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Incentivizing supplier participation in buyer innovation: Experimental evidence of non-optimal contractual behaviors

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ABSTRACT

Original equipment manufacturers increasingly involve suppliers in new product development (NPD) projects. How companies design a contract to motivate supplier participation is an important but under-examined empirical question. Analytical studies have started to examine the optimal contract that aligns buyer-supplier incentives in joint NPD projects, but empirical evidence is scarce about the actual contracts offered by buying companies. Bridging the analytical and empirical literature, this paper compares optimal contracting derived from a parsimonious analytical model with actual behaviors observed in an experiment. In particular, we focus on how project uncertainty, buying company effort share, and buyer risk aversion influence three contractual decisions: total investment level, revenue share and fixed fee. Our results indicate significant differences between the optimal and actual behaviors. We identify various types of non-optimal contractual behaviors, which we explain from a risk aversion as well as a bounded rationality perspective. Overall, our findings contribute to the literature by showing that (1) the actual contractual behaviors could differ significantly from the optimal ones, (2) the actual contract design is sensitive to changes in project uncertainty and buying company effort share, and (3) the significant roles of risk aversion and bounded rationality in explaining the non-optimal contractual behaviors.

1. Introduction

Original equipment manufacturers (OEM) are more and more relying on suppliers for innovations. In a 2015 CAPS research survey, 83% of responding companies either had or were planning to have formal supplier innovation programs in place so as to capture valuable ideas and information from suppliers (Jennings, 2015). However, there is mixed empirical evidence regarding the effectiveness of supplier involvement for enhancing buying company NPD performance (Primo and Amundson, 2002). To explain why, the empirical literature has mostly focused on pre-contract strategies, such as supplier base rationalization, supplier integration, supplier selection (Petersen et al., 2005), or post-contact tactics, such as supplier involvement timing, supplier design responsibility, or project execution (Parker et al., 2008; Yan and Dooley, 2014). Relatively less attention has been focused on the contracting process that the buying company uses to motivate supplier participation, which seems to imply an assumption: a supplier is always willing to participate in buyer innovation projects irrespective of the contract. This assumption is problematic because a supplier, as an autonomous organization, could reject a buying company's offer that is either too risky or does not produce enough return for the supplier, especially when the supplier possesses valuable resources for buying company innovation (Barney, 2012). Of the few empirical studies that examine contract design in innovation, the focus has been on comparing the effectiveness of fixed-price and flexible contracts (cost sharing or performance based) in various task contexts (Carson et al., 2006; Gefen et al., 2008; Gopal and Koka, 2010; Gopal and Sivaramakrishnan, 2008). However, even if a certain type of contract performs better from a buying firm perspective, that does not mean a supplier necessarily sees the value of the contract and ultimately accepts the contract. Therefore, one empirical question still remains unanswered: how does a buying company determine contractual parameters (i.e., fixed fee, revenue share, etc.) when motivating a supplier to accept the contract in a joint NPD context?

The analytical contract management literature has extensively studied contractual coordination in a buyer-supplier production context. The focus of this stream of work is on the design of a contract, specified by parameters, such as revenue share, fixed fee, investment levels,

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quantity discounts, that maximize supply chain utility by aligning buyer and supplier incentives (Cachon, 2003). Within this stream of work, there is an emerging set of studies that examines contractual coordination in an inter-firm joint innovation context, which represents a more tacit and uncertain knowledge exchange context when compared to the traditional product exchange settings (Yan and Kull, 2015). Most of these studies assume risk-neutral decision makers, which has been shown to be unrealistic. Decision makers are generally risk averse according to the decision making under uncertainty literature (March and Shapira, 1987). In particular, a risk averse decision maker prefers a certain profit to a risky profit, even when the certain and risky profits have the same expected value (Gan et al., 2011). In fact, Ülkü et al. (2007) points out that "by not negotiating on risk, parties leave money on the table" (p.238). Given the possible influences of risk-sensitivity on contractual designs, it is necessary to see how buyer risk aversion influences the contractual design, particularly, in a highly uncertain supply chain context, such as a joint new product development project (Ülkü et al., 2007). In addition, very few "optimal" contractual behaviors specified in the analytical NPD literature have been empirically validated. By saying "contractual behaviors", we refer to the relationship between a contractual parameter and a contextual variable, or how a particular contractual decision, such as fixed fee, changes in relation to changes in a contextual variable, such as project uncertainty, effort split, and buyer risk aversion. Given the fact that decision makers have individual biases (i.e. risk aversion) and bounded rationality, it is important to examine whether a buying company decision maker, shortened as buyer hereafter, behaves optimally when offering a contract to a supplier, and if not, how and why the actual behavior differs from the optimal one (Simon, 1982).

To fill the above literature gaps, we adopt a multi-method approach to examine how a buyer designs a contract to motivate supplier participation in a NPD project. Specifically, we want to answer two questions: *(1) How do the characteristics of a NPD project context and risk aversion of a buyer influence the optimal and actual contractual behaviors? (2) Do the actual contractual behaviors of a buyer match the optimal ones? If not, why?* We chose to focus on two contextual characteristics of an inter-organizational NPD context, project uncertainty and buyer-supplier effort split, which help differentiate a buyer-supplier NPD context from a mass production context. Unlike a mass production context which is usually about existing products, a NPD task faces significant uncertainty because the new technology used for developing the product could fail or the newly developed product may not perform well in the market. Buying company effort share is another critical contextual factor. In a mass production context, a supplier usually does the complete job (100% supplying company effort share) in order to get compensated by a buyer financially. In contrast, in a joint NPD project, a buyer and a supplier could share the total development efforts, usually in a way that is determined by the nature of the technology involved and the skill sets of the two firms (Bhaskaran and Krishnan, 2009).[2]

We answer the two questions by adopting a multi-method approach. To answer the first question, we set up a mathematical model to see how the two contextual variables and buyer risk aversion influence the optimal contract design (Wacker, 1998). In particular, we focus on the total cost and the transferrable payment of a typical buyer-supplier contract, which is characterized by three contractual parameters (Katok and Wu, 2009; Zhang et al., 2016). To capture the cost aspect, we look at the investment level (the first parameter) that the buying company and the supplier together need to commit to the project. Regarding the transferrable payment between the two firms, we focus on revenue share (the second parameter) and fixed fee (the third parameter), which are two typical ways for the two firms to share revenue and cost from the joint effort (Cachon, 2003). Then we run a behavioral experiment to test hypotheses derived from the math model. By comparing the mathematical and experimental results, we answer the second research question.

This study contributes to the literature in two ways. First, we contribute to the supplier involvement in NPD literature by examining how project uncertainty, buying company effort share and buyer risk aversion influence the optimal as well as actual contractual designs. Second, we contribute to the behavioral operations management literature by explaining the differences between the mathematical and experimental results. In particular, we focus on two possible mechanisms to explain non-optimal behaviors: (1) risk aversion, a type of individual biases, which changes the utility functions to include not only the expected profit but also a risk premium (Katok and Wu, 2009), and (2) bounded rationality, or the fact that decision makers want to maximize their expected profit, but make errors in doing so (Kahneman et al., 1982).

2. Literature review

There is abundant empirical evidence about benefits of involving suppliers in an OEM's NPD process. Suppliers contribute to buyers' product innovation efforts in a wide variety of ways. One major benefit can be a more efficient development process (Kessler et al., 2000), better product quality (McGinnis and Vallopra, 1999), and improved product manufacturability (Swink, 1999). When engaged in the process at the right time with an appropriate level of design responsibility, suppliers contribute to the success of a buyer's NPD project by providing access to advanced technology, helping understand design feasibility, improving translation of customer requirements into manufacturing specifications (Parker et al., 2008). More recent NPD studies start to show challenges of managing suppliers in a buyer's innovation process (Yan and Dooley, 2014; Yan and Kull, 2015). The difficulty of integrating two highly differentiated groups suggests the possibility of inefficient process and low-quality designs (Yan and Dooley, 2013). Furthermore, a buying company might involve suppliers that are neither willing nor capable to undertake collaborative NPD, which might force buyers to spend limited project resources to motivate or develop suppliers and thus deter project progress (Lawson et al., 2014). To safeguard against these risks, the literature emphasizes a collaborative buyer-supplier relationship as well as utilizing contractual governance (Wang et al., 2011).

Most of these empirical studies, however, examine activities or problems that happen after a supplier agrees to participate in a buying company NPD project. Not much attention has been given to the contracting process that is used to motivate supplier participation through aligning buyer-supplier incentives. Some empirical work, however, does allude to the importance of contract management in an innovation context: MacCormack and Mishra (2015) show the significant influence of contract choices on the relationship between partner integration and alliance performance, while Ederer and Manso (2013) find that flexible contracts within a firm provide the greatest incentives for employees to innovate when compared to fixed-fee and pay-by-performance contracts. There are also few studies that examine the effectiveness of fixed price, cost/material sharing, and performance-based contracts vary in different outsourcing contexts (Gefen et al., 2008; Gopal and Koka, 2010; Gopal and Sivaramakrishnan, 2008). Finally, the literature also showed that relational governance complement formal contract in more ambiguous, uncertain and complex innovation contexts (Carson et al., 2006; Mani et al., 2012).

However, one empirical question remains unanswered: how does a buying company determine contractual parameters (i.e., fixed fee, revenue share, etc.) for aligning buyer-supplier incentives in a joint NPD context? Disparate incentives, if not aligned, could demotivate the participation of a capable supplier and/or cause the involvement of an incapable supplier (adverse selection), and even if the supplier agrees to get involved, could induce supplier opportunism (moral hazard), a

[2] Although our model is built to study buyer-supplier NPD, it could be generalized to any inter-organizational collaboration context where two parties jointly complete a highly uncertain task.