The interplay between trust and contracts in open innovation projects

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**Abstract**

The performance of the relationship with external partners is a key indicator of the effectiveness of an open innovation strategy at the project level for the innovating firm. This performance is largely influenced by the way that the inter-firm relationships are governed during collaborative New Product Development projects. Our understanding of the governance of open innovation relationships at the project level remains rather unclear. The objective of this paper is to examine the interplay between formal (contracts) and informal (trust) mechanisms in open innovation projects. The empirical results from a survey of manufacturing firms in the UK indicate that the relationship between trust and contracts is a substitutive one for incremental innovation projects, with trust being positively associated with the performance of the relationship with external partners. However, this substitutive relationship between trust and contracts shifts to a complementary one for radical innovation projects. Moreover, we find that the performance of the relationship with external partners is directly linked to the ability of firms to maximize profits as it is reflected from the high performance of the new products derived from the New Product Development project.
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ABSTRACT

The performance of the relationship with external partners is a key indicator of the effectiveness of an open innovation strategy at the project level for the innovating firm. This performance is largely influenced by the way that the inter-firm relationships are governed during collaborative New Product Development projects. Our understanding of the governance of open innovation relationships at the project level remains rather unclear. The objective of this paper is to examine the interplay between formal (contracts) and informal (trust) mechanisms in open innovation projects. The empirical results from a survey of manufacturing firms in the UK indicate that the relationship between trust and contracts is a substitutive one for incremental innovation projects, with trust being positively associated with the performance of the relationship with external partners. However, this substitutive relationship between trust and contracts shifts to a complementary one for radical innovation projects. Moreover, we find that the performance of the relationship with external partners is directly linked to the ability of firms to maximize profits as it is reflected from the high performance of the new products derived from the New Product Development project.

Keywords:
Open innovation; trust and contracts; project level
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1. Introduction

The transition of firms to inbound open innovation (OI), which is ‘a model using a wide range of external actors and sources to help achieve and sustain innovation, [Laursen and Salter, 2006: p. 131]’, has led scholars to investigate its direct benefits at the firm level (Almirall and Casadesus-Masanell, 2010; Leiponen and Helfat, 2010; Love, Roper and Vahter, 2014). There is a considerable broad literature that supports that R&D openness helps to stimulate innovation as the combination of knowledge gained from different types of external partners (i.e. suppliers, customers, universities, start-ups, and research institutes), enriches the internal knowledge base of firms, provides them access to a broader pool of technological opportunities and increases the variety of knowledge inputs that facilitates the novel recombination of disparate bodies of knowledge (Leiponen and Helfat, 2009).

However, the gains derived from open innovation can be curtailed as the shift from closed to open innovation is likely to increase transactions costs that transpire through the additional time and resources required to search and select new external partners as well as the rise in co-ordination and monitoring costs after the formation of new external linkages (Dyer and Sign, 1998). The benefits accrued from the synergy gained from the breadth of collaboration with heterogeneous types of external partner can be mitigated, due to the challenges of managing the relationships with diverse types of external partner (i.e. science- or market-based, and start-ups), who may have different attributes in relation to their value-creation potential to the firm and the risks to them in acting opportunistically (Ritala and Humelina 2013; Dyer and Singh, 1998). This can thus impair the ability of the innovating firm to profit from its innovation (Teece, 1986).

In this paper, we seek to examine how the governance of inter-firm relationships plays an important role in creating the benefits but reducing some of the risks of open innovation. The
proper management and performance of the relationships with external partners is a key facet of the successful implementation of an open innovation strategy, and the design of appropriate governing mechanisms can potentially mitigate the inherent risks of open innovation, such as opportunistic behavior, loss of intellectual capital, loss of control, and unintended knowledge spillover (Pullen et al., 2012; Gesing et al., 2015; Hagerdoon and Zobel, 2015; Vanhaverbeke, 2006). Yet, little attention has been paid to the way that firms ought to design the governance of their relationships with external partners to maximize its performance (i.e. satisfaction with the collaboration to reach its goals and to contribute to core competencies) and ultimately, its product innovation performance during their NPD projects. We identify the two main sources of uncertainty that firms face when implementing an open innovation strategy during their NPD projects: 1) types of NPD project (radical innovation projects are characterized by a higher level of uncertainty and risk than incremental innovation project); and, 2) the project’s open environment, in which the risk of knowledge of misappropriation is inherently present.

As the types of projects and an open innovation environment are sources of uncertainty, organizations ought to develop governance mechanisms capable of dealing with both external and internal sources of uncertainty (Zaltman, Duncan and Holbek, 1973, Gesing et al, 2015).

The objective of this paper is to understand how the performance of collaborative New Product Development (NPD) project is associated with the fit between the governance mechanisms (trust and contracts) and two types of collaborative NPD project (incremental and radical projects). Our primary motivation is to advance the theoretical understanding of complementarity and substitution between trust and contracts, specifically in the context of open innovation projects. we address the following research questions: 1) How do innovating firms calibrate their governance mechanisms (trust and contracts) for different types of NPD projects (incremental and radical) to maximize the performance of the relationship with external partners at the project level?; and 2) What is the link between the performance of the
relationship with external partners and the ability of the innovating firm to capture the profits from its innovation at the project level?

Based on a survey in the manufacturing sector in the UK at the New Product Development project level, our findings provide new insights on how trust-contract governance interact by supporting that managers structure and adapt their governance mechanisms according to the type of New Product Development (NPD) projects. The performance of the relationship with external partners is associated with the fit between the governance mechanisms (trust and contracts) and the type of collaborative NPD project (incremental and radical projects). We found that the relationship between trust and contracts is a substitute for incremental innovation projects, with trust being positively associated with the performance of the relationship with external partners. However, this substitutive relationship between trust and contracts shifts to a complementary one for radical innovation projects. Additionally, our findings support that the performance of the relationship with external partners is directly linked to the ability of firms to maximize profits from their NPD projects (i.e. performance of the new products derived from the NPD project).

The paper is structured as follows. First, we review the open innovation literature at the project level and identify the tensions in this stream of the literature. Second, the conceptual model and the development of the hypotheses are presented. The next sections describe the data collection and report the findings of the survey. We close with a discussion of the main contributions of the study and highlight the limitations and avenues for future research.

2. Literature Review

2.1 Factors influencing the success of open innovation at the project level

In recent years, the majority of studies on OI have focused on the aggregated firm level, rather than the micro-foundation of R&D projects. This is despite the fact that innovation
activities are typically conducted via R&D projects which have a high degree of heterogeneity (Cassiman, Di Guardo and Valentini, 2010; Dahlander and Gann, 2010). The integration of a range of external partners such as suppliers, customers in New Product Development projects creates synergies and a collaborative competence that influence the project performance (Mishra and Shah, 2009). Recently, scholars have started to advance further research on open innovation at the R&D project level, because decisions on collaboration with external partners are taken at the project rather at the firm level, according to the type of projects (i.e. incremental, radical, process innovation), the objective of the project, the strength of the appropriability regime, and the resource needs, all of which can vary across different R&D projects within the same firm (Bahemia, Squire, and Cousins, 2017; Vanhavebeke et al., 2014; Salge et al., 2013).

Previous research has emphasized the high variability of the performance of R&D projects, with estimated project failure rates of at least 35 percent across different industries (Boulding, Morgan, and Staelin, 1997). This high variability can be explained by the variability of project strategies and contextual factors that influence the success of open innovation projects. Project processes tend to be temporary and unique, and present non-routine characteristics that are not always amenable to systematic repetition (Gann and Salter, 2000). Similarly, R&D projects vary in terms of the critical success factors that shape the performance of each project, such as budgeted resources, team size, team composition, project leadership, management support, and project management practices (Cooper, Edgett and Kleinschmidt, 2004; Salge et al., 2013) In addition, the degree and nature of the formalization of the collaboration with external partners, and the types of governance mechanism between the firm and the external partners (rigid versus flexible contract), can also be key influences on the performance of R&D projects (Du et al., 2014).
2.2 Governance mechanisms in the context of open innovation at the project level

The deployment of the appropriate governance mechanisms can alleviate to some extent the high level of uncertainty and unequivocality that prevail in open innovation projects. At the New Product Development (NPD) project level, the risks and uncertainty associated with open innovation are reflected in the way that manufacturing firms in the UK judiciously manage their collaboration with external partners during their NPD projects. Firms tend to limit the pattern of interaction and information sharing with external partners for the development of innovative products new to the industry due to the dark side of embedded or close relationships (Bahemia, Squire and Cousins, 2017). Similarly, in a collaborative radical innovation project in the automotive industry, external partners were kept at a distance and the focal firm developed guarded relationship as a relational defense mechanism (Bahemia, Sillince, Vanhaverbeke, 2018). This is potentially due to the fear of losing proprietary information as a result of high information exchange and communication (Bidault and Cummings, 1994).

However, a different picture emerges in other studies. Trust can substantially be differentiated in terms of high and low performing collaborative New Product Development projects. A high level of trust between the firm and the external partners leads to better satisfaction with the efficacy of the collaborative relationship during NPD projects, while a low level of trust appears to be appropriate in certain circumstances when the relationships are characterized by ongoing conflicts and the partners behave egoistically (Bsteiler, 2006). Other open innovation studies have broadened the governance mechanism beyond trust and simultaneously focused on the importance of a contractual agreement at the project level; they have shed light on the importance of contracts to govern collaborative NPD projects. For example, in the Dutch construction industry, case studies of technological innovation projects have indicated that the relationship with external partners has a governance structure in which mutual trust prevails alongside the presence of a general contracts for the most successful
innovation projects, suggesting a more complementary relationship between trust and contracts (Bosch-Sijtsema and Postma, 2009).

2.3 The importance of boundary conditions in the interplay between trust and contracts

The inconclusive and mixed nature of previous findings on the role of trust and contracts in the context of open innovation at the project level that we have reviewed above may potentially be explained by several factors namely, the dominance of qualitative research in this area (Bahemia et al, 2018; Bosch-Sijtsema and Postma, 2009; Bsteiler, 2006), the lack of research on the interactive relationship between trust and contracts (i.e. substitutive or complementary), and the presence of moderating factors that potentially influence the interaction between these factors. In other areas such as marketing, strategic and supply chain management, scholars have been investigating the boundary conditions that may influence the interplay between contractual and relational governance (Cao and Lumineau, 2015). For example, the relationship between contractual and relational governance is influenced by contingencies such as the institutional environment, and the type and length of the inter-organizational relationship (Cao and Lumineau, 2015). Scholars have also recognized the need to explore contextual contingencies that influence the choice of governance mechanism (Lumineau, 2017).

Apart from an open environment to external partners, which is a source of greater uncertainty, different types of NPD projects also tend to differ in their amount of predictability, and uncertainty. For example, radical innovation projects are characterized by a higher level of uncertainty and risk compared to incremental innovation projects and they vary in the kinds of knowledge they draw upon (Abernathy and Clark, 1985; Cardinal, 2001). This is because incremental innovations require skills that refine existing products while radical innovations require skills and resources that significantly transform existing products (Subramaniam and Youndt, 2005) and disrupt an existing technological trajectory (Dosi, 1982). Despite of the
inherent differences between incremental and radical innovation projects, yet the type of NPD project has not been explored as a contingency that can potentially influence the way that governance mechanisms (trust and contracts) are calibrated in an open innovation environment, to maximize the performance of the relationship with external partners. In this paper, our primary theoretical motivation is to provide new insights by examining the boundary conditions when and how trust and contracts complement or substitute each other for collaborative New Product Development projects, and to contribute to the wider ongoing debate, related to the conflicting and dichotomous views on the relationship between trust and contract that still prevail in the governance literature (Huber, Fischer, Dibbern and Hirschheim, 2013).

3. Development of hypotheses

In the next section, we develop the hypotheses of our conceptual model (Figure 1).

3.1 Trust and the performance of the relationship with external partners.

Relational governance is derived from – and reinforced by - trust, commitment and social capital between partnering organizations (Bachmann and Inkpen, 2011) acting as behavioural guidelines that enforce social obligation during the exchange (Cannon et al., 2000). Here, future contingencies and uncertainties are addressed by flexibility and increased information sharing procedures between partnering organizations (Zaheer and Harris, 2006). Relational governance facilitates a bilateral approach to problem solving, solidarity and information sharing and this in turn helps to consolidate the long-term relationship. In this context, social obligations enforce compliance with relational norms and practices (Uzzi, 1997). This perspective is supported by research findings showing that a variety of enforcement mechanisms, such as expectations of repeat businesses, reputation effects, social obligations,
and fulfilment of basic social needs support the use of relational governance (Zhou and Poppo, 2006). Mishra and Shah (2009) argue for the importance of collaboration in NPD projects. Collaboration driven by relational governance is based on social norms of: reciprocity, flexibility, solidarity, personal bonding or routinized behavior (Klein Woolthuis et al., 2005).

In collaborative innovation, trust can increase the transparency and initiative of inter-organizational learning (Gulati, 1995). Symmetric mutual trust, respect and friendship among partners may significantly affect the ability of a firm to successfully manage the dual objectives of learning from its suppliers and protecting its own core proprietary assets from them (Kale et al., 2000). Thus, with the potential opportunistic or self-serving behaviour by the business partner(s) being counteracted by trust, the managers will be less concerned about the risk of losing their core proprietary assets to the partner. Therefore, we propose that a high level of trust between the firm and the external partners engaged in New Product Development projects will help to enhance the smooth flow of knowledge, ideas and information and to reduce the inherent uncertainties associated with open innovation. This leads us to hypothesize:

**H1** There is a positive relationship between trust and the performance of the relationship with external partners at the project level

### 3.2 Contracts and the performance of the relationship with external partners.

In the absence of trust, monitoring and safeguarding are measures used to manage uncertainty by influencing others' behaviours and protecting oneself. Uncertainty creates the need to alter the terms of agreements and adjust the design and operation of coordination mechanisms to respond to unforeseen events (McEvily et al., 2003). Contracts specify what is acceptable and what is not in a relationship by providing threats of legal enforcement or non-legal retribution, thus reducing a number of inter-organisational relationship uncertainties (Lyons and Mehta, 1997; Lumineau, 2017). Control in inter-organizational
relationships refers to the process of aligning objectives and monitoring partner actions in a manner that promotes desirable partner behavior (Inkpen and Currall, 2004). Control might suppress concerns about the partner behaving opportunistically and/or help firms coordinate supplier-executed NPD activities to achieve satisfying NPD performance (Gulati and Singh, 1998). However, even the most well-intentioned formal control efforts can be derailed by exploitation arising from weaknesses such as incomplete contract design or intellectual property rights (Williamson, 1996), particularly when uncertainty, complexity, and transaction duration increases (Ring and Van de Ven, 1994). Prior studies highlight the negative effect of incomplete contracts, leading to conflicts and disagreements between partnering organizations when interpreting the contract (e.g. Bernheim and Whinston, 1998). Likewise, contractual governance mechanisms may lead to more “cumbersome, overregulated, and impersonal processes” (Beck and Kieser, 2003, p. 794) that, in turn, may hinder creativity and flexibility because of over-regulated and prescriptive procedures (Weber and Mayer, 2011). Therefore, we conclude that:

H2 There is a negative relationship between contracts and the performance of the relationship with external partners at the project level.

3.3 Interaction between trust and contracts as substitutes and its effects on the performance of the relationship with external partners.

The interactive relationship between trust and contracts is more contested (Cao and Lumineau, 2015). Some authors argue the complementary nature of contractual and relational governance mechanisms (e.g. Das and Teng, 2001; Luo 2002; Poppo and Zenger, 2002; Klein et al., 2005; Zheng et al., 2008; Cao and Lumineau, 2015) while others argue for a substitutive one (e.g. Cavusgil et al. 2004; Gulati, 1995). Trust reduces the need for contracting and monitoring and it is conceptualized as being a substitute for formal contract
(Lyons and Mehta, 1997) because relational and formal governance are considered to be
‘functional equivalents’ in reducing uncertainty and therefore, there is no need for one if the
other is deployed (Das and Teng, 2001; Goo, Rao and Nam, 2009). Contracts obviate the
need for setting up and maintaining social relationships whereas, conversely, trusting
relationships facilitate governance without the costs and complexity associated with
contracts (Ring and Van de Ven, 1994). On the one hand, the workings of relational
governance can dampen the functioning of formal governance as firms bypass formal
governance when they are over-depending on their prior good relationship (Liolio, Zimmermann, Willcocks and Gao, 2014).

On the other hand, Das and Teng (1998) propose that the use of formal, contract-based
governance mechanisms undermine trust among collaboration partners, whereas informal
control mechanisms enhance the level of trust. Contracts are intended to establish control
over innovation partners by prescribing their roles and responsibilities, specify penalties for
noncompliance, and determine the outcomes to be delivered (Ghoshal and Moran, 1996).
However, an overly-complex contract and active use of it can be interpreted as a sign of
distrust (Ghoshal and Moran, 1996), which is very harmful to the knowledge transfer
between firms, especially tacit knowledge transfer (Nonaka and Takeuchi, 1995). From this
perspective, contract and trust are negatively related as the high reliance on contracts are
likely to conflict with trust and disable its development (Woolthuis, et al., 2005).

It has been suggested that informal safeguards such as trust are the most effective
and least costly in facilitating complex exchange, increasing the willingness of partner to
engage in value-creation initiatives, and hence enhancing performance (Barney and Hansen,
1994; Dyer and Singh, 1998; Uzzi 1997). The presence of trust renders detailed contracting
unnecessary or superfluous (Jarillo, 1988, Uzzi, 1997) and allows more flexibility in dealing
with the uncertainties that are inherent in the innovation process. In addition, in the context
of collaborative innovation activities, there is a higher need for absorptive capacity so that the focal firm can effectively obtain, assimilate, transform and utilize knowledge from the external partners during the NPD project (Zahra and George, 2002). Trust is considered as being a critical component of absorptive capacity (Johnson et al., 1996); relational capital based on mutual trust between alliance partners forms the basis for learning and know-how transfer across the exchange while mitigating at the same time the opportunistic behavior of alliance partners (Kale, Sigh and Perlmutter, 2000).

In addition, there is empirical support for a substitutive relationship between contracts and trust, with trust being more important in inter-firm collaborations for improving innovation performance (Wang et al., 2011). Wang et al., (2011) argue that innovation demands more creative ideas, and the outcome is unpredictable, which means it is impossible to specify the terms and clauses in advance, and it requires a more flexible and self-motivated control mechanism. Therefore, in the context of open innovation, we hypothesize that trust will facilitate co-ordination between the focal firm and the external partners than a high reliance on contracts to explain the success of the performance of the collaborative relationship. As absorptive capacity and learning are important during collaborative innovation projects and they are closely related to trust, it is more likely that trust will potentially push the reliance on formal contracts to the background and ’supplant’ it (Dyer and Sigh, 1998, Gulati, 1995) in order to facilitate the absorption of knowledge from external partners (Cohen and Levinthal, 2000) during the project. This leads us to the formulation of a substitutive relationship between trust and contracts:

H3 Trust and high reliance on contracts operate as substitute in explaining the performance of the relationship with external partners at the project level

Previous research has highlighted that the flexibility and information exchange superiority of trust in enhancing the ability of the firm to co-ordinate better their activities
when the R&D tasks are more readily taught (Carson et al., 2006). Given that incremental innovations are only new to the firm, the level of dependence from the focal firm on its external partners is likely to be higher in order to acquire knowledge that is only be new to the firm and it is likely to be more readily taught. In such a case of one-sided dependence, research has shown contracts is a ‘poor ordering mechanism for social considerations (Woolthuis, et al., 2005). In this scenario, trust becomes a more reliable governance mechanism and the partners made use of a very incomplete contract that will enhance learning, flexibility and preservation of relational capital that will create an open and constructive atmosphere during the project (Ring and Van de Ven, 1994). Over-reliance on the goodwill trust of suppliers leads to the development of incremental innovation and hampers the ability of firms to develop radical innovations (Bunduchi, 2013). In addition, longitudinal studies show that in some cases of collaborative innovation projects, the completeness of contract did not entail a successful outcome while relationship characterized by trust were more successful (Woolthuis, et al., 2005). The needs for coordination and flexibility are higher than the need for control for incremental innovation projects as the costs and risks of misplaced trust would be lower. As the level of uncertainty as exemplified by the risks of misappropriation of unique knowledge resources are lower for incremental innovation projects, we hypothesize that:

H4 The substitutive relationship between trust and contracts, in explaining the performance of the relationship with external partners, is strengthened for incremental project innovation

3.4 Interaction between trust and contracts as complements and its effects on the performance of the relationship with external partners.

Although research suggests that informal agreements based on trust are generally more effective and involve lower transaction costs than formal safeguards, trust and contracts
can be both substitutes and complements (Woolthuis, et al., 2005). Huber et al., (2013) challenge the dichotomous view of either complementarity or substitution by showing that the relationship between contractual and relational governance is a dynamic one that can oscillate between complementarity and substitution over time and this oscillation is dependent on several factors such as goal fuzziness, goal conflict and goal misalignment (Huber et al., 2013). The development of radical innovations is a different process from that of the development of incremental innovations, warranting different approaches and development practices to maximize NPD outcomes (Holahan, Sullivan and Markham, 2013). Among the main differentiating characteristics between these two types of innovation are the level of uncertainty and need for flexibility (Holahan et al., 2013), level of risks (Kessler and Chrabarti, 1999, More, 1982) and higher need to have tighter appropriability regime (Ritala and Hurmelinna, 2013). Based on a large scale empirical study, Holahan et al., (2013) found that the more radical a project, the more inflexibly the project ought to be managed as more structure and less flexibility are mechanisms to mitigate the level of risks. High reliance on contracts is generally viewed as a mark of inflexibility and parties will elaborate on extensive contracts that fully detailed obligations and rights as a device to mitigate uncertainty and to constrain opportunism (Carson et al., 2006).

We posit that as the risks of uncertainty and opportunism are higher for radical innovation project than incremental ones, different types of governance mechanism will be deployed for radical innovation projects that will provide more structure and control. A higher reliance on contracts can also form part as an additional mechanism to strengthen the appropriability regime (Levin et al. 1987) for radical innovation projects. This is because contracts may reduce the risk of opportunism (Achrol and Gundlach, 1999) and provide a safeguard against ex-post performance problems (Luo, 2002; Lumineau, 2017).

As discussed in the previous section, social processes safeguard against exchange
hazards, uncertainties and facilitate the enforcement of obligations (Luo, 2002) and trust is an effective mechanism that can reduce complexity and uncertainty by enabling firms to cope better with inevitable uncertainties that arise in a long-term exchange (Wicks, Berman, and Jones (1999). As the exchange hazards, ambiguity and uncertainties are higher for radical innovation than incremental projects (Abernathy and Clark, 1985; Cardinal, 2001), firms will require more complex information processing mechanisms by combining both trust and contracts to mitigate the level of uncertainty and risks of opportunism. For medium and high level supplier-led innovations, there is empirical support that contracts and trust act as complements rather than substitutes (Dul and Schroeder, 2016). Therefore, based on the premise that less flexibility, more stronger appropriability mechanism, and structure are required for radical innovation projects than incremental innovation ones while simultaneously maintaining a high level trust with external partners to maximize the absorption capacity of the focal firm, we hypothesize that there will be a change from substitution to complementarity between the interaction of trust and reliance on contracts for radical innovation projects:

H5 The substitutive relationship between trust and contracts is transformed into a complementary one for radical innovations in explaining the performance of the relationship with external partners at the project level

3.5 Relationship between the performance of the relationship with external partners and product performance.

Our final hypothesis posits that the ability of the firm to profit from its innovation at the project level is positively influenced by the performance of the relationship with external partners. The satisfaction with the performance of relationship with the external partners and it contributions to the firms core competencies and competitive advantage imply that there was no significant misappropriation that would have curbed the ability of the firm to maximize profit. We control for other key factors such as the strength of the appropriability
regime (i.e. patents) and complementary assets (brand name and marketing, complementary sale and service efforts, control over distribution channels) that may determine the ability of firms to profit from their innovations (Teece, 1986). It is hypothesized that:

H6 There is a positive relationship between the performance of the relationship with external partners and product performance at the project level

4. Method

4.1 Data and sample.

To test the above hypotheses, we designed a survey instrument after developing the conceptual model from an in-depth review of the literature, and interviewing sixteen managers from the manufacturing sector in the UK. The dual objectives of the interviews were to obtain feedback on the conceptual model, and to validate the questionnaire. The questionnaire was further improved, and we pre-tested it with scholars and managers. This process was iterative, and led to several revisions of the questionnaire. We obtained a sample frame of 1,480 manufacturing companies in the UK from the Manufacturing Database. The target respondents were Innovation/R&D and Engineering managers, and companies with size of smaller than 50 employees were excluded in the population frame. The survey was administered online. We sent potential respondents an introductory letter to explain the objectives of the research project, and invited them in participating to the survey while assuring confidentiality and anonymity. The unit of analysis of the sample is the project level. In the questionnaire, the respondents were asked to select a New Product Development project that was completed in the last 5 years, and which involved at least one type of external partners such as suppliers, customers, universities, competitors, commercial labs, private and public research institutes.

A total of 1,480 questionnaires were sent by emails, and 211 questionnaires were returned and 205 were complete, giving us a response rate of 15%. The firms in our sample
came from a variety of industry technology (based on OECD classification) spanning from the high technology industry (30.73%), high-medium technology industry (44.39 %), medium-low technology (6.34%) and low technology (18.54%). To assess for response bias, we compared respondents with non-respondents in terms of project size and company size (Armstrong and Overton, 1977), and found no statistically significant difference between these two groups. As data pertaining to the independent and dependent variables were collected from a single source (Engineering and Innovation Managers), we used Korsgaard and Roberson’s (1995) approach to identify the level of severity of Common Method Variance among the ten main constructs (transformational leadership, inter-functional connectedness, brand and marketing, strength of appropriability regime, trust, contracts, incremental innovations, radical innovations, the performance of the relationship with external partners and performance of new product) by comparing the fit of one-factor model (i.e. all the items of our multi-item measures in Table 1 loaded on a common factor) with the fit of the proposed eight-factor model. In the event that Common Method Variance is a problem in the dataset, it is expected that the one-factor model would fit the data better than the proposed ten factor model. The results indicate that the fit of the ten-factor model (Chi-square/df = 930.37/532 = 1.74; comparative fit index (CFI) = .92; Tucker–Lewis index (TLI) = .91; IFI = .92) is significantly improved when compared with the fit of the one-factor model (Chi-square/df = 3608/945 = 3.80; comparative fit index (CFI) = .38; Tucker–Lewis index (TLI) = .31; IFI = .38). Therefore, neither response bias nor common method bias was problematic in this study.

4.2 Measures.

Measures for all of the constructs of the conceptual model were derived from previous studies, and the variables were measured using a seven-point Likert scale in which ‘1’ represented ‘strongly disagree’ and ‘7’ strongly agree to measure the items. Table 1 reports
Independent variables. We followed the definition of trust as based on good-faith effort, honesty in exchange, and limited opportunism (Cummings and Bromiley, 1996), and adapted items from the measure of Cummings and Bromiley (1996). As for contracts, we used three items measure from the studies of Cannon et al. (2000) and Jap and Ganesan (2000). For the moderating variables, we followed the definition of incremental innovations as being new to the firm only (Subramaniam and Youndt, 2005), and radical innovations as being new to the industry (Garcia and Calantone 2002; Johannessen et al. 2001). We adapted the items from Cooper (1979) and Song and Parry (1999) to assess whether the innovations were either incremental or radical during the project.

Dependent variables. We measured the performance of the relationship with external partners in relation to the overall level of satisfaction of the focal firm with the relationship with the external partners engaged in the New Product Development project, and the extent to which the inter firm exchanges achieved their objectives and contributed to the core competences and competitive advantage of the project (Saxton, 1997). Finally, the performance of new product measures the degree to which performance goals such as profit margin, sales, and market share, returns on assets and investment of the new product, are met. In the survey questionnaire, the measurement instrument for this construct is similar to the one of Moorman (1995).

Control variables. We also controlled for other confounding factors such as project size, company size, timing of market entry (first to market, fast follower, and delayed entrant), transformational leadership and inter-functional connectedness which are likely to
influence the performance of the relationship with external partners. Transformational leadership was measured using the Global Transformational Leadership Scale developed by Carless et al., (2000) while inter-functional connectedness was measured with the seven-items scale developed by Jaworski and Kohli (1993). The survey also controlled for complementary assets related to the brand name and marketing of the new product that can be used as an informal appropriation mechanism for the innovation of the project: we expect that a strong brand name and marketing of the new product under development would increase the attractiveness and credibility of the focal firm, and would positively influence the performance of the external partners during the project. These complementary assets are likely to impact on the ability of the firm to generate a profit from the innovation (Teece, 1986). We used a 3 items scale from Levin at al., (1987) to measure this variable. As for the strength of the appropriability regime that represents the effectiveness of a formal appropriation instrument (a patent) to prevent duplication and to secure royalties income for the innovation of this specific innovation generated during the NPD project, we use similar measure for this construct as Hurmelinna-Laukkanen and Puimalainen, 2007, Arbussa 2007). We control for the strength of the appropriability position for this particular innovation as it will influence the ability of the firm to profit from the innovation (Teece, 1986).

4.3 Reliability and Validity of Measures.

We conducted several tests to assess the reliability of the constructs and measurement model. We performed a Confirmatory Factor Analysis (CFA) of the multi-item measures. Overall, the model indicated a reasonably good fit with the data as indicated by the following fit indices: Chi-square/df = 930.37/532 = 1.74; comparative fit index (CFI) = .92; Tucker–Lewis index (TLI) = .91; IFI = .92; root mean square error of approximation (RMSEA) = .06. These values are within the acceptable range for the goodness of fit indices (Bentler and
Bonett, 1980). We tested the convergent validity of the constructs: first all items loaded significantly on their corresponding factors, and the standardised loading of each item related to its corresponding factor, is above the accepted level of .50. We checked the reliability of the constructs, and the results in Table 1 show that the Cronbach’s Alpha for the constructs is above the accepted level .70 (Nunally, 1978).

5. Results

The conceptual model was tested with hierarchical multiple regressions. Following the recommendation of Aiken and West (1991) and Cohen (2003) for regression analysis with multiplicative interaction effect, we mean-centered the independent variables in the regression equations to reduce possible multi-collinearity in the square terms. We examined multicollinearity issues for the models described below in several ways: the variance inflation factors that were related to each regression coefficient range from 1.03 to 1.53, which is below the cut-off value of 10 (Neter et al., 1985). In addition, the bivariate correlations across all variables in Table 2 are below the threshold of .80 (Mason and Perreault, 1991), indicating thereby that multicollinearity problems were not present in the sample data.

We provide the results for the hierarchical multiple regression in Table 3. In Model 1, we include only the control variables that are likely to influence the performance of the relationship with external partners. In Model 2, we include the first-order association between trust, contracts, incremental innovations, radical innovations, and the performance of the relationship with external partners. In Model 3, we add all second-order associations to test the two-way interaction. Finally, in Models 4 and 5, the three-way interaction effects between trust, contracts, incremental and radical innovations are included.
Except for transformational leadership ($\beta = .14, p < .05$), and inter-functional connectedness ($\beta = .13, p < .05$), the remaining control variables are not significant. The results indicate a positive relationship between trust and the performance of the relationship with external partners ($H1 \beta = .67, p < 0.001$) while the coefficient between contracts and the performance of the relationship with external partners was statistically not significant ($H2 \beta = .03, p > .05$). The results suggest that trust is more important than contracts to increase the performance of the relationship with external partners at the project level. $H3$ states that there is a substitutive effect between trust and contracts on the performance of the relationship with external partners. We found that the interaction between trust and contracts is negatively and significantly linked with the performance of the relationship with external partners ($H3 \beta = -.16, p < .01$), supporting the substitutive relationship that we posited. However, we do not find any support for $H4$ which postulates that the substitutive relationship between trust and contracts will be strengthened for incremental innovations as the three way interaction in Model 5 is not significant ($\beta = -.02, p > .05$). $H5$ states that the substitutive relationship between trust and contracts will be transformed into a complementary one in explaining the performance of the relationship with external partners for radical innovations. Our results lend support to this hypothesis, as illustrated by a positive and significant relationship between trust, contracts, and radical innovations ($\beta = .11, p < .05$) in the final three-way interaction model. In addition, there is a high increase in the value of R2 increases from Model 1 (.17) to Model 5 (.55). Our results clearly suggest that it was appropriate to hypothesise that radical innovation is a significant moderating variable that transforms the initial substitutive relationship between trust and contracts. As the level of risks, uncertainty and financial investments is higher for radical innovations as compared to incremental innovations, it becomes more important for firms to have in place contractual agreements that mitigate any potential risks of opportunistic behaviour by the external
partners involved in the project while at the same time nurturing trust with them.

In H6, a positive relationship between satisfaction with the performance of the relationship with external partners and product performance was expected. As illustrated in Table 4, our results indicates that the performance of the relationship with external partners during the NPD project is positively related to the performance of the new product in generating high profits, market share, returns on assets and investment. These indicators demonstrate clearly the ability of the firm to profit from the innovation generated from the project (Teece, 1986).

6. Discussion and conclusions

Our paper contributes to the open innovation literature in several ways. Prior studies suggest that the challenges of implementing open innovation are partly associated with a higher level of uncertainty that emerges from the risk of knowledge misappropriation by external partners (Appleyard and Chesbrough, 2016; Hagerdoon and Zobel, 2015) as well as the high level of uncertainty that is inherently present in collaborative R&D activities (Carson et al., 2003). We argue that in the context of open innovation, the risk of misappropriation by external partners can be a threat for the innovating firm to maximize profits from its innovation, and it becomes therefore important to manage effectively the governance structure of the inter-firm relationship, yet little attention has been paid to the way that firms ought to design the governance of their relationships with external partners to maximize its performance (i.e. satisfaction with the collaboration to reach its goals and to contribute to core competencies) and ultimately, its product innovation performance during their NPD projects.
The nature of the interplay between trust and contracts has been explored in a wide range of other contexts than open innovation, but the results have been mixed with empirical support for both substitutive (Dyer and Singh, 1998; Faulkner, 2000; Gulati, 1995) and complementary relationships (Liu et al., 2009; Luo, 2002; Poppo and Zenger, 2002). In these contexts, the choice of optimal governance modes appears to be contingent upon contextual factors and they are effective in different situations (Carson et al. 2006; Poppo and Zenger, 2002; Cao and Lumineau, 2015). Our results support this line of argument too in the specific context of open innovation projects.

Our findings suggest that the relationship between trust and contracts is substitutive, as we anticipated in Hypothesis 3 that contracts have a negative effect on the satisfaction with the performance of the relationship with external partners due to its inherent over-regulated and prescriptive procedures, which may stifle creativity and flexibility. Trust, however, has a positive effect on the performance of the relationship with external partners (Hypothesis 1) as it facilitates inter-organizational learning and flexibility (Gulati, 1995). All of these attributes are important in a context of collaborative New Product development.

We contribute to the ongoing debate of whether trust and contracts act as substitutes or complements by stressing the importance to take a contingency view in understanding the complex interplay between trust and contracts in a context of open innovation at the project level. The mixed findings on the interplay between trust and contracts can further be explained and reconciled by the presence of moderating factors (Cao and Lumineau, 2015). In the open innovation literature, much of the previous research has tended to examine each type of governance mechanisms (trust and contracts) in an isolated way at both the project and firm levels with only few exceptions (Gesing et al., 2015; Bosch-Sijtsema and Postma, 2009). In this study, we focus not only on the interplay between both types of governance mechanism, as firms are likely to use simultaneously contractual and relational governance to
manage their inter-organizational relationships (Bradach, 1997), but we also follow recent calls from scholars to explore further when contractual and relational governance complement and substitute each other in different contexts (Cao and Lumineau, 2015).

We provide empirical support for the importance of moderating factors in the trust-contacts debate by showing that the effectiveness of the performance of the relationship with external partners at the project level is indeed associated with the fit between the choice of governance mechanism (trust and contracts) and the type of NPD project (incremental and radical innovation projects). The relationship between trust and contracts is a substitute for an incremental innovation project, with trust being positively associated with the performance of the relationship with external partners, however this relationship shifts to a complementary one for radical innovation projects; this provides support for both hypotheses 4 and 5. As the level of risk and uncertainty is higher for radical innovation projects in an open project environment, more complex governance structures (a combination of trust and contracts) are required to increase the firm’s capacity to process information flows with external partners for projects new to the industry, where the information requirements are higher than incremental ones due to the fact that task variety is likely to be higher. In contrast, trust is sufficient and effective for increasing the performance of the relationship with external partners for incremental innovation projects as the level of risk and uncertainty is lower for such projects that are only new to the firm. The findings from our project level study in the UK manufacturing sector diverge significantly from a previous firm level study; for instance, Gesing et al., (2015) show that, in the German context, formally governed collaborations are associated more strongly with the firm’s incremental and radical NPD success than their informally governed counterparts. However, the authors warrant that their findings remain constrained to the specific economic and institutional context of Germany, where ‘decision-makers were found to exhibit notably higher confidence in the efficiency
and stability of the legal system than their counterparts in other countries such as Italy or Great Britain’ (Gesing et al., 2015; Ariihetti et al., 1997). Our findings highlight that the institutional context and level of analysis matter, as they influence the dynamic and effectiveness of governance mechanisms such as trust and contracts. Finally, the positive association between the performance of the relationship with external partners and product performance at the project level (Hypothesis 6) provides support for our initial argument that the performance of the open innovation relationship is an important factor which influences the ability of firms to maximize profits from their NPD projects.

Limitations and future research.

The first limitation of the study is related to the cross-sectional nature of the data, and this has prevented us from examining how trust evolved during the different stages of the lifecycle of the NPD projects. We also acknowledge that drawing information from a single respondent is a second limitation to our study, and future research will provide more insights by comparing the performance of the relationship with external partners from the perspective of both the focal firm and the external partners involved in the projects. Future research will benefit from longitudinal studies of NPD projects to capture how the interplay between trust and contracts co-evolve with the level of uncertainty, which is likely to vary during the different stages of the project. Our study has identified the importance of types of NPD projects as being a key contextual variable that provides a plausible explanation when trust and contracts complement or substitute one another in a context of open innovation.

Longitudinal studies will allow for the exploration of other contextual NPD factors which could determine the nature of the relationship between trust and contracts for incremental and radical innovation projects. Several other factors could be further explored, such as whether the external partners are longstanding or new to the firm, and to whom does the ownership of the IPs belong during the NPD project. The interplay between trust and
contracts can potentially vary depending on whether the IPs belong to the focal firm or the external partners, or if they have been co-developed during the project.
FIGURE 1

Conceptual Model

Trust

H1

Performance of the relationship with external partners

H2

Contract

H6

Product Performance

Trust x Contract (H3)
Trust x Contract x Incremental Innovation (H4)
Trust x Contract x Radical Innovation (H5)
<table>
<thead>
<tr>
<th>Constructs and Items</th>
<th>Cronbach Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transformational leadership</strong></td>
<td>0.96</td>
</tr>
<tr>
<td>Source: Carless et al. (2000)</td>
<td></td>
</tr>
<tr>
<td>a. My supervisor communicates a clear and positive vision of the future.</td>
<td></td>
</tr>
<tr>
<td>b. My supervisor treats staff as individuals, supports and encourages their development.</td>
<td></td>
</tr>
<tr>
<td>c. My supervisor gives encouragement and recognition to staff.</td>
<td></td>
</tr>
<tr>
<td>d. My supervisor fosters trust, involvement and cooperation among team members.</td>
<td></td>
</tr>
<tr>
<td>e. My supervisor encourages thinking about problems in new ways and questions, assumptions.</td>
<td></td>
</tr>
<tr>
<td>f. My supervisor is clear about his/her value and practices what he/she preaches.</td>
<td></td>
</tr>
<tr>
<td>g. My supervisor instills pride and respect in others and inspires me by being highly competent.</td>
<td></td>
</tr>
<tr>
<td><strong>Interfunctional connectedness</strong></td>
<td>0.79</td>
</tr>
<tr>
<td>Source: Jaworski and Kohli (2000)</td>
<td></td>
</tr>
<tr>
<td>It was easy to talk with virtually anyone you need to, regardless of rank or position</td>
<td></td>
</tr>
<tr>
<td>b. There was ample opportunity for informal &quot;hall talk&quot; among individuals from different departments</td>
<td></td>
</tr>
<tr>
<td>c. Employees from different departments felt comfortable calling each other when the need arises</td>
<td></td>
</tr>
<tr>
<td>d. Managers discouraged employees from discussing work-related matters with those who are not their immediate superiors or subordinates</td>
<td></td>
</tr>
<tr>
<td>e. People around here were quite accessible to those in other departments</td>
<td></td>
</tr>
<tr>
<td>f. Junior managers in my department could easily schedule meetings with junior managers in other departments.</td>
<td></td>
</tr>
<tr>
<td><strong>Brand and marketing (Complementary assets)</strong></td>
<td>0.7</td>
</tr>
<tr>
<td>a. Complementary sale and service efforts</td>
<td></td>
</tr>
<tr>
<td>b. Brand name and marketing</td>
<td></td>
</tr>
<tr>
<td>c. Control over distribution channels</td>
<td></td>
</tr>
<tr>
<td><strong>Strength of Appropriability Regime (patent)</strong></td>
<td>0.829</td>
</tr>
<tr>
<td>a. Patents to prevent duplication</td>
<td></td>
</tr>
<tr>
<td>b. Patents to secure royalties income</td>
<td></td>
</tr>
<tr>
<td><strong>Trust</strong></td>
<td>0.951</td>
</tr>
<tr>
<td>Source: Cummings and Bromiley (1996)</td>
<td></td>
</tr>
<tr>
<td>a. We thought the external parties told the truth in negotiations</td>
<td></td>
</tr>
<tr>
<td>b. We thought that the external parties met its negotiated obligations</td>
<td></td>
</tr>
</tbody>
</table>
c. In our opinion, the external parties were reliable
d. We felt that the external parties negotiated with us honestly
e. We felt that the external parties kept its word
f. We thought that the external parties did not mislead us
g. We felt that the external parties negotiated joint expectations fairly

Contracts

Source: Jap and Ganesan (2000)
a. Our relationships with the external parties were governed primarily by written contracts
b. We had formal agreements that detailed the obligations and rights of all the external parties
c. Over time, we developed ways of doing things with the external parties that never needed to be expressed contractually or formally

Radical innovation

Source: Song and Parry (1999) and Cooper (1979)
a. This product relied on technology that has never been used in the industry before
b. This product caused significant changes in the whole industry
c. This product was one of the first of its kind introduced into the market
d. This product was highly innovative - totally new to the market

Incremental Innovation

Source: Song and Parry (1999) and Cooper (1979)
a. The product class itself was totally new to our company *
b. The nature of the manufacturing process was totally new to our company
c. The technology required to develop the product (R&D) was totally new to our company

Performance of the relationship with external partners

Source: Saxton (1997)
a. Overall, we were very satisfied with the performance of the co-operation with the external parties
b. The co-operation with the external parties had realized the goals we set out to achieve.
c. The co-operation with the external parties had contributed to our core competencies and competitive advantage.

Performance of New Product

Source: Moorman (1995)
a. Market share relative to its stated objective
b. Sales relative to its stated objective
c. Return on assets relative to its stated objective
d. Profit margin relative to its stated objective
e. Return on investment relative to its stated objective

Item marked with an * was deleted due to the low factor loading
<table>
<thead>
<tr>
<th></th>
<th>Transformational Leadership</th>
<th>Interfunctional connectedness</th>
<th>Brand and marketing</th>
<th>Strength of appropriability (patents)</th>
<th>Timing of market entry</th>
<th>Project size</th>
<th>Company size</th>
<th>Inter-partner trust</th>
<th>Contracts</th>
<th>Incremental Innovation</th>
<th>Radical Innovation</th>
<th>Performance of the relationship with external partners</th>
<th>Performance of new product</th>
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<tr>
<td>1</td>
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<td></td>
<td>.480**</td>
<td>.044</td>
<td>.300**</td>
<td>.283**</td>
<td>.370**</td>
<td>.178*</td>
</tr>
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<td></td>
<td>.240**</td>
<td>.386**</td>
<td>.140*</td>
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<td>.103</td>
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<td>0.125</td>
<td>0.064</td>
<td>0.064</td>
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<td>0.057</td>
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<td>0.113</td>
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<td>.208**</td>
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<td>.703**</td>
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<td>.282**</td>
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<td>0.068</td>
<td>0.069</td>
<td>.188**</td>
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<tr>
<td>12</td>
<td>5.16</td>
<td>1.00</td>
<td>.370**</td>
<td>.386**</td>
<td>0.073</td>
<td>0.089</td>
<td>0.009</td>
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<td>.140*</td>
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<td>0.129</td>
<td>0.040</td>
<td>.218**</td>
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</table>

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).
TABLE 3
Hierarchical regression with the performance of the relationship with external partners as dependent variable

<table>
<thead>
<tr>
<th>Control variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
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<tbody>
<tr>
<td>Transformational Leadership</td>
<td>.24***</td>
<td>0.12*</td>
<td>.14*</td>
<td>0.14*</td>
<td>0.14*</td>
</tr>
<tr>
<td>Interfunctional connectedness</td>
<td>.28***</td>
<td>.14*</td>
<td>.13*</td>
<td>0.13*</td>
<td>0.13*</td>
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<td>Brand and marketing</td>
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<td>-0.04</td>
<td>-0.07</td>
<td>-0.07</td>
<td>-0.08</td>
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<tr>
<td>Timing of market entry</td>
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<td>0.02</td>
<td>0.04</td>
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<td>0.05</td>
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<td>Project size</td>
<td>-0.01</td>
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<td>0.02</td>
<td>0.02</td>
<td>0.01</td>
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<tr>
<td>Company size</td>
<td>-0.01</td>
<td>-0.02</td>
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<td>0.02</td>
<td>-0.02</td>
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<table>
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<tr>
<th>Main Effect</th>
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<tr>
<td>Trust</td>
<td>0.63***</td>
<td>.66***</td>
<td>0.66***</td>
<td>0.67***</td>
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<tr>
<td>Contracts</td>
<td>-0.01</td>
<td>0.03</td>
<td>0.03</td>
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<tr>
<td>Incremental Innovation</td>
<td>-0.01</td>
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<td>-0.01</td>
<td>-0.01</td>
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<tr>
<td>Radical Innovation</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.06</td>
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<table>
<thead>
<tr>
<th>Two-way interactions</th>
<th>(-0.15**) (0.16**) (-0.16**)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trust x Contract</td>
<td></td>
</tr>
<tr>
<td>Trust x Incremental Innovation</td>
<td>-0.03</td>
</tr>
<tr>
<td>Contracts x Incremental Innovation</td>
<td>-0.03</td>
</tr>
<tr>
<td>Trust x Radical Innovation</td>
<td>0.01</td>
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<tr>
<td>Contracts x Radical Innovation</td>
<td>.12*</td>
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</table>

<table>
<thead>
<tr>
<th>Three-way interactions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Trust x Contracts x Incremental</td>
<td>-0.02</td>
</tr>
<tr>
<td>Innovation</td>
<td></td>
</tr>
<tr>
<td>Trust x Contracts x Radical Innovation</td>
<td>.108*</td>
</tr>
</tbody>
</table>

| R Square                              | 0.20  | 0.54  | 0.58  | 0.58  | 0.58  |
| Adjusted R Square                     | 0.17  | 0.52  | 0.54  | 0.54  | 0.55  |
| R Square Change                       | 0.20*** | 0.34*** | 0.04** | 0.00 | .01*  |

*p < .05  *p < .01**  **p < .001***
## TABLE 4

Hierarchical regression with Product Performance as dependent variable

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength of Appropriability position (Patent)</td>
<td>0.110</td>
<td>0.090</td>
</tr>
<tr>
<td>Brand name and marketing</td>
<td>0.110</td>
<td>0.093</td>
</tr>
<tr>
<td>Project size</td>
<td>(0.153*)</td>
<td>(.154*)</td>
</tr>
<tr>
<td>Company size</td>
<td>-0.087</td>
<td>-0.087</td>
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<tr>
<td><strong>Independent Variables</strong></td>
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<tr>
<td>Performance of the relationship with external partners</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>R Square</strong></td>
<td>0.051</td>
<td>0.108</td>
</tr>
<tr>
<td><strong>Adjusted R Square</strong></td>
<td>0.032</td>
<td>0.085</td>
</tr>
<tr>
<td><strong>R Square Change</strong></td>
<td>.051*</td>
<td>.056***</td>
</tr>
</tbody>
</table>

*p < .05 * p < .01 **
*p < .001 ***
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