Initiating and Sustaining Supplier Involvement in Development Projects: Behavioral Aspects in the Contract Design

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1. Motivation

Manufacturers increasingly rely on external partners to engage in new product development due to the heightened product complexity and knowledge specificity required for modern development projects (Bhaskaran and Krishnan 2009). Suppliers are a key source of innovations since they often possess both unique knowledge, and the resources required of new product development activities (Billington and Davidson 2012, Quinn 2000).

Coordination and cooperation is not automatic between decentralized supply chain partners, this is especially true of development projects (van Echtelt et al. 2008, Karlsson et al. 1998). In this paper we examine coordination issues that may arise when the decision rights associated with R&D investments, as well as the underlying development risks, are shifted from the manufacturer (buyer) to the supplier. In such a setting, a key question for the buyer is how to develop a contractual relationship that entices the supplier to invest in innovation while sharing the revenue gains associated with the more innovative product. Our goal is to provide insights into what factors influence the supplier's decision to initially accept to enter into an innovation contract, as well as the likelihood that the supplier will continue the R&D investment once the cost of the innovation becomes more apparent.

More specifically, we study a contract that allows the buyer (Stackelberg leader) to offer increased revenues to the supplier (follower) if the supplier develops an innovation,

and a penalty if the supplier starts to develop, but later abandons the innovation. The buyer's problem is to set the revenue and penalty terms in such a way that they initiate and sustain supplier involvement in development projects. The supplier, in turn, decides whether to accept the contract and, if accepted, whether to continue with the innovation as costs become more apparent. Formally, we model this using an update of the cost distribution through a signal observed by the supplier. Let us summarizes some of the key findings that we derived from the analysis of our formal model under the assumption of profit-maximizing suppliers. We find

- a necessary and sufficient condition for the supplier to continue a contract given contract parameters and updated cost expectations,
- a necessary and sufficient condition for the supplier to accept a contract offer,
- the optimal contract which the buyer should propose,
- Pareto optimality and channel coordination under the proposed contract,
- and that this contract belongs to the class of best contracts which a buyer could offer, i.e. even considering further parameters would not lead to higher expected profits.

However, it is well known from the behavioral economics literature on decision making under uncertainty that individuals can deviate from profit maximizing behavior in such complex settings (c.f. Bendoly et al. 2006, Katok and Wu 2009). Understanding how the supplier's behavior may deviate from normative predictions will help the buyer make better informed contract design decisions (Becker-Peth et al. 2013). Therefore, we take our model and the above-presented results as a normative benchmark and seek to answer two research questions: (1) What are the underlying behavioral factors that influence the supplier's decisions?, and (2) how can the buyer create a contractual environment to more effectively incentivize supplier innovation?

2. Hypotheses

There are several theories which guide our hypotheses development. First, we consider Prospect Theory in combination with Social Exchange Theory when we hypothesize how framing the contract might influence the supplier's acceptance decision. While the baseline frame relies on breach penalties to incentivize the supplier's continuation as described

above, an alternative contract could rely on rewards. More precisely, under this alternative frame, the buying firm could offer a guaranteed revenue to the supplier. If the supplier accepts the contract, he will receive the guaranteed revenue independent of his continuation decision. If, however, he continues, he will receive an additional reward. We find that the optimal decision for the buyer is to incorporate the amount of the breach penalty in the guaranteed revenue. The reward, in turn, covers the prior deduced breach penalty and the expected development costs. We then establish the mathematical equivalence of both frames — for each of the supplier's strategy the outcomes are the same as in the penalty frame. The equivalence allows for studying the pure behavioral implications of using different frames. Against Prospect theoretical reasoning, the supplier should feature a higher propensity to accept under the reward contract because the penalty could be interpreted as uncompensated loss opposed to the gap between guaranteed revenue and outside option, which might rather be considered as necessary up-front investment. Likewise, Social Exchange Theory predicts that suppliers would rather engage in agreements which involve rewards than those which involve penalties. Hence,

HYPOTHESIS 1 **(Framing)**. *The acceptance rate of the reward contract is higher than the acceptance rate of the penalty contract.*

In order to identify more sources of deviations from the normative benchmark, one can decompose the value of the innovation into a core component and a real options component. The former is due to the gap between revenue increase and expected costs. The latter results from the option of breaching a contract based on updated cost information. From a behavioral perspective, the real options value is of particular interest as its estimation bears a large cognitive load because it requires more sophisticated evaluations. Related research on valuing options and information (e.g. Arrow and Fisher 1974, Rauchs and Willinger 1996) indicates that people generally understand the concept of option value. However, often the fail to estimate it correctly. In our specific setting we hypothesize,

HYPOTHESIS 2 **(Real options value)**. *Real suppliers are more likely to accept an offer, ceteris paribus, if the real options value represents a small fraction of the overall innovation value.*

We also study the supplier's continuation decision as it might be affected by two effects: consistency and sunk costs. Consistency refers to the effect that people are reluctant to change their judgment: If I accepted a contract initially, I intend to carry it out and stick to my former decision to develop the innovative version. Formally, we relate this effect to Festinger (1957)'s theory of cognitive dissonance.

HYPOTHESIS 3 (**Consistency**). *Individuals are more likely to continue R&D investment if they also made the initial contract decision.*

Finally, previous studies have shown that once costs have occurred, people are reluctant to stop projects even when they should. In our setting this would imply,

HYPOTHESIS 4 (**sunk cost**). *The continuation rate will increase with the magnitude of sunk cost.*

3. Experiments

To test our hypothesized predictions and gain insight into how suppliers may deviate from normative theory, we conducted a series of controlled laboratory experiments. We used a computer-interface written in Google script. Participants took part in two different tasks whose order was systematically varied. The experiment was run in a large public university in the American Midwest. The participants were recruited through the business school's subject pool. In total, 110 students participated. After finishing a total of 40 rounds, participants responded to a demographic survey and gave a qualitative description of their strategies.

We used a 2×3 design with two frames (penalty/ reward) and three effects (baseline/ high real options value/ high sunk costs) and the two distinct tasks for each subject (acceptance - continuation, continuation only). Having each subject do both tasks enabled us to test the consistency hypothesis.

We ran several models to test our hypotheses with the two key dependent variables of interest in our study: Acceptance decisions and continuation decisions. We model our data in a random effects probit framework. Independent variables were the different experimental treatments and their interactions, as well as control variables for order effects,

individual risk attitude measures, undergraduate vs. graduate students, number of business courses taken, major, and the natural log of the time period of the decision to control for learning effects.

4.   Findings and discussion

Overall, we find support for the hypothesis that the penalty contract leads to lower acceptance rates than the reward contract. This suggests that sourcing managers should consider rewards rather than penalties as a way to motivate their suppliers to undertake new product development. From a legal point of view, this implication is positive as it is usually easier to withhold rewards than it is to enforce penalties. In turn, managers of suppliers should be aware of their acceptance bias. In our baseline reward treatment, we find that about 62% of contracts with negative expected value have been accepted opposed to a rejection of only 22.5% of economically attractive contracts.

Moreover, analyzing the structure of profit generated by the innovation, we find two components: its core value and its real options value. It is common to distinguish between two types of innovations, namely incremental innovation and radical innovation (eg. Ettlie et al. 1984, Song and Thieme 2009). In our context, incremental innovations imply low real options value since costs are fairly predictable, right from the beginning, and less information will be gained. Our findings indicate that, when facing incremental innovations, sourcing managers may seek to obtain the entire innovation value by setting contract parameters accordingly. When facing radical innovations, however, a better strategy is not to demand the entire real options value, for suppliers may reject the contract.

Finally, we find strong support for the consistency hypothesis. Therefore, buyers should take their suppliers' decision authorities into account. For instance, if a sourcing manager deals with a small supplier whose CEO makes all R&D related decisions, the sourcing manager may assume that the CEO exhibits a consistency tendency and thus a breach penalty lower than the profit-maximizing benchmark would be required, which, in turn, increases the acceptance probability. However, we do not find support for the sunk cost effect. This indicates that not sunk costs per se, but only the consistency effect leads to escalated commitment.

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