-fulfillment, as the drawbacks of sharing the knowledge required to perform the activity will be low compared to the benefits the firm may obtained as a result of governance improvements. However, we expect that when the outsourced service is customized to the firm, thus requiring the transfer of more valuable and strategic technological knowledge, intangible relationship-specific investments may generate important appropriability hazards for the firm, conducting to lower levels of goal-fulfillment within the outsourcing agreement. Hence, we hypothesize that:

H1. Intangible relationship-specific investments will lead to higher levels of performance in R&D outsourcing agreements when the R&D service outsourced is standardized.

H2. The positive effect of intangible relationship-specific investments on the performance of R&D outsourcing agreements will be reduced as the degree of customization of the outsourced R&D service increases, becoming negative for the highest levels of customization.

DATA AND METHODS

Research Setting and Data

We obtained data on R&D outsourcing agreements through a mail survey conducted on a sample of firms competing in R&D-intensive industries. The targeted population was companies headquartered in the U.S. and the European Union (EU) with more than 100 employees and whose 2-digit SIC code was one of the five defined in the OECD classification as technology-intensive industries: (28) chemicals and allied products, (35) transportation equipment, (36) computers and electronics, (37) industrial machinery, and (38) analysis and measurement equipment. We stratified the sample according to industry and firm size to ensure external validity using both the domestic and international versions of the *Dun & Bradstreet Million Dollar Database,* which spans all industries providing information on companies with $1 million, or more in sales, or 20 or more employees. Using these criteria, we obtained a list of 3,529 U.S. firms and 3,375 EU firms. From these lists, we randomly selected stratified samples of 2,000 firms from the U.S. and 2,000 from the EU. As mentioned above, efficiently managing R&D plays a crucial role in the competitive strategy of these industries, so we expect these firms

to undertake efforts in order to achieve superior performance in their R&D outsourcing agreements worldwide.

In order to better understand the R&D outsourcing phenomenon and develop a more comprehensive questionnaire, we conducted interviews with the heads of Technology and Innovation of a large US-based multinational company. Furthermore, the questionnaire was pre-tested on 7 R&D managers located in different countries. Due to the international nature of the targeted population the questionnaire was translated into five languages: English, French, Italian, Spanish, and German. Given the different sizes and industries included in our targeted population, the questionnaire was mailed to the firm's CEO along with a request to pass it on to the head of R&D or technology if desired. We also made all of the versions of the questionnaire available on the Internet. The returned questionnaires were filled out by senior managers, namely, CEOs, VPs, heads of R&D or heads of technology or engineering departments.

We followed the principles of the Total Design Method (Dillman, 1978). A total of 105 completed questionnaires were received from the first mailing in July 2006. A second mailing was sent three months later and an additional 33 questionnaires were received. 303 mailings were returned as undeliverable (197 for the U.S. and 106 for the EU). After a telephone follow-up process, 44 extra questionnaire replies were collected. We thus obtained a final sample of 182 usable responses (81 for the U.S. and 101 for the EU). After excluding the undeliverable addresses, our response rates were 4.5 % for the U.S. and 5.3% for the EU. It must be noted that cross-national mail surveys aiming at an industrial population generate very low response rates, normally similar to the ones obtained in this study (see for instance, Yip and Dempster, 2005). In

addition, in an international context there are virtually no alternatives to mail surveys if more than a couple of countries are included (Harzing, 2000). The 182 responses obtained are representative of the spectrum of firms in terms of industry, country of origin, and firm size (see table A1 in the Appendix for the distribution by firm, country of origin, and industry). Besides this, we compared the responses from first mailing and those from the second but we found no significant differences at the 95% confidence level between early and late respondents in terms of firm size or the decision to outsource R&D. We thus conclude that a significant non-respondent bias is unlikely.

We asked firms to indicate which R&D service activities they were outsourcing from a comprehensive list of twelve, and where. The R&D services included on the list are basic or fundamental research, applied or experimental research, development of new products or new or improved processes, product design, design of technology processes and engineering systems, architectural services, software development, scientific and technical support consulting services, software implementation services, and testing and analysis services. Given this list, 108 of the 182 firms outsource R&D services (60% of our sample). Due to the fact that 96 of the 108 firms outsourcing R&D indicated that they were outsourcing more than one type of R&D service, and in order to be able to focus our study on a specific outsourcing relationship for each of the firms in our sample, we asked these firms to identify the type of R&D service that the company was outsourcing regularly, representative of the R&D activities carried out by the company (in terms of resources compromised and volume being contracted) from the range of different R&D services outsourced, according to its strategic importance. By focusing on these agreements we can analyze the most strategically important R&D agreements within the firm strategy more

precisely. Missing data on some of the variables reduced the sample to 170 usable questionnaires, with 96 of the firms reporting to be outsourcing one or more R&D services.

Because our dependent and some independent variables were obtained using the same survey instrument, our results may be affected by common-method bias. In order to deal with this issue, we used the procedural remedies related to questionnaire design suggested by Podsakoff, MacKnenzie and Podsakoff (2003). First, we guaranteed response anonymity and we did not reveal to respondents the exact goal of the survey. Second, the questionnaire items related to the dependent variable followed, rather than preceded, the independent variables. Third, the data used for some independent variables do not come from the survey. Lastly, in order to address the issue of common-method bias statistically, we performed Harman's single-factor test (Harman, 1967). This technique consists in loading all of the variables in the study into an exploratory factor analysis, and examining the unrotated factor solution to determine the number of factors necessary to account for the variance in the data. Consequently, if there is a significant amount of common-method bias in the data a single factor will emerge from the factor analysis, or one general factor will account for the majority of the covariance among the measures. Unrotated factor analysis using eigenvalue-greater-than-one criterion revealed seven factors accounting for 69.6% of the variance, with the first factor accounting for only 21.2% of the variance, thus suggesting the absence of common-method bias.

Method of Analysis

It is important to note that because the R&D outsourcing decision represents a choice variable not randomly assigned across the sample, our analysis is susceptible to self-selection bias. In this

regard, a problem may arise if we analyze the influence of relationship-specific investments on the performance of outsourcing agreements, as the observed performance may be conditional upon unobserved variables influencing the decision to outsource. In order to assess and correct for self-selection bias, we used the standard two-stage technique to identify and treat self-selection (Heckman, 1978, 1979), which consists in re-estimating regression coefficients by introducing an adjustment term in the second-stage performance model (i.e. the inverse Mills ratio). This approach enables us to obtain consistent and unbiased estimates in the second-stage regression model (Greene, 1997; Leiblein, Reuer and Dalsace, 2002; Shaver, 1998). We implemented this Heckman two-stage regression model in STATA.

Measures

Stage 1: Outsourcing decision selection

The dependent variable in the first-stage model, *OUTSOURCING*, takes a value of one when the firm outsources any R&D service either to providers located at the home country or abroad, and zero otherwise. We included several independent variables. First, as an indicator of the firm's valuable technological resources and capabilities, we use the number of patents assigned to the firm until the end of 2006 (*PATENTS)*, as recorded by the United States Patent and Trademark Office, UPSTO). Second, in order to analyze the effect of the strength of intellectual property rights in the firm's home country we used the index of protection of intellectual property rights (IPR) developed by Ginarte and Park (1997), and updated by Park for the year 2000. This index has been widely used in the literature. It assigns a value from 0 to 5 to each country depending on its national patent legal system (value 5 indicating maximum protection). The relative superiority of this index compared to other alternative measures is due to the fact that this index

is more detailed what leads to a greater variability of the index both among countries and time. We took the value of the index for the firm's country of origin as their home country is usually the first option to outsource.

In addition to this, in this first-stage we introduced the following control variables. First, in order to control for the importance of the R&D department within the firm's competitive strategy, we asked firms to indicate which of the following four statements best applied to their company: (1) "R&D activities represent the basis of our company's competitive strategy, so research guides the actions of the remaining areas or departments"; (2) "The R&D department must support our company's competitive strategy, so it must coordinate and align its objectives and actions with the other departments"; (3) "The R&D department must be effective and competitive but it operates very independently to the other departments"; and (4) "Our company considers that the R&D department has no influence on the company's competitiveness and just buy the technologies available in the market". We created a dummy variable (*R&D STRATEGY*) coded one if the R&D activities represent the basis of the company's competitive strategy, so research guides the actions of the remaining areas or departments in the company, and zero otherwise. Second, in order to control for firm size we used sales during 2005 in dollars (*FIRM SIZE*). We also ran models using the number of employees as an alternative measure of firm size, and we obtained comparable results.

Stage 2: Level of performance achieved in the outsourcing relationship.

The dependent variable in the second-stage model, *PERFORMANCE,* measures the level of performance achieved in the outsourcing relationship with the outside provider. In order to code

this variable we used perceptual measures of performance. Research shows that subjective measures of performance are well correlated with objective measures (Dess and Robinson, 1984; Geringer and Hebert, 1991), especially when respondents are top managers (Krishnan and Martin, 2006; Olk, 2002). Using a Likert scale from 1 (low) to 5 (high) , we asked firms to rate the degree to which the firm achieved the following seven goals in the outsourcing relationship with the main supplier for the R&D service being analyzed: (1) increased flexibility, (2) cut production costs, (3) cut administrative and management costs, (4) faster access to markets, (5) increased service quality levels, (6) increased firm performance due to a greater concentration of resources to the development of its core activities, and (7) reduction of time-to-market. Thus, these seven items represent the different production objectives traditionally considered in the literature. The seven measures were averaged for each firm to create a composite performance index (Cronbach's alpha=0.7).

Our independent variables were constructed as follows: First, in order to measure the degree to which the human and physical assets required to perform the R&D service were custom-tailored to the firm we developed the variable *CUSTOMIZED SERVICE*. In order to develop this variable we used a Likert scale from 1 (low) to 5 (high) and asked firms to indicate their level of agreement with three statements related to the attributes of the R&D service they were outsourcing. To do so we used three items adapted from Poppo and Zenger's (1998) work. Our interitem reliability was also very high (Cronbach's alpha= 0.886) so we combined these three items to represent our construct: (1) Individuals must acquire company-specific or division-specific information to perform the service adequately; (2) The service is custom-tailored to the company; (3) Switching provider would be costly (i.e. time required to locate, qualify, train,

make investments, conduct testing, develop a working relationship…). Second, in order to measure the level of relationship-specific investments made by the parties to the outsourcing agreement we developed two different variables: one to account for tangible relationship-specific investments and one to account for intangible ones. On the one hand, to capture the level of physical investments made by the supplier in order to adapt plants and equipment to the specific requirements of the company we introduced the *TANGIBLE INVESTMENTS* variable. In order to develop this variable we used a Likert scale from 1 (low) to 5 (high) and asked firms to indicate their level of agreement with three statements related to their outsourcing relationship with the main provider for the R&D service being analyzed: (1) "The supplier made important investments to adapt its plant and facilities to the specific requirements of our company"; (2) "The supplier increased its capacity in order to work for our company"; (3) "The supplier has set up new facilities or plants near to some of our production plants". These three items measure Williamson's (1985) dimensions of physical specific investments. The interitem reliability was quite high (Cronbach's alpha= 0.742), and hence these items were combined to represent our variable. On the other hand, to account for those relationship-specific investments in human resources, skills, and organization aimed at facilitating knowledge transfer between the partners as well as to develop a trustful relationship we introduced the variable *INTANGIBLE INVESTMENTS*. In order to develop this measure we again used a Likert scale from 1 (low) to 5 (high) and asked firms to indicate their agreement with five statements related to their outsourcing relationship: (1) "The supplier incurred in high costs in training its staff to meet the specific requirements of our company"; (2) "The supplier has always shown its commitment to our firm"; (3) "The supplier has invested in developing knowledge-sharing routines with our company"; (4) "A high level of personnel transfer exists between the supplier and our company";

and (5) "The supplier is willing to share their knowledge with our company." The inter-item reliability was above 0.7 (Cronbach's alpha= 0.702) so these items were combined to represent our construct. These items measures investments in specific human capital (Williamson, 1985), as well as relationship-development specific investments (Dyer and Singh, 1998; Kang et al., 2009; Levinthal and Fichman, 1988; Madhok and Tallman, 1998).

We introduced the following control variables in all regressions. We created the dummy variable *INTERNATIONAL NON-OECD PROVIDER* to account for the contractual costs arising due to the nature of the activity in connection with the outside provider's location (Kobrin, 1987; Hill, Hwang and Kim, 1990). This variable is coded as one if the provider of the R&D service is located in a non-OECD country, and zero otherwise. We also introduced *INTERNATIONAL OECD PROVIDER* coded as one if the service provider is located abroad but within a country belonging to the OECD. Domestic providers act as the reference category for these two dummy variables.

In order to reduce biases stemming from the longevity of the relationship being analyzed, we introduced a variable (*RELATIONSHIP TENURE*) which controls for the year the firm first signed a contract with the R&D service provider. Furthermore, as Madhok (1996) suggested two main ways to govern alliances, trust and formal control, we created a dummy variable (*SAFEGUARDS*) to proxy for the existence of control mechanisms. This variable is coded as one when the outsourcing agreement involves a joint-venture between the firm and the service provider, a long term agreement, or a relational contract, and zero otherwise. In order to account for other sources of firm heterogeneity, we added the following control variables in both stages

of the regression model. We introduced a dummy variable (*FIRM ORIGIN*) coded as one if the firm region of origin is the European Union and 0 if it is the US. Finally, we introduced four dummies to control for the industry (*SIC 28, SIC 36, SIC 37, SIC 38*), omitting SIC 35.

RESULTS

Table 1 shows correlations and descriptive statistics for all variables used in the first-stage, and table 2 for those used in the second-stage. Most correlations are low. Given the high correlation between the interaction terms and the main effects, we mean-centered the continuous variable PATENTS before calculating the interactions (Jaccard and Turrisi, 2003). We also used the mean-centered transformation of this variable in the second-stage estimation.

First-stage outsourcing decision estimates

Table 3 reports maximum-likelihood estimates for the outsourcing decision probit model. Although the main purpose of this model is to account for endogeneity, some interesting results can be highlighted.

The results reported in Table 3 lend support to the resource-based view of alliances and to the role of contractual hazards in governance decisions (Leiblein and Miller, 2003; Mayer and Salomon, 2006). First, the results indicate that the net effect of PATENTS is dependent on the value of the variable IPR. In this regard, from the analyses of the interaction term in, in figure 2 we have represented the net effect of PATENTS considering that the variable IPR takes the minimum, mean and maximum values. PATENTS exert a positive and statistically significant effect on the decision to outsource only when the IPR protection system is strong. This suggests

that valuable technological capabilities improve the firm's ability to govern transactions, increasing the likelihood of outsourcing R&D services. This finding is consistent with Mayer and Salomon's (2006) work. However, when the IPR protection system is weak, or not strong enough, the net effect of PATENTS is negative and significant, showing that in countries with weak protections, firms possessing valuable technological capabilities are reluctant to outsource R&D services in order to protect them.

The positive and significant interaction effect of PATENTS and R&D STRATEGY ($p<0.001$) indicates that firms with valuable technological resources and for whom R&D activities represent the basis of the company's competitive strategy are more likely to outsource R&D services. This suggests that these firms may feel more pressure to efficiently manage their R&D activities in order to remain competitive, thus increasing firms' propensity to outsource those R&D services which can be performed more efficiently by a specialized provider.

Second-stage performance estimates

Table 4 reports the results of our performance models controlling for self-selection into outsourcing arrangements using four different specifications. Model I provides a specification with only the intercept term and control variables. Model II presents control and independent variables. Model III adds the interaction effect for INTANGIBLE INVESTMENTS and CUSTOMIZED SERVICE. Model IV adds the interaction effect for TANGIBLE INVESTMENTS and CUSTOMIZED SERVICE. As expected, an F-test of the null hypothesis that all the coefficients are jointly zero is rejected in all models ($p<0.001$). In addition to this, we find that the estimated coefficients for the inverse Mill's ratio (lambda) in all models are

significant ($p< 0.05$) indicating that our analyses are affected by self-selection. Consequently, the use of Heckman's (1976, 1978, 1979) two-stage regression technique is justified in our sample.

The significant and positive coefficient of INTANGIBLE INVESTMENTS in models IV and V ($p<0.05$) supports hypothesis 1. Intangible relationship-specific investments appear to contribute to achieving better performance results for standardized services (low values of CUSTOMIZED SERVICE). However, the interaction term in model IV and V INTANGIBLE INVESTMENTS*CUSTOMIZED SERVICE is negative and highly significant ($p<0.05$) so, according to our hypothesis 2, our results indicate that the net effect of INTANGIBLE INVESTMENTS is dependent on the level of customization of the R&D service being outsourced. Because these two variables are continuous —INTANGIBLE INVESTMENTS ranges from 1 to 4.4 and the variable CUSTOMIZED SERVICE ranges from 1 to 5— in figure 3 we have represented the marginal effect of intangible relationship-specific investments on the performance achieved in the R&D outsourcing agreements for different levels of service firm-specificity, i.e. when the variable CUSTOMIZED SERVICE takes the minimum (1), median (3.35) and maximum (5) value. From the graph, it seems that the more customized the service, the lower the effectiveness of the intangible relationship-specific investments. In particular, we observe that intangible investments seem to contribute to obtaining superior performance when the service is standardized, although this relation does not hold when the service is closely customized to the firm. In fact, for the highest values of customized services, that is for values higher than 4.32 (value taken in 29 cases) the net impact of INTANGIBLE INVESTMENTS is negative. This result can be attributed to the additional difficulties firms must face in order to effectively manage partnerships when customized activities are involved.

As regards the control variables, the level of tangible relationship-specific investments does not seem to determine the level of goal fulfillment within the relationship, as neither the variable TANGIBLE INVESTMENTS nor the interaction term TANGIBLE INVESTMENTS*CUSTOMIZED SERVICE are significant in our models. Regarding other control variables, none of them seem to have a significant effect on performance.

DISCUSSION AND CONCLUSION

Although previous research has highlighted the positive contribution of relationship-specific investments to the performance of buyer-supplier agreements and strategic alliances, recent evidence casts some doubts on the real impact of these investments on the performance of agreements exhibiting high risks of opportunism. While studies on the impact of relationship-specific investments on outsourcing agreements performance have focused mainly on hold-up hazards, we wanted to highlight the role of appropriability hazards, hence our distinction between tangible and intangible relationship-specific investments. We have argued that intangible relationship-specific investments facilitate the governance of the agreement while also increasing appropriability hazards. For this reason, we proposed that the positive effect intangible relationship-specific investments may have on the performance of outsourcing agreements would turn to a negative impact as the degree of customization of the service increased.

The empirical results confirmed our hypotheses. For standardized R&D services, intangible relationship-specific investments increase the performance of outsourcing agreements. This

result is consistent with the findings of previous studies showing that relationship-specific investments in other types of non-R&D alliances increase performance (Asanuma, 1989; Parkhe, 1993; Saxenian, 1994; Dyer, 1996; Dyer and Singh, 1998; Zollo et al., 2002).

However, the most important result in our paper is that the positive impact of intangible relationship-specific investments on the performance of outsourcing agreements cannot be generalized to all kinds of R&D outsourcing agreements. In fact, as the degree of customization of the service increases, the net impact of these investments on the performance of the agreement is negative, confirming our hypothesis 2. Sampson's (2004b) work has shown the mediating role absorptive capacity has on appropriability hazards. By extending this insight to the field of R&D services outsourcing, our paper highlights the dark side of developing intangible relationship-specific investments, as they increase the partners' absorptive capacity and, as a consequence, the hazards of the provider taking advantage of their clients proprietary knowledge. This result complements Kang et al.'s (2009) study. In this recent study the authors' found that suppliers may make unilateral relationship-specific investments without ex ante economic safeguards as these can yield them both positive knowledge and reputation spillovers. We extended their result by finding that these positive knowledge spillovers for the supplier may act as a drawback from the buyer's perspective and, thus, detrimental to performance.

Thus, the success of these outsourcing relationships will be dependent on the capability of the firm to manage the alliance in order to avoid undesired transfers of knowledge. This finding suggests that when the risk of misappropriation of technological knowledge entails very harmful consequences in terms of being able to maintain firms' technological competitiveness, as

happens with customized R&D services, high levels of intangible relationship-specific investments provide the potential for undesired leakage of core competences to the provider. Thus, when outsourcing a specific activity related to firm's core competences managers have to be aware of the fact that making relationship-specific investments increases knowledge management complexity and intellectual property concerns, as occurs with the creation of knowledge-sharing routines. In order to get the most from relational investments, knowing how to effectively manage knowledge and these hazards within these alliances in order to prevent the leakage of valuable knowledge is crucial. Our results thus provide empirical support to Larsson's et al. (1998) argument that the way partners manage the collective learning process plays a key role in the success or failure of strategic alliances, as opportunistic learning strategies followed by partners may undercut the collective knowledge development in the alliance. Intangible relationship-specific investments may contribute to upgrading providers' technological competences, leading to a longer-term risk of the provider becoming an eventual competitor (Arruñada and Vazquez, 2006; Hennart et al, 1999). Obviously, the best way to manage these core alliances would be to develop what Kale et al. (2000) call alliance capabilities, i.e. skills that allow the firm to learn while protecting its proprietary resources. Firms having such capabilities are also prepared to make the most of outsourcing agreements for customized services, as they can protect their core knowledge and resources without damaging the functioning of the alliance.

Our theoretical analysis improves our understanding of buyer-supplier collaborative relationships in two ways. First, it extends the transaction-cost perspective to analyze the impact of relationship-specific investments on appropriability hazards. Second, it develops a more fine-grained measure of relationship-specific investments by distinguishing between tangible and

intangible relationship-specific investments. From an empirical point of view, our analysis offers evidence regarding the performance implications of R&D outsourcing agreements, analyzing separately the effectiveness of intangible relationship-specific investments.

However, our paper is not devoid of limitations. We analyzed a firm's technological capabilities as a whole by counting the cumulative number of patents, without specifying the value of those patents. We obtained a low response rate, although our respondent firms are representative of the population of firms in the selected industries. We do not control for the relative size of the provider compared to the firm, nor for the relatedness of the provider's core business to the firm's, variables which can increase or decrease the likelihood of the provider becoming the firm's competitor and consequently the level of appropriability hazards. Future research using more comprehensive data should address these limitations.

The practical and managerial relevance of our findings is that firms must carefully ponder, on the one hand, which R&D activities they decide to outsource, and, on the other, their ability to manage those agreements properly, especially the interorganizational learning process. Given competitive pressures, firms are increasingly forced to outsource to specialized providers not only non-specific functions but those more specific and strategically important to the firm's strategy. In fact, the empirical setting of our study, the outsourcing of R&D services, is a recent but ever more prevalent organizational practice which can generate valuable benefits but which also entails significant risks. Thus, learning how to efficiently manage these agreements is crucial in order to remain competitive and to make the most of outsourcing relationships.

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Table 1. First-stage descriptive statistics and correlation matrix.

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12
1. OUTSOURCING	0.53	0.49												
2. PATENTS (mean centered)	0	237	0.13											
3. IPR	4.63	0.39	0.09	0.15*										
4. PATENTS*IPR	14.22	1170.65	0.13	0.99*	0.13									
5. FIRM SIZE (in million dollars)	475	2320	0.09	0.28*	0.10	0.27*								
6. R&D STRATEGY	0.19	0.39	0.10	-0.08	-0.12	-0.08	-0.03							
7. PATENTS*R&D STRATEGY	-7.81	27.77	0.02	0.12	0.07	0.11	0.14	-0.56*						
8. FIRM ORIGIN	0.55	0.49	-0.11	-0.18*	-0.81*	-0.18*	-0.11	0.13	-0.03					
9. SIC 28	0.24	0.43	0.00	0.08	-0.16*	0.09	0.01	0.00	0.10	0.12				
10. SIC 35	0.31	0.46	-0.10	-0.03	-0.01	-0.03	-0.07	-0.10	0.02	0.01	-0.39*			
11. SIC 36	0.21	0.41	0.00	-0.02	0.08	-0.02	-0.06	0.06	-0.13	-0.08	-0.30*	-0.36*		
12. SIC 37	0.87	0.28	0.05	-0.06	0.07	-0.06	0.22*	-0.00	0.06	-0.07	-0.17*	-0.21*	-0.16*	
13. SIC 38	0.12	0.33	0.07	0.01	0.03	0.01	-0.01	0.06	-0.05	-0.02	-0.21*	-0.26*	-0.20*	-0.11

Note: (*) significant at the 5% level

Table 2. Second-stage descriptive statistics and correlation matrix

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. PERFORMANCE	3.14	0.61															
2.TANGIBLE INVESTMENTS	1.82	0.84	0.19														
3. INTANGIBLE INVESTMENTS	2.96	0.81	0.31*	0.44*													
3. CUSTOMIZED SERVICE	3.35	1.17	0.32*	0.19	0.51*												
4.TANGIBLE INVESTMENTS*CUSTOMIZED SERVICE	6.28	3.86	0.33*	0.82*	0.60*	0.65*											
5.INTANGIBLE INVESTMENTS*CUSTOMIZED SERVICE	10.43	5.54	0.33*	0.33*	0.85*	0.86*	0.70*										
6.INTERNATIONALOECD PROVIDER	0.2	0.4	-0.04	0.04	-0.08	-0.15	-0.08	-0.16									
7. INTERNATIONAK NON-OECD PROVIDER	0.17	0.37	0.10	0.13	0.22*	0.21*	0.25*	0.25*	-0.22*								
8. SAFEGUARDS	0.54	0.5	-0.01	0.54*	0.33*	0.33*	0.54*	0.39*	-0.14	0.09							
9. RELATIONSHIP TENURE	1995	10.01	-0.00	0.03	-0.01	-0.20*	-0.10	-0.15	0.03	0.10	0.02						
10. PATENTS (mean centered)	0	236.7	0.09	0.34*	0.16	0.01	0.25*	0.07	0.22*	0.12	0.05	-0.09					
11. FIRM ORIGIN	0.55	0.49	-0.10	-0.01	-0.25*	-0.16	-0.12	-0.26*	-0.09	-0.18	-0.06	-0.05	-0.18*				
12. SIC28	0.24	0.43	-0.19	0.03	-0.23*	-0.20*	-0.13	-0.27*	0.18	-0.19	0.00	-0.02	0.08	0.12			
13. SIC35	0.31	0.46	0.22*	0.09	-0.01	-0.07	0.12	-0.03	-0.12	0.21*	-0.16	0.02	-0.03	0.01	-0.39*		
14. SIC36	0.21	0.41	0.15	-0.14	0.24*	0.23*	-0.00	0.26*	0.02	-0.12	-0.06	-0.11	-0.02	-0.08	-0.30*	-0.36*	
15. SIC37	0.87	0.28	-0.05	0.12	0.06	0.02	0.11	0.07	-0.17	0.09	0.19	0.08	-0.06	-0.07	-0.17*	-0.21*	-0.16*
16. SIC38	0.12	0.33	-0.19	-0.10	-0.06	0.04	-0.08	-0.01	0.06	0.03	0.10	0.06	0.01	-0.02	-0.21*	-0.26*	-0.20*

Note: (*) significant at the 5% level

Table 3. Results of maximum-likelihood probit analysis for outsourcing decision (N=170)

Independent variables	Full model
PATENTS (mean centered)	-0.110
	(2.59)***
IPR	1.462
	(1.96)
PATENTS*IPR	0.023
	(2.67)***
R&D STRATEGY	41.993
	(3.64)***
PATENTS*R&D STRATEGY	0.713
	(3.64)***
FIRM SIZE	0.000
	(2.61)***
FIRM ORIGIN	0.057
	(0.18)
SIC28	0.312
	(1.49)
SIC36	0.311
	(1.58)
SIC37	0.325
	(1.33)
SIC38	0.411
	(1.57)
Constant	-7.282
	(1.93)*
Log pseudo-Likelihood	-109.298

Robust z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. Probit estimates for second-stage performance models (N=96)

Independent variables	Model I	Model II	Model III	Model IV
TANGIBLE INVESTMENTS		0.127	0.072	-0.146
		(1.55)	(0.87)	(0.59)
INTANGIBLE INVESTMENTS		0.101	0.706	0.808
		(0.82)	(2.42)**	(2.51)**
CUSTOMIZED SERVICE		0.147	0.575	0.545
		(1.99)**	(2.84)***	(2.75)***
INTANGIBLE INVESTMENTS*CUSTOMIZED SERVICE			-0.161	-0.187
			(2.25)**	(2.37)**
TANGIBLE INVESTMENTS*CUSTOMIZED SERVICE				0.061
				(0.92)
INTERNATIONAL OECD PROVIDER	0.015	0.026	0.009	0.020
	(0.08)	(0.16)	(0.05)	(0.11)
INTERNATIONAL NON-OECD PROVIDER	0.174	0.043	0.026	0.016
	(1.40)	(0.36)	(0.23)	(0.14)
SAFEGUARDS	0.138	-0.151	-0.108	-0.088
	(1.03)	(0.92)	(0.77)	(0.61)
RELATIONSHIP TENURE	0.004	0.009	0.004	0.004
	(0.58)	(1.10)	(0.51)	(0.53)
PATENTS (mean centered)	0.000	0.000	0.000	0.000
	(1.99)**	(1.33)	(1.15)	(1.16)
FIRM ORIGIN	-0.018	0.007	-0.035	-0.034
	(0.13)	(0.06)	(0.30)	(0.29)
SIC28	-0.380	-0.303	-0.374	-0.336
	(2.21)**	(1.74)*	(2.28)**	(1.92)*
SIC36	0.059	-0.040	-0.096	-0.066
	(0.37)	(0.24)	(0.59)	(0.42)
SIC37	-0.254	-0.215	-0.187	-0.165
	(1.11)	(1.17)	(1.10)	(0.96)
SIC38	-0.312	-0.266	-0.361	-0.332
	(1.73)*	(1.41)	(1.99)**	(1.87)*
Constant	-4.598	-15.633	-6.829	-7.007
	(0.36)	(0.96)	(0.47)	(0.49)
Lambda (λ)	0.544	0.521	0.415	0.4
	(0.216)**	(0.209)**	(0.166)**	(0.148)**
Log-pseudo likelihood	-180.123	-171.587	-169.371	-168.99
Wald X^2	16.75	42.65	66.27	71.02

Robust z statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 1. Correspondence of our typology of relationship-specific investments with Williamson's types of asset specificity & relationship-development specific investments.

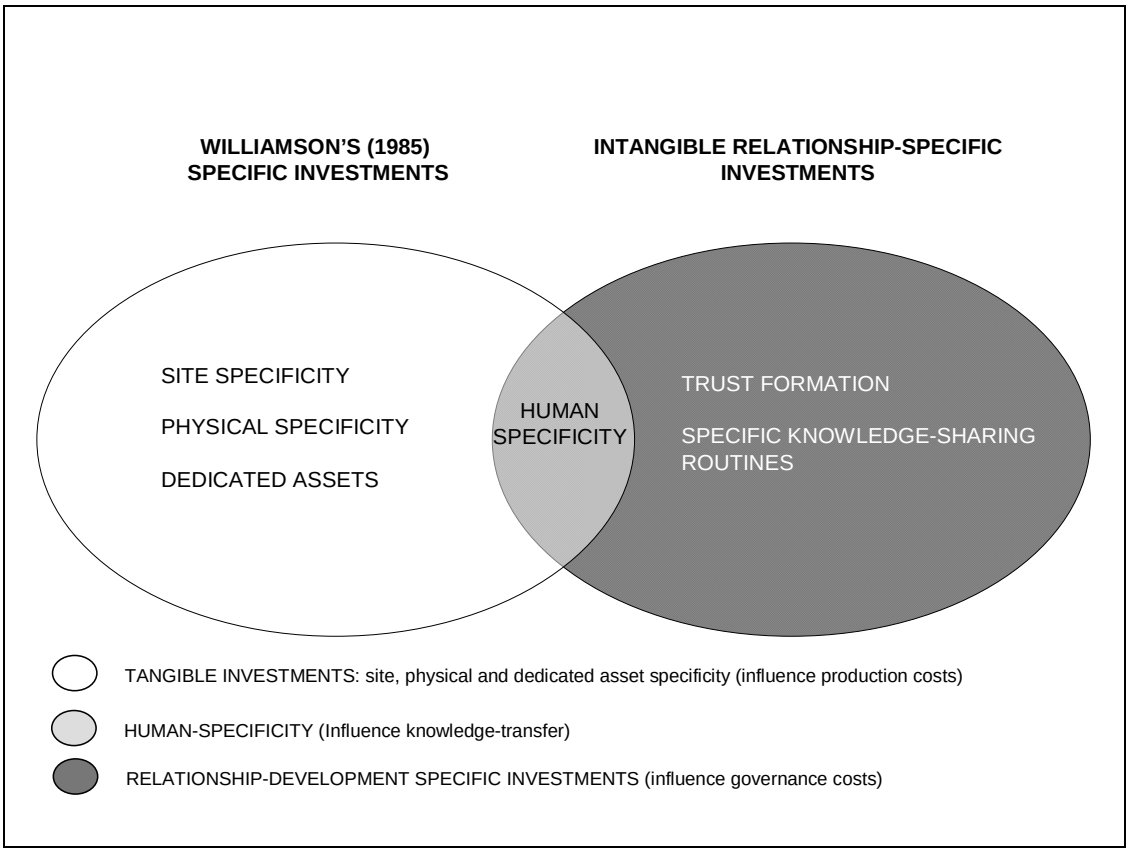
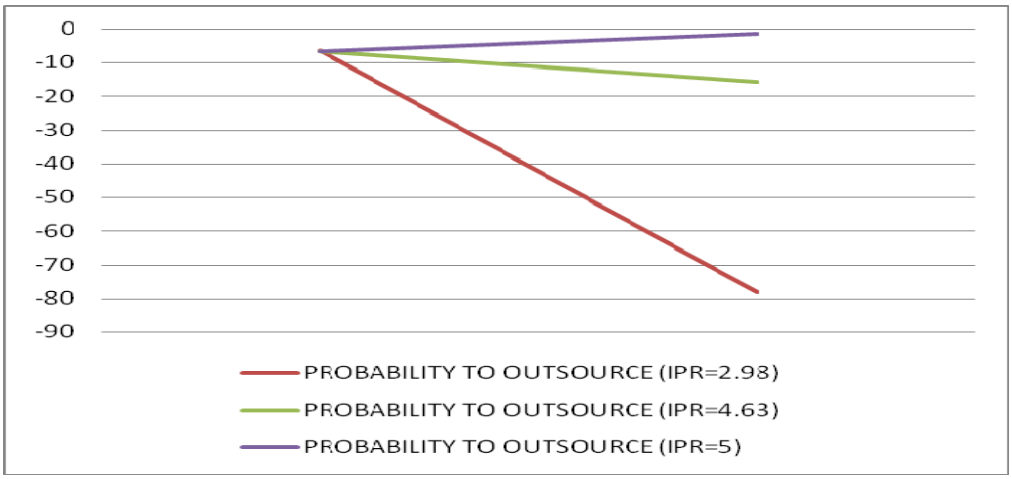
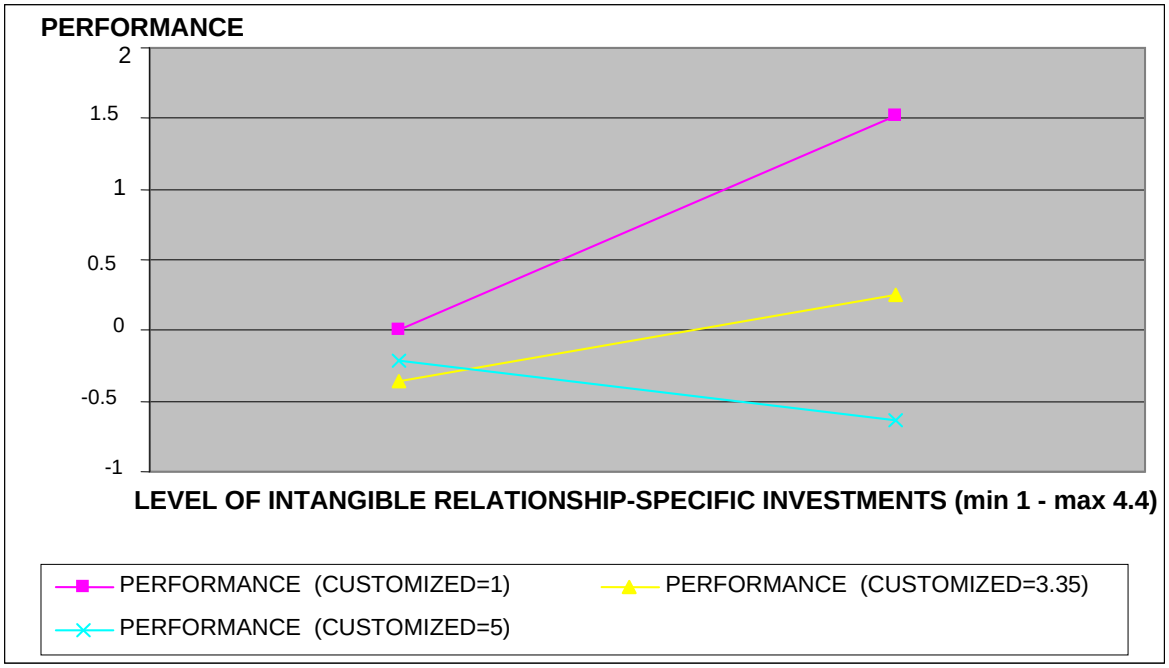


Figure 2. Net impact of PATENTS on the probability to outsource R&D services when the index IPR takes its minimum, mean, and maximum values[a].



[a] Using the estimates from Table 3. Control variables were evaluated at the sample mean.

Figure 3. Net impact of intangible relationship-specific investments on the performance of R&D outsourcing agreements when the variable CUSTOMIZED SERVICE takes its minimum, mean, and maximum values [a].



[a] Using the estimates from Model IV in Table 4. Control variables were evaluated at the sample mean.

APPENDIX

Table A1. Distribution of survey responses by country of origin and industry.

		Mailed		Received	
		Number	%	Number	%
COUNTRY	U.S.	2000	*50%*	81	*4.05%*
	European Union	2000	*50%*	101	*5.05%*
	Austria	56	*2.80%*	2	*1.98%*
	Belgium	25	*1.25%*	2	*1.98%*
	Czech Republic	20	*1%*	1	*0.99%*
	Denmark	23	*1.15%*	0	*0%*
	Finland	32	*1.60%*	0	*0%*
	France	221	*11.05%*	9	*8.91%*
	Germany	617	*30.85%*	24	*23.76%*
	Greece	2	*0.10%*	2	*1.98%*
	Ireland	17	*0.85%*	0	*0%*
	Italy	507	*25.35%*	32	*31.68%*
	Luxembourg	1	*0.05%*	0	*0%*
	Poland	37	*1.85%*	3	*2.97%*
	Portugal	13	*0.65%*	1	*0.99%*
	Spain	93	*4.65%*	9	*8.91%*
	Sweden	42	*2.10%*	3	*2.97%*
	The Netherlands	21	*1.05%*	1	*0.99%*
	UK	249	*12.45%*	12	*11.88%*
	East Europe	24	*1.2%*	0	*0%*
INDUSTRY	SIC 28 (Chemicals)	760	*19%*	45	*24.7%*
	SIC 35 (Transportation Eq.)	1357	*33.93%*	58	*31.9%*
	SIC 36 (Electronics)	947	*23.68%*	40	*22%*
	SIC 37 (Machinery)	487	*12.18%*	16	*8.8%*
	SIC 38 (Measurement Eq.)	449	*11.23%*	23	*12.6%*

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