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Complexity, Contract Design and Incentive Design in the Construction Management Industry

A dissertation presented

by

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to

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Complexity, Contract Design and Incentive Design in the Construction Management Industry

Abstract

In this paper I examine how one construction management company uses contract design and incentive design to respond to aspects of task complexity and relationship complexity present in its construction projects. In terms of contract design, I find that the company is unable to increase its use of cost-plus pricing when faced with technically complex projects. Instead, the company uses increased pre-execution design modification and price markups when technically complex projects are contracted with fixed-pricing. Further, I find that design modification is only margin-improving when used in projects that are both technically complex and fixed-price and that price markups are only margin-improving when projects are fixed-price. In terms of incentive design, I find that the company provides more qualitative feedback to employees and quantitatively rates employees with less centrality bias (i.e. more dispersed ratings) when employees work on fixed-price projects. Further, when employees work on fixed-price projects, they are granted greater average financial rewards, their financial rewards are relatively more based on input-behaviors (i.e. less based on output-results), and their bonuses, raises and promotions appear to be awarded with more managerial discretion (i.e. are less systematic.)

1. Table of Contents

Dedication and Acknowledgements

I dedicate this paper to my mother, Priscilla, who never understood my work, and my father, Azim, who will always be the Principal of the Line.

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2. Introduction

2.1. Overview

Firms face risk: There is uncertainty in the financial outcomes that firms can expect to realize from their planned operations. Their operations could yield less revenue than expected or require more cost than expected, leading to smaller margins than expected. This financial risk is at least partly the outcome or manifestation of operational uncertainty. Following Bajari and Tadelis (2001), I refer to this operational "uncertainty" as "complexity[1]." More operational complexity (uncertainty) translates into more financial risk.

Operational complexity takes myriad forms. Chenhall (2003), in his review of the literature on contingency-based management control systems, identifies six contextual variables that have been considered sources of complexity within organizations: the external environment, technology, structure, size, strategy and national culture. For the purpose of this paper I define project complexity as the condition of uncertainty of an organization (the seller) to understand and satisfy the needs of its buyer. I focus on two elements of project complexity: task complexity[2] (which I define as the uncertainty driven by the buyer's needs) and relationship

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[1] Bajari and Tadelis (2001) use the term "complexity" to refer to the number of ex-post states involved in a procurement contract. When contracting for a construction project with more ex-post states the seller is less certain about scope of the project. Chenhall (2003) uses the term "uncertainty" to describe situations in which probabilities cannot be attached to events occurring or in which potentially relevant events or elements are not predictable.

[2] Chenhall (2003) considers task uncertainty an element of the technology context in which there is low analyzability of processes and poor measurement of processes.

complexity (which I define as the uncertainty driven by the seller's ability to communicate and coordinate with its buyer[3].)

As summarized by Dekker (2004), inter-organizational research has suggest several control mechanisms by which firms can try to reduce transaction costs and improve coordination and joint-decision making in buyer-seller relationships. Firms can use Outcome Controls by setting goals and establishing incentive systems and rewards structures. They can use Behavioral Controls by establishing plans, procedures, rules and regulations. They can also use Social Controls by selectively choosing partners, building reputations, and repeating interactions to increase trust.

In this paper, I attempt to bridge the contingency-based management control systems literature and the inter-organizational research literature. I first examine Contract Design through three Outcome Controls by which sellers can address task and relationship complexity through the buyer-seller relationship. Sellers can use a pricing model that shifts risk to the buyer (i.e. cost-plus pricing.) They can change the stated goal or deliverable to accommodate the uncertainty of customer's needs (i.e. pre-execution design modification.) They can also charge higher prices to cover unforeseen costs (i.e. higher revenue quotes.)

I then examine how sellers try to address project complexity through Incentive Design, the relationship between the firm and its employees, within the context of the inter-organizational control system. The ultimate goal of incentive design is for employees to expend sufficient effort on appropriate behaviors (i.e. provide the inputs most likely to yield desired outputs) while being exposed to the least amount of risk (see Prendergast's (1999) review.) To

[3] Chenhall (2003) considers supplier relations as part of the external environment context.

do this, firms can provide quantitative feedback (i.e. ratings) and qualitative feedback (i.e. comments) so employees know what levels of effort are sufficient and behaviors are appropriate. Firms can establish formal compensation plans (e.g. bonuses, raises and promotions) that reward employees for their inputs and outputs. Firms can also use discretion (i.e. subjective performance evaluation) in their compensation practices to shield employees from risk.

The purpose of this paper is to examine the effect of complexity on contract design and incentive design. By utilizing a unique and highly rich data source from a construction management company, I examine two different types of Project Complexity: Task Complexity (characteristics of the buyer's needs that create uncertainty in the seller's ability to understand and satisfy the buyer's needs) and Relationship Complexity (characteristics of the buyer and seller's relationship that create uncertainty in the ability for the buyer and seller to communicate to understand and satisfy the buyer's needs.) In my model (see Figure 1,) I examine how the Company uses contract design (pricing model, design modification, and revenue quote) to mitigate the risk imposed by complex construction projects. I then examine how the Company adjusts its employees' incentive design in response to the risk imposed by complex construction projects and the contract design.

In the first set of empirical tests I examine how the Company uses contract design to mitigate its risk imposed by project complexity. I do not find evidence that the Company uses cost-plus pricing when faced with greater task complexity. Rather, in my sample, the use of cost-plus or fixed-price pricing is driven by relationship factors: Certain types of clients predominantly or exclusively use one type of pricing (government and private clients use fixed-price contracts) and, for client-types that use both (military clients,) the pricing model is heavily driven by the relationship between the seller and the client. Specifically, a lack of previous

experience between the parties, which reflects a lack of trust (greater relationship complexity,) leads to the use of fixed-price contracts, which impose the financial risk on the seller.

Given that a project's pricing model is decided by the client at the request-for-proposal stage, I find that the Company uses other contract design mechanisms when it submits proposals for fixed-price projects with greater task complexity. The Company is more likely to modify the project design for fixed-price contracts (fixed effect) and there is an incremental likelihood of modification if the project is both technically complex and fixed-price (interaction effect.) Further, design modification is only profit-enhancing for projects that are both technically complex and fixed-price. The Company also uses higher revenue quotes to mitigate risk by charging an incremental markup on estimated costs only when the project is both technically complex and under a fixed-price contract (interaction effect only.) Further, increased revenue quotes are associated with greater actual profit only in fixed-price contracts.

In the second set of empirical tests I examine how the Company modifies incentive design when faced with project complexity. I compare the incentive characteristics found in fixed-price projects (in which the risk is imposed on the Company) to the incentive characteristics found in cost-plus projects (in which the risk is imposed on the buyer.)

I find that managers are more lenient (generous) with rewards under fixed-price contracts. The average bonus level is higher and is relatively more strongly associated with inputs (ratings on soft behaviors and technical behaviors,) rather than outputs (goal achievement ratings.) In fixed-price projects, greater ratings in hard behaviors are associated with relatively higher raises and increased promotion likelihood. There also appears to be more managerial discretion in the awarding of bonuses, raises and promotions in fixed-price projects (lower explanatory power of the model.)

I find that in fixed-price projects managers provide more descriptive feedback to employees, this feedback level is maintained even in periods of high employee performance and they provide more feedback when there are cost overruns (in cost-plus projects managers provide a lower level of average feedback, they provide less feedback when employee ratings are high, and they don't provide extra feedback when costs go over budget.)

I also find that, in fixed-price projects, greater technical complexity is associated with greater dispersion (less centrality) in output ratings. In cost-plus contracts complexity does not affect the dispersion of ratings.

In summary, I find evidence that the Company uses a portfolio of mechanisms to respond to project complexity. While the Company has little control over the pricing-model of its projects, it selectively uses design-modification and higher price quotes to protect its margin. While the company insulates employees from financial harm caused by greater project complexity, it provides greater information through performance feedback and ratings dispersion.

2.2. Contribution

In their review of the literature on management control in inter-firm relations, Caglio and Ditillo (2008) find extensive work explaining how the nature of inter-firm transactions (e.g. frequency, asset specificity, supplier substitutability, product uncertainty, and risk) and the parties (e.g. size, experience, networks, and reputation) affect the structure of the inter-firm relationship (e.g. market-based, hierarchical/bureaucratic, trust/relational, or hybrid.) They find a small set of papers that document instances of inter-firm relationships diverting from or oscillating between the ideal forms of control. Of these, only a few go as far to suggest that

institutional factors might drive the form of the relationship. Further, Caglio and Ditillo (2008) find that the extant literature has made few conclusive links between control archetypes (i.e. market vs. hierarchy vs. trust) and other methods of control (e.g. the contract and price) and what types of controls are best to respond to different types of uncertainty.

This paper builds on the economics literature on inter-firm relationships (particularly in business-to-business transactions which tend to include ex ante uncertainty, asymmetric information between the buyer and seller, product customization, process adaptation and information acquisition) by examining the relationship of several seller decisions: pricing model, deliverable (design) modification and revenue quote (pricing level.) While the literature has traditionally treated the transaction (including the supplier's workflow) as only an input to the contract decision, I show a condition in which the supplier alters the workflow (i.e. modifies the deliverable design prior to execution) in response to the contract and context (i.e. when institutional factors force a fixed-price model despite high task uncertainty.)

The procurement literature has found that firms use contract design, specifically the choice between cost-plus contracts and fixed-price contracts, to mediate complexity, broadly defined. I add to this literature by tying it into the management control system literature and more-concretely defining project complexity into constructs for task complexity and relationship complexity. Task complexity includes items that affect the underlying difficulty of the project like size, duration, design modification and reliance on subcontractors. Relationship complexity includes items that make communication and cooperation between the buyer and seller more or less difficult like prior experience with each other, amicability of the relationship and potential rigidity of client procurement behaviors.

This paper builds on the incentives literature by addressing several gaps in the analysis of subjective performance evaluation as identified by Bol (2008). The literature on subjective performance evaluation broadly examines how firms use non-contractible information when providing incentives to employees. The general implication is that using subjective information allows firms to reduce the risk imposed on employees, increasing average performance and reducing average compensation. While almost all research on subjectivity has focused on ex post performance assessment (using more or less subjectivity when evaluating employees' prior work), I examine supervisor discretion in both the evaluation stage and the compensation stage. Analyzing these stages separately shows how subjectivity can be used to both differentiate employees and protect employees. Additionally, I examine how firms apply subjectivity in response to two different types of risk: Task Complexity (risk inherent to the work) and Relationship Complexity (risk caused by the inability of the buyer and seller to efficiently and effectively work together.)

The construction management industry has several features that lend themselves to the study of contract design and incentive design. As identified by Baiman and Rajan (2002) in their survey of incentives in inter-firm relationships, modern supply chain management faces issues of ex ante uncertainty, asymmetric information between the buyer and seller, product customization, process adaptation and information acquisition. In the construction management industry, long project times, variations in the types of projects performed, uncertainties of project needs, and the importance of the contractor-customer relationship are directly applicable to this broader supply chain literature. Additionally, the importance of collective production, the complexity of the work and the importance of difficult-to-measure outputs make subjective performance evaluation highly relevant. Finally, the role of governments (military and public

buyers) and rigid buyer processes in the procurement process introduces an interesting stimulus on the contracting decision that enables us to potentially observe off-equilibrium outcomes. These features contribute to my research by revealing the interactive effects of project complexity, contract design and incentive design.

Despite the nuances of the construction management industry, this paper's results are broadly applicable to many business-to-business transactions. Such transactions (for example in IT development, consulting, and automotive supply development) regularly involve ex ante uncertainty, asymmetric information between the buyer and seller, product customization, process adaptation, information acquisition, and significant investments in both technical and human capital. As Cohan (1999) describes of the web consulting market, these types of transactions are commonplace in industries that span large public firms and small private firms, established firms and startups, supplier networks and one-stop-shops, and billable/cost-plus models and fixed-service/fixed-price models.

The rest of paper is presented as follows. In Section 3, I describe the academic literature on procurement contracting (namely the use of cost-plus versus fixed-price contracts) and performance evaluation (namely the use of subjectivity in performance evaluation) and present my hypotheses. In Section 4, I describe the how the research site's performance evaluation system has evolved over time. In Section 5, I empirically test the hypotheses. In Section 6, I discuss my findings. In Section 7, I provide a bibliography. In Section 8, I present my figures and tables.

3. Literature Review and Hypothesis Development

3.1. Contract Design Hypotheses

In large procurement contracts, buyers (e.g. municipalities) have certain needs (e.g. safe transit over a waterway) for which sellers (e.g. construction companies) offer services and products (e.g. bridge design and construction). Many times these transactions involve ex ante cost uncertainty: At the time of contracting, neither the buyer nor the seller fully knows the specifications of the project (e.g. the actual depth and conditions of the waterway) and the actual costs to be incurred by the seller (e.g. the amount of engineering, materials and labor to handle the actual depth and conditions of the waterway). These uncertainties are ultimately resolved over the project's timeline as the parties gain information and communicate with each other. The resulting "procurement problem," as developed by the economics literature, refers to difficulties the parties face when contracting in the face of these and related uncertainties.

In this paper, I examine two types of factors that contribute to contracting uncertainty, jointly referred to as "project complexity": (1) factors contributing to the underlying uncertainty around the ultimate needs and costs of the project ("task complexity") and (2) factors contributing to the uncertainty of the parties' ability to work together ("relationship complexity".) More specifically, task complexity can be thought of as characteristics of the project that affect the likelihood that and magnitude by which actual project costs will deviate from expected project costs and relationship complexity can be thought of as characteristics that affect the ability for sellers to articulate their needs, the willingness for buyers to trust sellers' honest reporting of costs and efficient use of resources and the degree to which sellers can trust buyers' willingness to renegotiate as uncertainty is resolved.

The economics literature has traditionally considered the procurement problem as one of ex ante asymmetric information coupled with moral hazard. Laffont and Tirole (1993) provide a summary of this literature. In this type of situation, frequently observed in the construction industry, the seller has hidden information on the expected production cost (e.g. construction companies might overcharge municipalities, who have little understanding of the true technical costs of the project.) As summarized by Baiman and Rajan (2002), this hidden information puts sellers in a position to overprice, which drives buyers to underinvest and generates dead weight loss. The literature has used mechanism design models to suggest that buyers should offer menus of contracts to induce sellers to reveal their private information.

Bajari and Tadelis (2001) note that menus are rarely offered in procurement transactions. Rather, procurement contracts are almost always constructed as either fixed-price or cost-plus (or a mixture of the two). In fixed-price contracts sellers are guaranteed a flat payment regardless of whether the ultimate production cost deviates from the cost expected at the onset of the contract. In these contracts, sellers are incentivized to cut out as much cost as possible; however, they are allocated the risk in the project and must incur whatever costs are necessary to achieve a stated level (lower bound) of performance. On the other hand, in cost-plus contracts sellers are guaranteed a constant margin rate[.] In these cases, buyers are allocated the risk since they must reimburse sellers for any costs incurred (additionally, they incur extra administrative costs to process the reimbursements) and buyers are incentivized to heavily invest in quality-enhancing expenditures.

Focusing on the fixed-price/cost-plus contracting choice, Bajari and Tadelis (2001) extend the model of the procurement problem beyond sellers' hidden information and focus on "problems of adaptation when the initial design is *endogenously incomplete*." They analytically

examine the effect of complexity, which is loosely defined as the number of ex post states, on the optimal contract. Ex ante task complexity increases the need for flexibility during the project: Sellers are more likely to need to adjust their operations and incur more costs as uncertainty is resolved and the true state is revealed. To allow sellers this flexibility, cost-plus contracts are preferred. Further, Turner and Simister (2001) find that, to the degree that contracts are used as a tool to facilitate buyer-seller communication, high product uncertainty and high process uncertainty are expected to lead to cost-plus contracts (in which frequent communication and billings are to be expected). Bajari and Tadelis (2001) suggest that when projects are complex the need for flexibility outweighs the need for incentives and cost-plus contracts are preferred[4].

However, buyers can invest more effort in understanding and documenting their needs prior to contracting. These efforts reduce ex ante uncertainty, lower task complexity, reduce the risk to sellers and make fixed-price contracts more acceptable to sellers. A further consideration is that under cost-plus contracts, greater task complexity gives sellers more opportunity to justify overinvestments in operations (i.e. bill buyers for unneeded work under the pretense of task complexity.) These considerations suggest that greater task complexity drives a buyer-preference for fixed-price contracting.

These conflicting considerations lead me to the following hypothesis:

H1: Greater task complexity is not associated with the likelihood of fixed-price contracting.

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[4] Vistnes (1994) finds a similar result for California hospitals serving Medicaid patients: At low-cost/low-complexity levels services tend to be billed at fixed prices while high-cost/high-complexity levels services tend to be billed at cost-plus prices.

Compared to the above literature on the role task complexity on the contracting choice, the literature offers less concrete direction on relationship complexity. Bajari and Tadelis (2001) suggest that buyers and sellers with good relationships can more readily renegotiate, making fixed-price contracts more acceptable (to sellers). From case studies in the web consulting industry, Cohan (1999) suggests that sellers are most willing to accept fixed-price contracts when they are confident that the buyer will act collaboratively and be engaged to achieving project success. Despite these expectations, Corts and Singh (2004) and Kalnins and Mayer (2004) find that repeated interactions (which imply lower relationship complexity through greater trust) are associated with greater use of cost-plus contracts. Finally, Corts (2011) finds that repeated interaction creates implicit contracts between buyers and sellers, increasing trust in effort and trust for faithful renegotiation, making both fixed-price and cost-plus contracts efficient.

One possible interpretation of these conflicting results is that, from the buyers' perspective, lower relationship complexity makes cost-plus contracts more palatable by increasing trust that the seller will perform efficiently. From the sellers' perspective, lower relationship complexity makes fixed-price contracts more palatable by increasing trust that the buyer will renegotiate if work conditions deviate from expectations. Taken together, the literature suggests that relationship complexity between buyers and sellers has an ambiguous effect on contract design. Since the construction management industry tends to be a buyers'

market (many sellers bid for each buyer's project) I expect that the buyer's perspective takes precedence[5].

This leads me to the following hypothesis:

H2: Greater relationship complexity increases the likelihood of fixed-price contracting.

There is reason to expect that the hypothesized optimal contract (one that appropriately addresses complexity) might not always be observed. For example, Anderson and Dekker (2005) examine the effects of three primary transaction characteristics (size/dollar-value, buyer exposure to failure, and transaction complexity/number of parts) on four management control levers as specified in the contract (assignment of rights, product and price terms, after-sales service terms, and legal recourse.) They find that, due to the costliness of adding contract terms, different transaction characteristics are addressed by different subsets of control levers: large transactions are more likely to use all four control levers; transactions in which the buyer is more exposed to failure are more likely to use assignment of rights and legal recourse terms; and

[5] This interpretation agrees with Cooper and Slagmulder's (2004) examination of hybrid organizations and management accounting practices in which they find greater relational ties between buyers and suppliers enable more demanding cost management techniques to overcome information asymmetry and improve coordination and collaboration and with Gulati's (1995) finding that repeated interactions between partners reduces the need to use equity arrangements (which, like cost-plus contracts, are more complicated to negotiate and organize) to counter opportunistic behavior.

complex transactions are more likely to use assignment of rights. Contrary to their expectations, they do not find that greater ex ante product uncertainty leads to increased use of management control levers. However, they do find that transactions that involve ex ante product uncertainty are more likely to experience ex post performance problems.

A nuance in the construction management industry that could lead to off-optimal results as witnessed by Anderson and Dekker (2005) is that the government or military is often the dominant buyer. Demski and Magee (1992) find that in these cases, normal utility functions are replaced by nuances of the political institution. In this manner, the contracting decision can be driven by a buyer's procurement policies and be misaligned with the elements of task complexity (i.e. a complex project might use a fixed-price contract.) In cases like this, the seller would need to use other contract mechanisms to mitigate the risk caused by elements of task complexity. One option would be for the seller to invest in more modification (customization) of the project's design prior to execution. Another option would be to quote a higher level or rate of revenue to provide more surplus margin.

This leads me to the following hypotheses:

H3: Under fixed-price contracting, sellers use design modification to address task complexity.

H4: Under fixed-price contracting, sellers use higher revenue quotes to address task complexity.

3.2. Incentive Design Hypotheses

In addition to affecting the contracting stage of procurement contracts, project complexity likely has an effect on how sellers structure the incentives they provide for their employees who perform under the procurement contracts. As part of procurement contracts (e.g. construction

jobs) employees need to understand client needs, design work plans, execute those design plans and adapt as conditions and information about client needs change. Sellers (e.g. the construction company) establish goals for their employees, provide performance feedback and reward or punish employees based on how they perform. I examine how project complexity (task complexity and relationship complexity) affect the firm's (1) setting of employees' goals, (2) feedback to employees, and (3) employee incentives.

One major dichotomy in the implementation of incentive systems is the use of objective versus subjective performance evaluation. Objective performance evaluation is loosely defined as being contractible and externally verifiable. On the other hand, subjective performance evaluation is loosely defined as being non-contractible or utilizing manager discretion. Gibbs et al. (2004), suggest three ways in which subjectivity can be used in performance evaluation: (1) ex-ante inclusion of non-contractible measures, (2) ex-post flexible weighting of objective measures ("discretion"), and (3) ex-post flexible inclusion or exclusion of measures ("discretion").

Subjectivity provides several benefits to incentive contracts. Subjectivity mitigates incentive distortions, for example, by excluding uninformative objective performance measures (see Baker et al. (1994), Budde (2007) and Gibbs et al. (2009).) It reduces the amount of risk to which employees are subjected (see Holmstrom (1979), Banker and Datar (1989) and Baker et al. (1994)) and is especially valuable when it is difficult to meet formula-based incentives/bonuses (see Gibbs et al. (2002).) These benefits are particularly valuable in the construction industry where uncertain and changing customer needs can severely impact employees' ability to perform to plan. In these cases, not only does the use of subjectivity

reduce the reservation wage demanded by employees, it actually induces adaptive behavior to potentially improve project outcomes (Moers (2006).)

The use of subjectivity in performance evaluation is not without cost. It increases the ability for supervisors to renege on providing appropriate bonuses (Baker et al. (1994)) and introduces uncertainty about measurement criteria (Ittner et al. (2003)), both of which reduce the strength of incentives. Subjective assessments are more susceptible to self-interest, cognitive limitations, incomplete information (costly information) and favoritism (Bol, 2008). Further, subjective assessment have been shown to be biased by unrelated objective measures and perceived uncontrollability in objective measures (Bol and Smith (2011).)

Given the costs of subjective performance evaluation, I expect that construction companies rely on it more when there is greater need for it. Under fixed-price contracting the financial risk resulting from project complexity is imposed on the seller and its employees, increasing employees' reservation wage and decreasing the usefulness of formula-based incentives.

This leads me to the following hypothesis:

H5: Under fixed-price contracting, managers are more lenient with rewards.

As Bol (2008) describes, one characteristic of subjective performance evaluation is that gathering information and providing feedback is more costly for managers. Managers incur more information gathering cost for non-contractible information and incur more social cost when providing subjective feedback to employees. It follows that subjective performance ratings tend to suffer from centrality bias. Given the cost for managers to gather and provide subjective

absolute performance feedback (i.e. information of employees' performance) and relative performance feedback (i.e. compression or dispersion of ratings across employees) I expect that they do so when there is greater operational need (i.e. to counteract risk imposed by project complexity and fixed-price contracting.)

This leads me to the following hypotheses:

H6: Under fixed-price contracting, managers provide more feedback.

H7: Under fixed-price contracting, managers compress ratings less.

4. Research Site

In this chapter, I describe one company in the construction management industry and tell the story of how one Company's incentive system has evolved in response to a changing labor market.

My research site[6] (the "Company") is a privately-owned construction, engineering and project management company headquartered in Edison, NJ. It has approximately 250 company-track employees and 500 non-company-track employees (primarily unionized field laborers). It currently runs approximately 35 construction projects throughout the US with clusters of projects in NY, NJ and LA.

4.1. Construction Management Operations

4.1.1. Staffing

The Company has several "Job Families" which serve as vertical successions of roles (i.e. positions) in each business function. Each job family is structured as progression of roles (from entry-level to senior) for a specific business function, though there are instances where a single entry-level position in one job family leads to several mid-level positions in different job families. In this paper I examine three job families that are closely related to project service: Project Operations (Project Engineers and Project Managers), Field Operations (Superintendents and Foremen), and Estimating[7].

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[6] The research site has requested I keep the Company's name confidential.

[7] I exclude job families that are not billed to client projects, for example Accounts Payable, Finance, Human Resources, and Information Technology.

Each construction project is managed by a Project Operations Leader who oversees the two branches of project management (Project Operations and Field Operations.) Employees in project management begin as a Field Engineer, a role that is focused on internal-company operations (i.e. coordinating with estimating, project accounting and other support functions). Field Engineers can continue in the internally-focused Project Operations family: Project Engineer 2 > Project Engineer1 > Project Manager 3 > Project Manager 2 > Project Manager 1.

Alternatively, after 6 months as a Field Engineer, project management employees can switch to Field Operations, a job family that is focused on external-company operations (i.e. coordinating with subcontractors and customers): Assistant Superintendent 2 > Assistant Superintendent 1 > Superintendent 3 > Superintendent 2 > Superintendent 1.

Employees with extensive experience in Project Operations or Field Operations sometimes transfer to Estimating. This job family is focused on bidding for new projects, finalizing project specifications and establishing work plans and budgets to guide project management teams as they execute projects. While separate from the project management branches, estimating employees work closely with Project Operations and Field Operations.

4.1.2. Profitability

Realizing and recognizing profits in the construction management industry is an extensive process. The project financial timeline is as follows:

- Request for Proposal: The first step of a construction management project is for the client to specify its needs. These needs might specify the goal (e.g. a bridge spanning a specific river), the technical requirements (e.g. load requirements and river conditions,) additional criteria (e.g. local labor quotas) and contractual criteria (e.g. fixed-price model.)

- Bid: Given the client's specifications, the Company prepares a bid based on internal estimates, supplier estimates and subcontractor estimates.
- Award: The client awards the bid to the Company.
- Estimate: The Company refines the estimate now that the project is confirmed.
- Budget: The Company establishes budgets for the project team. Project goals and progress are reviewed at "Weekly Cost Huddles"
- Cost Recognition: As construction progresses, entries are posted in the cost system. Project forecasts are updated within 15 days of month-end, with estimate-at-complete (EAC) updates being reflected in the general ledger either monthly (for smaller projects) or quarterly (for larger projects).
- Revenue Recognition: Depending on the nature of the project, revenue is recognized on a percentage-of-completion (POC) method as actual costs and EACs are updated or as project deliverables/milestones are achieved.

Project profitability is measured as actual against budget (bid +/- change orders) and is composed of four items:

- Buyout: The purchasing department can sometimes secure better deals from subcontractors and suppliers when finalizing the order (as compared to the initial quote prepared for the bid). This is pure profit.
- Time: By reducing the days a project is underway, the company saves overhead costs.
- Labor Productivity: Design and execution can reduce the amount of labor costs.
- Equipment Productivity: Design and execution can reduce the amount of equipment costs.

4.2. The Company's Incentive System

4.2.1. Scorecard Changes

Throughout the decade 2001-2010, the Company experienced a dearth of skilled managers. They attribute this shortage to the internet bubble which attracted the most highly skilled engineers out of the construction industry. The lack of management-depth, coupled with the Company's strong sense of team culture and an overabundance of "engineer-types" caused the quality of the Company's performance evaluation to deteriorate.

Through 2007 the Company's employee reviews were based on an approximately five-page scorecard (see Figure 2.) The first page identified the employee's current goals (one line of text per goal.) The next page provided one line of free form text for managers to specify the employee's strengths and weaknesses. The next page allowed managers to assess employees on 7 competencies (Leadership, Principles, Drive, People Skills, Problem Solving, Technical and Position Description Specific.) Each competency had several behaviors or characteristics on which the manager the manager would provide a 1-5 rating (each behavior was a word or short phrase describing an aspect of the competency.) The final page of the scorecard identified the employee's goals for the next evaluation period (again, one line of text per goal.)

According to one senior HR manager, this scorecard system made it difficult to differentiate "good people" and "good workers." They found that high competency ratings were not predictive of future success. The Company's managers found subjective feedback (the standalone free form strengths/weaknesses section) too abstract; they wanted a check-the-box system. Managers' overly subjective evaluations were not generating constructive feedback and, overtime, the loose control systems proved ineffective as the company grew nationally and internationally.

To address these concerns, in 2009-2010 the Company began transitioning to using expansive scorecards for evaluation and development of its management/supervisory-track employees. These scorecards are used to communicate the expectations of each role and to solicit formal supervisor feedback on employee behavior. The stated goals for this scorecard performance evaluation system are:

- Skill Development: to prepare employees for promotion
- Skill Analysis: to review overall skills of workforce or specific
- Skill Alignment: to ensure projects are staffed by the most able employees

The new feedback system changed many aspects of the evaluation system[8]. The behaviors were arranged into three groups (Core Attributes, Leadership, and Job Function) instead of seven competencies. More specificity and granularity was added around the desired behaviors[9]. Fewer scoring increments were available ("A, B or C" instead of 1-5.) There was a new ability for free-form comments on each behavior. Additionally, the time frame was shifted towards March/September reviews to decouple the feedback process from the rewards process.

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[8] The empirical tests are based on data from the new scorecard system.

[9] For example, in the old scorecard, the competency "People Skills" had a line for the behavior "Communication/Listening. Verbal Skills." In the new scorecard, under the group "Core Attributes" is the behavior "Communication/Listening/Verbal." That behavior has five sub-behaviors including "Listens actively and responds appropriately with empathy. Genuinely seeks to understand" and "Communicates clearly, completely, and concisely with external customers and suppliers/subcontractors. Asks questions and communicates lessons learned, both positive and negative."

The new scorecard is 20-30 pages long (see Figure 3.) It begins with a description of the employee's position and mission. Next, managers provide several lines of text for each of the employee's objectives identifying the goal and specifying the metrics by which the goal will be evaluated. In the following sections, managers provide unlimited free form text describing the employee's strengths and weaknesses. Next are the sections for the manager's assessment of the employee's behaviors. Each of the three broad groups are subdivided into several behaviors and each behavior is subdivided into sub-behaviors that specify in full sentences what the behavior entails. Managers must provide a letter rating and can provide unlimited free form text on each sub-behavior.

Many aspects of the incentive system remained unchanged, however. The competencies (buckets of behaviors) being evaluated remained. The timing and guidelines regarding awarding raises, promotions and bonuses did not change. Employees decision rights remained constant. Finally, project staffing remained based on timing and convenience (not based on employee skills.)

4.2.2. Feedback

Regular formal 6-month employee performance reviews occur in March and September and additional reviews are held at the end of an employee's initial period (at 45 and 90 days) in any new position. The following schedule occurs in the year:

- At the beginning of March, employees provide self-evaluations (ratings and comments) on all items.
- In the first two weeks of March, managers gather 360-degree feedback on their employees (from team members, managers, subordinates, clients, sub-contractors and

vendors) and provide evaluations (ratings and comments) on all items and submit to HR for review.

- In the second week of March, all managers meet with HR and other managers to present a single scorecard to calibrate their approach (Calibration Sessions). Within 2 days, the managers adjust the evaluations after the calibration if necessary and resubmit to HR for review.
- By the end of March, Employees receive the evaluations, discuss them with their manager and acknowledge the evaluation. An HR manager may sit in on the discussion to observe (and later coach) the supervisor on his evaluation skills.
- In September, employees and managers update ratings and provide additional comments for those categories in which the employees have changed.
- Steps 3 and 4 are repeated: Calibration sessions and employee-supervisor discussions occur in the first few weeks of October.

Each position has a mission to describe the overall goal of the position. The Project Management functions (Field Operations and Project Operations job families) have the following position mission: "To construct a safe, high quality project that beats the estimated budgets, improves the total gross margin over the original bid, develops a high quality workforce and builds strong customer relationships that enhance our reputation. We must ensure all projects are executed in accordance with all contract requirements and [Company] standards such that our customers know that [Company] has created the highest value of any contractor that has worked for them." This mission drives the behaviors that are expected of the Company's employees.

Prior to 2010, managers evaluated employees on 33 competencies, providing a 1-5 rating. The competencies did not have sub-behaviors to explain the expectations. Rather, the scorecard

provided a grading matrix (see Figure 4) illustrating what type of behavior would qualify for a low (1), medium (2-4) or high (5) rating. A rating of 1 is described a "major problem", 2 is "Occasionally (room for improvement)", 3 "Often (doing your job)", 4 "Often and Consistently (exceeding expectation)", and 5 "Always (walking on water)".

In 2010, the Company changed the format of feedback to provide more detailed and constructive feedback. For the 2010 first half Scorecard, the Company used a transitional evaluation format while the new system was being implemented. The competencies were not grouped by topic section (e.g. Core Attributes) but by prioritization for each job. For example, Execution/Urgency is a top priority for a Superintendent but a second-level priority for a Project Manager.

For the 2010 second half evaluation, the Company adopted its new format. These scorecards contain text-field comments on 150-200 items per employee (scorecards are customized by job position from a large bank of items; the items are used in the position description). Each item (behavior) is rated as A, B or C and is given free-form text comments. There are three general sections for all scorecards (Core Attributes, Employee Development/Leadership, and Job Function). Each section contains a number of competencies (slightly customized by job family). Each competency contains a number of behaviors (highly customized by job family). The sections are presented in order of descending importance. The competencies are presented in alphabetical order. The behaviors were subjectively ordered by HR to reflect a continuity of thought.

The final section of new scorecards mechanically aggregates the competencies' and sections' ratings and provides an overall rating. Behaviors have different weights (i.e. 1x, 2x, 4x) when aggregated to the competency-level (this weighting is not disclosed to employees or

managers.) Competencies have different weights when aggregated to the section-level (this weighting is disclosed.) Sections are weighted when aggregated to the overall rating (this weighting is disclosed.

After the first HR review of the submitted scorecards, all managers are invited to participate in calibration sessions. Each calibration session consists of 5-6 employees of similar rank and job function, is attended by the team's HR lead and is led by a senior manager in the function. Prior to the session HR selects one employee from each manager's team to be discussed. By design, the selected employee is not a peer of anyone in the room. The process is designed to promote honest feedback and provide managers with practice and assistance. Each manager leads a one-hour discussion of his/her selected employee's scorecard by first presenting short summaries of their personal experience with the employee and of the 360-degree feedback. Then he/she explains the employee's strengths and areas for improvement by comparing the feedback, self-evaluation and manager evaluation. The other managers in the session then challenge and confirm each other's scorecards. Following the sessions, the managers update their scorecards as necessary to incorporate any specific or procedural changes that came up during the session.

The stated goal of the Calibration Process is to have managers "on the same page" so employee scores are more reliable. Scoring is normalized across managers and HR ensures consistent interpretation of the behavior descriptions. It is emphasized that employees be rated against the scorecard %-thresholds (e.g. 95% of achievement), not against other employees. Managers are encouraged to not be afraid of giving too many A's (above 95%) or C's (below 85%) or "N/A" if the employee really did not have a chance to exhibit the behavior. Managers are reminded to avoiding being swayed by the employees' self-ratings (which are visible when

the managers complete their evaluations.) Finally, managers are instructed to only consider employee performance over the preceding 6 months and to judge employees against their actual responsibilities (not theoretical responsibilities.)

The calibration sessions are also used to test and improve manager's evaluation skills. Managers are asked to consider how current behavior is a signal of strong or weak future potential without discounting or inflating current performance ratings. HR follows up when the manager and employee disagree about whether a behavior was applicable to the current role (only one party enters an N/A rating for a behavior) or when the employee self-ratings and supervisor ratings significantly differ. The process tests the logic behind the scores and comments, improving the objectivity and consistency of employee feedback. Finally, the sessions ensure that the strengths and weaknesses identified by the manager in the upfront, free-form section are reflected in the behavior ratings in the detailed, template section; with the most important strengths and weaknesses listed first and provided with comments and examples of particularly strong or weak behavior.

4.2.3. Rewards

The Company has an Employee Compensation Program for managing and tracking compensation decisions. During January, managers plan for the year's raises and promotions, though raises and promotions can be offered to employees throughout the year. Employees' salary raises are based on Pay-for-Performance for meeting or beating prior expectations. Approximately the bottom 10% of employee pool does not receive a raise. The mid 70% of employee pool get a 3 to 5% raise. The top 20% of employee pool receive a 6 to 10% raise.

In addition to base salary, employees can earn several bonuses. Company profitability bonuses are based on a company-wide bonus pool and are allocated by each employee's position and goal accomplishment. Travel bonuses are awarded for just showing up to projects outside the southern NJ area. Training spot bonuses, which are discretionary, are subjective rewards given when employees train others. Finally, employee recognitions bonuses, which are discretionary, are subjective rewards for general performance.

The Company operates a semi-annual goal tracking system, running between January and June. Each half, employees and their managers agree on a set of 3-5 goals for the employee to pursue during the half and specific metrics by which to measure goal accomplishment. Some of these goals are tied to division and departmental goals (low-sensitivity items); others are generally specific to the role and can differ in characteristics. Some are outcomes while others are activities. The goal tracking system is run separately from the scorecard system and while scorecard behaviors might affect goal achievement the goal tracking system does not explicitly reference the scorecards[10].

Each goal is assigned a target score such that the employee can earn a total of 25 points (50 points starting in 2012) for completing all personal goals. By the end of the half, managers award actual scores for employee accomplishment. Employees can earn an additional 25 points (50 points starting in 2012) for extremely high performance. Prior to 2010, employees were

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[10] For example, one the sub-behaviors of the Job Function "Safety" is "Leads and enforces safety procedures and policies and addresses non-compliance among all employees, subcontractors, and vendors." A related goal would be "[Achieve a] Total Recordable Incident rate of 2.0 per 200,000 hours or less from January 1, 2012 to the end of the project."

automatically awarded 50 points just for showing up. Starting in 2010, these 50 points were made contingent on division and department goals being accomplished.

Each half the company sets aside a percentage of its profits for a bonus pool (the Company profitability bonus mentioned above.) Each employee is entitled to a share of that pool, depending on their position in the company. His score out of 75 (100 after 2012) dictates the portion of his share that he receives: i.e. If he earns 50 points out of 100 he will receive half of his bonus; if he earns 125 points out of 100 he will receive a 25% greater bonus share. The company retains unearned portions of the pool.

4.3. A Rich Research Setting

The construction management industry is a rich setting in which to study the interaction of several aspects of contract design. The construction management industry provides transactions that are large enough to be individually meaningful (having variation to potentially affect behavior) but numerous enough to allow statistical examination. Projects involve different levels of complexity, uncertainty and cost and require individual attention from both buyers and sellers. Contracting between buyers and sellers occurs in a distinct project stage that considers aspects of the task and the relationship between the parties. Finally, the fact that construction management contracting can be greatly affected by political institutions means that practices might fall outside traditional expectations.

The specific research site provides a detailed setting in which to study the interaction of several aspects of incentive design. The employees I study are highly skilled so their work deliverables are multifaceted and include employee management, client relations and quality management in addition to task completion. Feedback is recognized as an important part of the

Company's incentive system; it not only identifies past results but also guides future improvement. Further, this feedback not only addresses outcome performance, it also specifically addresses input behaviors. The Company provides financial bonuses as a means to incentivize and reward performance. Finally, the fact that this incentive system entails subjectivity in its application means that practices might be influenced by the characteristics of the construction project.

Taken together, the research site's variation in contracting practices and incentive practices provide a broadly applicable setting to study contract and incentive design. Most empirical incentives research has focused on variations in incentives within a single type of work and contract. Most empirical contracting research has focused on variations in work and contracting within a single company and its singular incentive system or across different firms with unknown incentive systems. This research site allows me to analyze variation in both contracting and incentives within the same company.

5. Empirical Tests and Results

5.1. Contract Design Tests

In this section, I use project-level data to examine how firms use contract design (i.e. pricing model, design modification, and revenue quote) to mitigate the risk caused by task complexity and relationship complexity (see Figure 5.)

Contrary to my expectations, I find no support for Hypothesis 1, that task complexity leads firms to use cost-plus pricing. Rather, client type (government, military or private company) is the biggest driver of the pricing model (with government projects being 100% fixed-price, private projects being 92% fixed-price and military projects being 61% cost-plus.) Restricting the sample to military projects, I find support for Hypothesis 2, that aspects of relationship complexity (specifically, having no prior experience with a client) increases the use of fixed-price contracts.

Having found that sellers cannot fully utilize the pricing model to mitigate risk from task complexity, I find significant support for Hypothesis 3, that sellers use design modification to mitigate risk under fixed-price contracts. Fixed-price contracts have a higher level of design modification on average and greater task complexity is associated with greater design modification only for fixed-price contracts (pricing model has an interactive effect with task complexity.) Further, I find that design modification is only associated with increased actual profits when done on projects that are both technically complex and fixed-price.

I also find support for Hypothesis 4, under fixed-price contracting, sellers use higher revenue quotes to mitigate risk. Specifically, sellers charge an incremental markup on estimated costs only when a project is both technically complex (there is more risk) and the contract is fixed-price (the risk is placed on the seller.)

5.1.1. Contract Design Variables

The research site has approximately 35 projects in process at any time. Between 2008 and 2011, it worked on over 300. I examine all 85 projects that were active in the 2008 to 2011 time period and were completed for over $500,000 in revenue. These projects vary on several dimensions (see Table 1 and Table 2.) Objective financial, operational and staffing data was taken from the company's financial system and project management system. For qualitative information on the projects, I surveyed the executives who lead the Company's project management team.

5.1.1.1. Dependent Variables: Contract Design

Pricing Model: Of the 85 projects evaluated, 24 (28%) were cost-plus ("CP") and 61 (72%) were fixed-price ("FP".)

Design Modification: According to the project management team, 42 of the projects used an unmodified design (i.e. generic or uncustomized,) 38 required some innovative modification to the designs prior to commencement and 5 required radical adaption prior to commencement. Grouping the projects by Unmodified (42) and Modified (43), I see that Unmodified projects are relatively more likely to be cost-plus (43% CP/57% FP) compared to Modified projects, which are relatively more likely to be fixed-price (14% CP/86% FP).

Revenue Quote: The project management system indicates that the average revenue quote at project award (commencement) for the sample is $20.7 million. The average revenue quote for cost-plus projects and fixed-price projets is $10.1 million and $24.9 million, respectively. The project management system also tracks the total revenue of each project at completion. The

accounting system tracks the annual revenue budgets and annual revenue earned. I calculate total revenue variance as revenue at completion less revenue at award. I calculate annual revenue variance as revenue earned less revenue budget.

5.1.1.2. Independent Variables: Project Complexity

Cost: The project management system tracks the total cost of each project at award (the expected cost at the beginning of the project) and at completion. The accounting system tracks the annual cost budgets and annual cost incurred. I calculate total cost variance as cost at completion less cost at award. I calculate annual cost variance as cost incurred less cost budget.

Duration: The project management system tracks each project's start date and expected completion date as of award (the expected completion date as of the beginning of the project) and the actual completion date. I calculate Duration at Award (estimated duration) as the number of 30-day months between the expected completion date and the start date. I calculate Duration at Completion (actual duration) as the number of 30-day months in between the actual completion date and start date. I calculate Duration Variance as the Duration at Completion less the Duration at Award.

Customer Needs Complexity: According to the project management team, 24 of the projects had relatively simple customer needs, 40 had a regular level of complexity and 21 had complex customer needs. By separating these into Low/Medium (64) and High complexity groups (21), I see that the low complexity projects were split 33%/67% between cost-plus and fixed-price, similarly to the overall split. High complexity projects, however, were more likely to be fixed-price (14% CP/86% FP).

Subcontractor-Use: The Company uses subcontractors when jobs require specific expertise that the Company lacks. For example, the Company always uses subcontractors for demolition work. Given that subcontractors are used only for specialty tasks, it seems reasonable that greater subcontractor use implies higher task complexity. Of the 85 projects, 18 required little contractor use, 39 required medium level, and 28 required high use of contractors. Grouping the projects by Low/Medium (57) and High (28) Contractor Use, shows that Low Contractor-use projects are relatively more likely to be fixed-price (23% CP/77% FP) and High Contractor-use projects are relatively more likely to be cost-plus (39% CP/61% FP).

Prior Experience with Client: Given the high level of interaction between the Company and its clients (e.g. for planning, execution and validation of the projects), I requested information on the level of experience the Company with the client of each of the projects. Of the 85 projects, 32 were for new clients, 20 were for clients the Company had some experience with and 33 were for clients with which the Company had extensive experience. Grouping the projects by No/Little (52) and Much (33) Experience shows that the new clients are much more likely to use fixed-price contracts (10% CP/90% FP) while old clients are more likely to use cost-plus contracts (58% CP/48% FP).

Relationship with Client: In addition to the amount of experience the Company had with the client, I asked about the actual tone of the relationships. The project management team classified the projects as follows: Partnership (13) < Amicable (48) < Neutral (14) < Antagonistic (8) < Adversarial (2). Grouping the projects as either Positive/Neutral (75) or Negative (10) shows that Positive relationships led to the average split between cost-plus and fixed-price (32% CP/68% FP) while Negative relationships were exclusively fixed-price (0% CP/100% FP.)

5.1.1.3. Control Variables

Product/Service Lines: The Company has 3 broad product lines: Environmental (29) (e.g. brownfield, landfill, remediation), Infrastructure (40) (e.g. bridge, airport, building, road), Power/Utility (16) (e.g. solar). Environmental projects are much more likely to be cost-plus (62% CP/38% FP) while Infrastructure and Power/Utility are much more likely to be fixed-price (15% CP/85% FP and 0% CP/100% FP).

Location: The Company's headquarters has traditionally served the New Jersey, New York and Pennsylvania markets (60 projects). Following Hurricane Katrina, the Company established a hub in New Orleans, Louisiana (5 projects). These locations are considered "home base". All other locations are considered "away sites" (20 projects). Employees receive extra compensation to work at away sites. I associate projects that occur at away sites with more complex task administration. I see that NJ/NY/PA and New Orleans projects are relatively more likely to be fixed-price (25% CP/75% FP and 20% CP/80% FP, respectively) while Away Sites are relatively more likely to be cost-plus (40% CP/60% FP).

Contract Deliverable: The company provides three general types of service: Construction (50), Design/Build (26), Other (9). "Other" services mostly include environmental inspections. Construction projects exhibit the average cost-plus/fixed-price split (30% CP/70% FP) while Design Build projects are relatively likely to be fixed-price (4% CP/96% FP) and Other Services are more likely to be cost-plus (89% CP/11% FP.)

Client: The Company primarily serves public entities though the contracting choices are not uniform. The projects for the Army Core of Engineers and Other Military (38) are relatively more likely to be cost-plus (61% CP/39% FP) while projects for private entities (13) and

governments (34) are more likely to be fixed-price (8% CP/92% FP and 0% CP/100% FP, respectively.)

The concepts above yield the following variables for the 85 observations (construction projects)[11]:

- proj_id: unique identifier for the project
- fixedprice_d: indicator variable where 0 = cost-plus contract and 1 = fixed-price contract
- complex_d*: indicator variable where 0 = a simple or regular project and 1 = a project with complex customer needs
- modified_d*: indicator variable where 0 = an unmodified project design and 1 = a project design that requires moderate or extensive modification
- subcontractor_d*: indicator variable where 0 = low or regular reliance on subcontractors and 1 = high reliance on subcontractors
- away_d: indicator variable where 0 = a project site that is within the company's home bases of NJ, NY, PA and LA and 1 = a project site in another state
- line_infra_d: product line indicator variable where 1 = a infrastructure project
- line_power_d: product line indicator variable where 1 = a power/utility project
- line_environ_d: product line indicator variable where 1 = an environmental project
- deliver_constr_d: project deliverable indicator variable where 1 = construction
- deliver_design_d: project deliverable indicator variable where 1 = design only
- deliver_services_d: project deliverable indicator variable where 1 = other services

[11] Variables indicated by an asterisk were assessed by the project management team.

- littleexperience_d*: indicator variable where 0 = extensive experience between the company and the client and 1 = no or little experience with the client
- negrelationship_d*: indicator variable where 0 = a positive or neutral relationship with the client (i.e. friendly) and 1 = negative relationship (i.e. antagonistic)
- client_private_d: client type indicator variable where 1 = private company
- client_military_d: client type indicator variable where 1 = military or, specifically, the Army Corps of Engineers
- client_government_d: client type indicator variable where 1 = local, state or national government agency
- months_award: expected duration of the project at the time of contract award
- months_complete: actual duration of the project
- rev_award: expected revenue in millions of dollars of the project at the time of contract award
- rev_complete: actual revenue in millions of dollars of the project
- cost_award: expected cost in millions of dollars of the project at the time of contract award
- cost_complete: actual cost in millions of dollars of the project
- gm_award: expected gross margin rate in percent of the project at the time of contract award
- gm_complete: actual gross margin rate of the project

5.1.2. Descriptive Statistics

Basic statistics reveals several relationships between project characteristics. I first provide summary statistics for all project and then separately for cost-plus projects and fixed-price projects (see Table 3.) I provide a matrix of project characteristics (see Table 4) to help illustrate how some project characteristics are related to each other (e.g. certain product lines tend to be found with certain clients.) I then provide a standard correlation table of the variables (see Table 5.)

There is strong correlation between product lines and clients. Infrastructure jobs are the biggest ticket jobs: They involve high cost and revenue and are usually non-design/build projects with government clients. Power projects are shorter term and lower dollar and are more likely to be non-build/design projects with private clients. Environmental projects are also low dollar but are longer term and tend to be non-build service projects with military clients (e.g. site clean-up projects.)

The contract decision is heavily correlated with product line, client type and deliverable. This suggests that difficult jobs (i.e. infrastructure and power, and designing and building) are more likely to be fulfilled via a fixed-price contract. Also, contract decision is heavily correlated with experience, relationship and client. This suggests that difficult partners (i.e. less experience, negative relationship, and government buyers) are more likely to require fixed-price contracts. These correlations conflict with my hypotheses that more complexity increases the use of cost-plus contracting. There is not much relationship between contract type and revenue, cost or duration.

The use of modified design tends to match the use of fixed-price contracts. There is a strong correlation between the use of modified design and fixed-price contracts and there is a

strong correlation between modified design and the task and relationship characteristics that are related to fixed-price contracts. This relationship tends to be weaker though, suggesting that modified design might be used as a mechanism to mitigate risk imposed on a seller by a fixed-price contract.

Technical complexity is correlated with other aspects of complexity. These projects are more likely to involve a design deliverable, more likely to require modified design work and are more likely to involve a government partner and a partner with whom the seller has a negative relationship. They also have slightly longer duration, more costs and more revenues.

5.1.3. Regression Analysis

5.1.3.1. Pricing Model

I test Hypotheses 1 and 2 (that task complexity is not associated with the use of fixed-price contracting and that relationship complexity increases the use of fixed-price contracting) by running an ordinary least squares regression[12] of the fixed-price indicator variable on the

[12]Given the binary nature of the dependent variable a logit or probit regression would be more appropriate than a linear regression. However, since all projects with the power product line, a negative client relationship and a government client are either fixed-price or cost-plus (those variables predict success perfectly) the logit model drops half of the observations. The results for the variables that can still be predicted in non-linear models are consistent with the linear regression results so I use the linear model for the primary test.

variables for task and relationship complexity[13]. I run the model first for all clients, then separately for military clients (all government clients' projects and all but one private clients' projects are fixed-price.) In these tests, a negative coefficient indicates that the independent variable makes a cost-plus contract more likely.

The results support Hypothesis 1 (see Table 7): There is no significant evidence that task complexity affects the contracting decision. The coefficients on technical complexity, use of specialized subcontractors and product line fail to load at traditional significance levels. Rather, the most significant driver of pricing model appears to be the client type.

Seeing that client type is the primary driver of pricing model, I run the model just for military clients (38 observations). In this model, task complexity still does not seem to drive the pricing model but there seems to be an effect of relationship complexity. Having no experience with a client is associated with a 42.8% greater likelihood of using fixed-price contracting (at the 10% significance level). There also is a suggestive result that having a negative relationship increases the likelihood of using a fixed-price contract by 57.3%; unfortunately, perhaps due to the low sample size, the results are outside normally accepted levels of significance. These

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[13] Before testing the effect of complexity on contract design I test whether manager characterized "technical complexity" is a distinct construct from other aspects of complexity. Regressing the Highly Technical indicator variable on the projects' task and relationship characteristics (see Table 6) shows only a marginal association between technical complexity and design deliverable and private company client. There is no significant effect of product line, duration or cost. The results suggest that the technical complexity variable is distinct from other characteristics.

results support Hypothesis 2, that greater relationship complexity increases the likelihood of fixed-price contracting, lending support to the idea that the buyer's lack of trust in an opportunistic seller trumps the seller's lack of trust in faith renegotiation.

5.1.3.2. Design Modification

Given that contract design decision is driven by relationship complexity and client type, not task complexity, I examine how sellers use other contract levers to mitigate the risk imposed on them by task complexity and fixed-price contracts. I suggest that design modification (altering or customizing the execution plans for a construction project prior to project execution) and revenue quote (requesting a higher price during the project bid phase) are two mechanisms that sellers can use to protect themselves when the pricing model does not. I first estimate design modification (an indicator variable) as functions of task and relationship characteristics for all projects and then separately for cost-plus contracts and for fixed-price contracts (see Table 8) using ordinary least squares.

There is strong evidence that sellers selectively use design modification to mitigate risk under fixed-price contracts. On average, fixed-price contracts have design modification with 30.1% more likelihood. Further, in fixed-price contracts, sellers respond to high technical complexity by modifying designs with 42.2% greater likelihood (1% significance level) and they respond to specialized project requirements (indicated by heavy use of subcontractors) by modifying designs with 38% greater likelihood (10% significance level). Under cost-plus contracts, where sellers do not face the same risk exposure, there is no such response.

Having no experience with a client (more risk) is significantly associated with a 25% lower likelihood of design modification (less risk-mitigation) for fixed-price contracts (10%

significance level) but not for cost-plus contracts. A possible explanation is that relationship complexity reduces the seller's understanding of the client's needs and, therefore, his ability to appropriately modify the design (an inappropriate modification is one that would require future corrective costs or uses resources sub-optimally for the customers' needs.) Since cost-plus contracts place the risk of inappropriate modification on the buyer, the seller would not face the same potential cost and resulting reluctance to modify.

To validate the effect of design modification on project performance, I model projects' gross margin at project completion as a function of contract design, project characteristics and complexity using ordinary least squares (see Table 9.) I find no average effect on margin from having a fixed-price contract. However, I find that technical complexity is significantly associated with $2,203,000 greater margin on average for cost-plus projects and $4,170,000 lower margin on average for fixed-price contracts. This finding supports my expectations that technical complexity is a source of risk that adds cost over the estimated levels (cost at award); in cost-plus contracts sellers pass along the added cost and take margin while in fixed-price contracts the sellers must bear the extra cost.

I find no average effect of design modification on margin for cost-plus contracts, fixed-price contracts or the pooled sample. However, by interacting design modification and technical complexity, I find a significant positive effect of $3,132,000 under fixed-price contracts (there is no effect for cost-plus contracts.) This supports the claim that sellers selectively and successfully use design modification to mitigate task risk under fixed-price contracts.

These results lend strong support behind Hypothesis 3, that sellers use design modification or customization to mitigate risk under fixed-price contracts. Fixed-price contracts have a higher level of design modification on average and demonstrate an interactive effect with

task complexity: Greater task complexity is associated with greater design modification only for fixed-price contracts.

5.1.3.3. Revenue Quote

I first model revenue quote as a function of project characteristics including pricing model, task complexity, relationship complexity and duration estimate and cost estimate (at the time of project award) using ordinary least squares. In the pooled sample (see Table 10, Panel A) Controlling for cost at award (a measure of project size,) the average project receives an 18% markup. I find no fixed effect of fixed-price contract but there is evidence that modified designs are associated with greater pricing ($2,107,000 on average.) Higher pricing for modified designs is as expected though it does not necessarily support the hypothesis: Design modification might be indicative of a complex project that needs revenue cushion or it might be just a billable service.

Contrary to expectations, the effect of relationship complexity on revenue quote shows a significantly negative effect of having a negative (antagonistic) relationship on revenue. I would expect a seller to "bake in" revenue cushion when facing greater risk from an antagonistic client; however, the opposite is observed. Given the information available, though, it is not reasonable to infer a causal relationship. One possible explanation is that the only way the seller won the bid from an already-antagonistic buyer was by bidding low. Alternatively, a low price level could have caused or widened the animosity between the two parties (from the seller's perspective.) Unfortunately, negative relationships are only observed under fixed-price contracts so no relative effect can be gauged.

Running the model separately for cost-plus contracts and fixed-price contracts (see Table 10, Panels B and C) shows that highly technical projects are associated with $761,000 greater revenue quotes under fixed-price contracts though the coefficient is only significant at the 15% level. There is no similar effect at all under cost-plus contracts. For modified design projects, a $2,433,000 price premium is noted for fixed-price contracts but not for cost-plus contracts. For high-subcontractor (specialized skill) projects, there is a significant negative effect on price in cost-plus contracts of $519,000 (at the 5% level) but no effect in fixed-price contracts (revenue quotes under fixed-price are *relatively* higher compared to cost-plus contracts when specialized work is involved.)

Interestingly, there is no evidence in the first three models to suggest that sellers mark-up cost estimates differently under cost-plus and fixed-price contracts. For both types of price models a dollar of initial cost estimate is associated with approximately $1.18 of revenue quote. In the fourth model (see Table 10, Panel D) I suppose that an estimated dollar of cost in a simple project is different from a dollar of estimated cost in a complex project: i.e. an estimated dollar of cost in a complex project is riskier so it should have a higher price. By interacting projects' cost estimates with the indicator variables for fixed-price contract and technically complex project, I find that there is no incremental markup (the coefficient on cost estimate) for fixed-price contracts or complex projects *alone* but there is a statistically significant effect of having *both* a complex project and a fixed-price contract: Sellers quote an additional $0.084 of revenue per $1.00 of estimated cost when there is technical complexity and the contract is fixed-price.

Beyond finding increased price quotes for technically complex projects only when they are under fixed-price contracts, I find that increased price quotes are only associated with increased actual profits for fixed-price contracts. For fixed-price contracts, each additional dollar

of revenue at award (the price quote) is significantly associated with $1.343 of incremental gross margin at project completion (see Table 9.) Having controlled for project characteristics and cost at award, I find no incremental relationship between revenue at award and actual profit for cost-plus contracts.

The results support Hypothesis 4, under fixed-price contracting, sellers use higher revenue quotes to mitigate risk. Specifically, sellers charge a higher markup on estimated costs when a project is technically complex (there is more risk) and the contract is fixed-price (the risk is placed on the seller.) Further, increased revenue quotes are margin-improving only in fixed-price contracts.

5.2. Incentive Design Tests

In this section, I use employee-year, employee-project-year and project-year data to examine how firms use incentive design (i.e. feedback, reward leniency and ratings compression) to respond to task complexity and relationship complexity (see Figure 6.)

I find support for Hypothesis 5: Managers are more lenient (generous with rewards) under fixed-price contracts. The average bonus level is higher and is relatively more strongly associated with behavior (input) ratings than with goals (output) ratings. Behaviors are rewarded more under fixed-price contracts (a one-unit change in skills rating is associated with a greater increase in reward.) Further, the econometric models have less explanatory power for fixed-price contracts, suggesting greater presence of managerial discretion in those projects.

I find support for Hypothesis 6: Relative to cost-plus contracts, under fixed-price contracts, managers provide more feedback on behavior on average, they do not reduce feedback

when current-year employee performance is high (as occurs in cost-plus contracts), and they provide relatively more feedback when costs are over-budget.

Finally, I find suggestive evidence in support of Hypothesis 7: Complexity is associated with relatively more ratings dispersion in fixed-price contracts but not in cost-plus contracts. It is plausible that this association is caused by managers' evaluating employees more thoroughly and generating more dispersed ratings.

5.2.1. Incentive Design Variables

Between 2008 and 2011, over 600 client-facing employees worked for the research site, servicing the company's over 300 projects. My sample is limited to the 223 employees who worked on any of the 85 in-sample projects.

Incentive data (bonuses, raises and promotions) were provided by the research site at the employee-year level. Performance evaluation data (goal performance rating, skills rating and descriptive feedback) were provided at the employee-year level from the firm's evaluation scorecards. I link employee-year data to all projects for which the employee billed hours that year.

The 223 in-sample employees cover 481 employee-years of data (see Table 11.) During a single year employees can work on several projects (and each project is served by many employees.) High-level managers might work on several projects at a time (in parallel) while low-level managers might work on several projects over time (in sequence.) In my sample, the average employee worked on 3.76 projects, yielding 1,809 employee-project-years of data. My data covers 1,770 hours per employee year (471 hours per employee-project-year,) consistent

with a standard 2,000 hour work year. I analyze at the employee-project-year level (1,809 observations) except for ratings dispersion which is analyzed at the project-year level[14].

Since each employee works on several projects per year there may be an identification problem in which the employee's annual performance evaluation and rewards are linked with projects of different types, particularly with both fixed-price and cost-plus projects. In my data, most employee-years are heavily fixed-price or heavily cost-plus (in any year an employee tends to work on either fixed-price or cost-plus projects) (see Figure 7.) Of all employee-year observations, 11% spent 10% or less of their time on fixed-price jobs, 75% spent 90% or more. Any remaining misidentification (for the 14% of employee-years that spent between 11% and 89% of their time on fixed-price contracts) would bias against my finding results that the characteristics of the project affect the incentive design.

5.2.1.1. Dependent Variables: Feedback Amount and Rating Compression

Employees' regular evaluation cycle includes two main components: Goals and Behavior Feedback. In the Goals component, managers and employees agree on targets to satisfy the specific needs of the employee's projects, the broader needs of the company and the development needs of the employee. While most managers set 5 or 10 goals for employees, they have discretion to assign more or fewer and to provide more or less formal documentation or direction of the goal: Goals are provided in free-form text and managers can provide more or less text. While goals are always worth up to 5 points (for use in the company's bonus pool formula)

[14] I calculate the standard deviation of employees' ratings by project-year.

managers have discretion to award extra credit for superb performance or partial credit by their own pre-established formula or not at all.

In terms of Behavior Feedback, managers are granted similarly broad discretion. The standard evaluation form features seven broad competencies (drive, leadership, people skills, principles, position description skills, problem solving and technical skills) and dozens of behaviors that explain and/or exemplify each competency. Managers can choose which behaviors they rate (on a 0-5 scale) and whether they add free-form text comments. Employees overall rating (which is not directly linked to compensation) is a weighted average of the components' scores, which are weighted averages of the behaviors' scores. While the standard evaluation form lists the seven competencies in parallel, I have sorted them into "Soft Skills" and "Hard Skills" subgroups.

Soft Skills

- Leadership: Employee development, Employee empowerment, etc.
- Principles: Dedication, Honesty, Integrity, Loyalty, etc.
- Drive: Goal orientation, Entrepreneurism, Planning, Work ethic, Reliability, etc.
- People Skills: Teamwork, Customer relations, Respect, Behavioral intelligence, Communication, Crisis management, etc.

Hard Skills

- Problem Solving: Innovativeness, Productivity, Judgment/Decision making, Attention to detail, Organization/Time management, etc.
- Technical Skills: Analytical abilities, Management, Business sense, Execution/Urgency, etc.

- Position Description Specific: Business development, Change orders, Forecasting, Purchasing, Quality, Safety, Subcontractors, Cost control, etc.

Scores: The 0-5 rating an employee receives on their annual performance review for Goals (average rating of all the employee's goal-achievement for the year,) Soft Skills (average rating of Drive, Leadership, People Skills and Principles behaviors,) and Hard Skills (average rating of Position Description Skills, Problem Solving and Technical Skills behaviors.)

Ratings Dispersion: Rating compression is measured by the standard deviation of Goal, Soft Skills and Hard Skills Scores when grouped by project-year.

Items/Subcomponents Rated: The number of Goals and Soft Skill and Hard Skill sub-behaviors rated for an employee in a year.

Comment Length: The character count for all comments on an employee's Goals, Soft Skills and Hard Skills in a year.

5.2.1.2. Dependent Variables: Reward Leniency

The reward cycle is run separately from the feedback cycle (they are usually run 3 or 6 months apart.) The research site believes this reduces feedback bias. Employees' bonus is calculated based on their level in the company (which entitles them to an allotted share of division profits) and their overall Goal rating (which determines how much of the allotment they receive.) Raises are awarded by managers each year according to company-wide human resource planning: Each team is allotted an amount of potential raise and each team's manager allocates the raise among the teammates. Managers nominate and award promotions according company resource needs and employees' development and perceived potential for success.

Bonus: The average annual bonus (the sum of all bonuses received) for employees was $4,085. Linking employee-years to all the projects each employee worked on in that year shows that the average annual bonus for employees in cost-plus projects was $2,084; the average for employees in fixed-price projects was $4,815.

Raise: The average employee earned an annual raise of $1,645 (+2.2%.) The average annual raise for employees in cost-plus projects and fixed-price projects was $1,050 (1.3%) and $1,777 (2.3%,) respectively.

Promotion: The average employee enjoyed a 10.3% likelihood of being promoted in any given year. The likelihood for employees in cost-plus projects and fixed-price projects was 6.0% and 9.8%, respectively.

5.2.1.3. Descriptive Statistics

The incentives summary statistics (see Table 12) and correlation table (see Table 13) offer a few insights[15]. Managers tend to rate similar numbers of Hard Skill behaviors and Soft

[15] The first group of rows shows the scores (out of 5 points) awarded to Goals, Soft Skills and Hard Skills by employee-year. The next group of rows shows the number of goals or behaviors identified and rated by employee-year. The third group shows the character length for Goals and each behavior component (how much free-form text the manager added) by employee-year. The fourth group shows the incentive rewards received in each employee-year.

The first group of columns (638 observations) reflects all employee-years for which there is evaluation data; it includes some employees that did not serve the in-sample projects. The second and third groups of columns only include in-sample employees and projects and show the

Skill behaviors so there is similar opportunity for scoring and commentary. Nonetheless, ratings for Hard Skills are lower and more varied than are ratings for Soft Skills. This suggests that managers are stricter and put more effort into rating Hard Skills, which are more observable (and accrue lower cost of evaluation.) Also, overall, managers' ratings are lower and more varied in fixed-price contracts (compared to ratings in cost-plus contracts.) This suggests that managers are stricter and put more effort in evaluation when the contract places the financial risk on the company (the Company receives the benefit from performance-enhancing evaluation practices.)

In terms of comment length, managers tend to put more writing into Soft Skills and fixed-price contracts. This is consistent with my expectations that Soft Skills are less reflected by a simple 0-5 rating and benefit from greater commentary. Further, since fixed-price contracts place more risk on the company, it is reasonable that managers would spend more effort in commenting on employee behavior to improve performance.

5.2.2. Regression Analysis

I first examine ratings levels to see if managers are systematically biased in their evaluation of goal achievement, soft skills behavior and hard skills behavior in response to task complexity, relationship complexity and contract design. I model employees' annual ratings for each component (average Goal rating, average Soft Skill rating and average Hard Skill rating) as

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employee-project-years by cost-plus contracts (second group) and fixed-price contracts (third group.) The total employee-project-years (1809 observations) reflect that employees serve several projects in a single year.

a function of the characteristics of all the employees' projects during the year (task complexity, relationship complexity, descriptive controls and annual cost and revenue estimates and annual cost and revenue variance over estimate.) The unit of analysis is the employee-project-year. The ordinary least squares model is estimated with fixed year effects and robust standard errors.

Estimating across all projects (see Table 14) and cost-plus and fixed-price project separately (see Table 15), I find no evidence of bias. Ratings seem largely independent of my constructs of task complexity and relationship complexity, ratings are not affected by project size (duration, cost and revenue) or by project performance variances (missed timelines, cost and revenue budget misses), and rating level does not seem to be affected by contract design. These results give me confidence that I can use ratings levels as an independent variable when examining the effects of complexity and contract design.

5.2.2.1. Reward Leniency

To examine leniency, I test the effect of employees' annual component ratings, project complexity, project characteristics and annual cost and revenue figures on employees' annual bonus, %-raises and promotion likelihood. The ordinary least squares models are estimated based on employee-project-year observations with year fixed effects and robust standard errors.

Considering all projects (see Table 16) I see that skills ratings are associated with employee rewards but not uniformly. Soft skills are significantly associated with greater raises and a greater likelihood of being promoted in a given year but are associated with lower bonuses. Hard skills, on the other hand, are associated with earning greater bonuses but are not associated with raises and are negatively associated with promotion likelihood. At this level, I also see a

marginally significant positive effect of fixed-price contracts on bonuses (employees in fixed-price contracts get $1018 higher bonuses on average.)

Running the rewards models separately by pricing model (see Table 17) suggests several ways in which managers apply greater leniency under fixed-cost contracts. First, in cost-plus contracts, there is a significant effect of goal rating on bonus received (significant at the 10% level) which corresponds to our understanding of the bonus calculation: Employees' bonuses should be calculated based on the achievement of their goals. In fixed-price contracts, however, there is no significant effect of goal ratings on bonuses. This suggests that in fixed-price contracts managers apply more subjectivity in when awarding bonuses.

Looking at soft and hard skills ratings provides further evidence that managers put relatively more emphasis on behaviors when rewarding employees in a fixed-price contract. Higher soft skills ratings and hard skill ratings translate to relatively higher bonuses in fixed-price contracts and higher hard skills ratings translate to relatively higher raises and promotion likelihoods (with the exception of hard skill rating's effect on bonuses, these effects are estimated as lower *negative* effects on rewards.)

Finally, when I compare the power of the models to estimate each reward under the two pricing models I see that the explanatory power of the model (R-squared) is always higher for cost-plus contracts: Ratings, project characteristics, and project financials explain a greater portion of the variation in bonuses, raises and promotions for employees working in cost-plus contracts. Under fixed-price contracts, managers use more discretion when rewarding employees.

Overall, I see support for Hypothesis 5; managers are more lenient (generous with rewards) under fixed-price contracts. The average bonus level is higher and less formally based

on goal ratings. Behaviors are rewarded more under fixed-price contracts (a one-unit change in skills rating is associated with a greater increase in reward.) Further, the econometric models have less explanatory power for fixed-price contracts, suggesting greater presence of managerial discretion.

5.2.2.2. Feedback Amount

I estimate annual total comment length for each of the three components (Goals, Soft Skills, and Hard Skills) as a function of complexity, project characteristics and annual financial figures, controlling for employees' average rating in the component using ordinary least squares (see Table 18.)

I first notice that as the average Soft Skills rating increases on the 0-5 scale, the average length of comments decreases by 1,314 characters (46% of the 2,882 character average comment.) There is no statistically significant effect of rating level on the length of comments for Hard Skills and the 73 character increase effect for Goals, while statistically significant at the 1% confidence level, is economically negligible (5% of the 1,413 character average comment.) I interpret this as evidence that managers feel a greater need to justify (i.e. be more verbose when explaining) low ratings on more subjective measures. High ratings on subjective measures are easily accepted by employees (i.e. there is less need to explain the rating) and ratings on objective measures are more taken at face value (i.e. the rating level does not affect the need for justification or explanation.)

The coefficient on fixed-price contract indicator loads at the 10%-level for both soft skills and hard skills. This suggests that, controlling for annual project performance and behavior rating, managers provide more behavioral feedback -- 338 characters for soft skills (12% of

2,882 average), 286 characters for hard skills (14% of 2,028 average) -- when under the risk imposed by a fixed-price contract.

Running the comment length model separately by cost-plus contracts and fixed-price contracts (see Table 19) reveals more information on the differential effect of pricing model. Across both soft skills and hard skills and both pricing models, greater component rating is associated with shorter comments. However, the effect is greater in cost-plus contracts: In cost-plus contracts, managers are more willing to skimp on comments when performance is strong. In fixed-price contracts, where there is more risk imposed on the company, managers are less likely to cut comments short.

Looking at the effect of cost variance, there is a marginally significant positive effect of going over cost budget on comment length under fixed-price contracts (1-2 extra characters per million dollars of cost overrun) but a marginally significant *negative* effect for cost-plus contracts (20-30 fewer characters). Further, in cost-plus contracts, commentary is greater for more profitable projects (significant coefficients on cost estimate and revenue estimate) but there is no such effect in fixed-price contracts.

I fail to find evidence that the pricing model mediates the effect of other complexity factors on comment length. For example, I would have expected that technical complexity would have a higher effect on comment length under fixed-price contracts than under cost-plus contracts.

Overall, I find support for Hypothesis 6: Relative to cost-plus contracts, under fixed-price contracts, managers provide more feedback on behavior on average, they do not skimp on feedback when current-year employee performance is high (as occurs in cost-plus contracts), and they provide relatively more feedback when costs are over-budget.

5.2.2.3. Rating Compression

To test rating compression I summarize the employee-project-year evaluation data by project-year and use the standard deviation of each component's rating by year as the dependent variable. I estimate the effect of contract design, complexity, project characteristics and annual cost and revenue figures on the standard variation of each project-years goal ratings, soft skill ratings and hard skill ratings. The ordinary least squares model is estimated with year fixed effects and robust standard errors.

The pooled results (see Table 20) suggest that complexity is associated with greater ratings dispersion. First, technical complexity is associated with significantly greater dispersion of goal ratings. Second, having no experience with a client is associated with significantly greater dispersion of soft skills rating. However, these associations do not necessarily suggest that managers respond to complexity and risk with greater rating effort, which leads to greater rating dispersion. It is plausible that greater complexity and risk causes employees' performance to diverge by giving more skilled employees a chance to shine and giving less skilled employees a chance to demonstrate their shortcomings.

The results by pricing model (see Table 21) give a better opportunity to infer a directional relationship. Here I see that technical complexity is associated with greater goal rating dispersion in fixed-price contracts but not cost-plus contracts. Similarly, heavy subcontractor use (an indication of highly specialized work) is associated with a less dispersed goal ratings for cost-plus projects: goal ratings are relatively more dispersed for fixed-price contracts. If I assume that technical complexity and specialized work challenges all employees in the same way and that the goal setting process is constant across contract types (controlling for product line,

deliverable and client), it is more plausible that dispersion is driven by evaluation effort in response to project complexity.

Additionally, I see that there is a significant relatively negative effect of design modification and revenue estimate on goal rating dispersion in fixed-price contracts (design modification significantly reduces dispersion for fixed-price contracts; revenue level significantly increases dispersion for cost-plus contracts.) As previously demonstrated, design modification and revenue bid are risk-mitigation strategies that sellers can employ. It follows, then, that they would be associated with lower relative dispersion.

Taken together, these results provide some suggestive evidence in support of Hypothesis 7: Complexity is associated with relatively more ratings dispersion in fixed-price contracts. It is plausible that this association is caused by managers' evaluating employees more thoroughly and generating more dispersed ratings.

6. Discussion

6.1. Thesis and Empirical Findings

This paper bridges the literatures of contingency-based management control systems and inter-organizational relationships in order to examine the effect of complexity on contract design and incentive design. By utilizing a unique and highly rich data source from a construction management company, I examine two different types of Project Complexity: Task Complexity (characteristics of the buyer's needs that create uncertainty in the seller's ability to understand and satisfy the buyer's needs) and Relationship Complexity (characteristics of the buyer and seller's relationship that create uncertainty in the ability for the buyer and seller to communicate to understand and satisfy the buyer's needs.) I examine how the Company uses contract design (pricing model, design modification, and revenue quote) to mitigate the risk imposed by complex construction projects. I then examine how the Company adjusts its employees' incentive design in response to the risk imposed by complex construction projects and the contract design.

In the first set of empirical tests I examine how the Company uses contract design to mitigate its risk imposed by project complexity. I do not find evidence that the Company uses cost-plus pricing when faced with greater task complexity. Rather, in my sample, the use of cost-plus or fixed-price pricing is driven by relationship factors: Certain types of clients predominantly or exclusively use one type of pricing (government and private clients use fixed-price contracts) and, for client-types that use both (military clients,) the pricing model is heavily driven by the relationship between the seller and the client. Specifically, a lack of previous experience between the parties, which reflects a lack of trust (greater relationship complexity,) leads to the use of fixed-price contracts, which impose the financial risk on the seller.

Given that a project's pricing model is decided by the client at the request-for-proposal stage, I find that the Company uses other contract design mechanisms when it submits proposals for fixed-price projects with greater task complexity. The Company is more likely to modify the project design for fixed-price contracts (fixed effect) and there is an incremental likelihood of modification if the project is both technically complex and fixed-price (interaction effect.) Further, design modification is only profit-enhancing for projects that are both technically complex and fixed-price. The Company also uses higher revenue quotes to mitigate risk by charging an incremental markup on estimated costs only when the project is both technically complex and under a fixed-price contract (interaction effect only.) Further, increased revenue quotes are associated with greater actual profit only in fixed-price contracts.

In the second set of empirical tests I examine how the Company modifies incentive design when faced with project complexity. I compare the incentive characteristics found in fixed-price projects (in which the risk is imposed on the Company) to the incentive characteristics found in cost-plus projects (in which the risk is imposed on the buyer.)

I find that managers are more lenient (generous) with rewards under fixed-price contracts. The average bonus level is higher and is relatively more strongly associated with inputs (ratings on soft behaviors and technical behaviors,) rather than outputs (goal achievement ratings.) In fixed-price projects, greater ratings in hard behaviors are associated with relatively higher raises and increased promotion likelihood. There also appears to be more managerial discretion in the awarding of bonuses, raises and promotions in fixed-price projects (lower explanatory power of the model.)

I find that in fixed-price projects managers provide more descriptive feedback to employees, this feedback level is maintained even in periods of high employee performance and

they provide more feedback when there are cost overruns (in cost-plus projects managers provide a lower level of average feedback, they provide less feedback when employee ratings are high, and they don't provide extra feedback when costs go over budget.)

I also find that, in fixed-price projects, greater technical complexity is associated with greater dispersion (less centrality) in output ratings. In cost-plus contracts complexity does not affect the dispersion of ratings.

In summary, I find evidence that the Company uses a portfolio of mechanisms to respond to project complexity. While the Company has little control over the pricing-model of its projects, it selectively uses design-modification and higher price quotes to protect its margin. While the company insulates employees from financial harm caused by greater project complexity, it provides greater information through performance feedback and ratings dispersion.

6.2. Implications and Future Research

The systems and institutional nuances of my research site are both strengths and limitations of the study. The detailed performance evaluation practices and records that the Company maintain allow me to test specific implications about the use of incentive design but limit the generalizability of the study to organizations with coarser measurement systems.

While my research site is in the construction management industry it is broadly applicable to many business-to-business transactions. Such transactions (for example in IT development, consulting, and automotive supply development) regularly involve ex ante uncertainty, asymmetric information between the buyer and seller, product customization, process adaptation and information acquisition. The nature of the construction management

industry provides a significant institutional context variable: the procurement practices of public entities. This nuance allows me to study off-diagonal results that are relevant to other industries but might not be regularly observed.

One limitation of my research (as with most empirical studies of the procurement industry) is that it is susceptible to survivorship bias. I only have contract design information on projects for which the seller submitted a proposal and the client accepted. Further research should examine the conditions under which the seller declines to submit a proposal.

The multifaceted nature of complexity in this context adds to my study but is not without limitations. While prior papers have used objective measures like the number of parts to proxy for complexity, my measures for complexity were subjectively provided by project management executives at the company. It is possible that the executives' ratings of ex-ante project complexity were biased by ex-post project challenges.

My findings suggest that traditional research on inter-firm relationships underestimates the feedback that contract structure has on the characteristics of the transaction. Early transaction cost economics approaches and some recent relational approaches assume that the nature of the work and the nature of the parties are static. Accordingly, they find that the structure of the inter-firm relationship is the result of an optimized function balancing the costs and benefits of communication and cooperation. Having found that institutional characteristics can cause observed structures to divert from ideal forms and that firms respond by modifying the nature of the work I suggest that a contingency framework might be more appropriate or at least that other methods consider the endogeneity of the transaction in inter-firm relationship decisions.

My findings suggest that incentives research needs to consider the task and environmental contingencies of the work context to best explain and predict incentive design. Agency theory approaches to incentive design consider how the principal can gather information on agent performance. My findings suggest that differences in the relationship between a company and its customers will change the availability and need for performance information. Incentives research also needs to consider the broad range of incentive tools. Managers can use feedback details, ratings, raises, bonuses and promotions. A single contextual variable might cause different incentive tools to be adjusted in opposite directions: For example, under high complexity and fixed-price contracting feedback and ratings becomes more stringent (more feedback and greater differentiation) but rewards become less stringent (more generous.) Further, my findings illustrate how managers differentially use incentive tools for different needs. For example, managers at my research site find that social skills are more relevant than technical skills when making promotion decisions; they also rely on behavior ratings more than achievement ratings when the work context deems it more appropriate.

There are several ways in which future studies can build on this paper to better understand the effects of complexity, contract design and incentive design on performance. First, it has been suggested that unstandardized application of subjective performance evaluation can create perceptions of bias and can negatively affect employee morale. It would be valuable to see how unstandardized subjective performance evaluation affects employees' job satisfaction, career progression and tenure when incentive design is differentially driven by contextual variation instead of applied in a standardized fashion. Also, my research site adopted an extensive performance evaluation system because of specific human capital needs. What isn't

clear from the current analysis is the whether the cost of the system (in terms of hours spent and employee morale) has sufficiently improved hiring, promotion and work outcomes.

In this paper I examined the effect of complexity and contract design on high-level project profitability. Given the role of management accounting as a link between strategy and operations, it would be relevant to see how the contract and incentive design mechanisms studied affect more technical aspects of project performance like quality and broader aspects of organizational strategy.

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8. Figures and Tables

Figure 1: Model

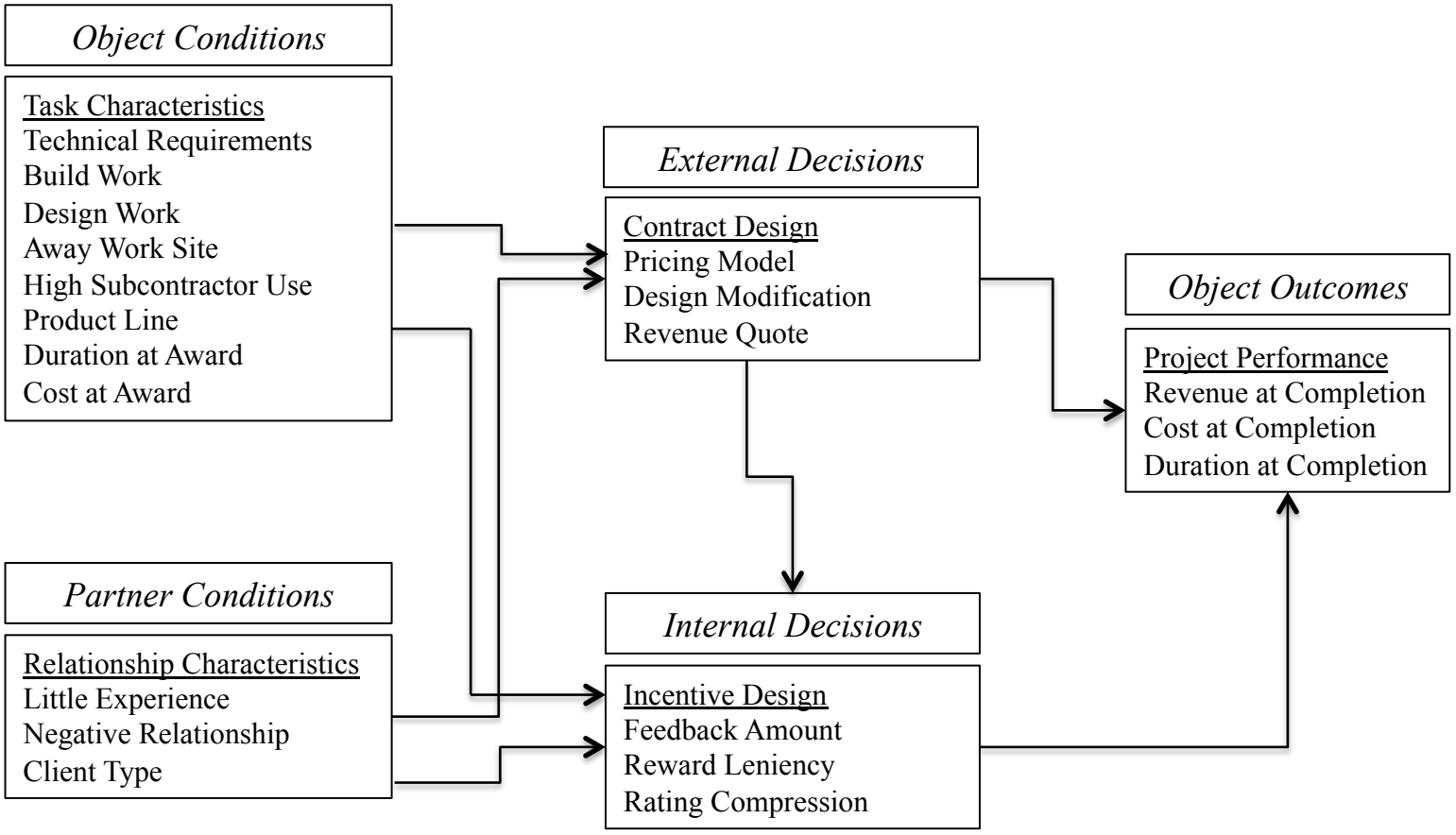
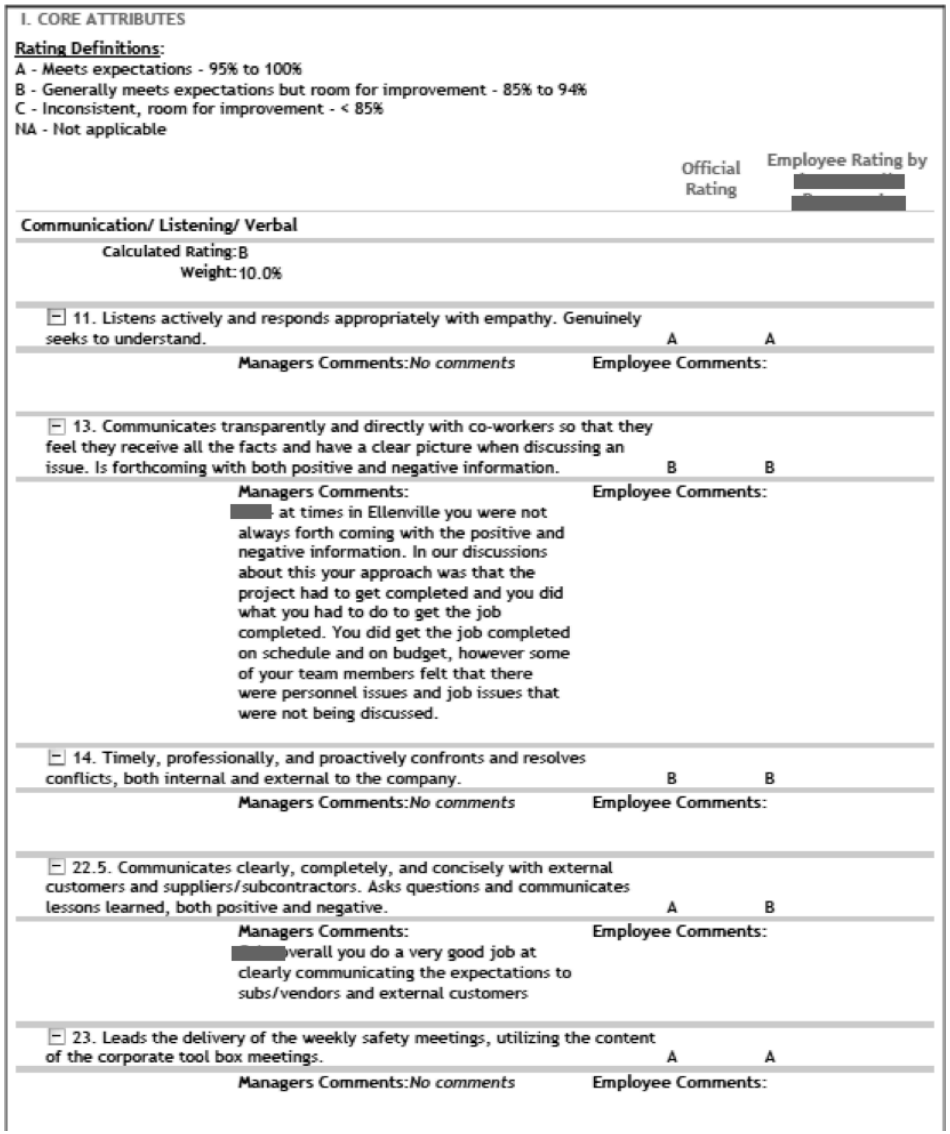


Figure 2: Old Scorecard Excerpt

Manager's Assessment		
Score based on Behavior Matrix detailed on following pages.		Score (1-5)
Leader-ship	Generate a following	3
	Empowerment of employees	3
	Employee Development	3
Principles	Loyalty	4
	Values	4
	Responsibility/Flexibility	4
	Judgment	4
	Vision/Strategic Plan Execution	4
Drive	Goal/Target Oriented/ Results Driven	4
	Initiative/Proactive	4
	Punctuality	4
	Work Ethic /Urgency	4
	Reliability/Follow Through	3
	Learning Experience	4
People Skills	Team Player/Contributor / Interpersonal Skills	4
	Professionalism/Customer Relations	4
	Communication/Listening, Verbal Skills	4
	Conflict Resolution	3
Problem Solving	Innovativeness	3
	Efficiency/Cost Saving	3
	Decision Making	4
	Detail Oriented	4
	Organization/Time Management/ Documentation	4
Technical	Analytical	4
	Skill	4
	Knowledge	3
	Execution	4
Position Description Specific	Expertise and experience in job responsibilities	3
	Overall performance in alignment with specific responsibilities	4
	Knowledge of department functions	4
	Demonstrates and promotes safe work conditions	4
	Negotiation Abilities	3
	Knowledge of Industry	3

Figure 3: New Scorecard Excerpt



I. CORE ATTRIBUTES

Rating Definitions:
A - Meets expectations - 95% to 100%
B - Generally meets expectations but room for improvement - 85% to 94%
C - Inconsistent, room for improvement - < 85%
NA - Not applicable

	Official Rating	Employee Rating by [redacted]
Communication/ Listening/ Verbal		
Calculated Rating: B Weight: 10.0%		
− 11. Listens actively and responds appropriately with empathy. Genuinely seeks to understand.	A	A
Managers Comments: *No comments*	**Employee Comments:**	
− 13. Communicates transparently and directly with co-workers so that they feel they receive all the facts and have a clear picture when discussing an issue. Is forthcoming with both positive and negative information.	B	B
Managers Comments: [redacted] at times in Ellenville you were not always forth coming with the positive and negative information. In our discussions about this your approach was that the project had to get completed and you did what you had to do to get the job completed. You did get the job completed on schedule and on budget, however some of your team members felt that there were personnel issues and job issues that were not being discussed.	**Employee Comments:**	
− 14. Timely, professionally, and proactively confronts and resolves conflicts, both internal and external to the company.	B	B
Managers Comments: *No comments*	**Employee Comments:**	
− 22.5. Communicates clearly, completely, and concisely with external customers and suppliers/subcontractors. Asks questions and communicates lessons learned, both positive and negative.	A	B
Managers Comments: [redacted]verall you do a very good job at clearly communicating the expectations to subs/vendors and external customers	**Employee Comments:**	
− 23. Leads the delivery of the weekly safety meetings, utilizing the content of the corporate tool box meetings.	A	A
Managers Comments: *No comments*	**Employee Comments:**	

Figure 4: Old Grading Matrix Excerpt

	Criteria	1 (major problem)	**2 – Occasionally** (room for improvement) **3 – Often** (doing your job) **4 - Often and Consistently** (exceeding expectation)	**5 – Always** (walking on water)
Leadership	Generate A Following	Individualist whom others are unwilling to follow. Tends to be inward focused in thinking.	Respected and viewed as approachable & credible by most at peer level and direct reports; people are generally willing to follow him/her even when the path is unclear. Is continually expanding scope of influence.	Respected, viewed as credible and approachable throughout organization; Inspires, challenges, and motivates others to reach their highest potential. Is continually expanding scope of influence. People are willing to follow him/her even when the path is unclear. Effectively leads and manages self and others to obtain maximum results.
	Empowerment Of Employees	Does not encourage input or suggestions from co-workers or team.	Actively empowers and encourages employees to make suggestions and give input for goals at hand.	Proactively empowers and encourages employees to make suggestions and gives input on new and existing procedures and/or processes. Respects others input and suggestions and allows them to take risks.
	Employee Development	Struggles to accurately assess others' performance, capabilities and development needs.	Accurately diagnoses others' performance, employee strengths/development needs. Identifies/plans development work assignments for individuals.	Proactively and accurately assesses employees' capabilities and development needs and contributes to and fosters continuous professional development/career growth.
Principles	Loyalty	Cares only for themselves, has a free agent mentality.	Even when the going gets tough, focuses on sticking it through and does not consider other career options.	Sticks with the company through the tough/loss years and throughout it all does not consider other career options. Works through tough adversity, with a passionate goal to make Conti healthy and successful.
	Values	Does not demonstrate good values.	Demonstrates Honesty, Integrity, and Credibility. Upholds good standards.	Outwardly demonstrates Honesty, Integrity, and Credibility. Upholds high ethical/professional standards and teaches others to do the same.
	Responsibility/Flexibility	Does not practice self-responsibility or accountability. Willing to perform tasks/projects within the position scope.	Practices self-responsibility and accountability. Willing to perform tasks/projects within the position scope with guidance. When directed, performs tasks outside of position scope with significant oversight.	Practices self-responsibility, accountability, and humility and guides others to do the same. Proactively willing to perform tasks/projects outside of position scope while handling own workload without guidance.
	Judgment	Lack of ability to demonstrate rational judgment in decision-making.	Demonstrates sound judgment and pragmatic decision making in both technical and people/leadership dimensions.	Proactively demonstrates sound judgment and pragmatic decision-making and teaches others to do the same.
	Vision/Strategic Plan Execution	Does not understand or agree with vision/ strategy. Focuses almost solely on the tasks at hand. Difficulty in thinking at the project level.	Only understands concept of vision/strategy. Is able to develop own vision when prompted and communicate it to others.	Proactively and continuously visualizes, develops, and communicates the vision/strategy. Is able to passionately sell vision to others throughout the organization. Communicates it with excitement to others

Figure 5: Contract Design Hypotheses

- **H1: Greater task complexity is not associated with the likelihood of fixed-price contracting: Supported**
  - Price model primarily driven by client-type (Table 7)
  - Government 100% F-P, Private 92% F-P, Military 61% C-P (Table 4)

- **H2: Greater relationship complexity increases the likelihood of fixed-price contracting: Supported**
  - Supported: For military clients, having no prior experience → +42.8% F-P contracting (Table 7)

- **H3: Under fixed-price contracting, sellers use design modification to mitigate risk: Supported**
  - F-P have higher 30.1% higher average level of modification (Table 8)
  - If F-P, technical complexity → +42.2% modification (Table 8)
  - If F-P & complex, modification → +$3MM actual profit (Table 9)

- **H4: Under fixed-price contracting, sellers use revenue quotes to mitigate risk: Supported**
  - If F-P & complex, +8.4% markup on cost estimate (Table 10)
  - If F-P, +$1 of revenue quote = +$1.343 actual profit (Table 9)

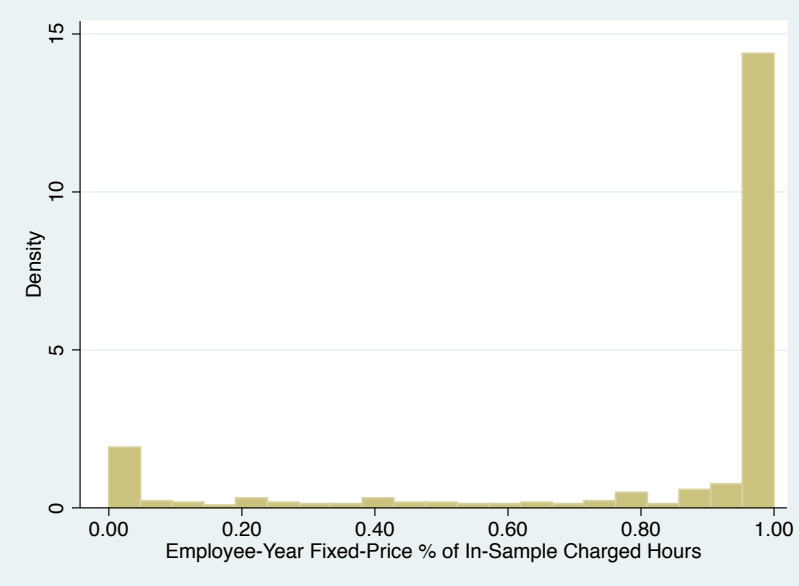
Figure 6: Incentive Design Hypotheses

- **H5: Under fixed-price contracting, managers are more lenient with rewards: Supported**
  - F-P has higher average bonus (Table 16)
  - F-P bonuses are more associated with behaviors (inputs); C-P bonuses more associated with goals (outputs) (Table 17)
  - Bonus, raise and promotion models have less explanatory power for F-P contracts; suggests more managerial discretion (Table 17)

- **H6: Under fixed-price contracting, managers provide more feedback: Supported**
  - F-P has longer average comments on behaviors (inputs) (Table 18)
  - F-P has no "cutting corners" when behaviors are good (Table 19)
  - F-P has incremental commentary when costs surpass budget (Table 19)

- **H7: Under fixed-price contracting, managers compress ratings less: Supported**
  - If F-P, technical complexity associated with greater dispersion of goal (output) ratings (Table 21)

Figure 7: Fixed-Price Percentage of In-Sample Charged Hours



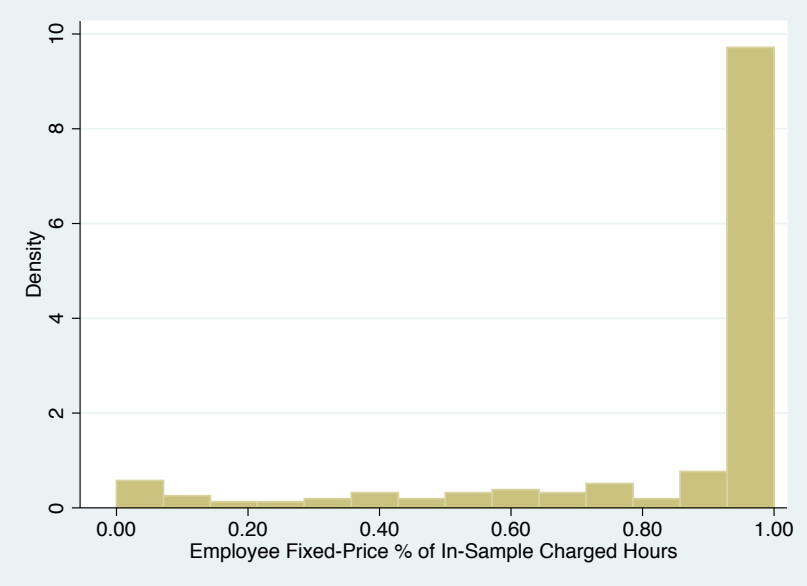


Table 1: Task Characteristics

Task Characteristic	Cost-Plus	Fixed-Price	Total	% Cost-Plus	% Fixed-Price
ALL PROJECTS	24	61	85	28%	72%
Complexity of Customer Needs*					
1-Low (Simple Project)	9	15	24	38%	63%
2-Medium (Regular Project)	12	28	40	30%	70%
3-High (Complex Project)	3	18	21	14%	86%
Design Modification*					
1-Low (Unmodified Design)	18	24	42	43%	57%
2-Medium (Innovative Modification)	6	32	38	16%	84%
3-High (Radical Adaptation)		5	5	0%	100%
Unmodified Design	18	24	42	43%	57%
Modified & Adapted Design	6	37	43	14%	86%
Reliance on Subcontractors*					
1-Low Contractor Use	4	14	18	22%	78%
2-Medium Contractor Use	9	30	39	23%	77%
3-High Contractor Use	11	17	28	39%	61%
Product Line**					
Environmental	18	11	29	62%	38%
Infrastructure	6	34	40	15%	85%
Power/Utility		16	16	0%	100%
Site Location**					
New Orleans	1	4	5	20%	80%
NJ/NY/PA	15	45	60	25%	75%
Other	8	12	20	40%	60%
Home Sites	16	49	65	25%	75%
Away Sites	8	12	20	40%	60%
Project Deliverable**					
Non-build Services	8	1	9	89%	11%
Build	15	35	50	30%	70%
Design & Build	1	25	26	4%	96%

*Data from survey of project management executives, **Data from project management database

Table 2: Relationship Characteristics

Relationship Characteristic	**Cost-Plus**	**Fixed-Price**	**Total**	**% C+**	**% FP**
ALL PROJECTS	24	61	85	28%	72%
Amount of Experience with Client*					
1-No Experience	4	28	32	13%	88%
2-Some Experience	1	19	20	5%	95%
3-Much Experience	19	14	33	58%	42%
Relationship with Client*					
1-Partnership	6	7	13	46%	54%
2-Amicable	14	34	48	29%	71%
3-Neutral	4	10	14	29%	71%
4-Antagonistic	0	8	8	0%	100%
5-Adversarial	0	2	2	0%	100%
Positive Relationship	20	41	61	33%	67%
Neutral Relationship	4	10	14	29%	71%
Negative Relationship	0	10	10	0%	100%
Client Type**					
Military	23	15	38	61%	39%
Private	1	12	13	8%	92%
Government	0	34	34	0%	100%

*Data from survey of project management executives, **Data from project management database

Table 3: Project Summary Statistics

	All Projects					Cost-Plus Project					Fixed-Price Project				
Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Fixed-Price Contract	85	0.718	0.453	0.000	1.000	24	0.000	0.000	0.000	0.000	61	1.000	0.000	1.000	1.000
Technical Needs - Simple	85	0.282	0.453	0.000	1.000	24	0.375	0.495	0.000	1.000	61	0.246	0.434	0.000	1.000
Technical Needs - Regular	85	0.471	0.502	0.000	1.000	24	0.500	0.511	0.000	1.000	61	0.459	0.502	0.000	1.000
Technical Needs - Complex	85	0.247	0.434	0.000	1.000	24	0.125	0.338	0.000	1.000	61	0.295	0.460	0.000	1.000
Modified Design	85	0.506	0.503	0.000	1.000	24	0.250	0.442	0.000	1.000	61	0.607	0.493	0.000	1.000
Subcontractor Use - Light	85	0.212	0.411	0.000	1.000	24	0.167	0.381	0.000	1.000	61	0.230	0.424	0.000	1.000
Subcontractor Use - Regular	85	0.459	0.501	0.000	1.000	24	0.375	0.495	0.000	1.000	61	0.492	0.504	0.000	1.000
Subcontractor Use - Heavy	85	0.329	0.473	0.000	1.000	24	0.458	0.509	0.000	1.000	61	0.279	0.452	0.000	1.000
Away Project	85	0.235	0.427	0.000	1.000	24	0.333	0.482	0.000	1.000	61	0.197	0.401	0.000	1.000
Product Line - Infrastructure	85	0.471	0.502	0.000	1.000	24	0.250	0.442	0.000	1.000	61	0.557	0.501	0.000	1.000
Product Line - Power	85	0.188	0.393	0.000	1.000	24	0.000	0.000	0.000	0.000	61	0.262	0.444	0.000	1.000
Product Line - Environmental	85	0.341	0.477	0.000	1.000	24	0.750	0.442	0.000	1.000	61	0.180	0.388	0.000	1.000
Deliverable - Non-build Service	85	0.106	0.310	0.000	1.000	24	0.333	0.482	0.000	1.000	61	0.016	0.128	0.000	1.000
Deliverable - Build	85	0.894	0.310	0.000	1.000	24	0.667	0.482	0.000	1.000	61	0.984	0.128	0.000	1.000
Deliverable - Design	85	0.306	0.464	0.000	1.000	24	0.042	0.204	0.000	1.000	61	0.410	0.496	0.000	1.000
No Experience	85	0.376	0.487	0.000	1.000	24	0.167	0.381	0.000	1.000	61	0.459	0.502	0.000	1.000
Some Experience	85	0.235	0.427	0.000	1.000	24	0.042	0.204	0.000	1.000	61	0.311	0.467	0.000	1.000
Much Experience	85	0.388	0.490	0.000	1.000	24	0.792	0.415	0.000	1.000	61	0.230	0.424	0.000	1.000
Positive Relationship	85	0.718	0.453	0.000	1.000	24	0.833	0.381	0.000	1.000	61	0.672	0.473	0.000	1.000
Neutral Relationship	85	0.165	0.373	0.000	1.000	24	0.167	0.381	0.000	1.000	61	0.164	0.373	0.000	1.000
Negative Relationship	85	0.118	0.324	0.000	1.000	24	0.000	0.000	0.000	0.000	61	0.164	0.373	0.000	1.000
Client - Private	85	0.153	0.362	0.000	1.000	24	0.042	0.204	0.000	1.000	61	0.197	0.401	0.000	1.000
Client - Military	85	0.447	0.500	0.000	1.000	24	0.958	0.204	0.000	1.000	61	0.246	0.434	0.000	1.000
Client - Government	85	0.400	0.493	0.000	1.000	24	0.000	0.000	0.000	0.000	61	0.557	0.501	0.000	1.000
Duration - at Award (Months)	85	19.537	16.901	0.067	77.067	24	17.615	11.748	0.300	40.767	61	20.293	18.573	0.067	77.067
Duration - at Completion (Months)	85	26.095	16.755	0.700	84.233	24	26.901	10.577	6.533	55.300	61	25.778	18.703	0.700	84.233
Duration - Variance (Months)	85	6.558	15.024	-50.400	37.233	24	9.286	13.902	-17.900	37.233	61	5.484	15.421	-50.400	35.367
Revenue - at Award ($MM)	85	20.677	36.403	0.000	198.764	24	10.060	14.555	0.043	48.439	61	24.855	41.366	0.000	198.764
Revenue - at Completion ($MM)	85	22.242	37.607	0.664	201.660	24	11.516	12.468	0.664	39.977	61	26.461	43.084	0.690	201.660
Revenue - Variance ($MM)	85	1.564	6.742	-37.957	25.995	24	1.457	11.130	-37.957	25.995	61	1.607	4.018	-2.500	24.151
Cost - at Award ($MM)	85	17.445	30.417	0.000	164.048	24	8.540	12.208	0.034	40.987	61	20.948	34.553	0.000	164.048
Cost - at Competion ($MM)	85	19.688	33.221	0.437	168.227	24	9.948	10.697	0.568	33.874	61	23.520	38.058	0.437	168.227
Cost - Variance ($MM)	85	2.243	6.792	-32.168	26.255	24	1.408	9.485	-32.168	22.057	61	2.571	5.450	-2.209	26.255

Table 4: Project Characteristic Matrix

	Govt Projects	Military Projects	Private Projects	Total Projects	No Client Exp	Neg Rel	Fixed-Price	Highly Technical	Modified Design	Subcontr Heavy	Away Work Site	Revenue at Award ($MMs)	Cost at Award ($MMs)	Duration at Award (months)
Environmental Line		24	5	29	24%	3%	38%	14%	52%	41%	41%	11.2	9.6	29.5
Non-build Services		8		8	25%	0%	13%	13%	13%	75%	25%	4.4	3.9	28.3
Build		13	5	18	28%	6%	39%	11%	61%	17%	39%	15.2	13.0	26.4
Design		3		3	0%	0%	100%	33%	100%	100%	100%	4.9	4.3	50.8
Infrastructure Line	25	14	1	40	35%	13%	85%	30%	48%	40%	18%	32.3	27.1	28.8
Non-build Services		1		1	0%	0%	0%	0%	0%	100%	0%	1.2	1.0	20.5
Build	19	12	1	32	34%	13%	88%	25%	47%	28%	16%	34.0	28.6	28.6
Design	6	1		7	43%	14%	86%	57%	57%	86%	29%	28.9	23.7	31.3
Power Line	9		7	16	69%	25%	100%	31%	56%	0%	6%	8.9	7.7	13.1
Non-build Services														
Build														
Design	9		7	16			100%	31%	56%	0%	6%	8.9	7.7	13.1
Total Projects	34	38	13	85	69%	25%	72%	25%	51%	33%	24%	20.7	17.4	26.1
No Prior Client Experience	41%	24%	62%	36%										
Neg Client Relationship	24%	3%	8%	12%										
Fixed-Price	100%	39%	92%	72%	46%	16%								
Highly Technical	41%	18%	0%	25%	48%	33%	72%							
Modified Design	68%	34%	54%	51%	35%	19%	86%	42%						
Subcontractor Heavy	26%	50%	0%	33%	32%	4%	61%	29%	50%					
Away Work Site	15%	39%	0%	24%	25%	10%	60%	35%	50%	75%				
Revenue at Award	35.3	12.2	7.3	20.7										
Cost at Award	29.6	10.3	6.4	17.4										
Duration at Award	26.8	28.6	17.0	26.1										

Table 5: Project Characteristic Correlation Table

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	Fixed-Price Contract	1.00																												
2	Technical - Simple	-0.13	1.00																											
3	Technical - Complex	0.18	-0.36	1.00																										
4	Modified Design	0.32	-0.53	0.40	1.00																									
5	Subcontractor Use - Light	0.07	0.25	-0.23	-0.12	1.00																								
6	Subcontractor Use - Heavy	-0.17	-0.05	0.06	-0.01	-0.36	1.00																							
7	Away Project	-0.15	0.02	0.13	-0.01	-0.22	0.50	1.00																						
8	Prod Line - Infrastructure	0.28	-0.17	0.12	-0.06	0.03	0.14	-0.13	1.00																					
9	Prod Line - Power	0.30	0.17	0.07	0.05	-0.03	-0.34	-0.20	-0.45	1.00																				
10	Prod Line - Environmental	-0.54	0.04	-0.18	0.02	-0.01	0.13	0.30	-0.68	-0.35	1.00																			
11	Non-build Service	-0.46	0.12	-0.11	-0.27	-0.08	0.33	-0.01	-0.25	-0.17	0.40	1.00																		
12	Build	0.46	-0.12	0.11	0.27	0.08	-0.33	0.01	0.25	0.17	-0.40	-1.00	1.00																	
13	Design & Build	0.36	0.04	0.21	0.15	-0.09	0.02	-0.01	-0.27	0.73	-0.32	-0.23	0.23	1.00																
14	Some Experience	0.29	-0.10	0.07	0.27	0.12	-0.09	0.02	0.09	0.09	-0.17	-0.19	0.19	0.05	1.00															
15	Much Experience	-0.52	0.04	-0.18	-0.18	0.00	0.16	0.13	-0.03	-0.38	0.34	0.28	-0.28	-0.27	-0.44	1.00														
16	Positive Relationship	-0.16	-0.19	-0.13	0.06	-0.06	0.16	0.04	-0.09	-0.10	0.18	0.13	-0.13	-0.04	-0.15	0.39	1.00													
17	Negative Relationship	0.23	-0.07	0.38	0.21	-0.19	-0.18	-0.03	0.02	0.20	-0.19	-0.13	0.13	0.15	0.06	-0.29	-0.58	1.00												
18	Client - Private	0.19	0.10	-0.24	0.03	0.26	-0.30	-0.24	-0.34	0.38	0.04	-0.15	0.15	0.21	0.00	-0.27	0.12	-0.05	1.00											
19	Client - Military	-0.65	0.01	-0.13	-0.29	-0.23	0.33	0.34	-0.18	-0.43	0.55	0.38	-0.38	-0.39	-0.22	0.45	0.20	-0.25	-0.38	1.00										
20	Client - Government	0.51	-0.09	0.31	0.28	0.05	-0.11	-0.17	0.43	0.16	-0.59	-0.28	0.28	0.24	0.23	-0.26	-0.29	0.30	-0.35	-0.73	1.00									
21	Duration - at Award	0.07	-0.19	0.08	0.13	-0.28	0.28	0.12	-0.02	-0.24	0.22	0.16	-0.16	0.03	-0.22	0.32	0.24	-0.05	-0.16	0.18	-0.07	1.00								
22	Duration - at Completion	-0.03	-0.12	0.16	0.09	-0.26	0.11	0.09	0.16	-0.37	0.15	0.03	-0.03	-0.15	-0.12	0.26	0.09	0.06	-0.23	0.13	0.03	0.60	1.00							
23	Duration – Variance	-0.11	0.08	0.09	-0.04	0.02	-0.19	-0.03	0.20	-0.15	-0.09	-0.15	0.15	-0.20	0.11	-0.08	-0.17	0.11	-0.08	-0.05	0.12	-0.45	0.44	1.00						
24	Revenue - at Award	0.18	-0.27	0.19	0.28	-0.20	0.11	-0.20	0.30	-0.16	-0.19	-0.16	0.16	-0.13	-0.14	0.03	0.10	0.01	-0.16	-0.21	0.33	0.37	0.31	-0.07	1.00					
25	Revenue - at Completion	0.18	-0.27	0.20	0.27	-0.19	0.11	-0.17	0.30	-0.17	-0.17	-0.16	0.16	-0.13	-0.15	0.01	0.11	-0.01	-0.12	-0.22	0.31	0.39	0.36	-0.04	0.98	1.00				
26	Revenue - Variance	0.01	-0.07	0.05	0.00	0.00	0.05	0.10	0.03	-0.12	0.07	-0.05	0.05	-0.05	-0.08	-0.08	0.12	-0.09	0.17	-0.07	-0.06	0.17	0.32	0.16	0.09	0.27	1.00			
27	Cost - at Award	0.18	-0.27	0.18	0.27	-0.19	0.10	-0.19	0.30	-0.15	-0.19	-0.16	0.16	-0.13	-0.15	0.03	0.09	0.01	-0.15	-0.21	0.33	0.37	0.31	-0.07	1.00	0.98	0.08	1.00		
28	Cost - at Completion	0.19	-0.27	0.19	0.27	-0.19	0.10	-0.18	0.31	-0.18	-0.17	-0.16	0.16	-0.15	-0.16	0.01	0.09	0.02	-0.12	-0.21	0.31	0.39	0.37	-0.02	0.98	1.00	0.26	0.98	1.00	
29	Cost - Variance	0.08	-0.14	0.15	0.09	-0.05	0.00	0.00	0.16	-0.19	-0.01	-0.09	0.09	-0.14	-0.09	-0.09	0.04	0.05	0.11	-0.10	0.02	0.25	0.46	0.23	0.32	0.48	0.92	0.32	0.50	1.00

Table 6: Complexity as a Function of Project Characteristics

	Highly Technical (0=No, 1=Yes)	
	Coeff.	p-value
Subcontractor Use - Heavy	-0.141	0.408
Away Project	0.237	0.158
Product Line - Power	-0.062	0.801
Product Line - Environmental	-0.085	0.486
Deliverable - Build	-0.099	0.624
Deliverable - Design	0.268	0.175
Client - Private	-0.205*	0.130
Client - Government	0.109	0.459
Duration - at Award (Months)	0.002	0.555
Cost - at Award ($MM)	0.002	0.289
Constant	0.171	0.470
Model	OLS	
Observations	85	
R-squared	0.2101	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 7: Pricing Model as a Function of Project Characteristics

	Fixed Price Contract (0=No, 1=Yes)		Fixed Price Contract (0=No, 1=Yes)	
	All Clients		Military Clients	
	Coeff.	p-value	Coeff.	p-value
Technical Needs - Complex	0.005	0.951	-0.079	0.671
Subcontractor Use - Heavy	0.000	0.999	-0.005	0.983
Away Project	0.073	0.630	0.056	0.799
Product Line - Power	-0.105	0.551		
Product Line - Environmental	-0.221*	0.148	-0.157	0.524
Deliverable - Build	0.256	0.212	0.191	0.558
Deliverable - Design	0.121	0.462	0.452	0.280
No Experience with Client	0.091	0.264	0.428**	0.083
Negative Relationship	0.041	0.596	0.573	0.152
Client - Private	0.423***	0.007		
Client - Government	0.384***	0.004		
Duration - at Award (Months)	0.002	0.574	0.003	0.735
Cost - at Award ($MM)	0.000	0.834	0.003	0.642
Constant	0.226	0.302	0.063	0.882
Model	OLS		OLS	
Observations	85		38	
R-squared	0.5283		0.3378	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 8: Design Modification as a Function of Project Characteristics

	Design Modification (0=No, 1=Yes)					
	All Contracts		Cost-Plus		Fixed-Price	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Fixed Price Contract	0.301***	0.031				
Technical Needs - Complex	0.391***	0.001	0.251	0.378	0.422***	0.001
Modified Design						
Subcontractor Use - Heavy	0.289**	0.058	0.068	0.826	0.380**	0.060
Away Project	-0.234*	0.112	-0.431	0.166	-0.051	0.740
Product Line - Power	0.230	0.247			0.542***	0.016
Product Line - Environmental	0.584***	0.000	0.538**	0.092	0.644***	0.000
Deliverable - Build	0.504***	0.004	0.531***	0.043	1.205***	0.000
Deliverable - Design	-0.117	0.385	-0.266	0.297	-0.325***	0.015
No Experience	-0.245***	0.014	-0.229	0.335	-0.250**	0.054
Negative Relationship	0.168	0.212			0.114	0.406
Client - Private	0.215	0.240	0.405**	0.070	0.191	0.307
Client - Government	0.262**	0.095			0.280*	0.120
Months at Award	-0.001	0.656	-0.013**	0.061	0.003	0.459
Cost at Award	-0.024	0.352	-0.001	0.997	-0.028	0.231
Revenue at Award	0.022	0.301	-0.005	0.987	0.025	0.192
Constant	-0.571***	0.009	0.023	0.948	-1.129***	0.003
Model	OLS		OLS		OLS	
Observations	85		24		61	
R-squared	0.4702		0.5153		0.5239	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 9: Project Performance as a Function of Project Characteristics

	Gross Margin at Completion ($MMs)					
	All Projects		Cost-Plus		Fixed-Price	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
Fixed Price Contract	-0.476	0.490				
Modified Design	-0.651	0.255	-0.753	0.167	-1.107	0.153
Technical Needs - Complex	-1.372	0.434	2.203***	0.011	-4.170***	0.000
Modified x Technical	0.448	0.814	1.151	0.311	3.132***	0.016
Subcontractor Use - Heavy	1.415***	0.014	-0.193	0.759	2.170***	0.045
Away Project	0.554	0.297	-0.574	0.555	0.279	0.755
Product Line - Power	1.332	0.176			2.103*	0.140
Product Line - Environmental	1.712***	0.021	0.744	0.339	2.568***	0.018
Deliverable - Build	1.197*	0.103	0.557	0.627	2.285	0.181
Deliverable - Design	0.177	0.812	-0.334	0.735	-0.166	0.879
No Experience	0.263	0.598	-0.728**	0.098	0.130	0.826
Negative Relationship	-2.267***	0.010			-1.970***	0.032
Client - Private	0.874	0.263	4.081***	0.003	0.131	0.869
Client - Government	1.880***	0.031			1.738**	0.078
Duration at Award	-0.022	0.261	0.068***	0.008	-0.032*	0.145
Total Cost at Award	-1.431***	0.000	-0.061	0.918	-1.451***	0.000
Total Revenue at Award	1.323***	0.000	0.101	0.835	1.343***	0.000
Constant	-1.616*	0.102	-1.572**	0.050	-2.770	0.195
Observations	24		24		61	
R-Squared	0.9002		0.9354		0.9304	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 10: Revenue Quote as a Function of Project Characteristics

	Revenue at Award ($MM)							
	All Contracts (A)		Cost-Plus (B)		Fixed-Price(C)		All Contracts (D)	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
Fixed Price Contract	-0.274	0.485					-0.245	0.519
Technical Needs - Complex	0.459	0.264	-0.004	0.987	0.761*	0.139	0.601	0.342
Modified Design	2.107***	0.012	0.528	0.193	2.433***	0.024	0.465	0.186
Subcontractor Use - Heavy	0.287	0.666	-0.519***	0.011	0.982	0.560	0.404	0.472
Away Project	-0.913	0.173	0.020	0.941	-1.996	0.181	-0.433	0.429
Product Line - Power	-0.233	0.839			-0.375	0.816	0.275	0.722
Product Line - Environmental	-0.224	0.687	-0.253	0.378	-0.156	0.824	-0.141	0.763
Deliverable - Build	0.192	0.788	-0.354	0.227	-1.794	0.303	0.243	0.655
Deliverable - Design	-0.125	0.907	0.330**	0.089	-0.158	0.912	-0.487	0.479
No Experience	0.125	0.783	-0.355	0.203	0.217	0.697	0.016	0.969
Negative Relationship	-1.574***	0.044			-1.574*	0.111	-1.601**	0.053
Client - Private	0.087	0.875	-0.086	0.820	0.264	0.689	0.158	0.747
Client - Government	-0.152	0.792			-0.107	0.875	0.032	0.949
Months at Award	0.005	0.840	0.021***	0.046	-0.004	0.905	0.005	0.807
Cost at Award	1.184***	0.000	1.187***	0.000	1.181***	0.000	1.188***	0.000
Fixed Price (0/1) x Cost at Award							-0.019	0.502
Complex Project (0/1) x Cost at Award							-0.014	0.643
Fixed Price (0/1) x Complex Project (0/1) x Cost at Award							0.084***	0.022
Constant	-0.376	0.661	0.002	0.995	1.287	0.579	-0.468	0.547
Observations	85		24		61		85	
R-squared	0.9979		0.9996		0.9979		0.9985	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 11: Incentive Design Sample Size

	In Sample	Total
Projects	85	311
Project-Years	248	655
Employees with Evaluation Data	223	304
Employee-Years with Evaluation Data	481	638
Client-facing Employees	223	669
Employee-Years	481	1479
Employee-Project-Years	1809	7916
Average Employee-Projects per Year	3.76	2.03
Average Hours per Employee-Project-Year	471	347
Average Hours per Employee-Year	1770	1885

Table 12: Incentive Design Summary Statistics

	All Employee-Years					Employee-Project-Years: Cost-Plus Contracts					Employee-Project-Years: Fixed-Price Contracts				
Scores (0-5)	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Goals	638	4.428	1.148	0.00	6.20	466	4.57	1.01	0.00	6.2	1343	4.373	1.178	0.00	6.20
Soft Skills	638	4.778	0.379	2.84	5.00	466	4.81	0.36	2.84	5	1343	4.727	0.416	2.84	5.00
Drive	638	4.750	0.441	2.60	5.00	466	4.80	0.40	2.80	5	1343	4.679	0.498	2.60	5.00
Leadership	638	4.736	0.491	2.00	5.00	466	4.80	0.40	2.58	5	1343	4.696	0.489	2.00	5.00
People Skills	638	4.790	0.395	2.40	5.00	466	4.82	0.40	2.40	5	1343	4.742	0.442	2.40	5.00
Principles	638	4.914	0.276	2.50	5.00	466	4.92	0.28	3.00	5	1343	4.896	0.295	2.50	5.00
Hard Skills	638	4.674	0.551	2.49	5.00	466	4.75	0.50	2.73	5	1343	4.609	0.585	2.49	5.00
Position Description Skills	638	4.635	0.647	1.29	5.00	466	4.71	0.59	2.27	5	1343	4.557	0.699	1.29	5.00
Problem Solving	638	4.715	0.479	2.40	5.00	466	4.78	0.43	2.67	5	1343	4.658	0.499	2.40	5.00
Technical Skills	638	4.720	0.573	1.00	5.00	466	4.80	0.45	2.33	5	1343	4.678	0.601	1.00	5.00
Items/Subcomponents Rated	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Goals	638	8.945	2.666	0	21	466	9.52	2.49	0	16	1343	9.028	2.749	0	21
Soft Skills	638	44.199	25.464	18	188	466	42.49	20.59	18	188	1343	47.494	27.538	18	156
Drive	638	14.334	7.973	5	55	466	13.92	6.45	6	55	1343	15.379	8.777	5	51
Leadership	638	8.401	6.564	2	49	466	7.91	5.25	3	49	1343	9.182	6.968	2	39
People Skills	638	13.397	11.432	4	73	466	12.08	9.78	4	73	1343	14.832	12.351	4	62
Principles	638	8.067	2.475	1	14	466	8.58	2.25	5	12	1343	8.102	2.464	1	14
Hard Skills	638	43.346	36.857	13	253	466	39.67	30.16	14	253	1343	48.053	41.242	13	238
Position Description Skills	638	21.781	25.069	4	154	466	18.67	20.22	5	140	1343	24.952	28.566	4	154
Problem Solving	638	13.813	9.665	5	67	466	13.10	8.33	5	67	1343	15.203	10.468	5	59
Technical Skills	638	7.752	3.712	2	46	466	7.90	3.08	4	46	1343	7.899	3.896	2	38
Comment Length (Characters)	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Goals	638	1,413	1,232	0	6015	466	1,609	1,271	0	6015	1343	1,374	1,152	0	6015
Soft Skills	638	2,882	2,359	0	18338	466	2,447	2,059	72	16316	1343	2,611	2,282	0	18338
Drive	638	903	926	0	5371	466	695	738	0	4644	1343	791	836	0	5371
Leadership	638	534	732	0	4947	466	492	653	0	4277	1343	482	672	0	4947
People Skills	638	1,012	1,120	0	8356	466	866	920	0	8356	1343	972	1,065	0	8356
Principles	638	432	635	0	4058	466	394	574	0	4058	1343	366	555	0	4058
Hard Skills	638	2,028	2,021	0	14580	466	1,612	1,583	0	13680	1343	2,016	2,040	0	14580
Position Description Skills	638	791	1,183	0	8828	466	555	818	0	8154	1343	792	1,155	0	8828
Problem Solving	638	882	1,013	0	6887	466	695	905	0	6307	1343	864	983	0	6887
Technical Skills	638	355	546	0	4391	466	363	528	0	4391	1343	359	522	0	4391
Incentive Rewards	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Bonus	638	4,085	7,330	0	66,991	466	2,084	4,294	0	25,253	1343	4,815	7,636	0	66,991
Raise	638	1,645	3,381	-7,191	41,694	466	1,050	2,155	0	19,720	1343	1,777	3,516	-7,191	41,694
Raise Percent	638	2.2%	5.5%	-6.0%	59.0%	466	1.3%	3.6%	0.0%	59.0%	1343	2.3%	5.7%	-6.0%	59.0%
Promotion	638	10.3%	30.5%	0%	100%	466	6.0%	23.0%	0%	100%	1343	9.8%	29.7%	0%	100%

Table 13: Incentive Design Correlation Table

		1	2	3	4	5	6	7	8	9	10	11	12
1	Goal Rating	1.00											
2	Goal Items Scored	0.22	1.00										
3	Goal Comment Length	0.42	0.28	1.00									
4	Soft Skill Rating	0.57	0.11	0.52	1.00								
5	Soft Skill Items Scored	-0.37	0.10	-0.33	-0.59	1.00							
6	Soft Skill Comment Length	0.06	0.18	0.22	0.01	0.28	1.00						
7	Hard Skill Rating	0.54	0.07	0.53	0.89	-0.57	0.05	1.00					
8	Hard Skill Items Scored	-0.41	0.08	-0.39	-0.61	0.97	0.22	-0.58	1.00				
9	Hard Skill Comment Length	-0.18	0.11	-0.07	-0.26	0.50	0.56	-0.25	0.47	1.00			
8	Bonus ($)	-0.25	0.10	-0.21	-0.31	0.46	0.15	-0.25	0.50	0.28	1.00		
9	Raise (%)	-0.07	0.02	-0.08	-0.05	0.09	0.10	-0.08	0.11	0.10	0.23	1.00	
10	Promotion (%)	-0.04	0.13	-0.01	-0.06	0.18	0.11	-0.15	0.18	0.15	0.20	0.33	1.00

Table 14: Rating Level as a Function of Complexity

	Goal Rating		Soft Skills Rating		Hard Skills Rating	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
Fixed-Price Contract	0.082	0.420	0.023	0.265	-0.022	0.417
Technical Needs - Complex	-0.022	0.763	-0.015	0.364	-0.017	0.461
Modified Design	0.056	0.499	-0.002	0.925	0.022	0.410
Subcontractor Use - Heavy	0.098	0.257	0.002	0.940	-0.014	0.634
Away Project	0.017	0.824	0.020	0.285	0.016	0.574
Product Line - Power	0.430***	0.009	0.091***	0.012	-0.131***	0.013
Product Line - Environmental	-0.010	0.889	-0.014	0.392	-0.024	0.329
Deliverable - Build	-0.029	0.730	-0.043***	0.032	0.029	0.327
Deliverable - Design	-0.106	0.215	0.013	0.521	0.013	0.618
No Experience	0.040	0.584	-0.004	0.793	0.022	0.343
Negative Relationship	-0.040	0.594	-0.009	0.619	0.004	0.877
Client - Private	-0.160	0.228	-0.012	0.676	0.012	0.771
Client - Government	-0.136*	0.116	-0.032*	0.104	-0.012	0.637
Duration at Award (Months)	-0.001	0.574	0.000	0.755	0.000	0.449
Cost Estimate for Year ($MMs)	0.000	0.304	0.000	0.372	0.000	0.264
Revenue Estimate for Year ($MMs)	-0.001	0.605	0.000	0.891	0.000	0.588
Duration Variance at Completion (Months)	-0.002	0.324	0.000	0.817	-0.002***	0.027
Cost Variance for Year ($MMs)	0.000	0.502	0.000	0.597	0.000	0.655
Revenue Variance for Year ($MMs)	0.001	0.537	0.000	0.897	0.001	0.170
Constant	4.472***	0.000	4.781***	0.000	4.649***	0.000
Observations	1809		1809		1809	
R-Squared	0.4220		0.7644		0.7838	
Adjuisted R-Squared	0.4149		0.7615		0.7811	
Fixed Effects	Year		Year		Year	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 15: Rating Level as a Function of Complexity by Pricing Model

	Goal Rating				Soft Skills Rating				Hard Skills Rating			
	Cost-Plus		Fixed-Price		Cost-Plus		Fixed-Price		Cost-Plus		Fixed-Price	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
Technical Needs - Complex	0.082	0.544	-0.083	0.403	-0.007	0.776	-0.004	0.864	0.004	0.897	-0.007	0.838
Modified Design	-0.091	0.516	0.189**	0.086	-0.009	0.703	-0.012	0.674	0.103***	0.033	-0.009	0.815
Subcontractor Use - Heavy	0.219**	0.096	0.022	0.905	0.015	0.568	-0.038	0.427	-0.018	0.657	-0.012	0.846
Away Project	-0.117	0.437	0.022	0.890	-0.027	0.331	0.082***	0.034	-0.024	0.576	0.043	0.508
Product Line - Power			0.270	0.194			0.077*	0.132			-0.115**	0.086
Product Line - Environmental	0.223	0.253	-0.161	0.231	0.048	0.159	-0.029	0.390	0.011	0.834	-0.038	0.434
Deliverable - Build	0.167	0.455	-0.053	0.798	0.031	0.427	-0.010	0.883	0.068	0.260	0.058	0.407
Deliverable - Design	-0.132	0.311	-0.041	0.768	-0.025	0.340	0.018	0.603	-0.027	0.484	-0.004	0.925
No Experience	-0.067	0.733	0.101	0.259	-0.055	0.224	0.011	0.584	0.004	0.954	0.021	0.492
Negative Relationship			-0.055	0.485			-0.018	0.349			0.005	0.831
Client - Private	0.077	0.922	-0.124	0.380	-0.276**	0.074	0.001	0.972	-0.054	0.743	0.033	0.480
Client - Government			-0.162**	0.087			-0.036**	0.095			-0.012	0.673
Duration at Award (Months)	-0.001	0.818	-0.001	0.600	0.001	0.341	0.000	0.604	-0.001	0.508	0.001**	0.081
Cost Estimate for Year ($MMs)	-0.004	0.670	0.000	0.340	0.002	0.361	0.000	0.368	0.001	0.651	0.000	0.496
Revenue Estimate for Year ($MMs)	0.017	0.797	-0.001	0.514	-0.018	0.171	0.000	0.753	-0.012	0.433	0.000	0.814
Duration Variance at Completion (Months)	-0.003	0.455	-0.004	0.223	0.000	0.816	0.000	0.600	0.000	0.761	-0.001*	0.122
Cost Variance for Year ($MMs)	0.000	0.992	0.000	0.681	0.002	0.285	0.000	0.417	0.003	0.211	0.000	0.744
Revenue Variance for Year ($MMs)	0.006	0.928	0.002	0.319	-0.018	0.206	0.000	0.424	-0.018	0.269	0.001**	0.098
Constant	4.421***	0.000	4.531***	0.000	4.786***	0.000	4.734***	0.000	4.743***	0.000	4.552***	0.000
Observations	466		1343		466		1343		466		1343	
R-Squared	0.5003		0.4025		0.8325		0.750		0.8226		0.7733	
Adjuisted R-Squared	0.4802		0.3930		0.8257		0.746		0.8155		0.7697	
Fixed Effects	Year		Year		Year		Year		Year		Year	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 16: Employee Rewards as a Function of Complexity

	Bonus ($)		Raise (%)		Promotion (%)	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
Goal Rating in Year	52.67	0.813	-0.001	0.537	0.030***	0.000
Soft Skills Rating in Year	-2159.84***	0.004	0.031***	0.000	0.362***	0.000
Hard Skills Rating in Year	4906.08***	0.000	-0.004	0.352	-0.100***	0.009
Fixed-Price Contract	1018.06**	0.082	0.003	0.449	0.005	0.831
Technical Needs - Complex	-76.82	0.884	0.003	0.317	0.007	0.731
Modified Design	-616.25	0.279	-0.001	0.831	0.016	0.476
Subcontractor Use - Heavy	-984.66*	0.112	0.005	0.369	-0.019	0.468
Away Project	-817.73**	0.068	-0.009***	0.039	-0.050***	0.030
Product Line - Power	-3170.85***	0.001	-0.012	0.152	0.020	0.660
Product Line - Environmental	-410.39	0.389	0.001	0.841	0.006	0.782
Deliverable - Build	32.34	0.950	-0.001	0.820	-0.049*	0.125
Deliverable - Design	-974.70*	0.143	-0.002	0.822	0.029	0.321
No Experience	-416.07	0.352	-0.001	0.683	-0.028*	0.135
Negative Relationship	-252.44	0.613	-0.007*	0.125	-0.013	0.559
Client - Private	757.31	0.284	0.004	0.319	-0.018	0.570
Client - Government	2121.39***	0.002	0.010***	0.015	0.018	0.436
Duration at Award (Months)	8.94	0.507	0.000**	0.080	0.000	0.503
Cost Estimate for Year ($MMs)	1.67	0.491	0.000	0.661	0.000	0.494
Revenue Estimate for Year ($MMs)	1.18	0.912	0.000	0.490	0.000	0.314
Duration Variance at Completion (Months)	-20.00**	0.096	0.000	0.626	0.001*	0.130
Cost Variance for Year ($MMs)	1.17	0.652	0.000	0.659	0.000	0.184
Revenue Variance for Year ($MMs)	-0.41	0.979	0.000	0.183	0.000	0.985
Constant	-9166.53***	0.032	-0.108***	0.000	-1.272***	0.000
Observations	1809		1809		1809	
R-Squared	0.2596		0.056		0.1195	
Adjusted R-Squared	0.2492		0.0428		0.1071	
Fixed Effects	Year		Year		Year	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 17: Employee Rewards as a Function of Complexity by Pricing Model

	Bonus ($)				Raise (%)				Promotion (%)			
	Cost-Plus		Fixed-Price		Cost-Plus		Fixed-Price		Cost-Plus		Fixed-Price	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
Goal Rating in Year	577.99**	0.099	-83.31	0.752	-0.003	0.222	-0.001	0.575	-0.005	0.650	0.033***	0.000
Soft Skills Rating in Year	-2794.91*	0.121	-1979.77***	0.022	0.024***	0.014	0.031***	0.000	0.357***	0.002	0.342***	0.000
Hard Skills Rating in Year	3544.40***	0.004	5259.36***	0.000	-0.028***	0.004	0.002	0.635	-0.328***	0.000	-0.050	0.202
Technical Needs - Complex	-40.61	0.945	-359.60	0.654	0.000	0.901	0.002	0.604	0.030	0.336	-0.007	0.807
Modified Design	-644.15	0.355	-107.33	0.910	0.002	0.781	0.002	0.713	0.004	0.898	0.041	0.223
Subcontractor Use - Heavy	-405.81	0.480	-2416.44**	0.086	0.007	0.456	0.003	0.760	0.001	0.979	-0.053	0.296
Away Project	553.62	0.457	-1577.00*	0.126	-0.007	0.305	-0.015*	0.102	-0.071**	0.050	-0.057	0.181
Product Line - Power			-4763.78***	0.004			-0.016	0.189			-0.030	0.622
Product Line - Environmental	-553.31	0.522	-818.78	0.396	0.008	0.421	-0.002	0.666	0.019	0.664	0.001	0.973
Deliverable - Build	-469.51	0.620	-1698.66	0.334	0.000	0.941	-0.007	0.647	-0.022	0.649	-0.251***	0.040
Deliverable - Design	-138.21	0.813	437.22	0.704	-0.012**	0.073	0.003	0.729	-0.041	0.211	0.074**	0.073
No Experience	-772.39	0.248	-416.11	0.477	-0.012***	0.038	-0.001	0.725	-0.047	0.233	-0.024	0.302
Negative Relationship			-168.97	0.752			-0.007*	0.109			-0.010	0.684
Client - Private	2372.71	0.405	282.47	0.716	-0.001	0.928	0.002	0.613	-0.033	0.627	-0.037	0.314
Client - Government			1626.84***	0.048			0.006*	0.123			0.010	0.695
Duration at Award (Months)	23.93	0.285	4.85	0.791	0.000**	0.074	0.000***	0.015	0.002	0.223	-0.001*	0.116
Cost Estimate for Year ($MMs)	28.45	0.399	2.39	0.391	0.000	0.748	0.000	0.486	0.001	0.174	0.000	0.290
Revenue Estimate for Year ($MMs)	-224.97	0.355	2.55	0.827	-0.001	0.650	0.000	0.514	-0.012**	0.080	0.000	0.385
Duration Variance at Completion (Months)	-25.71	0.232	-30.57**	0.063	0.000	0.251	0.000	0.951	0.000	0.825	0.001*	0.116
Cost Variance for Year ($MMs)	25.96	0.570	-0.48	0.884	0.000	0.968	0.000	0.554	0.001	0.303	0.000	0.194
Revenue Variance for Year ($MMs)	-239.55	0.443	8.38	0.624	0.000	0.965	0.000	0.202	-0.011	0.152	0.000	0.888
Constant	-3593.46	0.715	-7312.84	0.168	0.031	0.565	-0.116***	0.000	-0.101	0.799	-1.189***	0.000
Observations	466		1343		466		1343		466		1343	
R-Squared	0.5135		0.2177		0.1260		0.0520		0.1619		0.1261	
Adjusted R-Squared	0.4904		0.2034		0.0847		0.0347		0.1222		0.1102	
Fixed Effects	Year		Year		Year		Year		Year		Year	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 18: Comment Length as a Function of Complexity

	Goal Comment Length		Soft Skills Comment Length		Hard Skills Comment Length	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
Component Rating in Year	72.790***	0.000	-1314.143***	0.008	-136.956	0.518
Fixed-Price Contract	77.122	0.339	338.340**	0.085	285.805**	0.071
Technical Needs - Complex	-51.306	0.410	-93.991	0.591	-58.371	0.699
Modified Design	-14.834	0.811	7.210	0.968	-74.995	0.635
Subcontractor Use - Heavy	-113.792	0.227	-257.532	0.295	-207.575	0.292
Away Project	95.460	0.305	27.541	0.889	6.765	0.966
Product Line - Power	28.855	0.822	-1145.206***	0.001	-917.828***	0.003
Product Line - Environmental	82.717	0.364	-91.486	0.620	-38.392	0.799
Deliverable - Build	-3.378	0.981	-34.048	0.901	47.459	0.797
Deliverable - Design	-54.464	0.629	84.619	0.713	-20.999	0.916
No Experience	12.528	0.816	20.749	0.899	13.704	0.921
Negative Relationship	-80.783	0.293	113.070	0.565	137.346	0.421
Client - Private	-79.143	0.422	-397.379**	0.084	-417.434***	0.025
Client - Government	-11.056	0.874	-417.010***	0.048	-96.928	0.590
Duration at Award (Months)	0.072	0.974	-10.196***	0.032	-5.650	0.141
Cost Estimate for Year ($MMs)	-0.224	0.468	0.532	0.481	-0.226	0.758
Revenue Estimate for Year ($MMs)	0.074	0.946	1.822	0.589	7.020**	0.061
Duration Variance at Completion (Months)	-0.675	0.738	3.050	0.485	-0.055	0.989
Cost Variance for Year ($MMs)	0.533	0.228	1.227	0.157	0.778	0.249
Revenue Variance for Year ($MMs)	-3.224	0.138	-5.775	0.266	-1.530	0.749
Constant	1114.815***	0.000	9175.527***	0.000	2630.715***	0.010
Observations	1809		1809		1809	
R-Squared	0.3836		0.1183		0.1614	
Adjusted R-Squared	0.3756		0.1069		0.1506	
Fixed Effects	Year		Year		Year	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 19: Comment Length as a Function of Complexity by Pricing Model

	Goal Comment Length				Soft Skills Comment Length				Hard Skills Comment Length			
	Cost-Plus		Fixed-Price		Cost-Plus		Fixed-Price		Cost-Plus		Fixed-Price	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
Component Rating in Year	42.897***	0.045	78.653***	0.000	-2536.97***	0.032	-1043.07***	0.049	-663.383**	0.092	-22.452	0.924
Technical Needs - Complex	-147.325	0.454	-65.016	0.321	-188.416	0.592	-140.727	0.564	-464.954	0.170	-72.433	0.737
Modified Design	72.778	0.708	-24.130	0.726	-464.131	0.157	102.653	0.716	-20.662	0.950	-18.017	0.940
Subcontractor Use - Heavy	-237.882*	0.128	140.373	0.257	-149.491	0.603	-66.236	0.889	-178.645	0.457	-1.376	0.997
Away Project	206.692	0.327	-32.614	0.803	36.853	0.938	-213.933	0.530	278.629	0.399	-284.669	0.365
Product Line - Power			140.185	0.377			-1074.67***	0.033			-924.746***	0.039
Product Line - Environmental	-102.917	0.585	109.321	0.317	193.525	0.693	-162.125	0.624	8.380	0.980	-124.461	0.660
Deliverable - Build	-253.695	0.256	431.692	0.211	391.245	0.517	-16.492	0.977	-41.310	0.913	219.595	0.629
Deliverable - Design	-409.954*	0.121	-136.376	0.315	136.847	0.731	110.062	0.756	-0.445	0.999	-30.150	0.923
No Experience	42.327	0.826	-30.483	0.593	673.158	0.238	-50.384	0.794	294.406	0.312	-22.343	0.901
Negative Relationship			-53.522	0.494			144.508	0.485			152.529	0.399
Client - Private	68.252	0.813	-48.034	0.653	-963.265	0.428	-413.637**	0.081	228.656	0.744	-344.367**	0.090
Client - Government			25.041	0.731			-510.659***	0.032			-94.000	0.647
Duration at Award (Months)	3.376	0.614	-0.890	0.713	-7.966	0.518	-18.196***	0.002	-9.169	0.353	-6.151	0.200
Cost Estimate for Year ($MMs)	0.248	0.947	-0.219	0.530	-28.097***	0.018	0.970	0.251	-18.920***	0.020	-0.207	0.802
Revenue Estimate for Year ($MMs)	4.506	0.834	-0.646	0.578	145.727**	0.077	1.933	0.587	120.131**	0.070	6.102*	0.129
Duration Variance at Completion (Months)	1.077	0.874	-0.679	0.742	-1.835	0.882	4.913	0.369	6.204	0.535	-2.876	0.570
Cost Variance for Year ($MMs)	-0.258	0.957	1.072***	0.029	-26.898*	0.119	1.890**	0.072	-21.535*	0.108	1.262*	0.139
Revenue Variance for Year ($MMs)	-1.202	0.963	-4.935***	0.036	130.089	0.259	-5.695	0.275	107.649	0.235	-1.969	0.688
Constant	1507.4***	0.000	691.8**	0.060	14695.0***	0.010	8460.2***	0.002	4899.9***	0.010	2325.3**	0.067
Observations	466		1343		466		1343		466		1343	
R-Squared	0.3189		0.4144		0.2109		0.1141		0.1795		0.1567	
Adjusted R-Squared	0.2899		0.4047		0.1773		0.0993		0.1445		0.1427	
Fixed Effects	Year		Year		Year		Year		Year		Year	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 20: Ratings Dispersion as a Function of Complexity

	Goal Rating Dispersion		Soft Skills Rating Dispersion		Hard Skills Rating Dispersion	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
Fixed-Price Contract	-0.056	0.661	0.001	0.979	0.034	0.312
Technical Needs - Complex	0.185***	0.036	0.020	0.447	0.028	0.351
Modified Design	-0.081	0.363	-0.009	0.695	-0.001	0.985
Subcontractor Use - Heavy	-0.289***	0.035	-0.050**	0.074	-0.018	0.676
Away Project	-0.148	0.226	0.011	0.693	0.013	0.713
Product Line - Power	-0.461***	0.010	-0.046	0.286	0.027	0.662
Product Line - Environmental	0.090	0.439	-0.021	0.415	-0.005	0.905
Deliverable - Build	0.081	0.665	-0.012	0.711	-0.026	0.657
Deliverable - Design	0.139	0.267	0.015	0.590	0.018	0.648
No Experience	0.009	0.929	0.052***	0.038	0.030	0.364
Negative Relationship	-0.004	0.970	-0.026	0.339	-0.045	0.181
Client - Private	0.277	0.061	0.051**	0.096	0.069	0.217
Client - Government	0.092	0.382	0.022	0.414	-0.010	0.793
Duration at Award (Months)	0.002	0.481	0.000	0.538	0.000	0.565
Cost Estimate for Year ($MMs)	0.000	0.664	0.000	0.530	0.000	0.911
Revenue Estimate for Year ($MMs)	0.001	0.527	0.000	0.542	0.000	0.699
Duration Variance at Completion (Months)	0.001	0.498	0.000	0.950	0.002**	0.090
Cost Variance for Year ($MMs)	-0.001***	0.018	0.000	0.251	0.000	0.158
Revenue Variance for Year ($MMs)	0.007	0.055	0.001**	0.069	0.002	0.193
Constant	0.669***	0.001	0.144***	0.001	0.194***	0.006
Observations	175		175		175	
R-Squared	0.7500		0.7666		0.7464	
Adjusted R-Squared	0.7139		0.7328		0.7097	
Fixed Effects	Year		Year		Year	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively

Table 21: Ratings Dispersion as a Function of Complexity by Pricing Model

	Goal Rating Dispersion				Soft Skills Rating Dispersion				Hard Skills Rating Dispersion			
	Cost-Plus		Fixed-Price		Cost-Plus		Fixed-Price		Cost-Plus		Fixed-Price	
	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value	Coef.	P-Value
Technical Needs - Complex	-0.047	0.776	0.201***	0.042	0.014	0.759	0.000	0.993	0.068	0.205	0.030	0.454
Modified Design	0.084	0.708	-0.195**	0.076	-0.039	0.244	0.026	0.538	0.029	0.531	-0.015	0.750
Subcontractor Use - Heavy	-0.332***	0.042	-0.011	0.957	-0.036*	0.147	-0.022	0.732	0.004	0.939	-0.019	0.779
Away Project	0.032	0.853	-0.423***	0.021	-0.015	0.653	-0.055	0.252	-0.040	0.540	0.017	0.814
Product Line - Power			-0.205	0.346			-0.073	0.335			0.007	0.934
Product Line - Environmental	-0.291	0.170	0.252	0.156	0.026	0.551	-0.025	0.570	0.024	0.736	0.031	0.664
Deliverable - Build	-0.186	0.401	-0.013	0.965	-0.005	0.894	-0.127*	0.136	0.004	0.961	-0.052	0.579
Deliverable - Design	0.140	0.393	0.026	0.874	0.046**	0.096	0.028	0.561	0.012	0.830	0.032	0.590
No Experience	0.445	0.258	-0.167**	0.092	0.087*	0.129	0.045	0.198	0.054	0.610	0.014	0.665
Negative Relationship			0.055	0.590			-0.011	0.693			-0.040	0.227
Client - Private	0.838**	0.067	0.209*	0.121	0.170***	0.041	0.041	0.208	-0.038	0.808	0.070	0.250
Client - Government			0.133	0.193			0.029	0.409			0.003	0.960
Duration at Award (Months)	-0.008	0.278	0.003	0.353	0.002*	0.136	0.000	0.533	0.004**	0.068	-0.002	0.186
Cost Estimate for Year ($MMs)	-0.002	0.711	0.000	0.863	-0.002***	0.039	0.000*	0.140	0.000	0.903	0.000	0.675
Revenue Estimate for Year ($MMs)	0.053***	0.038	0.001	0.607	0.013*	0.118	0.000	0.737	-0.005	0.585	0.000	0.992
Duration Variance at Completion (Months)	0.005	0.316	0.000	0.908	0.001	0.578	-0.001*	0.125	0.001	0.654	0.001	0.222
Cost Variance for Year ($MMs)	-0.008	0.210	-0.001	0.169	-0.003***	0.030	0.000	0.553	0.000	0.801	0.000	0.862
Revenue Variance for Year ($MMs)	0.064***	0.033	0.003	0.346	0.016**	0.088	0.001	0.267	0.002	0.836	0.000	0.873
Constant	1.028***	0.000	0.783***	0.018	0.035	0.507	0.290***	0.007	0.029	0.725	0.288***	0.020
Observations	58		117		58		117		58		117	
R-Squared	0.81		0.7789		0.7724		0.8155		0.7679		0.7843	
Adjusted R-Squared	0.7223		0.73		0.6674		0.7747		0.6608		0.7366	
Fixed Effects	Year		Year		Year		Year		Year		Year	

*, **, and *** indicate significance at the 15%, 10% and 5% levels, respectively