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# An analysis of risk sharing in strategic R&D and new product development projects

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**Abstract**

While prior research regarding strategic projects recognizes the tension inherent in interfirm relationships, less is understood of the impact of risk sharing in the design of the contracts guiding those relationships. This investigation illuminates important performance elements of projects as they differ in the amount of contractual risk that is shared among firms. Through a multivariate analysis of 240 United States defense department R&D and new product development contracts, we found that defense contracts with partner risk sharing built in involve more change and growth than their concentrated risk counterparts. Our results suggest that projects, when managed through interfirm contracts, are more likely to involve strategic change when risk is shared than when either the buyer or seller assumes full design, technical, and/or financial risk. The results further suggest that projects containing shared buyer and seller risk enhance the prospects of joint gain through the generation of opportunities for learning.


*Keywords:* Projects; Risk-sharing; Contracts; Strategic management; Collaboration

## 1. Introduction

Greater than one-fifth of the world's gross domestic product, over $12 trillion dollars, was planned to be spent on projects in 2014 (Project Management Institute (PMI), 2014). Yet, we do not fully understand how these temporary endeavors affect the organization's permanent systems or its alliances with other organizations (Sydow et al., 2004; Windeler and Sydow, 2001). Research on strategic projects suggests that firms use contracts to scope out projects, manage joint ventures, encourage cooperation (Adler, 2007; Ring and Van de Ven, 1992; Zaheer et al., 2002), and, in general, implement firm strategy. As Triana notes (2014: 3): "Based on PMI's research, the Board's thinking and also by my own experience as a practitioner, project management is growing and becoming more strategic…we can see that more executives around the world are linking organizational business strategy and projects."

In this manuscript, we are interested in exploring strategic projects to determine whether risk management strategies embedded within the contract are related to key project outcomes. Specifically, we consider how the construction of a project contract provides evidence for managing the financial risk associated with unplanned changes to project deliverables. We partition this risk into three distinct contract risk-sharing profiles: risk born primarily by the seller of products and/or services, risk born primarily by the buyer of the products and/or services, and risk that is shared between the buyer and the seller. Furthermore, we are interested in exploring whether the contract risk profile is related to key contract outcomes such as cost and scheduling budget overruns, and engineering change proposals that occur during the life of the project contract.

To test our hypotheses, we use a robust data set that includes 240 contracts from the Air Force Material Command (AFMC) located at Wright–Patterson Air Force Base in Dayton, Ohio.

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AFMC serves as the primary center for the acquisition of weapon systems by the Air Force and the contracts surveyed represent projects related to Research and Development (R&D) and new product development (NPD). The data include a wide range of contractual terms and conditions spanning divergent R&D and NPD projects. The time period in which these data were collected, 1970–2003, reflects a time of continued, radical acquisition reform by the U.S. government (Fox, 2011). Morris (1997) provides a historical perspective of U.S. military acquisitions during this period that includes issues such as a lack of cost and schedule control because of an over-fixation of the Soviet threat, high technical uncertainty, and the overuse of cost-plus fixed fee contracts. According to Fox (2011), this led acquisition reformers to issue the Carlucci Initiatives in 1981 (also known as the Acquisition Improvement Program), Department of Defense (DOD) Directives 5000.1 and 5000.2 in 1985, and the Blue Ribbon Commission in 1986 to decentralize decision making in military research and development.

These reforms were intended to solve the three major problems facing military acquisitions: long program stretch outs, costly project starts and cancellations, and poorly developed program requirements (Guthrie, 1978). Fox (1988) pointed out, however, that the major problem in managing military contracts was the lack of business acumen by military project managers. The DOD quickly instituted a project (acquisition) certification program to improve project management competencies, especially in how to structure and manage DOD contracts with industry partners. Hence, incentive-based contracts that shared risk between contractors and the government became popular and part of the ensuing military–industrial partnership mind frame. It is in this period that the U.S. military R&D budget doubled from $142 billion to $246 billion (Fox, 2011) and contributing to this growth was the fruitful collaboration between military suppliers and DOD in the military procurement process.

As the dominance of innovation makes DOD procurement an unusual case, we agree with Williamson (1985) that defense contracts are akin to market-like exchanges. Thus, these contracts and their supporting documentation enabled us to record the different risk-sharing conditions, negotiation tactics, and project work requirements upon which the project was based, allowing us to code for indicators of trust and distrust in the relationships. Access to this level of data provides a unique opportunity to examine a fine-grained level of detail regarding the underlying framework of business partnerships as archived in these organizational contracts.

## 2. Literature review

### 2.1. Strategic project contracts

Projects have been demonstrated as a key aspect of implementing an organization's strategy (Adler, 2007; DeFillippi and Arthur, 1998; Engwall and Westling, 2004; Hobday, 2000; Manning, 2010; Manning and Sydow, 2011; Morgan et al., 2007; Schwab and Miner, 2008; Sydow et al., 2004). A Guide to the Project Management Body of Knowledge (2013) defines a project as being short-term (Piore and Sabel, 1984; Schilling and Steensma, 2001; Zenger and Hesterly, 1997) and temporary in nature (Sydow et al., 2004). As such, projects provide a means for organizations to focus on the immediacy of organizational needs in dealing with complex marketplace disruptions or opportunities. Other advantageous uses of projects include making process changes, initiating new ventures, and increasing customer involvement (Jones et al., 1997; Lampel et al., 2000; Storper, 1989). Following these authors, we posit that many projects are embedded into organizational change processes using contracts and their language.

Organizational scholars have long considered contracts as instruments of projects to get work done (Adler, 2005; Bubshait, 2003; Ryall and Sampson, 2009; Sommer and Loch, 2009). In the management of projects, contracts are used in most cases by DOD project oversight teams generally consisting of 3–5 members to manage the transaction. Drawing from well-known scholars like Coase (1937), Macaulay (1963), and Macneil (1978), contracts delineate the scope of the project, terms and conditions to accomplish the project, and conditional enforcement mechanisms regarding partner behavior (Blomqvist et al., 2005). Contracts serve as project communication devices describing not only what is to be communicated but also how it will be accomplished (Adler, 2005; Malhotra and Murnighan, 2002; Roxenhall and Ghauri, 2004; Williamson, 1975). Perceptions of cooperation or manipulation arise from how business partners work in accordance with the contract's intent versus its literal interpretation.

In this article, we extend the work of those who have built a foundation of trust and distrust for studying risk-sharing in R&D and NPD contracts (Camén et al., 2011; Graebner, 2009; Gulati, 1995; Jeffries and Reed, 2000; Lewicki et al., 1998; Luhmann, 1979; Meyerson et al., 1996). We view project contracts as extensions of organizations through the exploration and exploitation aspects (Engwall and Westling, 2004) contained within the terms and conditions of contracts that allow for joint innovation. Sharing risk between parties to a contract allows for better project integration since vulnerabilities in the innovation relationship are explored in the pre-negotiation, negotiation, and post-negotiation phases of the project (Schweitzer et al., 2004). Using contracts to codify project terms and conditions provides organizations with a mechanism to legally review and commit to terms and conditions and share risk in new ventures. When constructed properly, project contracts provide opportunities for greater returns by leveraging limited organizational resources that would not be possible in many other, traditional work arrangements (e.g., sharing of assets).

### 2.2. Comprehensiveness in project contracts

In serving as a mechanism for managing risk, contracts are written with terms and conditions that communicate how to best coordinate project requirements while controlling for risk (Adler, 2007; Gulati and Nickerson, 2008). Contrary to the argument that trust reduces the need for formal contracts (Malhotra and Murnighan, 2002), scholars have found that contracts become more detailed the more frequent the exchanges between business partners (Adler, 2005; Graebner, 2009; Ryall and Sampson, 2009).

Risk sharing is the most complex of business relationships (Lewicki et al., 1998), thus making the development and management of the project contract of considerable importance. The anticipation and possible actualization of deception by either seller or buyer is typically present (Graebner, 2009), however, and scholars have stated that deception by buyers is "standard practice" (Buono and Bowditch, 1989: 256). Marks and Mirvis (2001: 87) have gone even further, stating that "prior promises mean nothing." The use of deception is so pronounced that many managers find there is no way to prevent it from happening (Pittz and Adler, 2014; Zhang and Rajagopalan, 2002). International settings further complicate contracting due to differing laws and cultural norms. Lazarus and Folkman (1984: 32) suggest that threats of deception are nothing more than "harms and losses that have not yet taken place but are anticipated" in an international business venture. It was to avoid deception, possible disputes, and protracted legal battles that the British Airports Authority (BAA) used a legally binding T5 Agreement to allow contractors to collaborate (Davies et al., 2009). Instead of worrying about BAA litigation, contractors were allowed to collaborate in the design and build of the London Heathrow Terminal 5. BAA, as buyer, agreed to coordinate and control efforts of the many contractors involved so that one of the primary contractors on the T5 project, Laing O′Rourke (LOR), could serve as a catalyst for transferring lessons learned in follow-on projects.

An interesting aspect of this case is that the BAA was an active participant rather than overseer as a buyer and could therefore work with the contractors such as LOR to come up with innovative solutions to problems. While the BAA espoused a shared-risk approach, they took the lion's share of public criticism for major delays and cost overruns, even if it was the contractor's sole fault. With BAA assuming the risk in this project, contracts were naturally less comprehensive since safeguards against opportunism and mal-performance were not included. While collaboration was evident in this case, this is not to imply that collaboration equals risk sharing. Without unfettered collaboration among contracts, risk sharing many times requires a more detailed and formal approach leading to more comprehensive contracts.

Comprehensive contracts then are more structured (Ciborra, 1987) and less relational and can provide a roadmap for assessing and mitigating risks, particularly in projects related to R&D and NPD where project scope is difficult to pin down. As Nelson (1993) explains, determining where distinctions of exploration and invention (i.e., the R&D process) and desirable performance characteristics to meet customer needs (i.e., the NPD process) end and begin is a matter of real difficulty. Our study contributes to better understanding how innovation occurs under different risk-sharing scenarios in R&D and NPD contracts.

The comprehensiveness of project contracts reflects the amount of risk that is shared by partners in a project. Comprehensiveness typically refers to the extensiveness in which information from the environment is gathered and processed (Forbes, 2007; Fredrickson and Mitchell, 1984; Perry, 2001). In this study, we define contract comprehensiveness as the extent to which a DOD project team is exhaustive or inclusive in formalizing a project contract so that all necessary terms, conditions, and clauses are included. This is based on Atuahene-Gima and Li's (2004) definition and captures the extent to which the DOD project team governing the contract uses a flexible and wide lens to consider multiple approaches, multiple avenues to administer the contract, and multiple criteria to evaluate performance.

In an attempt to contribute to our understanding of comprehensiveness in a project contract setting, we surveyed 240 Department of Defense contracts to explore whether the amount of risk assumed by buyers and sellers in a project is related to the level of detail and legally binding language in the contract itself. Unlike relatively straightforward contracts (e.g. construction), these DOD contracts represent complex arrangements (Berrios, 2006; Stremersch et al., 2001) involving significant resources, stakeholders, and uncertainty surrounding the final deliverable. Our expectation was that a contract that represented shared risk between buyers and sellers in a project would be more comprehensive than a contract where either the buyer or seller assumed all of the project performance risk. Explicit contracts allow project teams to achieve better alignment with organizational goals according to Woolthuis et al. (2005). Their study of the "Pharm Venture" suggests that risk sharing and cooperation can be achieved even when there are stringent government regulations like in the case of DOD projects. To assess the comprehensiveness of a contract, we reviewed the "statement of work" since it represents the "primary source of all functional and technical customer requirements" (Thomas 2010: 71).

**Hypothesis 1**. *The length of the statement of work, the number of engineering change proposals, the unplanned growth in project schedule, and the unplanned growth in project costs will differ across three types of DOD contracts: one-sided buyer risk, shared buyer and seller risk, and one-sided seller risk.*

**Hypothesis 2**. *The length of the statement of work will be positively related to risk sharing in government contracts, such that it will be longer in contracts representing shared buyer and seller risk than in contracts representing one-sided buyer or seller risk.*

### 2.3. Risk-sharing in project contracts

While it is generally agreed in the literature that comprehensiveness increases performance with realistic evaluations of strategic choices, empirical findings have often met with inconclusive results as to how information is shared and how performance is measured (Forbes, 2007; Miller, 2008; Meissner and Wulf, 2014). On its face, there are many ways to measure performance that need to be considered when contracts are used to manage megaprojects. Certainly accommodating project risk is an important consideration in project planning, especially with regard to how scope, cost, and schedule parameters are measured. Contracts reflect project risks in the form of adjusted prices, milestones, and contractual terms and conditions. Contractual terms and conditions become more

detailed and more explicit with greater technical uncertainty. Project risks get encoded as requirements, terms and conditions, and events that can occur that would negatively affect the accomplishment of organizational and project goals (Adler et al., 1999).

When both partners in a two-party scheme are involved in identifying and planning responses to future project risk, there would naturally be more things to consider and more to respond to given potential risk scenarios. In fact, an important benefit of shared risk is that partners consider and conceive of new ways to brainstorm so that requirements are identified and explained proactively. One-sided risk-bearing partnerships, conversely, tend to be less explicit since either the buyer or seller is trying to safeguard against possible deception and self-interest seeking with guile. Given the nature of high-technology development, project teams operating in a concentrated risk contract environment have difficulty anticipating the intentions and future actions of their trading partner and this is reflected in less dense, less optimum safeguarding, monitoring, and controlling contract explicitness.

Thus, post-hoc contract changes are inevitable especially given the limitations of project teams in high-technology environments regardless of the risk-sharing profile. Requirements get left out, are understated, and change as innovation occurs. The main issue with contract changes is how parties to the contract view changes in the development process. Woolthuis et al.'s (2005) study of the "Pharm Venture" suggests that when there is trust between trading partners, detailed contracts are not written to safeguard against opportunism (Williamson, 1975) but are more likely to show partner commitment to one another through transparency. Sharing risks would also lead to higher commitment and trust since both sides are free from worrying about opportunism. Thus, changing contract requirements when risk is shared would be an advantage as this would more likely reflect changes in technology with long-term contracts, changes in project goals, changes in personnel, and changes in how project processes are conceived and executed. Contract changes under shared risk reflect a healthy relationship while changes in one-sided risk partnerships would be viewed as possibly opportunistic and, thereby, limiting to the innovation process.

In the case of DOD development contracts, any design, technical, or functional changes to a project deliverable are noted within the contract as "engineering change proposals." These engineering change proposals reflect trust in shared-risk situations since partners realize that contract alterations to a project deliverable are more the result of new ideas and learning from previous project work than opportunistic behavior (Adler, 2005; Woolthuis et al., 2005). When both buyer and seller share risks, change is more likely to occur to the contract since both sides do not feel threatened by opportunism. Engineering change proposals thus serve as an instrument, using Rose-Anderssen et al. (2008) framework, from which both buyer and seller can find commonality while cooperating in the innovation process. The quantity of engineering change proposals will be higher in project contracts that reflect shared risk than in those when either the buyer or seller bear full responsibility.

**Hypothesis 3**. *The number of engineering change proposals will be positively related to risk sharing in government contracts, such that more engineering change proposals will be present in contracts representing shared buyer and seller risk than in contracts representing one-sided buyer or seller risk.*

While the opportunity for learning during unplanned changes to a strategic project is robust, learning does not come without a cost. Variances to expected project costs and schedule coincide with unplanned changes and the sharing of project risk. The lessons learned during a project reveal more opportunities for design, technical, and functional changes, increasing the cost of the project and lengthening the timeline to completion. As the sharing of project risk has the potential to create unplanned changes to project deliverables, it also can affect the cost and schedule of the overall project. We anticipate this relationship between risk sharing and cost and scheduling variance to exist in our study of DOD contracts and, therefore, hypothesize the following:

**Hypothesis 4**. *The amount of unplanned growth in the contract schedule will be positively related to risk sharing in government contracts, such that more schedule growth will occur in contracts representing shared buyer and seller risk than in contracts representing one-sided buyer or seller risk.*

**Hypothesis 5**. *The amount of unplanned growth in contract costs will be positively related to risk sharing in government contracts, such that more cost growth will occur in contracts representing shared buyer and seller risk than in contracts representing one-sided buyer or seller risk.*

## 3. Methods

Following other research methodologies investigating project effects (Schwab and Miner, 2008), we randomly sampled 240 DOD contracts that occurred between 1970 and 1993. Both private and public seller firms were included in the study and firm size ranged from $222k to $123b in annual sales. To enhance generalizability, the period was specifically chosen because it pre-dates the creation of a national public database documenting contract misconduct (POGO, 2014) as we wanted data untainted by the perceptions of misconduct that could alter risk sharing terms and conditions. For this analysis to be applicable to other contractual settings, it was important to utilize data from contracts that were not altered by public perception of fraud. We chose military contracts because as Sydow et al. (2004: 1480) suggest, "projects with a duration of 10 to 15 years, not uncommon within the military and pharmaceutical industries, should give rise to knowledge/learning features which are not very different from those of permanent organizations." We believe that the study of military contracts adds insight into a business relationship where all three forms of risk sharing are possible as we discuss in this study.

We also grouped R&D and NPD contracts together in our investigation which allowed for the study of project contracts from one perspective—that of the development in high technology (Keller, 2001). As discussed previously, the differences between

R&D and NPD are sometimes tenuous and made difficult when military R&D (e.g., design prototyping for experimentation) is compared with military NPD (e.g., early design testing of product or service characteristics). Consequently, many authors have grouped R&D and NPD efforts together in innovation and development studies (Keller, 2001; Kessler and Chakrabarti, 1996; Ryall and Sampson, 2009). Our investigation of DOD contracts should increase our knowledge on how projects affect the tension between the fluidness of development projects and the permanency of organizations.

Following Mouzas and Ford's (2007) framework for degree of detail in a contract, the dependent variables tested in our study are comprehensiveness of the contract (represented by the length of the contract as detailed by the number of lines in the statement of work document), organizational learning (represented by the number of engineering change proposals occurring during the life of the contract), and the over-run in both cost (cost growth measured in dollars) and time allotted to complete the contract work (schedule growth measured in days). We pretested the variables used in our study with an expert panel of ten DOD project contract specialists who had managed at least five high-technology contracts during their careers. After two rounds of review and revision, the revised variables used in this study reflect these expert's suggestions.

According to our hypotheses, we are interested in testing the effect of the independent variable in our study, contract type, on the aforementioned dependent variables. It is our contention that shared risk in a contractual relationship allows for better management of the risk–reward function for both buyer and seller. In some cases, the seller bears more of the contractual risk whereas in others, the buyer assumes more risk. Thus, the independent variable of contract type in this study is trifurcated along the assumption of risk ranging across the following risk-sharing profiles: 100% buyer risk, 100% seller risk, and a mixed percentage of risk shared between the buyer and the seller in the contract. Table 1 shows the means and standard deviations of the dependent variables by contract type.

To test the hypothesized relationship between the independent variable (contract type) and the dependent variables (lines in the statement of work, engineering change proposals, cost growth, and schedule growth), we used a two-tiered approach at the multivariate and univariate levels. We first used a repeated-measures multivariate analysis of variance to test hypothesis H1 to see if differences existed between the different risk sharing profiles embedded in the project contracts. MANOVA was appropriate because the technique is able to simultaneously evaluate a set of outcome indicators through construction of a linear combination of those indicators which maximizes group differences. Second, given a significant multivariate effect, a follow-up analysis was then performed to identify the underlying structure of the four-indicator set using an analysis of variance (ANOVA) test on each risk-sharing indicator to identify the strength of the individual dependent variable relationships with contract type. All statistical analyses were conducted in R-Studio, version 0.98.1049.

## 4. Results

Prior to hypothesis testing, a preliminary analysis was conducted to assess the relationships between pairs of the risk-sharing indicators. Bivariate correlations for each pair are shown in Table 1. Strength of relationships ranged (in absolute value) from .17 for the correlation between cost growth and engineering change proposals to .55 for the correlation between schedule growth and contract type. More importantly, each dependent variable showed a moderate to strong correlation with our independent variable, contract type. All correlations were significant at $p < .001$. Overlaps in correlation between dependent variables were expected due to the related nature of contractual change and were witnessed in our analysis. For example, a strong correlation of .51 between our dependent variables of engineering changes and lines in the statement of work was expected since engineering changes affect contract alterations, which add to its length. Similarly, the correlations between engineering change proposals and schedule growth, and schedule growth and cost growth were expected since changes in substantive aspects of the project will drive up time and costs for the contract.

Interestingly, we also found that while the length of the statement of work, the number of engineering change proposals, and unplanned growth in the project schedule were higher for contracts where the seller assumed one-sided risk, unplanned growth in project cost was higher for contracts where the buyer assumed one-sided risk. While this relationship was not hypothesized, we suspect that it is due to the exploratory nature of R&D and NPD contacts, for which government buyers are willing to take on greater cost risk, particularly for military hardware.

Table 1
Means, standard deviations, and zero-order correlations.

| *Variables* | *Means* | | | *Standard deviations* | | | *Correlations* | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Independent* | | | | | | | | | | |
| 1. Contract risk profile | Buyer | Shared | Seller | Buyer | Shared | Seller | 1 | 2 | 3 | 4 |
| *Dependent* | | | | | | | | | | |
| 2. Statement of work | 174.84 | 960.37 | 429.81 | 167.85 | 1037.6 | 493.66 | .43 * | | | |
| 3. Engineering changes | 4.79 | 141.4 | 13.91 | 13.32 | 239.13 | 15.72 | .37 * | .51 * | | |
| 4. Schedule growth | 10.09 | 71.08 | 25.59 | 22.64 | 56.31 | 23.02 | .55 * | .32 * | .47 * | |
| 5. Cost growth | $2.18 mm | $73.3 mm | $636 k | $9.52 mm | $243 mm | $1.98 mm | .44 * | .31 * | .17 * | .43 * |

N = 240.
* Significant at $p < .001$.

After our findings from this initial review, our attention shifted to substantive tests of the five hypotheses. Multivariate analysis using Pillai's Trace indicated that the independent variable (contract type) was significantly correlated to the set of dependent variables ($p = .459$, $F_{8,468} = 17.451$, $p < .001$). Thus, the results from the MANOVA show support for Hypothesis 1 that the length of the statement of work (SOW), the number of engineering change proposals (ECP), and the unplanned growth of project schedule (USG) and cost (UCG) differ based on the type of risk-sharing profile in a contract (identified in Table 2 as contract type and referring to one-sided buyer risk, shared buyer and seller risk, and one-sided seller risk). Table 2 shows the multivariate results from the MANOVA.

The hypothesized relationships were then tested with univariate results from the MANOVA (Tabachnick and Fidell, 1996). Pairwise comparisons were used to assess whether the dependent variables differed across the three contract types. The results show that the number of lines in the statement of work is significantly greater in contracts with shared risk versus buyer risk than in contracts with shared risk versus seller risk ($F_{2,236} = 28.534$, $p < .001$; $F_{2,236} = 14.213$, $p < .001$), showing support for Hypothesis 2. For Hypothesis 3, our interest was whether contract risk sharing is related to the number of engineering change proposals (as a proxy for new ideas and learning during the project). Results show that the number of engineering change proposals differ based on the level of risk sharing in government project contracts ($F_{2,236} = 24.300$, $p < .001$; $F_{2,236} = 19.610$, $p < .001$), showing support for Hypothesis 3. For Hypotheses 4 and 5, our interest was whether risk sharing predicts an increase in unplanned time and cost. Results indicate that unplanned schedule growth of the contract was dependent upon the type of contract ($F_{2,236} = 57.092$, $p < .001$; $F_{2,236} = 42.765$, $p < .001$) as was the cost growth of the contract ($F_{2,236} = 29.250$, $p < .001$; $F_{2,236} = 41.394$, $p < .001$), showing support for Hypotheses 4 and 5. Table 3 shows the univariate results from the MANOVA.

## 5. Discussion

Firms have long engaged in the practice of forming temporary solutions to problems posed by environmental turbulence, using projects, temporary workers, and creating organizations and networks of finite duration. This phenomenon suggests that projects are transient in nature but misses an important strategic transition wherein they provide opportunities for firm learning and growth that morph into more permanent organizational structures.

Our findings demonstrate that the type of contract utilized in project management reflective of the risk sharing profiles of 100% buyer risk, 100% seller risk, or shared risk is a significant predictor of contract length, engineering changes, and schedule and cost growth and that these dependent variables are all higher at the shared contract level. Contracts that are established with pooled risk demonstrate a higher level of comprehensiveness in order to mitigate the threats of opportunism and are reflective of relationships that involve a higher level of changes and growth, which can lead to enhanced learning opportunities and new ideas.

In addition, our results support Sluis and De Giovanni's (2016) research into the difficulties in monitoring and controlling costs in a two-party contract. While the correlations in Table 1 indicate that the length of the statement of work, the number of engineering changes, and the growth in project schedule (variables 2 through 4) each increase based on type of contract from buyer to seller to shared risk, the growth in project cost (variable 5), conversely, increases from contracts that maintain seller risk to buyer risk to shared risk. We interpret these results as buyers being more interested in "getting the job done right" whereas sellers are more concerned with achieving financial performance objectives in a project contract.

Our findings could also suggest that when risk is appropriately shared between firms engaged in R&D and NPD projects that the contractual terms become more pronounced and serve to not only protect each firms' self-interest but also engender trust in the partnership. This perspective is a unique contribution of our work and suggests that as firms work more closely together, they become more invested in preserving the relationship as well as their own bottom line. While many investigators debate the presence of simultaneous use of contracts when partners trust each other (Lyons and Mehta, 1997), our investigation provides evidence that learning is improved such that sustained innovation can occur when formal contracts are used and trust is evident. In this respect, mutual expectations are not only developed but reinforced when risk is shared, thus making the partnership truly collaborative, eventually establishing a platform of trust (Rose-Anderssen and Allen, 2008). Using project risk-sharing contracts as an object of attention and, hence, commitment, partners feel free to trust and safe to experiment in the innovation process. Echoing Woolthuis et al. (2005), project contracts with shared risk provide a safe place to innovate with the knowledge and confidence that each party's interests are protected.

### 5.1. Directions for future research

Previous scholarship on interfirm projects has not fully explored the changes that occur in a contract throughout the project lifecycle. These results suggest that sharing risk mitigates distrust and vulnerability issues in the incremental

Table 2
Summary of MANOVA Results[a].

| *Independent variables* | *Dependent variable*: contract type | | |
|---|---|---|---|
| SOW, ECP, USG, UCG | Pillai | Approx F | p-value |
| MANOVA results | .459 | 17.451 | 2.2e-16* |

[a] F-statistics with df = 2, 236 are reported in this table.
* $p < .001$.

Table 3
Summary of pairwise comparison results[a].

| Variables | Buyer vs shared | Seller vs shared |
|---|---|---|
| Lines within statement of work | 28.53* | 14.21* |
| Engineering contract change proposals | 24.30* | 19.61* |
| Unbudgeted schedule growth | 57.09* | 42.77* |
| Unbudgeted cost growth | 29.25* | 41.39* |

* $p < .001$.

extension of the scope of the project contract through engineering change proposals. This adds to our discussion that trust can be both a precursor to a contract to enable communication and an outcome as the partnership evolves (Woolthuis et al., 2005). Contract changes are an extension of this partnership as both sides feel free to participate in development without downside safeguarding of interests to protect against opportunism.

Our research also suggests that risk sharing leads to increased contractual changes that may represent new ideas and learning from the lessons of the project. This also supports the findings of Lumineau et al. (2011) who demonstrated that the drafting of contractual clauses fostered learning and, in turn, this learning triggered new contractual negotiations extending the contract beyond the original planned partnership. Future research in this field could investigate in further detail the actual contractual changes to enhance our understanding of these phenomena such as the acquisition of dynamic capabilities and increasing the rate of innovation and how these are incorporated into the project contract via engineering change proposals.

This research posits that painting all projects, and by extension temporary structures, with the same broad brushstrokes is to take a myopic view of these arrangements. When properly executed, these temporary structures can enhance mutual organizational learning and profitability. As literature on absorptive capacity (Cohen and Levinthal, 1990) highlights the importance of external knowledge exploration and exploitation, these arrangements often provide an ongoing conduit for knowledge sharing and assimilation between partner firms. As a result, interfirm projects become an aspect of long-term firm strategy as opposed to a temporary reaction to market turbulence. Consequently, it would be appropriate to investigate how project contracts are governed, especially with regard to the project-organizational strategic management and learning interface, to see how risk-sharing partnerships affect organizational decisions and units.

Future research could also seek to evaluate alternative project types in different organizational settings. Our research considered R&D and NPD contracts in a government contract setting; would we expect the same risk-sharing phenomena to occur elsewhere, such as private firms, across multiple industries, or in different cultures? Future studies could consider construction projects, IT projects, agile projects, organizational change projects, etc. as alternative contexts for considering these results.

Additionally, future research could test whether a process model would be more appropriate to study the outcome variables highlighted by our work. More specifically, do temporary relationships move through a process of trust that leads to risk sharing? Does a "testing out" period occur whereby firms write contracts with minimal risk to experience work with a potential partner before slowly assuming more risk in contracts oriented toward more speculative projects and greater financial or innovative upside?

### 5.2. Limitations

Our study was limited to Department of Defense contracts that were chosen specifically because of their variety and unique availability. While a single industry source does limit the generalizability of our results, government contracts provide richness in terms of comprehensiveness not easily found in the private sector where information is closely guarded and the more powerful partner typically dictates terms. It can be difficult to find a repository of contracts that represent risk assumed completely by the buyer, by the seller, and risk that is shared, such as the data available in this study. With single source data, however, generalizability of results remains a concern. If similar contractual variety is available, future studies may want to consider research in for-profit or non-profit contexts to extend the application of these findings.

### 5.3. Conclusions

The findings from this study have strong application for project managers, operations managers, and strategic leaders. Managers, in general, should be aware that contractual relationships heavily tilted toward buyer or seller risk can achieve a transactional purpose but may limit the amount of learning and new ideas that can be achieved during a project where risk is shared. The findings here indicate that space is created for organizational learning when risk is shared and contracts are designed for protecting each party's self-interests. Pooling risk in a project contract (particularly in R&D or NPD) can engender a sense of interdependence toward project objectives and the lessons learned can become more permanently engrained as firm strategy.

## Conflict of interest

There is no conflict of interest involved in this paper.

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