R&D MANAGEMENT

The framing of knowledge transfers to shared R&D suppliers and its impact on innovation performance: a regulatory focus perspective

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When outsourcing research and development (R&D) services, fears of knowledge leakage can make client firms reluctant to transfer knowledge to their suppliers, even at the cost of reducing the performance of the agreement. Outsourcing to R&D suppliers shared with competitors ensures relying on refined capabilities due to the aggregation of the demands of related clients, but also aggravates this interorganizational learning dilemma. Taking a regulatory focus perspective, we argue that the client's commitment to the process of knowledge transfer with a shared supplier will depend on whether the relationship is framed with a promotion or a prevention focus. Using primary data at the transaction level from a survey conducted among 170 European and US technological firms, we find that sharing suppliers with competitors only boosts the client's innovative performance when outsourcing R&D services that do not require the transfer of tacit and firm-specific knowledge. Otherwise, the appropriability hazards involved will make the firm frame the relationship with a prevention focus limiting the client's ability to achieve its innovation objectives.

1. Introduction

As firms become more dependent on tapping the resources of external partners, both effective knowledge management and strategic partner selection become critical for firms to sustain its competitive advantage (Spencer, 2003; Neyer et al., 2009; Bessant et al., 2012). In particular, firms are increasingly relying on external suppliers to perform some processes or functions of their innovation process, giving way to the phenomenon of research and development (R&D) outsourcing agreements[1] (Hsuan and Mahnke, 2011; Stanko and Calantone, 2011). As happens with other types of R&D alliances, firms outsourcing R&D services have to face the so-called interorganizational learning dilemma (ILD) (Larsson et al., 1998). That is, although knowledge sharing and joint problem solving have been found to be beneficial for the success of strategic alliances (Chesbrough, 2003; Fey and Birkinshaw, 2005; Hoetker, 2005);

extensive knowledge sharing with suppliers may put the client firm on the verge of losing competitive edge due to knowledge leakages (Kale et al. 2000; Lado et al., 2008; Martinez-Noya et al., 2013).

Although this dilemma is also present when outsourcing manufacturing activities, overcoming this dilemma is much more complicated when considering R&D activities (Howells et al., 2008; Ho, 2009) because, given their nature, they generate higher appropriability hazards, that is, the risk of opportunism based on inadequate uses or modifications of the technology and knowledge transferred, not intended in the contract, and injurious to the transferor (Oxley, 1997). Therefore, when outsourcing these services, clients face the challenge of finding an adequate balance between maintaining the necessary knowledge exchange to achieve the alliance objectives, and avoiding the unintended leakage of valuable technology (Oxley and Sampson, 2004; Grimpe and Kaiser, 2010; Alcácer and Oxley, 2014; Ritala et al., 2015). Sharing R&D suppliers with competitors aggravates this ILD. Overall, two main benefits may arise from sharing suppliers with rivals. The most obvious are the economies of scale and scope stemming from the aggregation of demands from clients of the same industry (Williamson, 1985). In addition, clients can benefit from spillover effects stemming from competitors as suppliers have been found to become a hub for knowledge transfer (Ahuja, 2000). Indeed, there is evidence showing that there are firms which actively search for suppliers or customers that also deal with competitors to take advantage of these potential sources of knowledge spillovers (Alcácer and Chung, 2007). However, this second benefit is less obvious as knowledge spillovers are a two-way street and suppliers can leak (either intentionally or not) sensitive strategic information from one client to another. Therefore, as not all firms react in the same way to the problem of knowledge sharing when having shared suppliers, nor obtain the same performance levels, this article addresses the following research question: how does sharing R&D suppliers with competitors affect the client's innovative performance?

We adopt a regulatory focus (Higgins, 1997, 1998) to analyze this research question, because a firm's reluctance to share information with its supplier, and consequently to put in danger the performance of the alliance, can be conditioned by cognitive biases. We argue that the appropriability hazards perceived by the client will determine whether the relationship is framed with a promotion focus (e.g., outsourcing emphasizing achievement and the pursuit of gains) or a prevention focus (e.g., outsourcing emphasizing safety and the avoidance of losses); which ultimately affects its commitment to knowledge transfer and, thus, its innovation accomplishments. Original survey data at the transaction level from 170 European and US technology-intensive firms offer support for our hypotheses.

2. Theoretical background and hypotheses

Regulatory focus theory suggests that individuals differ in how they approach and pursue goals, either focusing on achieving positive outcomes – a promotion focus – or on avoiding negative outcomes – a prevention focus – (Higgins, 1998). For individuals with a promotion focus, self-regulation concentrates on the importance of 'accomplishments, hopes, and aspirations', whereas for those with a prevention focus self-regulation highlights the importance of 'safety, responsibilities, and obligations' (Higgins, 1998, p. 16). In this sense, extant literature has emerged showing how different regulatory focuses directly induce different emotions, behaviors, and expectations; not only at the individual level (Liberman et al., 1999; Higgins et al., 2001), but also in exchange relationships (Das and Kumar, 2011; Weber and Mayer, 2011; Weber et al., 2011). A prevention focus induces vigilant behavior within an exchange in an effort to meet the minimal goal and avoid losses, whereas a promotion focus induces greater creativity and flexibility so as to meet the maximal goal. It should be noted that although 'regulatory focus' is a microlevel concept, it has been shown to also influence macrolevel behavior (Das and Kumar, 2011). As demonstrated by Levine et al. (2000), the members of a group tend to converge in their strategic orientations for solving problems, especially when it comes to riskiness and conservatism. Thus, even if R&D outsourcing decisions are made by a group of boundary spanners, they will tend to converge on a regulatory focus. Thus, we posit that firm decision makers may frame an outsourcing agreement with either a promotion or a prevention focus. We also argue that this framing will influence the firm willingness to transfer knowledge and, therefore, the innovative outcomes of the agreement. In those agreements framed with a promotion focus, the client firm will be eager to share information and new ideas and, thus, more proactive and willing to take risks to achieve the expected outcomes. In those framed with a prevention focus, the client will be much more cautious in sharing information, especially if this can be commercially exploited by its partner, because it will be very concerned about preventing any loss (Das and Kumar, 2011).

Based on this, we posit that clients sharing R&D suppliers with competitors may frame positively (promotion focus) or negatively (prevention focus) the outsourcing agreement depending on the type of knowledge that they need to transfer to the supplier so as to adequately perform the service. This is so because level of tacitness and specificity of the knowledge to be transferred will determine the client's perception of risk of outgoing knowledge spillovers within the agreement and the size of the loss if leakage occurs. Therefore, when outsourcing R&D services to shared suppliers, we expect the client's commitment to the process of knowledge transfer and, thus, its ability to achieve its innovation goals to coevolve depending on how the relationship is framed.

2.1. *Interfirm knowledge flows, shared suppliers, and innovation*

In general terms, we expect sharing suppliers with competitors to be negatively framed by the client, leading to the adoption of a prevention focus in the relationship. This is so because, on the one hand, innovation is considered as a high-value adding activity within a firm's value chain, and, for this reason, a key part of the firm's competitive strategy (Chandler, 1990). And, on the other hand, R&D activities usually require the exchange of tacit and firm-specific knowledge, which is difficult to codify and as a result better transferred in close face-to-face interaction (Cantwell and Santangelo, 1999). This tacitness of the knowledge involved implies that it is very difficult for the client firm to establish knowledge transfer barriers, as property rights are likely to be ineffective in this case (Narula, 2001). In addition, the higher the transfer of this type of knowledge, the more likely the client will need to assist the supplier in improving its understanding of the tacit knowledge, which may ultimately increase appropriability hazards (Mudambi and Tallman, 2010). Given the hazards involved when transferring this kind of knowledge, we expect that sharing suppliers will increase the client's fears of knowledge leakage. It should be noted that when transferring this kind of knowledge, the provider is getting closer enough to its client not only to understand the codified and observable components of the client's capabilities, but also the more tacit components: what Lane and Lubatkin (1998, p. 463) call the 'how and why' knowledge. In fact, it is indeed for this higher absorptive capacity or receptiveness on the side of the supplier of the knowledge being transferred that the higher opportunities for knowledge creation and innovation emerge (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998).

Previous research confirms that firms are less likely to establish relationships with their competitors' partners if their relationship requires significant cospecialization (Gimeno, 2004). When they do form these relationships, the perceived potential of knowledge leakage by the client discourages it from sharing information along the supply chain (Li, 2002). For these reasons, we argue that sharing suppliers with competitors is expected to induce a prevention focus behavior on the side of the client. As a consequence, the client will reduce its transparency with the aim of limiting learning opportunities available to its suppliers, irrespective of the potential benefits associated with knowledge sharing with a supplier offering upgraded capabilities. Accordingly, we state that:

H1: The R&D supplier also having contracts with competitors will impede the client fulfilling its expected outsourcing innovation objectives.

2.2. *The moderating role of information standardization*

Not all scenarios of sharing suppliers with competitors can be considered negative. In fact, knowledge transfer spillovers are a two-way street; so outgoing spillovers need to be compared with incoming ones. On this basis, we argue that the degree of standardization of the outsourced R&D services will condition the regulatory focus adopted by the client. Standardized services, requiring low levels of client-specific and tacit knowledge, are not expected to generate severe leakage problems. In these cases, knowledge transfer barriers can be easily defined. In addition, coordination costs decrease, as there is a lower need to understand the client's idiosyncratic needs (Weigelt and Sarkar, 2012). Under this scenario, there are only advantages in outsourcing R&D to an established player within the industry with a broad customer base because the company can benefit from the specialization of the supplier without worrying about appropriability hazards (Oxley and Sampson, 2004; Janowicz-Panjaitan and Noorderhaven, 2009). As a consequence, we expect the client to frame the relationship with a promotion focus when outsourcing this type of services to shared suppliers. This is so because the broader client base on the side of the supplier may not be perceived as a disadvantage, but instead as a source of incoming spillover effects. Thus, we state that:

H2: The R&D supplier also having contracts with competitors will enhance the client's ability to fulfill its expected outsourcing innovation objectives

when outsourcing services requiring standardized information.

3. Data and methods

3.1. Research setting and data

We conducted a mail survey on a sample of US and European Union firms with more than 100 employees, and whose two-digit SIC codes were included in the Organisation for Economic Co-operation and Development (OECD) classification of technology-intensive industries (OECD, 1997): chemicals and allied products (28); transportation equipment (35); computers and electronics (36); industrial machinery (37); and analysis and measurement equipment (38). We selected these industries because in them innovative performance is a critical factors of a firm's competitiveness (OECD, 1997; Hagedoorn and Cloodt, 2003). We stratified the sample according to industry, country of origin, and firm size to ensure external validity using the *Dun and Bradstreet Million Dollar Database* (see Table A1). To overcome the problems associated with the key informant approach, we developed the survey in several stages. First, to develop a comprehensive questionnaire, we conducted interviews with the heads of technology and innovation of a large US-based multinational. Second, we reviewed the literature to identify relevant scale items for the concepts we wanted to measure. Finally, to avoid misunderstandings due to the international nature of the targeted population, the questionnaire was pretested on seven R&D managers located in different countries and written in five languages: English, French, German, Italian, and Spanish.[2] The questionnaire was mailed in 2006 to the firm's Chief Executive Officer (CEO) along with a request to pass it onto the head of R&D or technology if desired. The returned questionnaires were filled out by senior managers, namely CEOs, VPs, and heads of R&D or technology or engineering departments. After following the principles of the Total Design Method (Dillman, 1978), a total of 105 completed questionnaires were received from the first stratified mailing in July 2006. A second stratified mailing was sent 3 months later and an additional 33 questionnaires were received, 303 mailings being returned as undeliverable. After a telephone follow-up process, we obtained a final sample of 182 usable responses (81 for the United States and 101 for the EU). After excluding the undeliverable addresses, our response rates were 4.5% for the United States and 5.3% for the EU. Despite the low response rate, due to our strategy of launching a massive mailing, 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 A). Besides this, we compared the responses from the first mailing with those from the second, but found no significant differences at the 95% confidence level between early and late respondents in terms of all the variables used. We also run analyses to test whether there were differences in terms of country of origin, firm size, or industry between the respondents and nonrespondents but, again, significant differences were not found.

We asked firms to indicate which R&D service activities they outsourced from a comprehensive list, and where. After an exhaustive literature review of different sources and statistical reports on R&D, we identified a list of R&D services that could potentially be outsourced by technology-intensive firms in the selected industries. This list was refined with the help of a consulting firm and seven R&D managers. Given this list, 108 of the 182 firms declared to outsource R&D services, and 96 of those 108 firms outsourcing R&D indicated that they were outsourcing more than one type of service. To focus our study on a specific outsourcing relationship for each of the firms in our sample, we asked them to identify from the range of different services outsourced, '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)'. Once identified, each firm had to indicate the supplier of this service and several details of the agreement. Therefore, this question allowed us to analyze the performance achieved within the most representative R&D outsourcing agreement for each firm more precisely.[3] Because our dependent and some independent variables were obtained through survey data, our results may be affected by common-method bias. To deal with this, we used the procedural remedies related to questionnaire design suggested by Podsakoff et al. (2003). Lastly, to statistically address the issue of common-method bias, we performed Harman's single-factor test (Harman, 1967). 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. Moreover, our results are based on estimations that involve multiple independent variables and interaction terms, and Evans (1985) showed that interaction effects are robust against common-method bias.

3.2. Method of analysis

As the R&D outsourcing decision represents a choice variable not randomly distributed across the sample, our analysis is susceptible to self-selection bias. To assess and correct for this, we used a standard two-stage technique (Heckman, 1979), which consists of re-estimating the regression coefficients by introducing an adjustment term into the second-stage model (i.e., the inverse Mills ratio). This approach enabled us to obtain consistent and unbiased estimates in the second-stage regression model. We implemented this Heckman two-stage regression model in STATA, using the HECKMAN procedure in which the first stage is a probit model and the second stage is an ordinary least squares (OLS) regression. Thus, in the first-stage of the model or selection equation, the unit of analysis was the firm, and it assessed for the firm's likelihood of outsourcing R&D services.[4] In the second-stage, the unit of analysis was the most representative R&D outsourcing agreement for each firm, and it assessed for the client's ability to fulfill its innovation objectives within the agreement.

3.3. Measures

In the second-stage performance model, we defined innovation performance from the perspective of the client as the degree to which the firm was able to accomplish its expected innovation objectives in the outsourcing agreement (INNOVATION PERFORMANCE). Because our study deals with the difficulty of analyzing firms operating in five different industries, and it is known that some industries patent more than others, we did not just asked about level of patents, but about innovations launched (Hagedoorn and Cloodt, 2003). To develop this variable, we used perceptual measures of performance.[5] Using a Likert scale from 1 (accomplished to a very low degree) to 5 (accomplished to a very high degree), respondents were asked the degree to which its company achieved the following objective in the outsourcing relationship with the R&D supplier compared with what it was expected: 'Increased the number of patents or innovations launched by year'.[6] Given that we could not find any standard measure to account for innovation performance at the transaction level in the literature, this measure was pretested with seven R&D and technology managers from different industries and countries who told us that they found this question suitable to their respective industries.

Table 1 summarizes the independent and control variables used in this stage together with its operationalization.

4. Results

Table 2 shows the correlations and descriptive statistics for all the variables used in the second stage.[7]

Table 3 reports the results of our innovation performance regression models, controlling for self-selection using three specifications: control variables only (model I), independent and control variables (model II), and full model with interaction effects (model III). An F-test of the null hypothesis that all coefficients are 0 is rejected in all models, and the estimated coefficients for the inverse Mills ratio (lambda) in models I and II is significant, indicating the presence of self-selection. Consequently, the use of Heckman's (1979) technique is justified.

The negative and significant sign of CONTRACTS WITH CLIENT COMPETITORS ($P < 0.001$) indicates that, overall, the client's ability to fulfill its innovation objectives within the outsourcing relationship tends to diminish when suppliers also work for competitors, as predicted by our first hypothesis. However, consistent with our argument on the moderating effect of the level of the standardization of the knowledge required to perform the service, we find that the interaction term CONTRACTS WITH CLIENT COMPETITORS × INFORMATION STANDARDIZATION is positive and highly significant ($P < 0.001$; model III). As both interacting variables are continuous, to interpret this result, we display the net effect of the provider working for a client's competitors on innovation performance for different requirements of client's standardized knowledge; that is, when INFORMATION STANDARDIZATION takes the minimum, mean, and maximum values. Thus, as shown in Figure 1, when outsourcing R&D services requiring high levels of a client's tacit and specific knowledge (i.e., when INFORMATION STANDARDIZATION takes the minimum value), the more the supplier works for the client's competitors, the lower is the client's ability to achieve its innovation objectives within the agreement. While, by contrast, consistent with hypothesis 2, it can be observed that as INFORMATION STANDARDIZATION increases, the negative effect of sharing suppliers on innovation performance is attenuated in such a way that it is even positive for the case of the maximum value of INFORMATION STANDARDIZATION.

As for the control variables, the positive and significant effects of the variables related to INTANGIBLE INVESTMENTS and MULTIPLE CONTRACTS, in nearly all the specifications, are indicative of the importance of a supplier's commitment for the client

Table 1. Summary of independent and control variables used in the second-stage model

	Operationalization
Independent variables	
Contracts with client competitors	To assess for the client assessment of the degree to which their R&D suppliers are shared with their perceived competition we asked the interviewees' to indicate their level of agreement, on a 1–5 scale, with the statement: 'The supplier also has outsourcing relationships with some of our competitors'.
Information standardization	To capture the client's need to transfer tacit and firm-specific knowledge to the supplier, we used an inverse Likert (1–5) scale and asked interviewees to indicate their levels of agreement with the following statements related to the attributes of the R&D service outsourced: (1) individuals must acquire company-specific or division-specific information to perform the service adequately, and (2) it is difficult for third parties to understand the company know-how related to this service. Thus, these items capture the dimensions of the firm-specificity and tacitness of the knowledge being transferred (Cronbach's alpha = 0.7). They were adapted from Poppo and Zenger's (1998) and Kogut and Zander's (1993) works.
Control variables	
Intangible investments	Interviewee level of agreement on a Likert (1–5) scale with: '(1) the supplier incurred 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 its knowledge with our company' (Cronbach's alpha = 0.702).
Tangible investments	Interviewee level of agreement on a Likert (1–5) scale with: '(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 to work for our company'; and (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 (Cronbach's alpha = 0.742).
Relationship tenure	Year in which the firm first signed a contract with the supplier.
Joint venture	= 1 when the outsourcing agreement involves a joint venture between the parties, and 0 otherwise
Long-term contract	= 1 if it involves a long-term contract between the parties, and 0 otherwise
Multiple projects	= 1 if the supplier provides more services to the company, and 0 otherwise.
Nonprofit research center	= 1 if the interviewee indicated that the supplier was a university or a research institute and 0 if it was a business firm
Main client	Interviewee level of agreement on a Likert (1–5) scale with the following statement: 'We are the main client of our supplier'.
International non-OECD supplier	= 1 if the supplier is located in a non-OECD country, and 0 otherwise.
International OECD supplier	= 1 if the service supplier is located abroad but within a country belonging to the OECD, and 0 otherwise.
R&D budget	Logarithm of the firm's 2005 R&D expenditures in US dollars
Basic research, product design, software, process design, applied research	Dummies to control for the most frequently R&D services being outsourced
Patents, R&D strategy-basis, IPR and industry dummies	Controls from the first stage to account for other sources of firm heterogeneity

to have a promotion focus and thus be able to fulfill its innovation objectives in a satisfactory way. The negative and significant effect of INTERNATIONAL NON-OECD SUPPLIER across models suggests that the higher perceived political and relational risks associated to these economies (Cuervo-Cazurra, 2006) increases the likelihood of the firm framing the relationship with a prevention focus; thus reducing its ability to benefit from the non-OECD supplier's capabilities.[8] Because our dependent variable in the second-stage INNOVATION PERFORMANCE takes categorical values from 1 to 5, as a robustness check, we also ran estimations using an ordered probit model controlling for self-selection, and similar

Table 2. Second-stage descriptive statistics and correlation matrix

	Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1	Innovation performance	2.63	1.2																										
2	Contracts with client competitors	3.68	1.4	−0.1																									
3	Information standardization	2.92	1.0	−0.0	−0.04																								
4	Tangible investments	1.82	0.8	−0.07	−0.20*	−0.08																							
5	Intangible investments	2.96	0.8	0.13	−0.00	−0.49*	0.34*																						
6	Joint venture	0.07	0.2	−0.13	0.06	−0.13	−0.03	0.10																					
7	Long-term contrac	0.17	0.3	−0.05	0.02	−0.04	0.42*	0.22*	−0.12																				
8	Relationship tenure	1995	10	−0.07	0.06	0.15	0.03	−0.01	−0.04	0.15																			
9	Multiple projects	0.68	0.4	−0.02	0.14	−0.18	−0.01	0.08	0.02	−0.05	0.09																		
10	Main client	2.18	1.30	0.00	−0.26*	−0.07	0.44	0.37*	0.20*	0.28*	−0.14	−0.19																	
11	Nonprofit research center	0.14	0.3	0.20*	−0.04	0.13	−0.03	−0.12	−0.10	0.05	0.10	0.12	−0.21*																
12	International OECD supplier	0.17	0.3	−0.14	0.02	−0.10	0.13	0.22*	−0.02	0.14	0.10	0.12	0.12	−0.17															
13	International non-OECD supplier	0.20	0.4	0.04	−0.08	0.21*	0.04	−0.08	−0.04	0.03	0.03	−0.11	0.18	0.02	−0.22*														
14	Patents	0.05	5.1	−0.14	−0.17	−0.07	0.26	0.09	0.24*	0.26*	−0.15	−0.01	0.32*	−0.10	0.07	0.12													
15	R&D strategy-basis	0.19	0.3	−0.04	0.09	−0.07	−0.02	−0.08	−0.06	−0.01	0.14	0.00	−0.26*	−0.02	0.05	0.12	−0.02												
16	IPR	4.63	0.3	0.03	−0.09	−0.16	−0.02	0.19	0.03	−0.03	0.19	0.12	0.12	−0.17*	0.13	0.10	0.10	−0.12											
17	R&D budget (log)	19.31	1.7	−0.03	−0.14	−0.29*	0.35*	0.37*	0.23*	0.29*	−0.12	−0.04	0.5*	−0.19*	0.22*	0.06	0.34*	−0.01	0.12										
18	Basic research	0.10	0.3	0.10	−0.17	0.21*	−0.00	−0.04	−0.04	0.10	0.18	0.02	−0.01	0.23*	−0.22*	0.12	−0.07	0.04	−0.04	−0.04									
19	Applied research	0.06	0.2	−0.10	0.01	−0.11	0.03	0.04	0.15	0.00	−0.14	−0.00	−0.02	0.03	0.00	−0.01	0.04	0.04	0.02	0.27*	−0.08								
20	Software	0.08	0.2	−0.30*	0.01	−0.09	0.08	0.00	0.10	0.02	0.09	0.28*	−0.03	−0.13	0.33*	−0.14	0.26	0.05	0.16*	0.04	−0.10	−0.07							
21	Product design	0.09	0.2	0.19	0.13	−0.16	−0.05	0.21*	−0.12	0.02	0.00	0.02	−0.02	−0.14	−0.06	−0.16	0.02	0.03	−0.05	0.02	−0.11	−0.08	−0.09						
22	Process design	0.07	0.2	0.09	−0.05	0.06	−0.09	−0.16	−0.1	−0.11	−0.04	−0.05	0.05	−0.06	0.12	0.15	0.05	−0.03	0.12	0.02	−0.10	−0.07	−0.08	−0.09					
23	SIC28	0.24	0.4	−0.06	−0.07	0.10	0.03	−0.23*	0.1	−0.01	−0.02	−0.03	−0.02	0.06	−0.19	0.18	0.00	0.00	−0.16*	0.07	0.24*	0.17*	−0.07	−0.18*	−0.16*				
24	SIC35	0.31	0.4	0.08	−0.04	0.11	0.09	−0.01	−0.07	0.01	0.02	0.03	0.00	0.12	0.21*	−0.12	−0.09	−0.10	−0.01	−0.25*	−0.01	−0.12	0.05	−0.09	0.02	−0.39*			
25	SIC36	0.21	0.4	0.23*	0.18	−0.24*	−0.14	0.24*	−0.05	−0.10	−0.11	−0.14	−0.09	−0.16*	−0.12	0.02	−0.06	0.06	0.08	−0.00	−0.14	−0.13	0.03	0.19*	0.09	−0.30*	−0.36*		
26	SIC37	0.08	0.2	−0.10	−0.01	0.05	0.12	0.06	−0.09	0.17	0.08	−0.03	0.22*	−0.12	0.09	−0.17	0.06	−0.00	0.07	0.19*	−0.04	−0.07	−0.02	0.23*	−0.08	−0.17*	−0.21*	−0.16*	
27	SIC38	0.12	0.3	−0.21*	−0.06	−0.02	−0.10	−0.06	0.10	−0.04	0.06	0.20*	−0.05	0.05	0.03	0.06	0.14*	0.06	0.06	0.10	−0.08	0.18*	0.00	−0.06	0.13	−0.21*	−0.26*	−0.20*	−0.11

*Significant at the 5% level.

Table 3. OLS estimates for second-stage performance models ($N = 99$)

Independent variables	Model I	Model II	Model III
Contracts with client competitors		−0.236	−0.236
		(2.89)***	(2.83)***
Information standardization		0.215	0.129
		(1.45)	(0.91)
Contracts with client competitors* information standardization			0.251
			(3.29)***
Tangible investments	−0.173	−0.315	−0.341
	(1.01)	(1.75)*	(1.91)*
Intangible investments	0.414	0.595	0.634
	(1.91)*	(2.89)***	(3.08)***
Joint venture	−0.456	−0.172	−0.042
	(0.95)	(0.38)	(0.10)
Long-term contract	−0.145	0.135	0.175
	(0.52)	(0.40)	(0.54)
Relationship tenure	0.000	−0.000	0.001
	(0.04)	(0.02)	(0.12)
Multiple projects	0.354	0.496	0.493
	(1.22)	(1.82)*	(1.84)*
Main client	0.076	0.043	0.062
	(0.57)	(0.36)	(0.53)
Nonprofit research center	0.576	0.590	0.723
	(1.13)	(1.36)	(1.81)*
International OECD provider	−0.196	−0.190	−0.350
	(0.39)	(0.54)	(1.01)
International non-OECD provider	−0.600	−0.585	−0.609
	(1.56)	(1.97)**	(2.22)**
Patents	−0.426	−0.527	−0.369
	(0.57)	(1.16)	(0.88)
R&D strategy-basis	−0.048	0.099	0.271
	(0.13)	(0.33)	(0.98)
R&D budget (log)	0.056	0.059	−0.043
	(0.76)	(0.95)	(0.81)
IPR	−0.056	−0.078	0.056
	(0.15)	(0.23)	(0.18)
Basic research	−0.176	−0.335	−0.403
	(0.26)	(0.82)	(1.02)
Applied research	−0.786	−0.631	−0.890
	(0.77)	(0.88)	(1.41)
Software	−1.188	−1.215	−1.613
	(2.17)**	(2.83)***	(4.03)***
Product design	0.164	0.260	0.147
	(0.36)	(0.60)	(0.38)
Process design	0.471	0.407	0.328
	(1.19)	(1.03)	(0.90)
SIC28	−0.263	−0.248	−0.081
	(0.65)	(0.68)	(0.24)
SIC36	−0.051	0.189	0.383
	(0.11)	(0.55)	(1.17)

Table 3. (*Continued*)

Independent variables	Model I	Model II	Model III
SIC37	−0.945	−0.932	−0.816
	(1.40)	(2.31)*	(2.20)**
SIC38	−0.813	−0.921	−0.825
	(1.78)*	(1.97)**	(1.95)**
Constant	0.048	1.515	−2.440
	(0.00)	(0.06)	(0.10)
Lambda (λ)	−0.79*	−0.63*	−0.43
Log-pseudolikelihood	−232.72	−227.40	−223.94
Wald X^2	199.7***	274.9***	273.8***

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

results regarding the sign and significance of the estimated parameters were obtained.[9]

5. Discussion and conclusion

Firms operating in high-tech industries face the need of continually search for external sources of technological knowledge to sustain its competitive advantage. Therefore, they have to frequently assess decisions of what R&D activities to outsource within the innovation process and to whom. In relation to this second decision, a frequent dilemma emerges when analyzing the convenience of outsourcing R&D services to suppliers that also serves competitors, or allowing our exclusive supplier to work for other competitors. Having a supplier also working for competitors presents potential higher benefits resulting from their refined capabilities, but also entail higher risks. Analyzing international data at the transaction level, our results contribute to the literature on accessing external R&D knowledge by identifying under what scenarios sharing R&D suppliers with competitors can be an effective strategy to contribute to the client achieving its innovation objectives.

To address this research question, we suggest that it is crucial to take into account how firm's managers frame the fact of the supplier also contracting with competitors, that is, if it is framed as something positive (with a promotion focus) or negative (with a prevention focus). Specifically, applying regulatory focus theory, we argue the framing adopted and, thus, the client's commitment to the process of capability development within the agreement will be dependent on the type of knowledge that it needs to transfer to the supplier. This is so because the level of tacitness and specificity of the knowledge to be transferred determines the client's perception of the appropriability hazards and the size of the loss if leakage occurs. Indeed, we show that only in those cases in which standardized

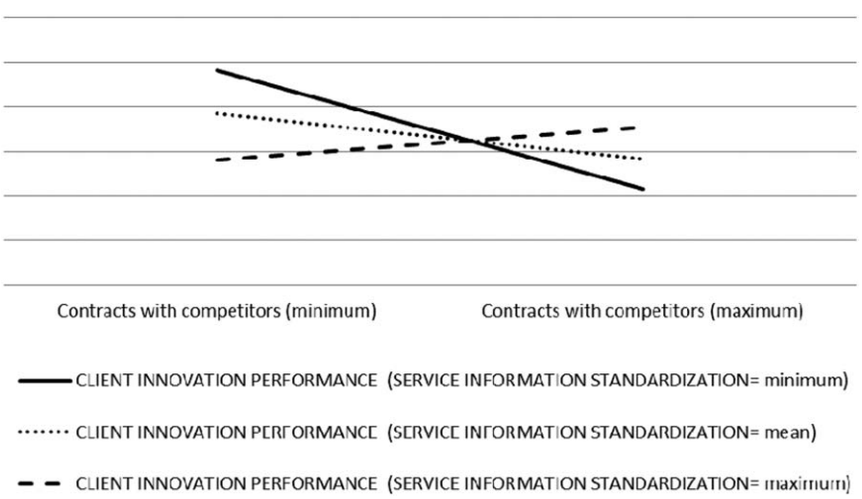

Figure 1. Net effect on client innovation performance of the R&D service supplier having contracts with client competitors (Using the estimates from Model III in Table 3. Control variables were evaluated at the sample mean).

information is required, the fact of sharing suppliers contributes positively to the client achieving its innovation objectives. Outsourcing standardized services allows the firm to benefit from the advantages of a specialized supplier without fears of knowledge leakage. Therefore, contracting to a supplier with upgraded capabilities – instead of performing the activities internally or contracting them to a less competent supplier – should increase firm's innovativeness. This result suggests that exclusive suppliers, although they may be perceived as more trustworthy partners, and easier to work with, may not be the most advisable technological partners for standardized services. In the remaining cases, our results show that the existence of indirect links to competitors through the shared supplier induce the client firm to frame the outsourcing relationship with a prevention focus, which limits the possibility of benefiting from the upgraded capabilities of the shared supplier.

An important contribution of our article is to show how psychological factors can influence knowledge exchanges (Bansemir et al., 2012). We also contribute to the interorganizational learning literature (Hamel, 1991; Larsson et al., 1998). This literature showed that fears of knowledge leakage in strategic alliances may lead firms to follow strategies that deviate from the optimal learning outcomes. However, something was missing in this literature to explain the reluctance to share information in strategic alliances, as it was not clear when and why this reluctance should appear. By adopting a regulatory focus perspective, we argue that the pros and cons of knowledge transfer are not assessed as a simple arithmetic calculation. Specifically, our results suggest that the comparison between incoming and outgoing spillovers is influenced by the way in which firms frame the relationship with their supplier. Thus, our article proves the benefits of introducing the regulatory focus in the field of R&D Management, as suggested by Stanko and Calantone (2011). Indeed, there is recent literature that points out that many firms have started to back-source R&D because they were not reaching the expected benefits (Zirpoli and Becker, 2011). We suggest that further analyzing how managers frame these relationships with their suppliers, as well as the mechanisms they implement to enhance or control knowledge transfers, can shed more light on why many R&D outsourcing do not offer the expected outcomes.

On the other hand, it should be noted that the way managers frame the ILD is expected to also have clear implications on how firms select partners in cooperative agreements, especially within an international context which is full of tradeoffs (Narula and Martinez-Noya, 2015). In relation to this, given that small and medium enterprises frequently act as suppliers, it would be interesting to further analyze how these firms may differ in their framings of the ILD, and thus in their partner selection decisions and behavior within the alliance. This would be of great interest because, given the limited resources of SMEs, cognitive biases are expected to play even a more significant role in their alliance decisions.

Although we believe this study has shed more light on this phenomenon, it is limited in several respects. First, although our respondent firms are representative of the population of firms in the selected industries by country of origin, industry, and firm size, we obtained a low response rate and it was not possible for us to account for country differences. Second, we could not collect survey data on the side of the provider, which would undoubtedly have enriched the study. Furthermore, we call for future research to take more explicit account of the role of a firm's capabilities to benefit from the supplier's, particularly when suppliers' capabilities are shared with competitors. This dilemma, among other ones firms face as they try to enhance their innovation capabilities across their distributed R&D networks, becomes a critical managerial challenge worthy of in-depth analysis particularly in an innovation context offering high learning opportunities (Contractor et al., 2010; Huizingh, 2011; Bessant et al., 2012; Narula and Martinez-Noya, 2015).

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Notes

1. R&D outsourcing occurs when a firm (client) contracts with an outside entity (supplier) to perform some process or function of its innovation process. These buyer–supplier relationships range from arms-length transactions to strategic sourcing relationships where purchasing firms seek to build long-term relationships with suppliers (McHugh et al. 2003).
2. These translations were done by native speakers that were bilingual in English and academic experts in management. Moreover, all versions were available on the Internet, so respondents could easily choose the language preferred to complete the questionnaire.
3. Missing data on some of the variables reduced the sample to 170 usable questionnaires, with 99 of the firms reporting to be outsourcing one or more R&D services. Table A2 presents descriptive statistics on the types of services outsourced by type of supplier.
4. Due to limited space and given that the first-stage just has the aim of controlling for self-selection, we have included the information in relation to this stage in Appendix B (see Tables B1 and B2).
5. Research shows that subjective measures of performance are well correlated with objective measures (Dess and Robinson, 1984), especially when respondents are top managers (Krishnan et al., 2006).
6. Of the 99 agreements analyzed at this stage, in 29 cases, the dependent variable takes a value of 1; in 13 cases, a value of 2; in 25 cases, a value of 3; in 29 cases, a value of 4; and in 5 cases, a value of 5.
7. Given the high correlations between the interaction terms and main effects, we mean-centered the relevant continuous variables before calculating the interactions (Jaccard and Turrisi, 2003).
8. To test the robustness of our results and, because differences may exist regarding the perceived trustworthiness of the different countries of origin of the supplier, we also analyzed how sharing suppliers with competitors affects the client's ability to fulfill its innovation objectives when the R&D supplier is located in a non-OECD country, and we found our results reinforced. Specifically, the results showed that when outsourcing

tacit and specific R&D services to a provider located in a non-OECD country, the negative effect of the supplier having contracts with competitors was significantly higher.

9. The results from this robustness test are available from the authors on request.

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Appendix A

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

		Population of firms		Mailed surveys		Received surveys	
		N°	%	N	%	N°	%
Origin	United States	3,529	*51.12%*	2,000	*50%*	81	*45%*
	European Union	3,375	*48.88%*	2,000	*50%*	101	*55%*
	Austria	95	*1.38%*	56	*1.40%*	2	*1.10%*
	Belgium	43	*0.62%*	25	*0.63%*	2	*1.10%*
	Czech Republic	33	*0.48%*	20	*0.50%*	1	*0.55%*
	Denmark	38	*0.55%*	23	*0.58%*	0	*0.00%*
	Finland	54	*0.78%*	32	*0.80%*	0	*0.00%*
	France	373	*5.40%*	221	*5.53%*	9	*4.95%*
	Germany	1,041	*15.08%*	617	*15.43%*	24	*13.19%*
	Greece	4	*0.06%*	2	*0.05%*	2	*1.10%*
	Ireland	29	*0.42%*	17	*0.43%*	0	*0.00%*
	Italy	854	*12.37%*	507	*12.68%*	32	*17.58%*
	Luxembourg	2	*0.03%*	1	*0.03%*	0	*0.00%*
	Poland	63	*0.91%*	37	*0.93%*	3	*1.65%*
	Portugal	22	*0.32%*	13	*0.33%*	1	*0.55%*
	Spain	157	*2.27%*	93	*2.33%*	9	*4.95%*
	Sweden	71	*1.03%*	42	*1.05%*	3	*1.65%*
	The Netherlands	35	*0.51%*	21	*0.53%*	1	*0.55%*
	UK	421	*6.10%*	249	*6.23%*	12	*6.59%*
	East Europe	40	*0.58%*	24	*0.60%*	0	*0.00%*
Industry	SIC 28 (chemicals)	1,312	*19.00%*	760	*19.00%*	45	*24.73%*
	SIC 35 (transportation eq.)	2,337	*33.85%*	1,357	*33.93%*	58	*31.87%*
	SIC 36 (electronics)	1,635	*23.68%*	947	*23.68%*	40	*21.98%*
	SIC 37 (machinery)	840	*12.17%*	487	*12.18%*	16	*8.79%*
	SIC 38 (measurement eq.)	780	*11.30%*	449	*11.23%*	23	*12.64%*

Table A2. Number of services outsourced by type of service and supplier

Type of R&D service outsourced	Type of supplier		Total
	Private company	University or technological center	
Basic or fundamental research services (including drug discovery in the pharmaceutical industry)	*8*	*12*	*20*
Designing products or prototypes	*16*	*1*	*17*
Customized software development services	*15*	*0*	*15*
Designing production processes or technology systems	*13*	*1*	*14*
Applied or experimental research services (including clinical research in the pharmaceutical industry)	*7*	*4*	*11*
Testing and analysis services (includes verification of products or processes, drug testing, routine product testing, and quality control processes)	*7*	*0*	*7*
Designing and engineering system architectures	*5*	*1*	*6*
Scientific and technical support consulting services for actual or proposed R&D projects	*4*	*2*	*6*
Software implementation services to help your company to implement new software	*1*	*0*	*1*
Development of product/prototypes or new or improved technologies (including drug manufacturing in the pharmaceutical industry)	*2*	*0*	*2*
Total outsoucing agreements (N= 99)	*78*	*21*	*99*

Appendix B

Table B1. Summary of variables used in the first-stage selection equation

Independent variables	Operationalization
Outsourcing	= 1 when the client outsources any R&D service to suppliers located either in the home country or abroad, and 0 otherwise
Independent variables	Operationalization
Patents	To proxy for a firm's technological capabilities, we included the number of patents assigned to the firm until the end of 2006, as recorded by the USPTO (PATENTS). As experience and capabilities are developed and accumulated over time, we accounted for the discounted complete track record of patents assigned to the firm. To control for industry biases, we divided the number of patents assigned to each firm by the number of patents assigned to the firm with the most patents in the same sector in the sample. Thus, PATENTS ranges from 0 to 1.
IPR	To account for cross-country differences in the propensity to outsource R&D services due to differences in the firm's home country institutional environment, we introduced the index of the protection of intellectual property rights (IPR) developed by Ginarte and Park (1997), and updated by Park in 2000.This index assigns a value from 0 to 5 to each country depending on the strength of its national patent legal system.
Control variables	Operationalization
Firm size	Logarithm of the firm's sales during 2005 in US dollars
Industry	We included one dummy for each of the five SIC sectors (SIC 35 was used as reference)
-To assess the importance of the R&D department within the firm's competitive strategy, we included four dummy variables depending on the response of the interviewee to a question asking which of the following statements best applied to the company:	
R&D strategy-basis	'R&D activities represent the basis of our company's competitive strategy, so research guides the actions of the remaining areas or departments'

Table . (*Continued*)

Independent variables	Operationalization
R&D strategy-aligned	'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' (used as reference category)
R&D strategy-independent	'The R&D department must be effective and competitive but it operates independently compared with other departments'
R&D strategy-no influence	Our company considers that the R&D department has no influence on the company's competitiveness and just buys the technologies available on the market

Table B2. Results of maximum-likelihood probit analysis for first-stage outsourcing decision ($N = 170$)

Independent variables	Full model
Patents	0.001
	(2.14)**
IPR	0.218
	(0.84)
R&D strategy-basis	−0.179
	(0.56)
Patents*R&D strategy-basis	0.534
	(2.13)**
R&D strategy-no influence	−1.133
	(1.74)*
R&D strategy-independent	0.227
	(0.59)
Firm size (log)	−0.087
	(1.06)
SIC28	0.201
	(0.74)
SIC36	0.198
	(0.72)
SIC37	0.445
	(1.07)
SIC38	0.389
	(1.13)
Constant	0.474
	(0.26)
Log-pseudolikelihood	−111.58

Robust z statistics in parentheses.
*Significant at 10%
**Significant at 5%
***Significant at 1%