EVALUATION OF STRATEGIES FOR REPEAT PROCUREMENT

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EVALUATION OF STRATEGIES FOR REPEAT PROCUREMENT

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This is dedicated to my wife who has supported and tolerated me for more than ten years. She and I started and ended this journey together and she believed in me the entire time (and only during the last eighteen months was she contractually obligated to do so by the marital laws of Georgia).

... and to my parents. Without their guidance, I would not be the person I am today. Their selflessness and acts of generosity often go unmentioned, but are never unappreciated.

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SUMMARY

For the past several decades, there has been a fundamental dispute between the appropriate mechanism for repeat procurement. On one hand, the supporters of Porter [83] advocate a competitive setting where short-term contracts are used to increase buyer power and lower supplier prices. On the other hand, the supporters of Deming [26] advocate the idea of long-term contracts to align buyer and supplier incentives. This trade-off between long-term and short-term contracts has fundamentally affected the practice of procurement, with most suppliers opting for hybrid strategies such as Incumbent Biasing: a strategy characterized by short-term contracts with frequent rebidding with an advantage given to the incumbent. This work examines this hybrid strategy to determine its effectiveness. First, we create an empirical model that identifies and measures the trade-offs between the Porter and Deming strategies. Using this model, we find that Incumbent Biasing has an impact on procurement performance via two mechanisms: first, Incumbent Biasing decreases bidding competitiveness in repeat procurement bidding, which decreases performance; second, Incumbent Biasing has a moderating effect where it improves incentive alignment between the buyer and supplier and improves procurement performance. We show that depending on the current contract design, the net effect of Incumbent Biasing on overall procurement performance can be either positive or negative. This is first work to empirically test the impact of Incumbent Biasing on procurement performance and the first to identify the positive and negative mechanisms by which this impact occurs. Using this research, managers will be able to identify their firm's position with regards to incentive alignment with their supplier to determine if Incumbent Biasing has a net positive effect for their firm.

After identifying the impact of Incumbent Biasing on procurement performance, we contribute to the literature by testing this analysis through two additional extensions. First, using secondary data analysis we show that our construct for procurement performance is correlated with firm performance. We do this by comparing the answers to our procurement performance construct items to the change in gross margin of the publicly traded respondents in our study over time. This shows that our construct is not only reliable, but that procurement performance has a positive impact on overall firm performance. This is the first work to provide an empirical construct for procurement performance that is validated via secondary data analysis of firm performance. Second, we test a competing theory to Incumbent Biasing which is Multi-Sourcing: the strategy of spreading a contract to multiple suppliers to maintain competitiveness in bidding. Approximately 46% of our sample identify as using both strategies simultaneously and we test for an impact between the two. We show that the two strategies to not impact each other and can be viewed independently. Subsequently, we test two Multi-Sourcing constructs in our model and find that there is no significant impact on bidding competitiveness from Multi-Sourcing.

Subsequently, we examine the impact of repeatedly awarding a contract to a pool of bidders. In our model, one contract is bid repeatedly over time, resulting in bidders gaining information about their competitors' cost. The academic literature is mixed on how a buyer should approach this type of contract bidding interaction. On one hand, it is argued that establishing an awarding structure that favors the incumbent decreases the frequency of switching, and thus cost. On the other hand, it is argued that an awarding structure that favors the non-incumbent (entrant) bidders places competitive pressure on the incumbent and generates low margin bids. This issue is further complicated by the practice cited in the academic literature of "defection", where entrant firms either perceive a bias or believe that their cost is uncompetitive and will not bid in future stages.

We create a framework that explores the apparent contradictions in these recommendations and gives conditions when biasing toward the incumbent or entrant should be implemented. We first characterize bidders based on their effort to bid and their cost to supply the contract. We then show that in the case of low effort to bid and high cost for the entrant, entrant biasing is optimal; when the reverse is true incumbent biasing is optimal. Using the results from our analysis, we provide guidance to buyers facing a repeated procurement process.

CHAPTER I

INTRODUCTION

Since the time of Henry Ford and Andrew Carnegie, management of a firm's suppliers has been seen as a means of differentiation and competitive advantage. In the early 1900's, the issue facing Ford and Carnegie was the extent to which a firm should vertically integrate [106]. Decades later, and with increasing complexity of products manufactured, specialization of suppliers is seen as a key to success, and the concern has become the means to manage specialized suppliers.

The primary concern for managing specialized suppliers is the contract mechanism by which these suppliers are selected and managed. Following the research of Porter [83], one school of thought views buyers and suppliers as competitors and promotes the idea of short-term, arm's length contracts. The goal of this buyer-supplier orientation is to increase the buying firm's options and create a credible threat to switch, thereby increasing buyer power. Another school of thought follows Deming [26] and bases its evidence on the Japanese automotive manufacturing success of the 1980's and 90's, promoting the idea of long-term partnership-based relationships with the purpose of aligning risk and reward sharing [22, 67, 94]. Based on the teachings of TQM and JIT, the partnership-based model is nearly axiomatic in buyer-supplier relationships today and is cited as one of the most significant reasons why Japanese competitors nearly doubled their market share in the US car market in the 1980's and 1990's [97]. However, in the 2000's, internet-based reverse procurement auctions gained support, with 25% of firms reporting the use of auctions by 2004 [107], once again promoting the use of arm's length relationships and challenging the mantra of partnership-based relationships. The dispute between these two schools of thought is summarized by

Niall Waters-Fuller:

> There is some disagreement within the literature on a number of issues. First, there is a body of literature which suggests that traditional purchasing practices of short-term contracts and multiple sources of supply is a more effective form of purchasing for the manufacturer. Firms which engage in long term, sole source relationships, open themselves to purchasing at above market prices, increase the risk of supply disruption, may fall behind the competition in terms of technological innovation and will incur expense should a switch of suppliers become necessary. These arguments are countered by other authors, who suggest that the closer form of relationship which is formed through JIT sourcing is more rather than less efficient. There are operational criteria cited indicating improvements in inventory turns, supplier responsiveness and quality, while others point to the strategic implications of JIT sourcing achieved through the long-term mutual dependency relationship forged between customers and reliable suppliers. [101]

In addition to the prevalence of online procurement, in 2010 one of the major flaws of the partnership-based system received considerable attention in the press. Toyota, the most commonly cited example of the practice of partnership-based suppliers, was subject to a US$2 billion recall of 5.6 million vehicles in the US and Canada for uncontrollable acceleration [40]. Toyota stock lost 19% of its market value in two weeks [40] and year-over-year sales in January 2010 declined 16% [50]. According to analysts, the effect of the recall will be particularly problematic long-term as consumers primarily purchased Toyota vehicles for quality-related reasons and the image of Toyota's quality will be fundamentally affected by this recall [51]. Upon investigation, it was identified that the cause of the problem was an improperly designed and tested part provided by a supplier, CTS Corp [28].

The example of Toyota shows one of the major draw backs of partnership-based buyer-supplier relationships: the potential for one supplier's "corner cutting" on a product (called shirking) to substantially impact the buyer. Other examples cited often include the potential risk from moral hazard [32], the cost to maintain close buyer-supplier relationships [46], and the potential lost opportunity of switching to a potentially superior supplier [95]. The choice of an improper procurement strategy, whether that is a strategy too focused on short-term contracting or too focused on long-term contracting, can have severe negative repercussions. Thus, managers must understand how the choice of proposed commitment (i.e. contract length) impacts their procurement success and how to best manage the tradeoffs involved.

1.1 Research Goals and Contribution

Through this work, managers will understand the trade-offs involved in longer-term proposed commitment contracts. This is the first work to evaluate this practice as a function of two mediating factors: Relationship-Derived Power and Focused Commitment Strategy. Further, this work explores the practice of incumbent biasing, a practice frequently cited in the literature [37, 53, 54, 109]. This is the first work to evaluate the impact of incumbent biasing on procurement performance. We evaluate the impact of this process on overall procurement success empirically by considering the strategy as a moderating factor on the long-term and short-term procurement model previously validated. This is the first work to explicitly explore the policy of incumbent biasing and to evaluate the overall value of such a strategy on the overall procurement performance.

In conjunction with the analysis of incumbent biasing, we also test the impact of another strategy frequently cited in literature: multi-sourcing. Multi-sourcing is the practice of using multiple suppliers for a sole procurement need as a means to increase competition. This is the first work to empirically test this relationship and compare

it to incumbent biasing, as well as the first work to test the interaction between the two strategies.

In addition, this research also tests the empirical construct of Procurement Performance and compares this to the gross profit margin of a firm obtained through publicly traded companies' $10K$ reports. This is the first paper to show that there is a relationship between the perceptual metrics of procurement performance and a firm's bottom line. This creates confidence in our metric and shows the impact of procurement on firms as a whole.

Subsequently, this dissertation is the first work to analytically model the strategy of procurement biasing to investigate the impact of this strategy on bidder defection in repeat procurement. The current academic literature gives conflicting recommendations for managers for using biasing as a method to prevent defection in repeat interaction procurement. In a white paper issued by the World Bank, Klein [61] explicitly recommends biasing towards incumbents in the case of repeat bidding opportunities to avoid switching cost. On the contrary, in the academic literature, Luton and McAfee [71] explicitly recommend biasing towards entrants to maintain the competitiveness of the bidding pool. Our research sheds light on this debate. We show that both strategies (biasing towards an incumbent and biasing towards an entrant) can be optimal depending on the parameters of the bidders (specifically their cost to supply the contract relative to a reservation price and the cost of effort to participate in bidding). Following this recommendation to managers, we determine when buyers should announce biasing to bidders based on how bidders update their perception of their competitor's cost. This is the first work to explicitly incorporate defection as a result of information updating in the bidding process. This is also the first work to evaluate the policy of biasing in awarding.

1.2 Organization

In this dissertation, we explore the issue of repeated procurement and evaluate the impact of several practices in this setting. In Chapter 2, we validate an empirical model that establishes the basic trade-offs present in procurement: the conflict between increased buyer power through greater competition and increased incentive alignment through the creation of a perception of a long-term commitment. Using this model we explore the efficacy of repeat incumbent awarding. In §2.4.4 we establish the relationship between the perceptual latent construct of Procurement Performance and the financial performance of a firm. In Section §2.5 we explore the impact of multi-sourcing on incumbent biasing, the interaction between the two strategies, and the impact of multi-sourcing on procurement performance. In Chapter 3 we investigate a key concern in repeat procurement: the phenomenon of defection between rounds of bidding. We explore a model that incorporates biasing to prevent defection in a framework in an indivisible good and show how the information updating between periods in the bidding process drives bidder defection. In Chapter 4 we conclude with managerial insights developed from this work.

CHAPTER II

EMPIRICAL FRAMEWORK FOR PROCUREMENT SUCCESS

2.1 Introduction

In Chapter 1, we demonstrate the clear presence of the tradeoffs between the partnership model of buyer-supplier relations and the arm's length model. Despite these trade-offs, the current research falls either into one of two absolutes: either assuming the use of arm's length relationships and determining the optimal mechanisms to maximize competition or arguing for the benefits of long-term relationships to align incentives. There is very little research that connects these two models. The notable exception is Dyer et al. [30] who explore the actual practices of Japanese automotive manufacturers and classify the relationships as either partnership based, arm's length, or as "durable arm's length" which is a hybrid strategy whereby traditional short-term arm's length contracts are used, but suppliers are promised renewed contracts for superior performance. In addition to the work of Dyer, it has been shown in practice that hybrid procurement strategies exist. In the area of online procurement auctions it has been seen that although there is no explicit strategy in place, the incumbent firm (the firm that already supplied the contract) wins the overwhelming majority of subsequent procurement contracts. In their study, Zhong and Wu [109] find that approximately 75% of procurement auctions are awarded to the incumbent. Elmaghraby [37] and Jap [53, 54] have reported that a large number of online auctions do not result in the awarding of a contract. Both believe the auctions without an award are being used as a price discovery mechanism to renegotiate with the incumbent.

Further, in the area of arm's length online reverse procurement auctions, there has been recognition of a need to study the impact of relationship-based factors on procurement. For example, Jap and Haruvy [55] use a quasi-experimental design to investigate the impact of auction design on the resulting opinion of bidders. Factors such as the number of bidders, the existence of an incumbent, and the number of bids are examined with regard to how firms bid and how likely they are to form a long-term relationship with the buyer. The authors find that as competition increases and prices decrease, bidders become disenchanted with the buyer and are less likely to form long-term partnerships. In response to this research, Ganesan et al. [42] suggest that a needed area of future research is to investigate the implication that "global sourcing through the use of online auctions can reduce the retailer's costs but also inhibit the development of long-term partnering relationships".

Despite the conflicting nature of these buyer-supplier orientations and the existence of hybrid strategies in practice, little research has been done linking the benefits of the partnership-based literature and the arm's length-based literature. One exception is Peleg et al. [81], who model the trade offs of long-term, short-term, and combination long-term and short-term contracts. They find that there is no one-best solution. Similarly, Swink and Zsidisin [95] empirically explore the idea of "focused commitment strategy" (FCS) which is a strategy of committing long-term to a few suppliers. They find that there are intermediate levels of FCS which are optimal.

This chapter contributes to the body of knowledge by examining a well cited hybrid strategy in the literature: incumbent biasing. As discussed previously, incumbent biasing is the strategy of repeatedly bidding contracts but deciding prior to bidding that the award process is biased in favor of the incumbent. This strategy is characterized by frequent rebidding, but also tends to develop long-term relationships because of the biasing effect. The result is Dyer et al.'s [30] durable arm's length relationship.

To examine this strategy, we model repeat-interaction procurement scenarios.

First we propose a base model that creates a relationship between the proposed commitment at the time of bidding (contract length, indication of mutual investment, etc.) to the performance (satisfaction or success) of the procurement process. We propose that this relationship occurs via two competing mechanisms based on the paradigms of Porter [83], who proposes that decreased commitment results in increased buyer power, and Deming [26], who proposes that greater initial commitment leads to incentive alignment. This is the first work to empirically evaluate these competing paradigms of procurement in one model. Once the base model is established, we incorporate incumbent biasing and quantify the impact of this strategy on the overall procurement performance.

2.2 Literature Review

To explore the phenomenon of repeat incumbent procurement on overall procurement performance, we review the literature to identify variables that characterize the phenomenon under investigation. As seen in Figure 1, these variables fall into three categories: controls that the buyer can manipulate, latent variables that characterize how the buyer-supplier relationship is impacted by those controls, then a performance variable that captures the benefit of the resulting relationship.

2.2.1 Proposed Commitment

One key factor that a buyer can use to manipulate a supplier is to signal the level of proposed commitment at the time of bidding. This signal can take several forms, but regardless of the form, the signal gives the impression of a long-term or short-term relationship. As such, this variable is important as it is the basis for one of the most fundamental disagreements in the buyer-supplier relationship literature.

One on hand, the supporters of Porter [83] argue that procurement should be based on short-term contracts that create competition, with the logic that competition lowers prices and maintains a high level of quality as suppliers fear a buyer

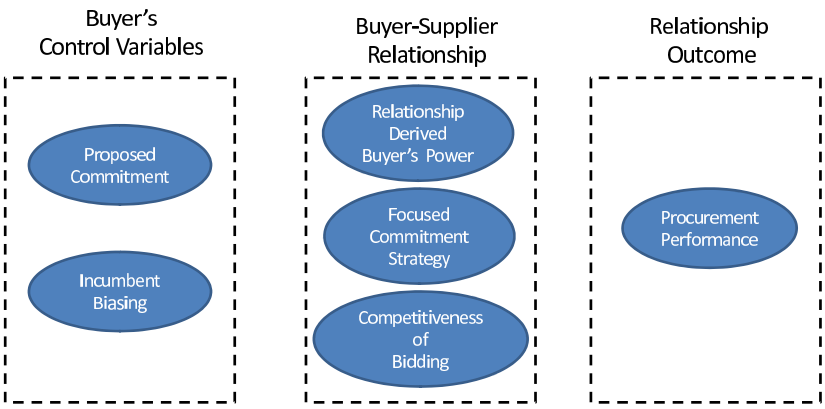

Figure 1: The constructs used in this chapter are grouped based on whether they are under the direct control of the buyer, whether they are relationship based variables or whether they are the performance variable.

that can switch. In a 2000 survey by Deloitte, over 90% of the surveyed businesses claimed that using e-procurement for short-term contracts was an important part of their strategy [102]. McAfee and McMillan [74], Klemperer [64], and Elmaghraby [34] provide reviews of the auction and operations research literature which reviews mechanisms to obtain optimal profits when requiring a competitive bid for a contract.

On the other hand, Deming [26] argues that procurement should be based on strategic alliances, where the supplier's assets become a part of the buyer and can be used for market differentiation. Companies such as Varian, a manufacturer of semiconductor processing equipment [103], Xerox, Motorola, General Electric, and Ford [58] have been successful in reducing costs by increasing their use of long-term relationships with fewer suppliers. The long-term relationships allow suppliers to reduce sales and customer management overhead and reduce inventory costs. These savings are partially retained by the supplier and partially passed to the customer [26].

Peleg et al. [81] build a model in an attempt to investigate long-term vs. short-term contracts. Their model gives the buyer three options: a long-term strategic relationship, an online search (short-term), and a combination of a long-term contract

with an online search for an alternative supplier. The authors find that there is no single solution and that the optimal policy depends on factors such as the cost to search, the distribution of the lowest price among competitors, and the terms about to be reached with the long-term supplier. In a similar finding, Tunca and Zenios [99] compare a model of short-term e-procurement models to a case where a long-term contract is used to purchase a product. They find conditions where each type of procurement strategy can be optimal.

In our model, commitment is communicated using several dimensions. First we incorporate the length of a contract, with longer contracts generally representing a perception of long-term commitment. While commitment length may inherently vary by industry, we control for industry in our work. Further, proposed commitment is measured by proposals for joint investment. Finally, we include items related to the difficulty and cost to qualify for bidding with the explanation that a higher cost and a more complicated qualification processes signal a greater commitment from the buyer.

2.2.2 Incumbent Biasing

The phenomenon of incumbent biasing in the procurement process is an emerging topic in the literature that has been identified by several authors in practice. For example, Zhong and Wu [109] noted in their work that 75% of procurement auctions in their study of an e-procurement site were awarded to the incumbent. Elmaghraby [37] and Jap [53, 54] have reported that a large number of online auctions do not result in the awarding of a contract. Both believe the auctions without an award are being used as a price discovery mechanism to renegotiate with the incumbent. Finally, there has been mention of the issues associated with disproportionate awarding to incumbents in the popular press [1, 2, 10, 68].

In our work, Incumbent Biasing is measured by a propensity of a buyer to reaward

to the same bidder. For example, we ask a buyer if she favors the incumbent when awarding bids, if the incumbent will win even if not the lowest cost bidder, and if it is expected a priori that the incumbent will win.

2.2.3 Relationship Derived Buyer's Power

The idea of a buyer's power over a supplier is a seemingly intuitive issue. In the early literature, including Porter [83], the argument was made that a more powerful player in the arm's length buyer-supplier relationship could use his power to achieve a lower (or higher in the case of a powerful supplier) price. Several of the early papers in this area review the buyer's power via a proxy: the size of a buyer relative to a supplier. For example, Snyder [92] shows the case where larger firms are able to achieve lower prices because of economies of scale. Tyagi [100], however, shows that because of downstream buyer competition, even in the absence of economies of scale or increased buyer bargaining power, suppliers may price differentiate and offer lower prices to larger buyers. Several empirical studies have also shown the importance of a supplier's market share on B2B pricing [70, 75].

While size is one component of power, Cool and Henderson [21] extend this theory to also include factors from other fields. Using the sociology literature, they include a "Dependence" factor that focuses on the dependency of a buyer on her suppliers and vice versa. Factors that indicate dependency include switching cost and the impact of the supplier's product quality on the buyer's final product. Using game theory as a basis, they also include a "credible commitment" factor that includes issues such as threats and promises made by the players in the buyer-supplier relationship. After proposing these components, they perform a factor analysis on a sample taken from 178 firms across seven industries. From these samples, four factors emerged, including Structural Supplier Power (number of suppliers and concentration), Dependence Supplier Power (impact on buyer's product differentiation, supplier switching

cost), Attributed Supplier Power (supplier bargaining power), and Integrated Supplier Power (impact on supplier's cost and forward integration).

In our study, we group the power factors into two fundamental sources: power derived from the environment (Environmentally Derived Buyer's Power) and power derived from actions of the buyer and/or supplier (Relationship Derived Buyer's Power). Factors derived from the environment include issues such as industry structure, supplier's impact on cost, and the supplier's effect on product differentiation. These factors exist independent of the buyer's actions and can not be realistically changed without a radical re-engineering of the product or industry. On the other hand, power derived from a buyer's actions, such as bargaining power, exist on a relationship by relationship basis and can vary within industry and within a particular firm.

Our goal is to focus on the impact of the buyer's contract design and awarding on the Relationship Derived Buyer's Power. However, this is complicated by the Environmentally Derived Buyer's Power, which will not only impact the Relationship Derived Power, but will also likely impact the buyer's contract choices. As such, we measure both constructs separately and use Environmentally Derived Buyer's Power as a control variable to ensure that we are able to extract and examine Relationship Derived Buyer's Power separately.

2.2.4 Focused Commitment Strategy

The perception of commitment to suppliers is an incentive alignment issue. In many cases, the long-term profit maximizing decision involves an initial sunk cost. Thus greater commitment allows for a longer period of time to recoup an initial sunk cost for the supplier and aligns the incentives of the buyer (who is presumably long-term committed to a product) and the supplier. This principal is a core component of the Japanese Keiretsu system, which uses longer-term contracts with fewer suppliers to align incentives and increase profitability [31]. In response to the success of the

Keiretsu system, over the last 20 years there has been a movement by manufacturers towards a reduced number, or even a sole source, of suppliers per component [81].

In the TQM and JIT literature, Deming [26] argues that supplier commitment reduces cost because of an incentive alignment mechanism. The argument of incentive alignment is furthered by several papers that argue that long-term relationships result in risk and reward sharing between the buyer and supplier [22, 67, 94]. As empirical evidence for this result, Carr and Pearson [14] perform an analysis using secondary data to show that longer-term relationships have a positive impact on firm performance.

Despite the benefits of supplier commitment, there are also risks associated with longer-term contracts. First, by limiting the number of suppliers available to a buyer via a long-term contract, a buyer incurs the potential of missing other potentially more profitable suppliers. A supplier may be viewed as a source of capabilities and resources available to the buyer [44]. Aligning closely with one supplier, resources of other suppliers are not identified. Long-term commitments also lead to the potential for moral hazard as a signal of commitment reduces the threat of immediate consequences for shirking [32]. Similarly, long-term commitments increase the consequence of adverse selection, where an unqualified supplier is chosen because of misrepresentation [32].

Swink and Zsidisin [95] explore the concept of a "Focused Commitment Strategy" to determine the impact of supplier commitment on firm performance. They developed and validated a scale for the measure of "focused commitment strategy," which measures commitment not simply as the length of a contract, but also includes factors such as trust and mutual investment. As such, we use their construct and terminology in this work.

2.2.5 Competitiveness of Bidding

The impact of the number of bidders on the performance of an procurement auction has been studied in both the economic and the management literature. McAfee and McMillan [74] argue that as the number of bidders increase in an auction, competition increases and the efficiency of the auction increases. On the other hand, Bulow and Klemperer [12] argue that auctions for common-valued assets may yield less efficient prices as the number of bidders increases. Their argument is based on the idea of the winner's curse (the theory that the winner of an auction is the one that overestimated the value the most): as the number of bidders increases in open auctions, the severity of the winner's curse increases, and therefore, firms have less of an incentive to bid competitively. Krishna and Rosenthal [66] and Elmaghraby [36] extend this argument to private valuation auctions. They argue that in multiple auction networks where synergies exist from winning one or more auctions, the addition of smaller bidders who only have capacity to supply the demand of one job deters competition from larger bidders who have the capacity for multiple jobs. However, Elmaghraby [36] shows that, in a scenario where all bidders have the capacity to meet all of the demand for all jobs, as the number of bidders increases, the bidders act more competitively.

2.2.6 Procurement Performance

One of the most difficult choices in any procurement study is to identify the success factors for a procurement project. This factor is obviously complex and existing literature has been almost exclusively concerned with price (e.g. [12, 34, 64, 74]).

While the final price is an important outcome, it is not the only measure of success. Wheelwright [104] proposes using the core competencies of quality, capacity, facilities, technology, vertical integration, workforce, control, and organization to characterize a firm's manufacturing strategy. Following the identification of manufacturing competencies, a number of taxonomy studies attempted to use these competencies to

characterize the firm. In their seminal work, Miller and Roth [76] characterize firms based on product quality, price, and lead time and show that these are the dimensions of manufacturing strategy on which firms base their competitive advantage. Based on this research, Rosenzweig et al. [88] use the characteristics of quality, delivery reliability, process flexibility, and cost to view the impact that these capabilities have on overall firm performance. The authors show that there is a strong correlation between these factors and firm performance (based on ROA, sales growth, customer satisfaction, and percent of revenues from new products).

This demonstrated relationship between core competencies and firm performance is the basis for Swink and Zsidisin's [95] work that attempts to link supplier commitment to firm success. The performance construct they developed is based on three sub constructs that follow the previously mentioned research: cost performance, quality performance, and delivery performance. It was validated for seven separate industries using multiple operations strategies. Their performance variable, however, is not used to measure a supplier's performance or the success of a buyer-supplier relationship, but rather to measure the performance of the buyer in the end market. Since our study evaluates the performance of a buyer-supplier relationship, this construct is inappropriate. Instead, we use the performance construct developed by Johnston et al. [57], which uses perceptual measures to assess a supplier's performance based on the buyer's assessment of Wheelwright's core competencies [104]. This construct is very similar to the one developed and validated by Prahinski and Benton [84].

The construct that we use contains four perceptual measures of procurement performance and one objective measure. The perceptual measures related to conformance quality, performance quality, price, and satisfaction and the objective measure considers the increase or decrease in the cost of procurement over the last five years. Incorporating an objective measure with subjective measures is important to ensure

that the construct actually reflects actual performance. To further ensure the reliability of this metric, in §2.4.4 we correlate the responses to this construct of publicly held firms with that firm's financial performance over the last three years.

2.3 Hypotheses

The hypotheses for this chapter are developed based on the two control variables to the buyer: Proposed Commitment and Incumbent Biasing. We explore the impact of both on Procurement Performance.

2.3.1 Proposed Commitment

Fundamentally, the argument of Porter [83] is that the buyer-supplier relationships are based on power, stating: "[i]n purchasing, then, the goal is to find mechanisms to offset or surmount these sources of suppliers' power." Porter's view is one of an adversarial role between the buyer and her suppliers. Buyers generate profit and both the buyers and suppliers create cost. The difference is that all firms compete in a zero-sum game to achieve the maximum portion of that profit. Within that framework are actors, each with varying power. Buyers have power based on their ability to change suppliers and suppliers have power based on the dependency of the buyer. Increasing the Relationship Derived Buyer's Power results in increasing the proportion of the profit that the buyer obtains.

The best cited example of the use of arm's length relationships to increase profit is General Motors (GM) in the 1990's when the head of purchasing, Jose Ignacio Lopez de Arriortua, invoked a strategy of hard-line negotiations with suppliers. The strategy was to reopen existing contracts and frequently negotiate new contracts [30]. Using this strategy, GM demanded and received 20% cost reductions from suppliers and reduced total procurement cost by $4 billion [98]. While the actions and outcomes of this process are well documented, the mechanism by which the actions influenced

the outcome has not been studied. While it could be argued that the GM situation was an example of a large buyer (i.e. a powerful buyer because of the characteristics of the industry) projecting influence onto suppliers, the fact remains that there was a change in procurement prices without a change in GM's size relative to suppliers. The major change in the system that occurred during the time period was a change in the frequency of bidding. Thus, it is appropriate to hypothesis that, controlling for firm size, a change in the frequency of bidding will cause a change in the outcome of the procurement process. Following from that logic, we hypothesize the following:

H_1: Higher levels of Proposed Commitment leads to lower levels of Relationship Derived Buyer's Power

H_2: Higher levels of Relationship Derived Buyer's Power leads to higher levels of Procurement Performance

However, there is another side to the General Motors example. While General Motors was able to greatly reduce its cost initially by decreasing contract lengths and increasing competition, in the long-term, General Motors could not compete with its Japanese counterparts who were lengthening their average contracts at the same time [29]. The observation that Japanese automotive manufacturers with longer term contracts were out performing American manufacturers, which is contrary to the argument of Porter, was a key insight that lead to the creation of the TQM philosophy on buyer-supplier relationships.

As summarized by Helper [46], one key premise of TQM is that long-term relationships lead to better supplier performance. As a buyer becomes more committed to a supplier, that supplier is willing to commit more resources and long-term investments to that supplier, thus reducing the procurement cost over time. A supplier with a low level of commitment from the buyer, on the other hand, will maximize his immediate

profit by minimizing his immediate cost, often at the expense of mutual long-term profit. In effect, researchers have argued that long-term relationships result in risk and reward sharing, which aligns firm incentives [22].

Early work was primarily anecdotal, with a famous example being the Japanese and American automobile manufacturers (summarized in [29]). This anecdotal work was strengthened by Carr and Pearson [14], who's empirical evaluation of a very large sample (739 firms across industries) found support that the presence of a long-term commitment positively impacted the overall financial performance of the firm. One paper that has empirically shown a relationship between strategic sourcing and incentive alignment, as well as incentive alignment and firm performance is Chen et al. [19]. In their work, Chen et al. test and show that higher levels of Strategic Sourcing (i.e. Proposed Commitment) lead to higher levels of Communication and Long-Term Orientation (i.e. FCS). These two constructs, in turn, have a positive impact on Customer Responsiveness, which has a positive impact on Financial Performance. While Procurement Performance is not explicitly named by Chen et al., it is straightforward to assume that Procurement Performance would need to mediate Financial Performance.

hile the classic literature claims a connection between long-term relationships and overall project success, there is clearly a missing step. The claim is made that long-term contracts result in risk sharing, but that is not necessarily the case, as there must be a mediating factor between the action of the buyer and the performance of the supplier: the internalization of the buyer's actions. Specifically, a long-term contract would result in a perception that the buyer is more committed to the supplier, thus resulting in the supplier investing in longer term solutions that result in overall cost savings for both the buyer and the supplier. This is often ignored in the literature because it is generally not in the interest of the buyer to maintain a large number of relationships while simultaneously increasing the length of relationships to

each supplier, rather buyers typically take the approach of reducing suppliers while increasing the length of the contracts. As such, we propose the following hypotheses:

H_3: Higher levels of Proposed Commitment leads to higher levels of Focused Commitment Strategy

H_4: Higher levels of Focused Commitment Strategy leads to higher levels of Procurement Performance

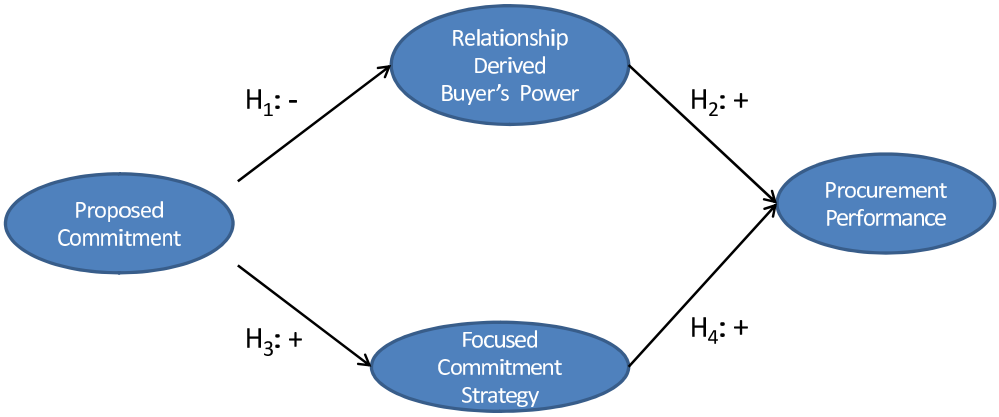

Figure 2: The basic model with hypotheses regarding how the Proposed Commitment impacts overall Procurement Performance

Figure 2 incorporates Hypotheses 1 through 4. This model hypothesis that both buyer power, as argued by Porter and evidenced in the General Motors case, and long-term commitments, as argued by the TQM literature and evidenced in the Toyota case, lead to higher procurement performance. The Proposed Commitment impacts both of these factors, one positively (Focused Commitment Strategy) and one negatively (Relationship Derived Buyer's Power).

2.3.2 Incumbent Biasing

The practice of repeat incumbent procurement is relatively new in the literature and came about following anecdotal findings in the e-procurement auction literature. As

such, the impact of this practice on overall procurement performance is not well defined in the academic literature. There are some discussions of how bidders react when faced with repeat procurement, however. Jap [53] discusses the fact that in procurement auctions, bidders learn over consecutive auctions and when they perceive that they are being treated unfairly, they may "opt out" of future auctions. Similarly, Elmaghraby [34], Chandrashekar et al. [17], and Rothkopf and Whinston [89] also cite the phenomenon of bidders acting "unaggressive" or otherwise negatively towards auctions where the bidders perceive an unfair situation.

Given the current literature, we make the following hypothesis:

H_5: Higher levels of Incumbent Biasing result in Lower Levels of Competitiveness of Bidding

The impact of the number of bidders on the performance of the auction is based in the auction literature. Experimental economists have been concerned with the impact of the number of bidders on the procurement performance. Experimentally it was shown that more bidders lead to higher prices in forward auctions [23, 24, 30]. This experimental work was then confirmed in Bulow and Klemperer's [12] seminal paper that showed that the expected revenue from $N+1$ bidders in a forward auction was greater than the expected revenue from N bidders. With regards to procurement, Millet et al. [77] showed that more bidders lowered prices in electric reverse auctions for procurement, and this finding was confirmed experimentally by Carter et al. [15]. In addition, there is some literature that seeks to explore the case where more bidders leads to less efficient outcomes. For example, Salop [90] explores the case where there is economy of scale in manufacturing and more bidders leads to less allocation per bidder. Rosenthal [87] explores the case where there are multiple markets and increased competition in one market hinders sales in a captive market. In our case,

we do not deal with such extreme situations, but rather focus on simple first price, sealed bid interactions.

While the previously mentioned literature explores the impact of the number of bidders on the auction or procurement performance, some research has been done in the area of repeat interaction procurement cycles. In an experimental study, Carter and Stevens [16] subjected MBA students to a situation where multiple procurement cycles occurred. Bidders in each round were given a cover sheet that disclosed the number of competitive bidders and the type of information sharing that would be provided (lowest bid vs. bid rank). Bidders competed three successive times. They found that the number of bidders did impact the overall price, but caution that this was likely only because the number of bidders was relatively small for each procurement cycle. Interestingly, they also found that prices did tend to decrease between rounds, though they attribute this to the bidders' comfort with the bidding process. From this literature, we develop the following hypotheses:

H_6: Higher levels of Competitiveness of Bidding leads to higher levels of Procurement Performance

In addition to affecting the competitiveness of the bidding pool in future rounds, incumbent procurement also plays another role on the procurement process. In Chapter 3 of this dissertation, we show an interesting phenomenon that impact bidders in the presence of repeat incumbent procurement: bidders that win repeatedly do not lower their prices. Rather than reducing bids in subsequent rounds, the incumbent suppliers maintain higher prices until they perceive a threat from an opposing bidder. Meanwhile, as an incumbent wins, his perceived advantage over other bidders (in that model, represented by the expected cost difference between bidders) increases. This perceived advantage over other bidders has two outcomes. First it acts to increase the

perceived switching cost of the buyer. This decreases the influence of Proposed Commitment on the Relationship Derived Buyer's Power over the supplier. That is, as a buyer reawards more frequently (or otherwise shows bias), Proposed Commitment has less of an effect on the Relationship Derived Buyer's Power over the supplier (the rebidding is seen as more of an empty threat). In short, the less Proposed Commitment a buyer signals, the more Relationship Derived Power that buyer has because the supplier knows that his contract is soon up for rebid. However, more frequent reawarding or bias to the same supplier decreases that effect because it reduces the threat to switch suppliers.

By the same token, frequent reawarding to an incumbent creates a greater perception of future profit despite the frequent rebidding. The bidder feels that he his more likely to retain the contract in the future if he wins, and his expected profit of future periods increases.

These lead to the following hypotheses:

H_7: Higher levels of Incumbent Biasing negatively moderates the impact of Proposed Commitment on Relationship Derived Buyer's Power

H_8: Higher levels of Incumbent Biasing positively moderates the impact of Proposed Commitment on Focused Commitment Strategy

2.4 Methodology

In this section, we summarize our methodology to analyze the data collected from our survey. Our methodology is broken into three issues: scale development, survey execution, and construct validity.

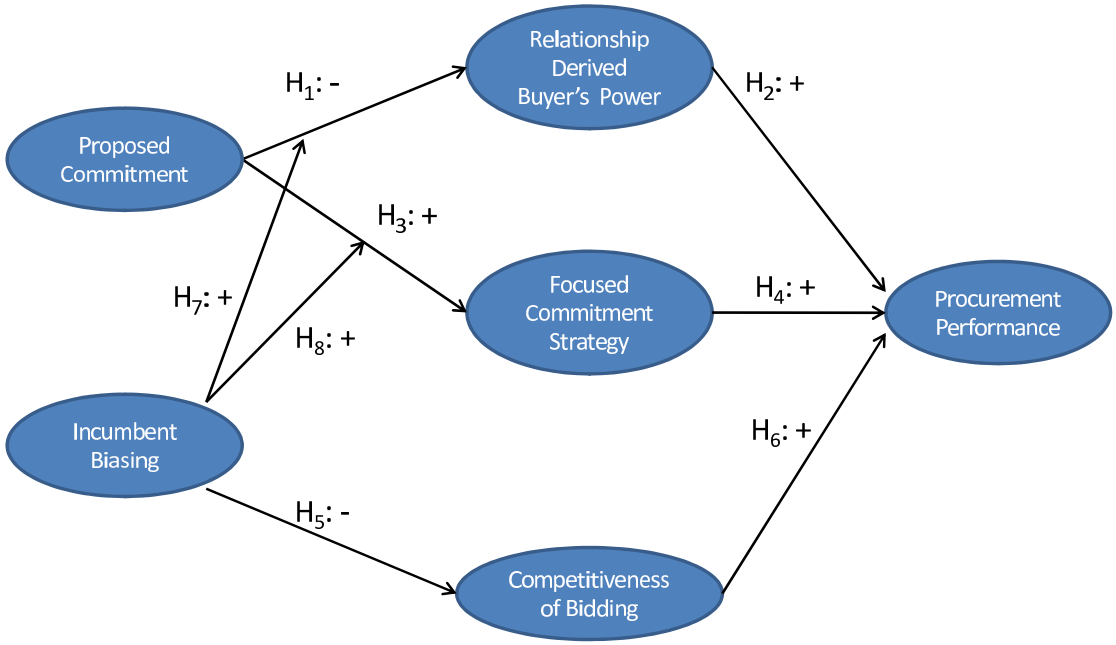

Figure 3: This model includes all hypotheses and incorporates the impact of Incumbent Biasing.

2.4.1 Scale Development

To generate our items, we use existing scales as much as possible. In fact, almost all items for the base model were derived directly from existing scales. For example, Johnston et al. [57] was used as the basis for the Procurement Performance items. These items were found to have very high reliability and high loading between the items and and latent variable of Buyer's Satisfaction. Similarly, the items for both Environmentally Derived and Relationship Derived Buyer's Power were taken from Cool and Henderson [21] and were validated as having high reliability by the authors. In addition to using existing scales from the literature, we also generate our items based on a detailed literature review as shown in §2.2. The use of a detailed literature review for item generation is suggested by many authors and is summarized in Hensley [47].

In addition to item generation, we validated our scales using a Q-sort procedure. This procedure is recommended by Moore and Benbasat [78], Hinkin [48], and Hensley [47]. In this method, reviewers were asked to sort items into constructs in order to demonstrate initial discriminant validity [78]. Our method also included an opportunity for reviewers to suggest other items to ensure complete coverage of the latent variable, similar to Moore and Benbasat's method. The metric to ensure a well designed scale is Perreault and Leigh's Index of Reliability (I_r), which compares the agreement of raters versus the probability that two raters would randomly agree on the same item. The threshold value for I_r is 0.65, as suggested by Moore and Benbasat.

For our raters, we used three procurement experts with varied experience and industry. Rater 1 is a "Senior Buyer" with thirteen years of experience in transportation and logistics. Rater 2 is a "Procurement Specialist" with 28 years of experience in chemical manufacturing. Rater 3 is a "Procurement Manager" with three years of expertise in the telecom industry. The inter-rater agreements are as follows:

Table 1: Inter-rater Reliability for the Item sort

Judge Pair	Perreault and Leigh I_r
1 and 2	0.685
1 and 3	0.759
2 and 3	0.759

Based on consistent misplacement, two items were considered to be moved from one construct to another. After discussion with two of the judges, it was decided to move both questions from the constructs they were designed to measure to the constructs in which they were placed. The item "My primary goal for rebidding a contract for this procurement need is to place pressure on the incumbent to lower or maintain his price, not to find the low cost supplier" was moved from Incumbent Biasing to Relationship Derived Buyer's Power and the item "We shift our demand

among suppliers to find the low cost supplier at the time" was moved from Use of Multi-Sourcing to Competitiveness.

2.4.2 Survey Execution

Following scale development, it is important to ensure that they survey is executed properly. First, the design of our survey is such that it is relatively short. Our survey contains less than 50 questions and testing has shown that it can be completed in less than 10 minutes. This was done to improve the response rate by lowering the respondent's expected effort [41]. We also layout our survey in a logical format to reduce the effort to complete the survey and use reverse scored metrics to maintain the respondent's alertness in the survey completion process [47]. Our survey is electronically based, which also decreases the respondent's effort, and research has shown that electronic surveys produce similar results to other methods of survey collection [11].

Our minimum recommended sample size is five responses per survey item [73]. Our overall survey has a total of 30 items, which requires a recommended number of respondents of at least 150. Our survey evaluates specific buyer-supplier relationships and requires the respondent to have a sufficient high level view of an organization to understand the performance of the overall relationship. Therefore our target sample is procurement managers working in industry.

Our sample was obtained through two groups. The first sample was collected by contacting the international office of the Institute for Supply Management (ISM, formerly the National Association of Purchasing Management). ISM provided a mailing list of 1996 procurement professionals with "Level 1" and "Level 2" job titles (corresponding to senior leaders and executives) in the United States from ISM's membership and a postcard was mailed to these individuals asking them to visit our electronic survey site "www.GTSurvey.com". Respondents were optionally allowed

to entire their name, email address, and company into a drawing for a gift card and report. Two weeks later a follow-up postcard was mailed to individuals that had not entered their information into the optional questions. Respondents were promised a benchmarking report and were entered into a contest to win Amazon.com gift cards. A total of ten postcards were returned as undeliverable for a total sample size of 1986. From these, a total of 92 usable reports were returned, for a response rate of 4.8%. This low response rate could be due to several reasons. First, many ISM addresses were personal addresses and apartment addresses. Individuals receiving this notification at home may have been less likely to take the time to respond or their mailing addresses may not have been up to date. Second, the multiple method of communication (receiving a post card with a request to respond electronically) may have created increased resistance for some respondents. Third, postal communication is an increasingly less frequent means of business communication in society and may be likely to be ignored. Unfortunately, ISM's national headquarters only provides physical mailing addresses.

Our second sample was collected by contacting the ISM affiliate that represents the North Carolina, South Carolina, and Virginia region. This group agreed to send an email to all members consisting of the same information found on the postcard. A follow up email was sent one week after the original email. The email was sent from the ISM affiliate to a total of 1050 members. From this group, 75 usable responses were obtained, for a response rate of 7.1%.

To prevent overlap, respondents in the postcard group who were located in North Carolina, South Carolina, or Virginia were excluded from the results. This resulted in the removal of 5 respondents from the postcard group. The sample consisted of 87 postcard respondents and 75 email respondents for a total of 162 responses. This is more than the 150 initially specified. The total number of contacted individuals

included 1986 postcard recipients and 1050 email recipients. There was a total overlap of 153 individuals among the two groups, leading to a total of 2883 individuals contacted. This leads to a response rate of 5.6%. This response rate is similar to Ellis et al. [33] who used a similar sample of ISM respondents and received a response rate of 7.1%. Further, ISM's own 2009 membership survey (the most recent at the time of writing) obtained a 6.6% email response rate from a sample of $7,405$ members contacted [52]. The consistencies with other studies of this sample indicates that the low response rate was likely not due to a systemic bias in our survey execution, but rather due to the quality of the sample.

To ensure our sample is adequate, we investigate several potential biases in the sample. First, non-response bias is a potential bias caused by the propensity for some subgroup in the population to not respond at a higher rate than the rest of the population. Our survey has no obvious tendencies to bias towards a subgroup of the population. However, to verify that there is no non-response bias, we compare the demographics of our sample to the demographics of the population [8]. Tables 2 and 3 provide the demographics of the sample and show no significant difference.

Table 2: Respondent Demographics by Industry

	Respondent Percentage			Sample
Industry	Postcard	Email	Total	Percentage
Agriculture	1.1%	0.0%	0.6%	0.4%
Mining and Construction	2.2%	2.7%	2.4%	2.5%
Manufacturing	28.1%	41.3%	34.0%	32.6%
Transportation	9.0%	5.3%	7.3%	8.4%
Retail	2.2%	4.0%	3.0%	3.1%
Financial Services	3.4%	4.0%	3.7%	3.5%
Hospitality Services	18.0%	6.7%	12.9%	18.4%
Government	1.1%	2.7%	1.8%	4.3%
Other	34.8%	33.3%	34.1%	26.9%

Table 3: Respondent Demographics by Firm Size and Years in Business

Firm Size		Firm Size		Time in Business	
US$MM per year	Responses	Employees	Responses	Years	Responses
≤ 100	22.2%	≤ 250	17.8%	≤ 1	2.4%
100 to 500	13.0%	250 to 1 000	17.3%	1 to 5	12.3%
500 to 1 000	13.0%	1 000 to 20 000	46.9%	5 to 25	19.7%
1 000 to 5 000	21.6%	20 000 to 100 000	14.2%	25 to 50	23.4%
$\geq 5\,000$	30.2%	$\geq 100\,000$	6.8%	≥ 50	42.0%

In our sample, Other seems to be over-represented while Hospitality Services are under-represented. We do not believe that these differences are enough to create a bias in the results. Further, our email sample seems to be disproportionately manufacturing firms; however we do not believe this represents a problem as the total respondent percentage is in-line with the sample percentage. Further, these demographics may explain the difference in respondents by delivery method. A review of the other demographics reveals no issue for concern. Firms in operation less than 1 year are under represented; however this is because our respondents were required to have requested bids multiple times for one contract, which is unlikely for a firm in operation less than one year.

In addition to demographic analysis for non-response bias, we compared the first ten respondents to the last ten respondents in the sample. We did this for both the the email and postcard respondents. To perform this analysis, we included a variable that differentiated the first ten, last ten, and other responses and performed a principal components analysis with varimax rotation on the entire data set. This "wave" variable loaded nearly entirely on one component and no other items loaded significantly on that component. In addition, we compared the postcard respondents to the email respondents using the same method and found no impact.

We also verified that there was no common method bias. Harman's Single Factor test is the most commonly used method to detect common method bias [82]. In this method, all items are loaded onto a single factor and the percentage of variance explained by that factor should be less than 50%. Our test resulted in 16.57% explained by a single factor. This is well below the 50% threshold so there is no concern with common method bias. Following the reliability testing mentioned in the next section, we eliminated items. The variance explained by a single factor in the reduced model is 21.50%, still indicating no common method bias.

2.4.3 Construct Validity

To ensure that our model accurately reflects the latent variables we seek to measure, we confirm the validity of our constructs using several techniques. Following the findings of Anderson and Gerbing [6], we use a two-step approach validate our constructs before evaluating the model results.

First, we tested our data to validate the reliability of our constructs, which is the level of agreement of items within the same construct. The reliability metric most commonly used in research is Cronbach's α. O'Leary-Kelly and Vokurka [79] and Hensley [47] found in their surveys of empirical research in OM that all papers they surveyed used this metric. However, the concern with Cronbach's α is the underlying assumption that all items within a construct are τ-equivalent (they have the same "true score"), which is not necessarily true. A metric that does not have this restriction is the Werts, Linn, and Jöreskog (WLJ) metric (ρ_c), which assumes only that the items are cogeneric (they are correlated) and therefore this metric is more robust [5, 79]. Our results for our base model indicated a concern with reliability. As a result, some items that were inconsistent were identified as candidates for removal. We contacted two of the judges involved in the initial scale development stage and discussed the implication of removal of these items. It was decided that removal did not jeopardize the content validity of the constructs and the items were removed. Following removal of these items, the only constructs with low values of α are Environmentally Derived Power and Proposed Commitment constructs. However, because these constructs have a value of ρ_c well above 0.5, we conclude that the items in these constructs are cogeneric and not τ-equivalent, which is sufficient for structural equation modeling. Table 4 shows the reliability metrics.

With construct validity ensured, we next tested our data for unidimensionality, which is the characteristic of items to load on only one construct. The literature recommends two methods to verify unidimensionality: exploratory factor analysis (EFA)

and confirmatory factor analysis (CFA). O'Leary-Kelly and Vokurka [79] provide a review of the two methods and conclude that "[g]iven the advantages of CFA over EFA, as outlined above, it should be the method of choice for future OM studies that require the assessment of unidimensionality." To assess unidimensionality, Ahire et al. [5] recommends using CFA with a GFI value greater than 0.9. Our results in Table 5 show that the GFI for all of our constructs are greater than that threshold.

Table 4: Construct Reliability Metrics

Construct	Unmodified α	Modified α	Unmodified ρ_c	Modified ρ_c
Env. Derived Power	0.667	0.615	0.636	0.667
Rel. Derived Power	0.632	0.652	0.705	0.707
Procurement Performance	0.731		0.780	
Focused Commitment Strategy	0.703	0.731	0.711	0.713
Proposed Commitment	0.581		0.614	
Competitiveness	0.647	0.762	0.669	0.779
Biasing	0.607	0.743	0.656	0.769

A value of $\alpha > 0.65$ and $WLJ > 0.50$ is considered strong reliability [4]

Table 5: Construct Validity Metrics

Construct	GFI	Bentler Bonnett Δ
Environmental Derived Power	0.988	0.966
Relationship Derived Power	0.992	0.983
Procurement Performance	0.961	0.932
Focused Commitment Strategy	0.996	0.989
Proposed Commitment	0.985	0.926
Bidding Competitiveness	0.991	0.985
Biasing	0.992	0.983

A value of $GFI \geq 0.90$ indicates strong unidimensionality and $\Delta \geq 0.90$ is considered strong convergent validity

In addition, we ensure that the constructs have convergent validity, which is the psychometric property that multiple methods of measurement lead to the same result. Traditionally, the Multi-Trait, Multi-Method matrix method of Campbell and Fiske [13] is used to ensure convergent validity. However since this survey does not include multiple methods for collecting information, we instead employed the commonly used CFA method of Ahire et al. [5]. Their uses CFA with the justification that each item in a sample represents a separate method of measurement of that sample. For each construct, Ahire et al.'s method compares a structural model for the construct against a null model and seeks a Bentler-Bonett coefficient of greater than 0.90. As seen in Table 5, all of our constructs meet this requirement.

Finally, we confirmed that the constructs have discriminant validity, which ensures that two latent variables are unique and do not highly correlate with each other. Discriminant validity was confirmed using two construct sub-models for all construct pairs. The construct pairs were modeled in a CFA model where their correlation was fixed to a value of 1 then in a CFA model where their correlation was allowed to be estimated by a statistical fit method. These two models are then compared using a χ^2 test to ensure that they are statistically different [5]. Table 6 shows the probability that two constructs are statistically similar.

Table 6: Discriminant Validity Metrics

Construct	Construct	$\Delta\chi^2$	Pr($\Delta\chi^2$,Δd.f.)
Env. Power	Rel. Power	77.82	< 0.0001
Env. Power	Proc. Perform.	67.12	< 0.0001
Env. Power	FCS	82.32	< 0.0001
Env. Power	Prop. Commit.	99.59	< 0.0001
Env. Power	Bid. Compet.	147.12	< 0.0001
Env. Power	Biasing	101.27	< 0.0001
Rel. Power	Proc. Perform.	28.30	< 0.0001
Rel. Power	FCS	56.09	< 0.0001
Rel. Power	Prop. Commit.	47.13	< 0.0001
Rel. Power	Bid. Compet.	93.17	< 0.0001
Rel. Power	Biasing	77.16	< 0.0001
Proc. Perform.	FCS	33.78	< 0.0001
Proc. Perform.	Prop. Commit.	29.53	< 0.0001
Proc. Perform.	Bid. Compet.	82.09	< 0.0001
Proc. Perform.	Biasing	99.93	< 0.0001
FCS	Prop. Commit.	37.89	< 0.0001
FCS	Bid. Compet.	86.29	< 0.0001
FCS	Biasing	129.41	< 0.0001
Prop. Commit.	Bid. Compet.	112.12	< 0.0001
Prop. Commit.	Biasing	93.12	< 0.0001
Bid. Compet.	Biasing	229.93	< 0.0001

The difference in degrees of freedom for all pairs is 1

2.4.4 Secondary Analysis of Procurement Performance

In addition to our Q-sort and construct validity metrics, we feel it is necessary to validate the Procurement Performance construct further. While the indicators that we use are grounded in theory, it is of utmost importance that this construct accurately reflects the overall performance of the procurement relationship and that this reflects in the performance of the firm. If it does not reflect in the performance of the firm, this research has little value to a manager.

The relationship between Procurement Performance and firm performance has been shown in work by Chen et al. [19] which shows a relationship between Strategic

Purchasing (i.e. high levels of Proposed Commitment) and Financial Performance via Customer Responsiveness. However, in their work, Chen et al. obtain the financial performance metrics via perceptual measures. Thus, there is the potential that the actual measurement was the respondent's opinion of that relationship and not necessarily the overall performance of their firm as a whole. In response to this, we perform a secondary data analysis to validate our latent construct for procurement performance. Such a relationship demonstrates that procurement performance has a significant impact on a firm's bottom line, and thus should be of concern to managers.

Table 7: Loadings for Procurement Performance

Items (1, Disagree; 5, Agree)		Mean	S.D.	Loading[a]
PP1	Since our last contract negotiation, we have seen significant improvement in the conformance quality (the percentage of time the supplier meets specification) of the good or service procured to fulfill this need.	3.27	1.10	0.850
PP2	Since our last contract negotiation, we have seen a significant increase in the performance quality (the functionality or appearance) of the good or service procured to fulfill this need.	3.31	0.91	0.843
PP3	Since our last contract negotiation, we have seen a decrease in price our suppliers charge or more favorable quantity discounts associated with this procurement need.	2.98	1.13	0.526
Items (1, Decreased by more than 5%; 3, No Change; 5, Increased by more than 5%)		Mean	S.D.	Loading[a]
PP4	Over the last five years, by approximately how much have you seen an increase or decrease in your procurement cost for this good or service?	3.51	1.35	0.246
Items (1, Dissatisfied; 5, Satisfied)		Mean	S.D.	Loading[a]
SAT	How satisfied have you been with the performance of the current supplier(s) that have fulfilled this need?	3.72	1.20	0.371

[a] All loadings are significant at $p < .05$

To ensure that this construct is well defined, we specified the construct with both qualitative and quantitative items. Specifically, items PP1, PP2, PP3, and SAT found in Table 2.4.4 are perceptual metrics while item PP4 is an absolute measure based on quantitative results. Despite the two different types of metrics, the previous tables show good internal consistence of the construct. The values of α and ρ_c from Table 4 are well above the threshold for acceptable construct agreement. Further, in the final SEM model, all items were found to be significant with $p < 0.05$.

To ensure that the Procurement Performance is valid and reflects in the performance of the firm, we also performed a secondary data analysis comparing the

answers of respondents to the Procurement Performance items to the financial performance of their firm. To do so, we first considered how an improved procurement process would propagate through the overall financial performance of a firm. In §2.2.6 we define Procurement Performance based on Wheelwright's core competencies [104] consistent with the work of Johnston et al. [57] and Prahinski and Benton [84]. This definition is that improved procurement performance is manifested through four primary outcomes: reduced price resulting in lower direct material cost, higher conformance quality resulting in less scrapping or a more reliable final product, improved performance quality resulting in a lower direct material cost or a high quality final product, or faster delivery resulting in lower work in process (WIP). These metrics can be divided into two groups: those that impact the buyer's final product and those that impact the internal operation of the buyer.

The metrics that improve final product should impact the customer's willingness to pay, increasing the gross profit margin $(1 - \frac{COGS}{Revenue})$. Metrics that do not impact the final product quality in a way noticeable to the consumer would be reflected in operating cost of the firm, primarily through the Direct Material cost to the firm. Equation 1 shows how a change in Direct Material Cost will propagate through a firm to the COGS, and thus to the gross profit margin.

$$\begin{aligned}
&\text{Direct Material} + \text{ Direct Labor} + \text{ Overhead} = \text{ Total Manufacturing Cost (TMC)} \\
&\text{TMC} + \text{ Beginning WIP} - \text{ Ending WIP} = \text{ Cost of Goods Manufactured (COGM)} \\
&\text{COGM} + \text{ Beginning FGI} - \text{ Ending FGI} = \text{ Cost of Goods Sold (COGS)}
\end{aligned} \tag{1}$$

Because both mechanisms (improved buyer's product's value to the consumer and decreased buyer's COGS) impact the gross profit margin of the buyer, we can verify the relationship using the data available on a publicly traded company's $10K$ report. While

this theoretical relationship should occur, we caution that there are many factors that impact a firm's gross profit margin that are unaccounted for in this analysis. Further, while a purchasing manager may be satisfied with the procurement process for one component, that does not mean that all procurement relationships are similarly satisfactory for that buyer (as is inherently assumed by reviewing the gross profit margin). However, in the absence of more detailed operating information for firms, calculating the gross profit margin is the best available indicator. Further, the above concerns bias against finding a relationship.

One key aspect of our analysis is that we examine factors of the contract bidding process (the proposed commitment in an RFB/RFQ and any biasing in the bidding process) and review how that impacts performance. As such, we wish to study a change a firm has before and after a contract is awarded. In fact, our Procurement Performance items are worded as such (e.g. "Since our last contract negotiation..."). To account for this, we asked the average length of contracts for buyers in our study. The result was 2.4 years. Knowing this, we calculate the change in gross profit margin over the last three years. This allows us to see any change that would have occurred as a result of the firm's last contract. We can then compare this with the perceptual and quantitative questions concerning the results from the last contract negotiation. This provides us with the following hypothesis:

H_9: Improvement in Procurement Performance increases the gross profit margin of a firm relative to its competitors over time

To obtain our sample of firms, we asked respondents to optionally indicate their firm and informed them that this information would only be used in aggregate and would not be released. Of the 162 respondents, 93 included the name of their company. Of those 93 firms, 35 were publicly held companies. Of the 35 publicly held companies, 31 had released information in the last three years and could be used in our analysis. One firm was removed from the study because of a substantial decrease in revenue over the time period studied (FY2008 revenue of $2.62 billion and FY2010 revenue of $991 million). The remaining 30 companies varied across industries with seven utilities companies, five heavy

machinery firms, three pharmaceutical companies, two aerospace companies, two business service firms, two banks, two telecom companies, one chemical manufacturer, one paper products manufacturer, one consumer goods firms, one publishing firm, one rental and leasing firm, one software company, and one tobacco products manufacturer. Of the firms that responded, four firms indicated a below average perception of procurement performance (1.0 to 3.0 on a scale of 1.0 to 5.0), seven firms indicated excellent average performance score (4.0 to 5.0 on a scale of 1.0 to 5.0), and nineteen indicated a moderate level of procurement performance (3.0 to 4.0 on a scale of 1.0 to 5.0). The average score is 3.5 and the median and mode are both 3.6.

To analyze the potential impact of procurement performance on firm performance, we calculated the FY2008 GPM of each firm, as well as the FY2010 GPM and calculated the change in margin over the time period. However, since the GPM of a firm is likely dependent on firm size, industry, and prior performance, a portfolio of similar firms was identified for each firm in our study. For each study firm, we established a portfolio of competitors by searching the COMPUSTAT system for all firms with the same two-digit SIC code, revenue of $\pm 50\%$ of the FY2008 revenue of the study firm, and a FY2008 GPM of $\pm 10\%$ the FY2008 GPM of the study firm. This use of an exhaustive search of competitors leads to different size competitive portfolios for each firm in the sample. This is not a concern as financial data analysis frequently uses mismatched competitive portfolios for analysis (e.g. [9]).[1] An average change in GPM between FY2008 and FY2010 was taken across firms in the portfolio, and this value was subtracted from the study firm's change in GPM, as shown in Equation 2.

The independent variable of interest in this study is the average procurement performance score given by the respondent from the firm. One concern with the use of perceptual data is to ensure that there is no reverse causation, i.e. to ensure that the superior (inferior) performance of a firm does not lead to the assumption that internal processes (such as procurement) is inherently superior (inferior) to the competitors' corresponding processes.

[1]To ensure that this would not affect the data, we also analyzed the data using five randomly selected members of each firm's competitive portfolio and obtained the same result.

To avoid this issue, we ask tactical questions regarding a firm's procurement performance: has the firm seen a decrease in cost over time, has the firm seen an increase in performance and/or conformance quality, etc. The answers from these tactical questions are then averaged to develop an overall perception of performance, and is compared to the gross profit margin. Asking directed tactical questions avoids the issue of reverse causation.

In addition to the independent variable of interest, several control variables are included in our model. First, to correct for the effect of firm size on performance, we include a variable which is the logarithm of the FY2008 revenue of the firm. To control for prior performance, the FY2008 GPM of each firm was included as an independent variable. To control for industry effects, each firm was classified by its two-digit SIC code, leading to twelve categorical variables to control for industry. As mentioned, there are also several variables that impact GPM other than direct material cost. To control for this, we include several variables reflected in the COGS not due to procurement: change in WIP and change in inventory. Since COGS is divided by revenue in the GPM equation, both values are divided by revenue as control variables. We also need to control for changes in overhead cost and the direct labor cost, however, neither of these variables are reported in a firm's 10K report. As a proxy for overhead cost, we control for Property, Plant, and Equipment. As a proxy for direct labor, we control for the number of employees. Again, since COGS is divided by revenue in the GPM equation, both numbers are scaled by revenue as control variables. These variables are shown in Equation 2.

$$\begin{aligned}\hat{y}_{\Delta GPM} - \underbrace{\Phi_{\Delta GPM}}_{\text{Portfolio}} &= \beta_0 + \beta_{PP} x_{\text{Proc. Perf.}} + \underbrace{\beta_{Rev} log x_{\text{2008 Rev}}}_{\text{Firm Size}} \\ &+ \underbrace{\beta_{GPM} x_{\text{2008 GPM}}}_{\text{Prior Performance}} + \underbrace{\beta_{FGI+WIP} x_{FGI+WIP}}_{\text{Change in FGI and WIP}} + \underbrace{\beta_{Emp} x_{Emp}}_{\text{Change in Revenue per Employee}} \\ &+ \underbrace{\beta_{PPE} x_{PPE}}_{\text{Change in Revenue per dollar PPE}} + \underbrace{\beta_{2100..7300} x_{2100..7300}}_{\text{Industry (2 digit SIC)}}\end{aligned} \tag{2}$$

Table 8 shows the results from the regression analysis. The original model was specified with all variables then the backwards elimination stepwise regression search procedure was

conducted with a removal criteria of $p > 0.10$ and an entry criteria of $p < 0.05$. Using these criteria and this procedure, the majority of the control variables were found to be insignificant, specifically the categorical variables for two-digit SIC and the logarithm of the FY2008 revenue. This reduction was expected because the portfolio analysis already adjusted for these factors indirectly. The two remaining factors following the procedure were the average procurement performance construct (the independent item of interest) and the FY2008 GPM control variable. This finding supports H_9 and gives strong evidence that the Procurement Performance metric is well defined and reliable and translates to firm performance as a whole.

Table 8: Results from Regression of Procurement Performance Construct on Gross Profit Margin

Coefficient	Step 1	Step 3	Step 6	Step 10	Step 14
β_0	0.284				
β_{PP}	0.923	1.058	0.828**	0.775**	0.657**
β_{Rev}	-0.346	-0.278			
β_{GPM}	-0.848	-0.798	-0.784*	-0.782**	-0.493**
$\beta_{FGI+WIP}$	-0.182	-0.201	-0.292	-0.330	-0.370*
β_{Emp}	-0.175	-0.169	-0.123		
β_{PPE}	0.120	0.117	0.135		
β_{2100}	0.196	0.216	0.277	0.332	0.328*
β_{2600}	-0.045	-0.034			
β_{2800}	0.175	0.188	0.139	0.164	
β_{3400}	-0.161	-0.149	-0.132		
β_{3500}	-0.016				
β_{3600}	0.073	0.084	0.072	0.0704	
β_{3700}	-0.087	-0.081	-0.105	-0.0870	
β_{3800}	-0.078	-0.062	-0.064		
β_{4800}	0.027	0.029			
β_{4900}	0.259	0.276	0.244	0.247	0.234*
β_{6000}	0.715*	0.733**	0.697**	0.697**	0.642**
β_{7300}	0.171	0.177	0.149	0.158	
R^2	0.753	0.752	0.749	0.739	0.708
Adj. R^2	0.326	0.429	0.529	0.608	0.634

* Significant at $p < 0.10$
** Significant at $p < 0.05$

2.4.5 Structural Model Fit

Following the specification of the model, execution of the survey, and construct validity analysis, we performed structural equation analysis of the specified model. For this analysis we used EQS version 6.1 with maximum likelihood estimation of parameters.

The moderation effects in our model were tested using the approach of Little et al. [69]. This method involves first creating new indicators that were formed by multiplying the pairs of indicators that form the interacting latent constructs (Biasing and Proposed Commitment). The three biasing indicators and three proposed commitment indicators

produced nine interaction pairs. All nine of those indicators were then regressed onto the first-order indicators and the residual that is orthogonal to the first-order indicators was calculated. The nine residual variables were then included in the model as an interaction construct.

Using the above structural model, we determined the loadings for each relationship in the model and calculated fit parameters. Hu and Bentler [49] exhaustively review the literature for structural model fit parameters and, through simulation, determine the cutoff values that minimize Type I and Type II errors are RMSEA with a recommended cutoff of ≤ 0.06 and SRMR with a recommended cutoff of ≤ 0.10. Our model fits these parameters with an RMSEA of 0.050 (90% confidence interval of 0.041 to 0.59) and an SRMR of 0.010. All indicators load significantly with 95% confidence on to their intended latent constructs. Hu and Bentler optionally recommend analyzing the CFI of the SEM model. The accepted cutoff for CFI is ≥ 0.90. Our model meets this cutoff. However it should be noted that Kenny [59] cautions that any incremental fit measure, such as CFI, will provide a very conservative CFI when the RMSEA of the null model is ≤ 0.158. The RMSEA of our null model is 0.064, thus our CFI of 0.90 is conservative.

Table 9: Correlation of Independent Variables in Secondary Analysis

Variable	$x_{\text{Proc. Perf.}}$	$logx_{\text{2008 Rev}}$	$x_{FGI+WIP}$	x_{Emp}	x_{PPE}	$x_{\text{2008 GPM}}$	x_{2100}	x_{2600}	x_{2800}
$x_{\text{Proc. Perf.}}$	1.000								
$logx_{\text{2008 Rev}}$	-0.052	1.000							
$x_{FGI+WIP}$	0.037	-0.080	1.000						
x_{Emp}	0.004	-0.224	0.333	1.000					
x_{PPE}	-0.030	-0.375	0.434	0.467	1.000				
$x_{\text{2008 GPM}}$	-0.432	-0.232	0.179	0.192	0.404	1.000			
x_{2100}	0.027	-0.004	0.835	0.035	0.121	0.092	1.000		
x_{2600}	0.154	0.013	0.173	-0.020	-0.047	-0.179	-0.034	1.000	
x_{2800}	-0.269	0.064	-0.040	0.193	0.173	0.364	-0.083	-0.083	1.00
x_{3400}	0.091	-0.389	0.134	-0.045	0.683	0.182	-0.034	-0.034	-0.083
x_{3500}	0.087	0.002	-0.030	-0.149	-0.016	-0.290	-0.062	-0.062	-0.149
x_{3600}	-0.099	0.153	0.042	-0.056	-0.172	-0.098	-0.034	-0.034	-0.083
x_{3700}	0.091	0.221	-0.045	0.034	0.070	-0.199	-0.034	-0.034	-0.083
x_{3800}	0.049	-0.258	-0.094	-0.087	-0.078	-0.042	-0.062	-0.062	-0.149
x_{4800}	0.085	0.135	-0.031	-0.071	-0.025	0.222	-0.050	-0.050	-0.120
x_{4900}	0.244	0.183	-0.128	0.079	-0.163	-0.405	-0.093	-0.093	-0.224
x_{6000}	-0.461	-0.001	-0.068	0.024	-0.082	0.073	-0.050	-0.050	-0.120
x_{7300}	-0.064	-0.153	-0.103	0.137	0.047	0.414	-0.062	-0.062	-0.149
Variable	x_{3400}	x_{3500}	x_{3600}	x_{3700}	x_{3800}	x_{4800}	x_{4900}	x_{6000}	x_{7300}
x_{3400}	1.000								
x_{3500}	-0.062	1.000							
x_{3600}	-0.034	-0.062	1.000						
x_{3700}	-0.034	-0.062	-0.034	1.000					
x_{3800}	-0.062	-0.111	-0.062	-0.062	1.000				
x_{4800}	-0.050	-0.089	-0.050	-0.050	-0.089	1.000			
x_{4900}	-0.093	-0.167	-0.093	-0.093	-0.167	-0.134	1.000		
x_{6000}	-0.050	-0.089	-0.050	-0.050	-0.089	-0.071	-0.134	1.000	
x_{7300}	-0.062	-0.111	-0.062	-0.062	-0.111	-0.089	-0.167	-0.089	1.000

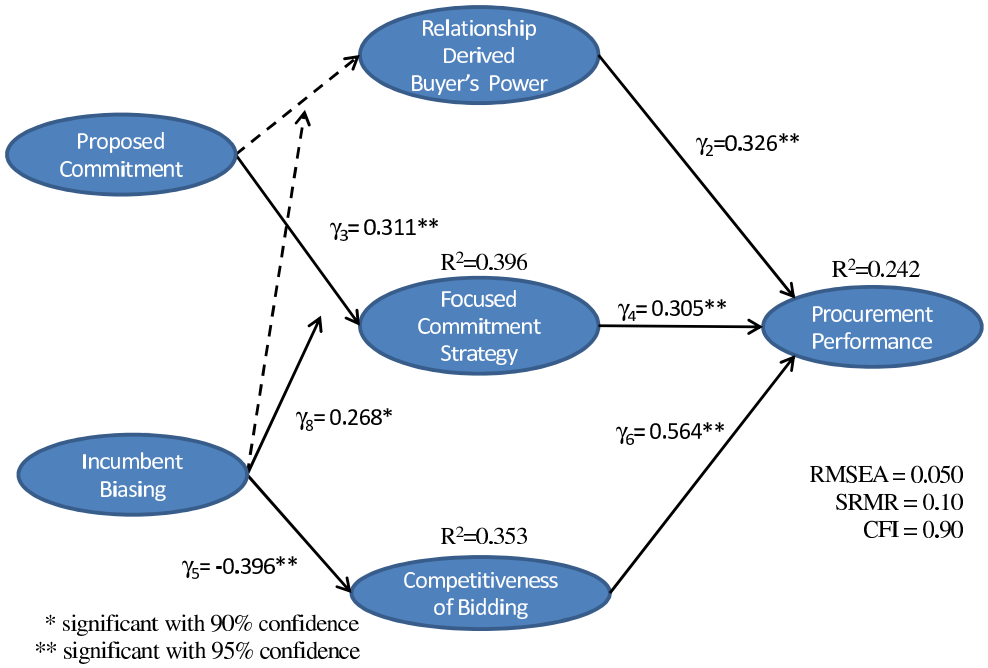

Figure 4: This figure shows the loadings and model fit parameters for the hypothesized model. Dashed lines represent loadings that were not significant with a 90% confidence interval.

Table 10: Loadings for Relationship Derived Power

Items (1, Low; 5, High)		Mean	S.D.	Loading[a]
–	The bargaining power (the capacity to impose their pricing conditions) of your supplier(s) for this procurement need is	–	–	–
RBP1	If your supplier's cost to supply this procurement need suddenly reduced mid-contract, the probability that you could force your supplier to reduce price is	3.25	1.21	0.634
–	If the price of your final product increased greatly, the probability that your supplier for this procurement need would be able to force you to share some of your increased profit is [b,c]	–	–	–
RBP2	If a superior technology was developed that your supplier could use to improve the quality of the good or service provided to you to fulfill this need, the probability that you could influence your supplier to invest in this technology is	2.99	1.05	0.740
RBP3	If your firm needed a rush shipment for this procurement need, your ability to force your supplier to prioritize your shipment over their other customers is	3.65	1.03	0.667
RBP4	Your ability to affect change on your supplier (to change their way of manufacturing or otherwise doing business) is	2.99	1.11	0.635
–	My primary goal for rebidding a contract for this procurement need is to place pressure on the incumbent to lower or maintain his price, not to find the low cost supplier (moved from Incumbent Biasing)[c,d]	–	–	–
Items (1, Dissatisfied; 5, Satisfied)		**Mean**	**S.D.**	**Loading[a]**
SAT	How satisfied have you been with the performance of the current supplier(s) that have fulfilled this need?	3.72	1.20	0.186

[a] All loadings are significant at $p < .05$
[b] Reverse coded item
[c] Dropped due to poor psychometric properties
[d] Moved from the Incumbent Biasing construct during the Q-sort

Table 11: Loadings for Focused Commitment Strategy

Items (1, Disagree; 5, Agree)		Mean	S.D.	Loading[a]
FCS1	For this procurement need, our firm establishes long-term contracts with our supplier(s).	3.61	1.34	0.478
FCS2	For this procurement need, our firm frequently sources from (a) supplier(s) that also service other needs in our firm.	3.15	1.32	0.402
FCS3	We have a high degree of mutual trust with our supplier(s) for this procurement need.	3.69	1.25	0.887
–	Our firm has joint investments (factories, machines, etc) with our supplier(s) that satisfy this procurement need.	–	–	–
FCS4	For this procurement need, our firm has a collaborative relationship with our supplier(s).	3.40	1.261	0.595
Items (1, Dissatisfied; 5, Satisfied)		Mean	S.D.	Loading[a]
SAT	How satisfied have you been with the performance of the current supplier(s) that have fulfilled this need?	3.72	1.20	0.359

[a] All loadings are significant at $p < .05$

Table 12: Loadings for Proposed Commitment

Items (1, Less; 5, More)		Mean	S.D.	Loading[a]
PC1	Compared to your competitors, your firm re-bids ___frequently for this procurement need[b]	3.00	1.22	0.502
PC2	When requesting bids for this procurement need, your firm signals that you are ___likely to jointly invest in technology and/or design with potential suppliers than your competitors	3.20	1.08	0.356
Items (1, Every Year or Less; 3, Every 18 Months to 2 Years; 5, Every 3 Years or More)		Mean	S.D.	Loading[a]
PC3	How often does your firm rebid the contract for this procurement need?	3.29	1.38	0.845

[a] All loadings are significant at $p < .05$
[b] Reverse coded item

Table 13: Loadings for Competitiveness of Bidding

Items (1, Less than 5; 3, 14 to 20; 5, More than 50)		Mean	S.D.	Loading[a]
–	The number of suppliers that last responded to you last request for bid/quote (RFB /RFQ) for this procurement need was[c]	–	–	–
Items (1, Disagree; 5, Agree)		Mean	S.D.	Loading[a]
CB1	Bidding for this contract is more competitive (more bids) than for our other contracts	1.70	1.00	0.420
–	We need to repeatedly post bid requests or seek out additional bidders to participate in our bidding process[b,c]	–	–	–
CB2	For this procurement need, bidders are highly engaged in the bidding process	2.79	1.11	0.943
CB3	For this procurement need, bidders spend considerable time and effort preparing their bids	3.53	1.20	0.795
CB4	We shift our demand among suppliers to find the low cost supplier at the time[d].	3.41	1.25	0.533

[a] All loadings are significant at $p < .05$
[b] Reverse coded item
[c] Dropped due to poor psychometric properties
[d] Moved from the Multi-Sourcing construct during Q-sort

2.4.6 Alternative Models

In this section, we present two alternative models. The first confirms the significance of the moderating effect. The second is an exploratory model to determine a path for future research.

2.4.6.1 The Significance of Moderation

The stated purpose of this dissertation is to examine the impact of incumbent biasing on the procurement process. As discussed previously, there is little literature concerning this phenomenon. As such, the theory development for the relationship between Incumbent Biasing and the other latent constructs are based on original research found in another chapter in this dissertation and anecdotal discussions found in the literature. For this reason, it is prudent for us to assume an alternative model to our original model which does not including the moderating effects of Incumbent Biasing (i.e. a model excluding the relationships of H_7 and H_8).

Using the data, we tested a model without these parameters. Since this alternative model and the originally hypothesized model are nested, we are able to compare these

Table 14: Loadings for Incumbent Biasing

Items (1, Disagree; 5, Agree)		Mean	S.D.	Loading[a]
B1	In our firm's process for choosing the winning bid for this procurement need, the incumbent supplier has an advantage over non-incumbents, for a given bid price	3.61	1.34	0.593
B2	Prior to receiving the bids for this procurement need, it is expected that the incumbent will win the contract	3.15	1.32	0.849
B3	When awarding a contract for this procurement need, the incumbent supplier may win even if he is not the lowest cost option	3.69	1.25	0.568
–	Our firm switches supplier(s) for this procurement need frequently[b,c]	–	–	–

[a] All loadings are significant at $p < .05$
[b] Reverse coded item
[c] Dropped due to poor psychometric properties

Table 15: Correlation of Latent Constructs

Variable	Env. Power	Rel. Power	Proc. Perform.	FCS	Prop. Comit.	Bid. Compet.	Biasing
Env. Power	1.000						
Rel. Power	0.444	1.000					
Proc. Perform.	0.347	0.381	1.000				
FCS	0.245	0.200	0.391	1.000			
Prop. Commit.	0.074	0.062	0.386	0.423	1.000		
Bid. Compet.	0.393	0.438	0.485	0.566	0.298	1.000	
Biasing	-0.027	-0.107	-0.322	-0.494	-0.322	-0.546	1.000

models using the χ^2 values for each. The alternative model has a χ^2 of 430.55 with 222 degrees of freedom. This leads to a $\Delta\chi^2 = 183.33$, $\Delta d.f. = 214$; $p < 0.001$. Based on the difference in χ^2, we see that the alternative model is significant than the originally specified model. The alternative model has an RMSEA of 0.076, SRMR of 0.14, and a CFI of 0.827. None of these values meet the cut-offs of Hu and Bentler [49], signifying a poorly fit model with unacceptable Type I error. Based on this we reject the alternative model.

2.4.6.2 Competitiveness of Bidding as a Moderator

While the previously specified model follows from literature, it is prudent to investigate potential alternative explanations of the relationship among the constructs. An additional relationship that should be investigated is the relationship between Relationship Derived Buyer's Power, Focused Commitment Strategy, and Competitiveness of Bidding. According to some literature [85], inter-organizational power can be explained using two mechanisms: dependence and exercised power. In this literature, dependence in based on structure and relationships; however that dependence has no impact on procurement performance unless that dependence is exercised in some way. In this context, "inter-organizational dependence" could be viewed partially as Relationship Derived Buyer's Power and Competitiveness of Bidding could be seen as the exercise of power, as the Competitiveness of Bidding dictates how pricing is set, particularly in a fixed-price contract. Gulati and Sytch [45] have studied this relationship and have shown that the exercise of power (Competitiveness of Bidding) mediates the relationship between interorganizational dependence (Relationship Derived Buyer's Power) and "performance of the procurement relationships". For this reason, we hypothesize an additional potential link in our model:

H_{10}: Higher levels of Relationship Derived Buyer's Power leads to higher levels of Competitiveness of Bidding

An additional relationship that is not found in the literature but which is of interest is the relationship between Focused Commitment Strategy and Competitiveness of Bidding.

It is logical to assume that a buyer-supplier relationship with significant incentive alignment will be evident to other bidders. Further, a bidder with a strong incentive alignment with the buyer is likely to react with a more competitive bid to continue the contract. Therefore, as an exploratory analysis, we hypothesize a positive relationship:

H_{11}: Higher levels of Focused Commitment Strategy leads to higher levels of Competitiveness of Bidding

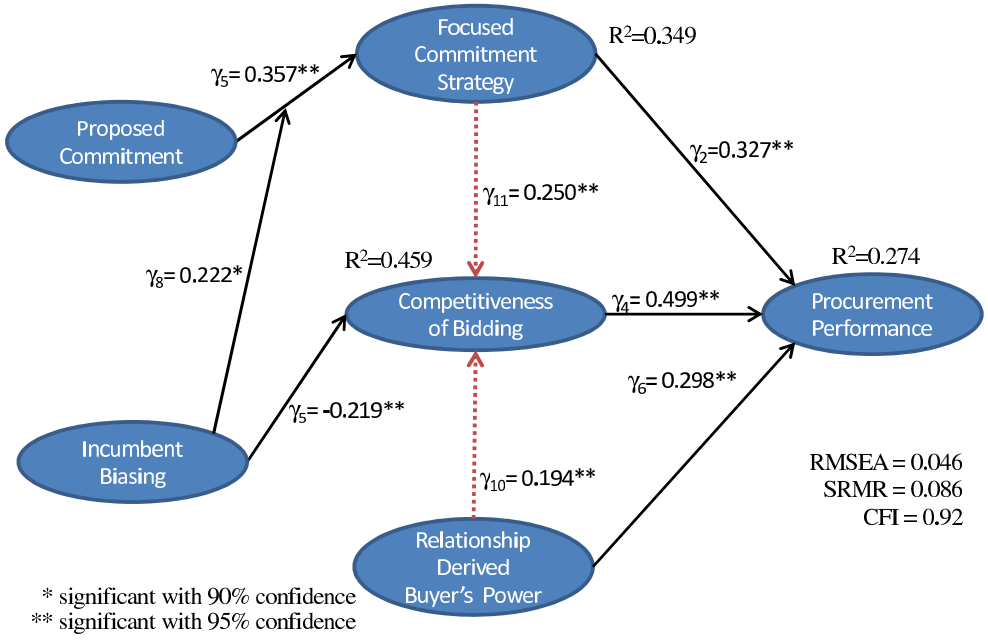

Figure 5: This figure shows the loadings and model fit parameters for the alternative model. The dashed red lines are the new connections in the alternative model not found in the originally hypothesized model.

Similar to the previous alternative model, this alternative model and the originally hypothesized model are nested, which allows us to compare these models using the χ^2 values for each. The alternative model has a χ^2 of 582.71 with 434 degrees of freedom. This leads to a $\Delta\chi^2 = 31.182$, $\Delta d.f. = 2$; $p < 0.001$. Based on the difference in χ^2, we see that the alternative model is significantly different than the originally specified model.

The alternative model has an RMSEA of 0.046, SRMR of 0.086, and a CFI of 0.92. All of these values meet the cut-off criteria of Hu and Bentler [49], supporting the belief that the hypothesized relationships may exist in practice. However, since the original model did not specify these hypotheses, it is possible that the model is an artifact of the data and does not exist in practice. As such, we identify this as an area for future research.

Despite the significance of the alternative model, it can bs seen when comparing the originally specified model and this alternative model that all paths remain significant with the same sign and similar loading. This supports the findings regarding hypotheses in the originally specified model.

2.5 The Impact of Multi-Sourcing

Multi-sourcing, which is the practice maintaining a pool of suppliers and spreading contract awarding among those suppliers, is not new. As early as the 1970's, the practice was in use in Japanese manufacturing [29]. In the Japanese structure, two qualified suppliers would be identified in the initial bidding for a contract. Following that bidding, those suppliers would receive substantial investment (including partial ownership) from the buyer. Those suppliers would then be used in subsequent bidding to compete against each other and maintain low costs [29].

Contrary to this strategy, the United States has been generally moving in the path of Vendor Rationalization (reduction in the number of suppliers) as promoted by Deming [26]. The justification of this practice is that dealing with multiple suppliers can increase cost because of scale economies and may result in delay of production ramp up [108]. Further, researchers have made the argument that long-term relationships with a reduced supply base helps align incentives between the buyer and supplier [22, 67, 94].

In recent years, however, there has been a reemergence of support in the US market for multi-sourcing, primarily due to issues such as the potential for quality concerns from a sole supplier [72], to manage yield uncertainty [96] to increase innovation [7], to share inventory risk [20], and to manage the risk of supplier disruption [39, 62, 96].

In addition to these risk-based works, several researchers have investigated the potential

for multi-sourcing as a means to reduce cost by maintaining a competitive bidding pool (i.e. preventing defection). The first researchers to mention this topic were Klotz and Chatterjee [65] who investigate the optimal quantity of dual-sourcing in a repeat procurement setting where there is learning-by-doing. In their model, two bidders compete in the first round and a split-award occurs with each bidder receiving a portion of the contract. The bidders then return in the second round and the contract is again bid and awarded. The researchers do not investigate the impact of defection, but argue that defection is inherently bad as it leads to a buyer being held "hostage" by the sole remaining supplier. As such, the authors set a constraint on the quantities awarded in each stage such that they create an incentive for two bidders to return in the second stage.

A similar work that follows from Klotz and Chatterjee is that of Chaturvedi et al. [18]. In their work, Chaturvedi et al. incorporate the potential for defection into their model and investigate the optimality of split awarding in minimizing cost for a buyer that procures repeatedly from a pool of qualified bidders. The authors find that split awarding is optimal for their model because it prevents information updating concerning the high and low cost bidders. They also find that split awarding prevents defections and thus maintains a qualified bidding pool instead of leading to the "hostage" situation mentioned by Klotz and Chatterjee.

Because of the prevalence of this strategy, we believe that it is important to explore the impact of Multi-Sourcing on our previous results. Further, we believe it is important to explore the potential for Multi-Sourcing as a substitute for Incumbent Biasing. Based on the above research, it is expected that the practice of Multi-Sourcing may have a positive impact on Bidding Competitiveness. We will formally define this hypothesis once we have defined the constructs for Multi-Sourcing.

Based on this work, we intend expand our previous study of the impact of biasing on procurement success to include and compare the impact of Multi-Sourcing as an alternative strategy. First, we define the measurement models for Multi-Sourcing. Second, we retest the structural model for Incumbent Biasing to ensure that there is no interaction between Incumbent Biasing and Multi-Sourcing. Following that, we remove Incumbent Biasing from

the model and add Multi-Sourcing. This will be the first work to directly compare these two strategies.

2.5.1 Construct Definition and Hypotheses

Unlike incumbent biasing, which can be a voluntary or involuntary action by the buyer, Multi-Sourcing has a clear and obvious definition. That is to say, Multi-Sourcing either exists or it does not exist, there is no way for a buyer to subconsciously Multi-Source. As a result of this definition, Multi-Sourcing is not a latent construct and does not require multiple items to predict its existence. Instead, we are able to directly ask buyers whether or not they use the strategy of Multi-Sourcing and can incorporate that as an observed variable in the model.

To ensure our question regarding Multi-Sourcing was clear, we included the item regarding Multi-Sourcing in our Q-sort described in §2.4.1. The Multi-Sourcing item was correctly placed by the judges into a separate construct for Multi-Sourcing. This ensured that respondents understood the question. Further, the question was asked in two ways to ensure understanding: buyers were asked if 100% of a particular procurement need was met by a single vendor, in other words, did they sole-source. If a buyer indicated that he or she did Multi-Source, he or she was asked the greatest percentage of the need that any one supplier met. Clearly a buyer that sole-sourced would indicate 100%.

In our model, we explore both the binary answer of whether or not a buyer multi-sources ("Binary Multi-Source") but also the percentage of multi-sourcing of firms that do multi-source ("Percent Multi-Source"). We test each of these two aspects separately to see if Multi-Sourcing impacts Procurement Performance, and if so how, then to see if greater dispersion among suppliers (the largest supplier having less of a share) increases that effect.

Based on the previously discussed work of Klotz and Chatterjee [65] and Chaturvedi et al. [18], there is theoretical support for a relationship between Multi-Sourcing and Competitiveness of Bidding. The argument of both of these works is that the presence of Multi-Sourcing increases competition by reducing the incentive for defection, either because firms are guaranteed enough business to prevent defection (in the case of Klotz and Chatterjee)

or because the Multi-Sourcing prevents learning the bid price of competitors, which allows low cost bidders to raise their prices over time (in the case of Chaturvedi et al.). Based on this, we make the following two hypotheses:

H_{12}: Binary Multi-Sourcing increases Bidding Competitiveness

H_{13}: Higher Levels of Percent Multi-Sourcing increases Bidding Competitiveness

2.5.2 Construct Validity

As mentioned previously in this dissertation, it is important to ensure that our survey and construct are defined properly to ensure that the results described by this model are reliable. The survey design is described in §2.4.2 and the construct validation of all latent constructs in this model are found in §2.4.3.

While our survey methodology did not change, it should be noted that for the Percent Multi-Source variable, the full sample was not used. Respondents only answered this question if they previously indicated that they used Multi-Sourcing. Of our sample of 162 respondents, 134 (85%) indicated that they use multi-sourcing. We see no difference in the demographics of those using multi-sourcing versus those who sole-source.

Because the Multi-Sourcing construct is not a latent construct, there are several validity metrics that are not needed. Specifically, the only concern with this construct is to ensure that the observed variable for Multi-Sourcing does not cross load with a latent construct. To do this, we model each latent construct with the observed variable for Multi-Sourcing as an indicator item and calculate the t-value for the loading of that item onto the construct. We found in Table 16 that the Multi-Sourcing variable did not load significantly on any existing construct.

In addition to the above determination that no cross loading is present, we also examined the discriminant validity of the Multi-Sourcing constructs using the same method as in §2.4.3. While the previous test showed that the Multi-Sourcing variables are not predictors of any latent construct, this test is necessary to ensure that the Percent Multi-Sourcing

variable is unique from those latent constructs. Since the Binary Multi-Sourcing variable is categorical, it cannot be modeled as having a covariance fixed at 1 with any latent construct. As such, the fact that it does not cross-load with another construct is sufficient to show that it is distinct from all latent constructs. The discriminant validity for Percent Multi-Sourcing is found in Table 17.

2.5.3 The Interaction between Multi-Sourcing and Incumbent Biasing

So far we have treated the practice of Multi-Sourcing as a distinct practice in procurement. However, we cannot ignore the fact that Multi-Sourcing and Incumbent Biasing might be used together. In fact, in our survey, 46% of respondents indicated that they Multi-Source and use Incumbent Biasing (quantified as a 3 or greater average score from the Incumbent Biasing construct). Given this relationship, it is important for us to ensure that the Multi-Sourcing strategies and Incumbent Biasing strategies are independent.

To perform this analysis, we create a structural equation model that contains both the Incumbent Biasing construct and the Multi-Sourcing variable. Further, we incorporate a first order interaction term between the Multi-Sourcing variable as described in §2.4.5. Both the interaction construct and the Multi-Sourcing variable are incorporated as control variables on the overall model shown in Figure 4. The result was that neither the Multi-Sourcing variable nor the first-order interaction construct significantly loaded as an indicator of any

Table 16: Loading for the Multi-Sourcing Variables on other Constructs

	Multi-Sourcing Construct			
	Binary		Percent	
Construct	Loading	t-value[a]	Loading	t-value[a]
Relationship Derived Power	0.003	0.031	0.035	0.349
Focused Commitment Strategy	0.002	0.019	-0.117	-1.212
Proposed Commitment	-0.027	-0.277	0.053	0.511
Bidding Competitiveness	-0.025	-0.300	0.055	0.602
Procurement Performance	0.018	0.210	-0.028	-0.296
Incumbent Biasing	-0.083	-0.913	0.120	1.197

[a] No loadings are significant as all have a t-value with $p > 0.1$

Table 17: Discriminant Validity Metrics for Percent Multi-Sourcing

Construct	Construct	$\Delta\chi^2$	ΔD.F.	Pr($\Delta\chi^2$,Δd.f.)
Percent Multi-Sourcing	Rel. Power	40.432	1	< 0.0001
Percent Multi-Sourcing	Proc. Perform.	45.785	1	< 0.0001
Percent Multi-Sourcing	FCS	60.188	1	< 0.0001
Percent Multi-Sourcing	Prop. Commit.	39.601	1	< 0.0001
Percent Multi-Sourcing	Bid. Compet.	56.749	1	< 0.0001
Percent Multi-Sourcing	Inc. Biasing	31.797	1	< 0.0001

latent construct in the model. Further, the results regarding hypotheses H_1 through H_8 did not change as a result of adding or removing these controls. This process was repeated for both the Binary Multi-Sourcing variable and the Percent Multi-Sourcing variable with the same result. Because there was no loading either direct or via a first order interaction, we conclude that there is no impact between Multi-Sourcing and Incumbent Biasing and the two strategies can be considered independently.

Table 18: t-values[a] for Multi-Sourcing Variables and Interaction with Biasing as a Control Variable

	Multi-Sourcing Construct			
	Binary		Percent	
Construct	Direct	Interaction	Direct	Interaction
Relationship Derived Power	0.180	0.079	0.262	0.034
Focused Commitment Strategy	-0.217	-0.874	0.583	-1.297
Proposed Commitment	0.079	0.803	-1.225	0.809
Bidding Competitiveness	-0.237	-1.290	-0.831	-1.630
Procurement Performance	0.216	-0.552	1.203	-0.366
Incumbent Biasing	0.099	0.022	-0.163	-0.923
Incumbent Biasing X Proposed Commitment	1.538	0.699	0.857	0.840

[a] No loadings are significant as all have a t-value with $p > 0.1$

2.5.4 The Impact of Multi-Sourcing on Procurement Performance

To determine the impact of Multi-Sourcing on Procurement Performance, we create and test a structural equation model as described in §2.4.5. As in our previous model, no control variable was statistically significant. The surprising result from the resulting SEM is that Multi-Sourcing is not statistically significant using either the Binary or Percent Multi-Sourcing constructs. In the case of the Binary Multi-Sourcing variable, the t-value for the relationship between Binary Multi-Sourcing and the Competitiveness of Bidding was -0.272 and for Percent Multi-Sourcing, the t-value was -0.373. These low t-values mean that we do not find support for H_{12} and H_{13}. The statistical power of these results are 98.6% for the Binary Multi-Sourcing variable and 99.9% for the Percent Multi-Sourcing variable, which leads to a strong conclusion that Multi-Sourcing does not impact Bidding Competitiveness.

This finding of no impact is surprising as the previous literature discussion created support for multi-sourcing as a means to maintain a competitive bidding pool, which this study shows to not be the case. Our results indicate that bidders do not increase competition

when a contract is multi-sourced, but instead likely view bid requests through a narrow focus: the amount that is being bid and the value of that potential contract to the supplier. This supplier belief disagrees with Klotz and Chatterjee [65] who assume that suppliers consider their own allotment and the allotment of competitors that can be captured in future rounds. Instead, it appears that suppliers are more myopic. This finding may be due to a belief that Multi-Sourcing buyers follow the practice of Multi-Sourcing as a systemic practice, and thus there is no opportunity for a sole-sourcing arrangement to emerge a as a result of significant underbidding.

While our research finds that Multi-Sourcing does not impact Procurement Performance via the Competitiveness of Bidding, we should caution that this does not imply that no impact exists. The value of Multi-Sourcing is likely to be seen as a risk mitigation measure: when a supplier fails or cannot deliver and order, additional suppliers to meet demand (or a portion thereof) will impact Procurement Performance. Since we surveyed respondents about existing relationships, we created a self-selection bias that would exclude failed relationships and the impact on firm performance from such a relationship.

2.6 Discussion and Results

In this chapter, we evaluate the impact of incumbent biasing on the overall success of a procurement process. Using the existing literature, we hypothesize a model where Proposed Commitment influences Procurement Performance and test that model using SEM to determine the significance of these relationships. This is the first work to hypothesize and test in one model both positive and negative mechanisms by which Proposed Commitment impacts Procurement Performance. Subsequently, we hypothesize a relationship between Incumbent Biasing and the Proposed Commitment-Procurement Performance relationship and show how Incumbent Biasing impacts Procurement Performance. This is the first work to hypothesize and test this impact. Further, in this chapter we perform a secondary data analysis that shows the statistically significant impact of our perceptual measures of Procurement Performance on gross profit margin of publicly traded firms. This is the first work to show this relationship using secondary data analysis. In addition, this chapter reviews

the strategy of Multi-Sourcing and shows that it is independent of Incumbent Biasing and does not impact Bidding Competitiveness. This is the first work to evaluate the relationship between Multi-Sourcing and Incumbent Biasing and the first work to empirically test the impact of Multi-Sourcing on the Competitiveness of Bidding.

Reviewing the relationship between Proposed Commitment and Procurement Performance, we find support for H_3 and H_4: Proposed Commitment influences Procurement Performance via total mediation with Focused Commitment Strategy. In other words, as the request for quote/bid (RFQ/B) signals that the buyer is willing to develop a long-term relationship with the supplier, the supplier aligns incentives with the buyer and the end result is improved Procurement Performance. We do not find support for the hypothesized competing mechanism: that Proposed Commitment influences Relationship Derived Power (H_1), which in turn influences Procurement Performance (H_2). While H_2 is supported, H_1 is not. This result is surprising for two reasons: first, it contradicts GM's experience of using short-term contracts to drive down pricing and second it implies that there is only a positive relationship between Proposed Commitment and Procurement Performance. Regarding the first reason, our results likely contradict GM's experience because we use a richer view of Procurement Performance than GM: while GM reported substantial cost savings, they did not report the impact of this practice on other aspects of the relationship. Thus, suppliers may have reduced cost by providing lower quality items, not because of increased GM influence over them. Our Procurement Performance metric would capture this practice, where as GM's self-reported metric would not. Regarding the second reason, while our data does indicate that only a positive relationship exists between Proposed Commitment and Procurement Performance, this does not mean that all managers should increase Proposed Commitment. Our model does not capture other factors that would encourage short-term contracts, such as the potential for supplier failure. Further, our results contradicts the literature regarding the competitive nature of repeated contracting. This contradiction may exist because the extant literature assumes a zero-sum game between the buyer and supplier. This is often not the case. A synergistic relationship may exist in many cases where a supplier and buyer relationship can increase overall buyer profit, and

thus make a game that is not zero-sum. To test this situation, it would be interesting to examine the difference in the buyer-supplier relationships when the final product is mature, such as oil and gas, and when the final product is innovative. We expect that the former represents a better situation for a zero-sum relationship and it might be possible to find the Porter Paradigm in effect. While our study did control for industry, we did not control for product life cycle. Thus we leave this to future research.

With regards to Incumbent Biasing, we find support for H_5 and H_6, which hypothesize that Incumbent Biasing influences Procurement Performance via total mediation with Competitiveness of Bidding. In other words, as a buyers biases towards an incumbent, there is a reduction in bidding competitiveness and this reduction decreases the procurement performance. While the influence of biasing on procurement performance has been discussed anecdotally, this is the first work to empirically demonstrate the relationship. Further, we also find support for H_8, which demonstrates that Incumbent Biasing mediates the influence of Proposed Commitment on Focused Commitment Strategy. In other words, the act of biasing towards an incumbent further aligns the incentives of the buyer and the supplier and improves performance. Again, this is the first work to hypothesize and demonstrate this relationship between Incumbent Biasing and Procurement Performance. This result is surprising because it indicates two competing mechanisms for Incumbent Biasing: one positive and one negative. Both mechanisms must be considered while evaluating the appropriateness of Incumbent Biasing.

Our secondary data analysis showed a statistically significant relationship between the latent construct of Procurement Performance and the change in gross profit margin of a firm over the last three years (H_9). While the positive relationship between these two factors is not surprising, it was surprising that we were able to show this relationship given our relatively small sample size of 30 firms and the number of factors that influence the gross profit margin of a firm. This indicates that there is a very strong relationship between these two factors. This work validates the accuracy of the Procurement Performance construct for future work and demonstrates to managers the influence of a procurement process on the overall success of a firm.

While reviewing Multi-Sourcing, we found that there was no significant relationship between Multi-Sourcing and Incumbent Biasing and that the two do not interact. Further it was found that Multi-Sourcing has no impact on the competitiveness of bidding of a contract. This is highly surprising as the literature recommends Multi-Sourcing as a means to create competition within a procurement scenario. Our work indicates that under a Multi-Sourcing policy, bidding is as competitive as it would be under a Sole-Sourcing policy.

2.6.1 Managerial Insights

Using this work, managers will be able to better design their procurement process to improve performance. First, our model indicates that higher levels of Proposed Commitment in the RFQ/B results in improved Procurement Performance. Managers should therefore strive to increase their relationship with suppliers. However, managers should also consider other factors that impact the relationship such as the potential and impact of a supplier failure in a long-term commitment. The factors that were not considered in this model may outweigh the benefits of improved Procurement Performance via incentive alignment.

Further, our research shows that the practice of Incumbent Biasing has both a positive and negative impact on Procurement Performance. To evaluate these competing mechanisms, we tested the sensitivity of increasing Incumbent Biasing and Proposed Commitment on Procurement Performance. At low levels of Proposed Commitment, we find that increasing Incumbent Biasing decreased Procurement Performance and at high levels of Proposed Commitment, increasing Incumbent Biasing has a positive impact on Procurement Commitment. Thus, there does not appear to be one solution for when to use Incumbent Biasing. Managers should consider their current level of Proposed Commitment and should employ Incumbent Biasing only if they feel they are already at a high level of Proposed Commitment.

In addition to Incumbent Biasing, our research shows that managers who use Multi-Sourcing should not do so with the expectation that such a policy increases the Competitiveness of Bidding. While there may be other reasons for using Multi-Sourcing, such as in the case where no single supplier is able to satisfy a need or as a means to diversity the

supply base to minimize the impact of supplier failure, influencing the competitiveness of bidding is not a valid reason for this practice.

Finally, our research supports a clear relationships between the gross profit margin of a firm and that firm's procurement practices. This finding indicates the need to maintain a strong focus on procurement practices and to invest in improving processes where ever possible.

CHAPTER III

BIASING TO PREVENT BIDDER DEFECTION

3.1 Introduction

In the highly competitive business environment of the last few decades, proper supplier management and control has become a key means of differentiation and competitive advantage. The classic example arguing for the importance of supplier management is the success of the Japanese auto-manufacturers in the 1980's and 1990's in the US market. Unlike their U.S. competitors who maintained an arm's length separation from suppliers, the Japanese firms valued cooperation and created strategic relationships with their suppliers [29]. Empirical evaluations of this situation show that the strategic relationship approach of the Japanese led to a significant competitive advantage that was later mimicked by US and European manufacturers. Motivated by the above classic example of strategic vs. arm's length relationships, several literature streams have emerged that promote the value of long-term relationships.

Similarly, with the ubiquitous growth in the use of information technology and the internet there has been a growing trend toward the use of on-line, short-term or arm's length mechanisms for procurement. In response, a stream of literature exists promoting the use of repeated procurement auctions for the awarding of contracts. Advocates of this strategy cite a 20% reduction in costs for standardized items due to the competitive nature of the procurement process [91].

While there is little explicit connection between these strategies in the literature, it is well known that the Japanese procurement system is not based solely on strategic relationships. As researchers have noted, strategic relationships are costly to establish and maintain and prevent separation from inefficient suppliers [46]. As a result, there is a type of relationship that Dyer et al. [30] term "durable arm's length relationships." Durable arm's length relationships are designed to minimize the cost of establishing and maintaining

the relationship by negotiating with firms at arm's length for short-term contracts, but seek to minimize the risks and switching cost by maintaining long-term relationships with only one or two potential suppliers. In effect, firms attempt to maintain strategic relationships with their suppliers while using arm's length techniques to reduce cost over time.

The durable arm's length relationship is often used in cases where the buyer of a product or service does not have extensive experience in that product or service but the competitive structure of the product or service's industry makes a relationship necessary. For example, consider the procurement of intermodal transportation of cargo by a shipper (such as UPS, J.B Hunt, or Hanjin) from a Canadian Class I railway. Because of the nature of the Canadian railway industry, there are only two providers of service (Canadian Pacific and Canadian National) who will need to invest capital to provide service the shipper. Thus, the shipper needs to form a strategic relationship with a railway. However, because of the extreme cost and difficulty in creating the internal expertise necessary in a strategic relationship, the shippers maintain an arm's length in the negotiating process with the providers. Thus the shippers form durable arm's length relationships.

Empirical research on procurement auctions has uncovered this phenomenon. In their study, Zhong and Wu [109] find that approximately 75% of short-term procurement auctions are awarded to the incumbent. Elmaghraby [37] and Jap [54, 55] have reported that a large number of online auctions do not result in the awarding of a contract. Both speculate that the auctions without an award are being used as a price discovery mechanism to renegotiate with the incumbent. Finally, there has been mention of the issues associated with disproportionate awarding to incumbents in the popular press [1, 2, 10, 68]. These findings support the claim that a middle ground between strategic and arm's length relationships exists.

Despite the apparent pervasiveness of this middle ground strategy, to date little research has been conducted on this procurement phenomenon and whether the practice of frequent rebidding with incumbent awarding achieves the goal of a price reducing strategic alliance. Anecdotally, we have seen negative aspects of this process in action. In 2007, the United States Air Force issued a $35 billion request for proposal for an in-flight refueling aircraft.

This bid was a rebidding of a contract already won by Boeing in 2002, because of charges of corruption. From this proposal, two bidders emerged: Boeing, the incumbent supplier and EADS (in a joint venture with Northrop Grumman), a rival firm interested in entering US defense contracting. After review of the proposals, it was ruled in 2008 that EADS won the contract [43]. The design by EADS subsequently won four more direct evaluations [3], each time with Boeing improving it's design. However, following a protest from Boeing with the Government Accountability Office (GAO), the contract was not awarded until another round of bidding could occur [60]. In the subsequent bidding stage, EADS identified a bias toward the incumbent and perceived an intention to reaward to Boeing regardless of the quality of the design. In effect, EADS argued that the bidding opportunity was being used solely to place pressure on Boeing to improve its design as it believed the US Government would ultimately award to the US-based Boeing regardless of the relative performance difference of the two firms. As a result, in 2010, EADS removed itself from the bidding process [3] and Boeing won the contract by default without further improving its design to match the performance of the EADS aircraft.

The above anecdote demonstrates a potential flaw with the strategy of repeat incumbent awarding: how other bidders will react to the strategy. While there is little literature on how these repeat incumbent awarding decisions impact overall procurement profitability, there are some suggestions of how potential suppliers react when faced with repeated incumbent awarding. Jap (2002) discusses the fact that in procurement auctions, bidders learn over consecutive auctions and may "opt out" of future auctions when they perceive that they are being treated unfairly. Similarly, Elmaghraby [37], Chandrashekar et al. [17], and Rothkopf and Whinston [89] also cite the phenomenon of bidders acting "unaggressively" or otherwise negatively toward auctions where the bidders perceive an unfair situation.

Given the above scenario of competitors "opting out," or otherwise bidding unaggressively (collectively termed "defecting"), there is a real concern that the practice of repeat incumbent awarding as a means to achieve a durable arm's length relationship may not only be ineffective, but counterproductive. As non-incumbents (entrants) bid less aggressively, there is the potential for the incumbent to raise his price if he perceives a bias. Based

on these concerns, we investigate the following research question: Is the policy of biasing toward an entrant or incumbent in a procurement process effective, and if so, under what conditions?

To answer this question, we develop a model where entrants and incumbents repeatedly interact over time. Each time the firms interact, they update a belief about the cost distribution of the other bidder(s). Firms exert the effort to bid which is costly to them, and will drop out of the bidding cycle if their expected profit is negative. We measure the impact of potential defections and how they may affect the end result of the procurement process. Further, even when there is not a defection, we are concerned with how bidders may react to a biased awarding policy.

We address the issue of whether or not biasing is an effective policy. The existing literature gives conflicting advice on this issue. In a white paper issued by the World Bank, Klein [61] explicitly recommends biasing toward incumbents in the case of repeat bidding opportunities to avoid switching cost. On the contrary, in the academic literature, Luton and McAfee [71] explicitly recommend biasing toward entrants to maintain the competitiveness of the bidding pool. Our research sheds light on this debate. We show that both entrant bias and incumbent bias can be optimal depending on the conditions involved. In the case of high entrant effort to participate and low entrant cost (relative to the maximum allowable price the buyer specifies for the contract), the buyer should bias toward the incumbent. Conversely, with a low entrant effort to participate and high entrant cost (relative to the maximum allowable price the buyer specifies for the contract), biasing toward the entrant can be optimal. As an example, The World Bank, whose large infrastructure type projects typically require a high effort to participate in the bidding process, may prefer biasing toward incumbents. On the other hand, the procurement of a non-skilled service oriented product, such as a janitorial service, would lend itself to biasing toward the entrant because of the low cost to bid such a contract.

This paper is organized as follows: in §3.2 we present a review of the literature that serves as a foundation for this research. In §3.3 we present the base model with two bidders. We extend this model to include multiple bidders. In §3.4 we perform several extensions. In

§3.5 we provide conclusions and managerial insights. All proofs are provided in an appendix.

3.2 Related Research

This research is based on the convergence of several different literature streams. First, we discuss the related research on strategic relationships, which argues for close buyer-supplier relationships via long-term term contracts and extensive monitoring and coordination. Next, we discuss the literature involving topics from arm's length research, including incumbency in bidding, switching cost, and the number of bidders in competitive bidding processes.

Strategic Relationships. As mentioned in the introduction, there is a substantial body of literature examining strategic relationships mostly based on Deming's [26] argument that supplier's assets should be treated as an extension of the buyer that can be managed for market differentiation. While there is an extensive amount of data in this field that confirms these types of supplier relationships [25, 31, 105], a contrasting finding came from the research of Dyer et al [30]. In their study of the auto manufacturing industries in Japan, South Korea, and the United States, Dyer et al. proposed the idea of strategic segmentation. After extensive discussions with first tier suppliers, contrary to the implication that the Japanese relied primarily on strategic relationships, Dyer et al. identified only 40% of the suppliers used by a typical Japanese manufacturer as a strategic relationship. The remaining 60% of suppliers, which manufactured standard components such as tires, batteries, and belts, were involved in a relationship that Dyer et al. termed a "durable arms length" relationship. This means that the suppliers were initially qualified as having the potential to be a low cost manufacturer, then were asked to repeatedly bid for short-term contracts against other qualified firms. The winning bidder is assured of future profit if the bidder remains price competitive in the next stage of bidding. In our research, we create a model where buyers are able to bias awarding decisions in favor of an incumbent. The result is a relationship where bidders repeatedly compete to supply a contract but can be favored in future stages as would be the case in a "durable arm's length" relationship. We believe that this is the first paper to model this relationship.

Incumbency. The impact of incumbency on an auction also received attention in the economic literature. Luton and McAfee [71] propose an optimal auction structure when an incumbent is present in multiple stages. They argue that the incumbent must be treated differently than entrants because of asymmetric information and propose a mechanism, based on one used by Ontario Hydro, where an incumbent must bid lower than all entrants as well as his previous bid in order to win the auction. This policy is designed with the presumption of retained offers and concludes that if the incumbent's bid beats all entrants' bids, but not his previous offer, that he would retain the contract at his winning bid from the previous stage. In an empirical study, DeSilva et al. [27] examine how aggressive (how much risk firms are willing to accept that the realization of an uncertain cost to supply a contract will be greater than their bid) when an incumbent is present in auctions for Oklahoma road construction contracts. They find that the presence of an incumbent alters the bidding behavior and note that the existing auction literature lacks emphasis on this issue.

Our research builds on this literature concerning the impact of incumbency on procurement. In our model, information asymmetry exists between the incumbent and the entrants. This asymmetry drives the bidding behavior of the firms and subsequently, the profit of the buyer. Unlike the previous literature, we incorporate an effort to participate for entrants and examine how this effort impacts defection among entrants in future bidding opportunities. We incorporate this parameter to examine the benefits of biasing when choosing a bidder.

There have also been several calls for future research in the area of procurement cycles with repeated interactions. For example, Elmaghraby [35] notes that "with few exceptions, the auction literature almost always assumes a one-shot framework, ignoring the strategic factors that may arise in a repeated interaction framework." She later continues, "an important area for future research is the design and bidding behavior of suppliers who repeatedly interact over time."

The paper most similar to ours is Chaturvedi et al. [18] who explore the impact of split-awarding (awarding to multiple suppliers to satisfy one procurement need) with defection.

In their paper, Chaturvedi et al. formulate a similar base model with a pool of qualified bidders. Bidders can defect or enter the bidding pool and the buyer attempts to minimize the cost of supplier awarding and the cost of qualification. The authors show that in their model, split awarding is optimal under certain conditions to prevent defection. The key difference in the model of Chaturvedi et al. and ours is that they incorporate past awarding to update an availability factor that determines defection. Losing multiple times will cause a bidder to reduce his availability and will cause defection. In our model, the determination to defect is based on the expectation of future profit. This reduces the need to split award to maintain a bidding pool. The use of split awarding to prevent information updating would be an interesting extension to our work.

While there is existing literature that discusses the role of bidding pool size and the role of incumbency in an auction, to our knowledge, ours is the first to include the impact of both of these well observed practices. Additionally, we believe that this is the first paper to consider the long-term impact of repeat incumbent awarding on the cost effectiveness of the procurement process.

3.3 Base Model and Analysis

In light of the conflicting suggestions from practice and academics as to how to deal with repeat interaction bidding, we construct a model to investigate the scenarios where firms optimally bias toward repeat incumbent awarding or toward a non-incumbent (entrant). Our goal is to examine supplier response to the buyer's awarding decision over time. Due to the complex nature of the resulting game, a generalized model is difficult to develop and solve with managerially relevant insights [18]. In order to analyze the model, we use several assumptions to simply the model into a tractable game. We then analyze this game and draw managerial insights from the model.

3.3.1 Base Model

Our goal in this section is to first show that bidder defection exists and is a concern, then to show the conditions under which biasing either toward an entrant or incumbent is optimal.

We begin our analysis with two qualified bidders, Firm 1 and Firm 2. We extend this the model for n bidders in §3.3.2. The two bidders in our base model differ on two dimensions: cost to supply the contact (c_1 and c_2 for Firms 1 and 2, respectively) and the cost of effort to bid (e_1 and e_2 for Firms 1 and 2, respectively). The cost to supply the contract is private but has support standardized to be between $[0, 1]$. In this range, 1 represents the reservation price, that is the price at which the buyer could acquire the good or service internally or the price at which a substitute good or service could be procured. We define Firm 1 as being the low cost bidder with a cost of c_1 and Firm 2 as the high cost bidder, with a cost of c_2, where $c_2 > c_1$. The contract being supplied is sufficiently mature that the cost does not change from stage to stage. Firms know if other competitors are present, but they do not know the cost of competitors. For analytical tractability, we assume that firms believe that competitors could have cost at any value in the support region with equal probability, and so we model a bidder's belief about his competitor's cost as a uniform distribution. Initially, a firm believes that the competitors cost is $\sim U[0, 1]$. In addition to the cost to supply the contract, the firms also have a non-negative cost of effort to bid. That effort, (e_1 and e_2) is specific to the firm. Managerially, this could be the travel cost for individuals to travel to the buyer's site to bid. Costly bidding is a typical assumption. For example, the cost to provide the detailed technical proposal for procurements funded by the World Bank can easily amount to $100,000 or more [38].

The bidders interact in a three stage model. Three stages are necessary because the first stage establishes the incumbent, the second stage allows for the potential incumbent re-award, and the third stage indicates the bidders' actions to the incumbent re-award or non-incumbent award. In our context, a stage includes an entire procurement process: firms decide whether or not to bid, bidding occurs, a contract is awarded, and the contract is executed. From this context it is clear that the buyer is purchasing the same good or service three times. This is in contrast to other repeat procurement models where the first stage is a product development or prototype stage and the second stage is the final good procurement [86, 93]. While these cases involve the development of a product, there are many cases where a product design is fixed prior to contracting. For example, the procurement of a

service, leasing of equipment, or the outsourcing of a component or product to a contract manufacturer.

The time line for this process proceeds as follows: before any bidding begins, Firm 1 and Firm 2 know their private costs c_1 and c_2. Stage 1 begins when both bidders, knowing their private cost, their cost of effort to bid, and a belief about the other firm's cost decide whether or not to incur effort e_1 and e_2 to bid. If both firms decide to incur the effort, Firm 1 and Firm 2 offer bids $b_{1,1}$ (bid of Firm 1 in Stage 1) and $b_{2,1}$ (bid of Firm 2 in Stage 1). The buyer evaluates the bids and chooses a winner. Firm 1 and Firm 2 are then notified which firm is awarded the contract and then update their belief of the other firm's cost. The winner provides the service at their bid price. Stage 1 ends. Stages 2 and 3 follow a similar pattern.

Given the structure of the bidders, we now evaluate how firms prepare bids. For Firm 1 in Stage 1, the expected profit function is simply the profit from providing the service $(b_{1,1} - c_1)$ and the probability of winning, which is $Pr(b_{1,1} < b_{2,1})$ in the first stage. The effort to bid, e_1, is subtracted from this:

$$\underset{c_2}{\mathbb{E}}[\Pi_{1,1}(b_{1,1})] = (b_{1,1} - c_1)Pr\{b_{1,1} < b_{2,1}\} - e_1 \tag{3}$$

Similarly, the expected profit for Firm 2 is found using the same method to be:

$$\underset{c_1}{\mathbb{E}}[\Pi_{2,1}(b_{2,1})] = (b_{2,1} - c_2)Pr\{b_{2,1} < b_{1,1}\} - e_2 \tag{4}$$

The equations above present the problem that firms compete on bids but only have information about the competitor's cost. As a result, we need a bid-cost transformation. Bid-cost transformation for repeated auctions develop into a highly complex game that are difficult to solve [18]. In the past, researchers have assumed a Vickrey auction which neglects the need for a bid-cost transformation (e.g. [65]). This would not work in our model because if firms bid their cost, the high cost bidder defects with certainty in the second stage as he would always lose to a low cost bidder. This result would artificially drive our finding of bidder defection in a repeat interaction scenario. To avoid this issue,

we instead use an equilibrium bid transformation.

To create a stable equilibrium, we assume that bidders only consider profit in the current stage when making decisions. This is a frequent assumption in the iterative auction literature, which generally considers the myopic best response (e.g. [56, 80]), where a Nash Equilibrium can be shown to exist for all bidders acting myopically in sequential auctions when the bidders have symmetric information. In our model, the assumptions that lead to the optimality of myopic best response only hold for the first stage and not for the entire model; however, we maintain the assumption because it is a common practice in industry and allows us to keep our model tractable while biasing against our intended result: that the entrant pool decreases with repeated awarding to the incumbent. It is straightforward that in the case of strategic bidding with the low cost firm identified in the first stage, the high cost firm is more likely to defect because it anticipates a higher probability of future loses. Thus, a strategic entrant is more likely to defect in future stages once a low cost bidder is identified.

Myopic bidding is also reported in practice, specifically where the buyer represents a small portion of the bidders' potential revenue and where future revenue is uncertain. Consider a coal mine that wishes to transport coal along the US rail system. There are only two providers of Class I railways in each corridor of of the US (BNSF and Union Pacific in the Western US and CSX and Norfolk Southern in the Eastern US). In order to procure transportation, the coal mine will request bids from the two Class I providers in their region. Because Class I railway providers are large with hundreds of coal mine contracts and because future regulation often jeopardizes the continued operation of individual coal mines, it has been reported by senior leadership at one of the Class I railroads to one of the authors that bidding occurs myopically based on current conditions. However, one condition that is considered in bidding is the state of the current contract: that the contract previously won by his railroad or his corridor competitor. The assumption of myopic bidding is appropriate for a scenario where firms do not interact frequently. For example, in the process of bidding for the replenishment of chemical reactor catalyst, the time between interaction can range from 18 months to 6 years for certain processes. Given the timing, bidders have reported

to one of the authors that their primary goal is maximizing profit in the current project, not in considering future implications.

Given the above assumptions concerning bidding and the uniform distribution of competitor's cost, bids from linear functions of cost (i.e. $b_{k,j}(c_k) = \alpha_k + \beta_k c_k$) form a stable equilibrium, similar to the model used by Chaturvedi et al. [18]. In addition to the structure being stable, it is simple enough to be practical to managers. The presence of a stable equilibrium is necessary to be able to solve explicitly for the bids and profit functions of Firm 1 and 2 and to draw insights regarding the impact of biasing on the solution. Using this bid structure, we can explicitly solve for the bidding strategy of the two firms in each stage. As a consequence of having the same range and belief for the other firm's cost in the first stage, the low cost bidder is revealed in that stage.

Lemma 1 *In the first stage, Firm* 1 *bids* $b_{1,1}(c_1) = \frac{1}{2} + \frac{1}{2}c_1$ *and Firm* 2 *bids* $b_{2,1}(c_2) = \frac{1}{2} + \frac{1}{2}c_2$

We should note that it is possible that a high effort bidder might choose to not participate in Stage 1. The condition for this participation is shown in Lemma 3. In such a case, there would be no competition and the buyer would procure the contract either internally or from the other bidder at the reservation price for all three periods. To avoid this uninteresting case, we assume that firms' cost structures are such that they choose to participate in the first stage.

Following the first stage award process, each firm updates its belief about the other firm's cost. We assume that the firms update their belief about the other firm's cost by modifying their belief of the range of the other firm's cost distribution. From Lemma 1, in Stage 1, Firm 1 bids $\frac{1}{2} + \frac{1}{2}c_1$ and Firm 2 bids $\frac{1}{2} + \frac{1}{2}c_2$ and Firm 1 wins because $\frac{1}{2} + \frac{1}{2}c_1 < \frac{1}{2} + \frac{1}{2}c_2$ if $c_1 < c_2$. Thus, both firms have discovered $c_1 < c_2$ and Firm 1's belief of c_2 is $c_2 \sim U[c_1, 1]$. This method is appropriate because the binary win/lose feedback that bidders receive provides only ordinal information with regard to cost.

To give the buying firm an opportunity to show a bias in awarding the bid in the second stage, we include a biasing factor i, which is a barrier cost that either the incumbent or

entrant must overcome to win a contract. Because cost is standardized to have support in $[0, 1]$, the biasing factor has support in $[-1, 1]$. Values of i outside of this support would lead to a case where the auction was designed such that an entrant or incumbent always won. Negative values of i represent biasing toward the entrant and positive values of i represent biasing toward an incumbent. There is no biasing before the incumbent and entrant has been established (i.e. no biasing in Stage 1). We assume that for the base model the bias is announced publicly and there is no inherent switching cost.

Given the information updating and the biasing factor, the profit functions in future stages are identical to the functions for the first stage, with the augmentation that the probability of winning for Firm 1 in future stages is $Pr(b_{1,j} < b_{2,j} + i)$ and the probability of winning for Firm 2 is $Pr(b_{2,j} + i < b_{1,j})$. We continue the bidding sequence by assuming both firms bid in each stage (the conditions under which this holds are found in Lemma 3):

Lemma 2 *Assuming that Firms* 1 *and* 2 *both bid in each stage,*

(a) In the second stage, the bids are: $b_{1,2}(c_1) = \frac{1}{2}c_1 + \frac{1}{2} + \frac{1}{3}i$ *and* $b_{2,2}(c_2) = \frac{3}{4}c_2 + \frac{1}{4} - \frac{1}{3}i$

(b) Following an incumbent award in the second stage, the third stage bids are: $b_{1,3}(c_1) = \frac{1}{2}c_1 + \frac{1}{2} + \frac{1}{9}i$ *and* $b_{2,3}(c_2) = \frac{7}{8}c_2 + \frac{1}{8} - \frac{7}{9}i$

(c) Following an entrant award in the second stage, the third stage bids are: $b_{1,3}(c_1) = \frac{4}{5}c_1 + \frac{1}{5} + \frac{1}{5}i$ *and* $b_{2,3}(c_2) = \frac{9}{10}c_2 + \frac{1}{10} + \frac{3}{5}i$

From Lemma 2 we can see that if there is no biasing, the incumbent maintains his initial bid until a credible threat is created (the entrant wins). The entrant, despite being the high cost bidder, returns because of the potential that if his cost is lower than the incumbent's bid, the entrant can reduce his bid (i.e. reduce his potential profit $b_{2,2} - c_2$) to capture the contract for a period. If a bias is present, the bidders include a function of biasing in their bidding, as the favored bidder increases his bid to capture additional revenue, while the unfavored bidder reduces his bid to increase his probability of winning. As time passes, the influence of the biasing factor decreases as the presence of biasing toward an incumbent accelerates, and toward an entrant decelerates, the learning of the loser about the cost of the winner, and as a result the loser lowers his bid more in future stages.

The above results assume that bidders participate in each stage. This would be the case if there was no effort to bid. However, if firms are profit maximizing, they will only bid if they have a positive expected profit. If their expected profit is negative, they will not bid, or will "defect" from the bidding pool. To characterize defection, we solve for the maximum cost (as a function of effort) under which a firm would participate in future stages at a given biasing factor. We only review the cost for the high cost firm as the low cost firm always participates if e_1 is low enough to induce bidding in Stage 1:

Lemma 3 *(a) In the first stage the threshold effort for Firm* 2 *to bid is:* $e_{2,1}^{threshold} \leq \frac{1}{2}(1-c_2)^2$

(b) In the second stage, the threshold effort for Firm 2 *to bid is:* $e_{2,2}^{threshold} \leq \frac{(3c_2-3+4i)^2}{72c_2}$

(c) Following an incumbent award in the second stage, the threshold cost Firm 2 *to bid in Stage* 3 *is:* $e_{2,3}^{threshold} \leq \frac{(9c_2-9+56i)^2}{432(9c_2-3-8i)}$

(d) Following an entrant award in the second stage, the threshold cost Firm 2 *to bid in Stage* 3 *is:* $e_{2,3}^{threshold} \leq \frac{3(1-c_2+6i)^2}{40(3-3c_2+8i)}$

Since firms only differ on two aspects in our model: cost and effort, we classify all firms based on the potential combinations of these values. From our assumption of costly bidding, we know that all potential bidders have the form $\{c_k, e_k : 0 \leq e_k \leq 1, 0 \leq c_k \leq 1, k \in \{1,2\}\}$.

From Figure 6, we can see the the potential combinations of cost and effort that induce a bid in Stage 1. The figure is then modified in Figure 7 to include the condition to Bid in Stage 2. With this is can be seen that the number of potential (c_2, e_2) combinations that participate in Stage 2 are fewer than the number that participate in Stage 1. This means that after an initial award, there is the potential for a high cost bidder to defect. Figure 7 graphically shows the regions of e_2 and c_2 for which Firm 2 participates in the first and second stages for the case of $i = 0$. In this case, a Firm 2 with a relatively low cost does not defect regardless of the effort required to submit a bid. This is because a relatively low cost Firm 2 has a narrow range for Firm 1's cost and believes that he "just missed out" on winning in the first stage. Thus, Firm 2 believes that he is competitive with lower cost Firm 1. A Firm 2 with high cost and high effort to bid defects because he

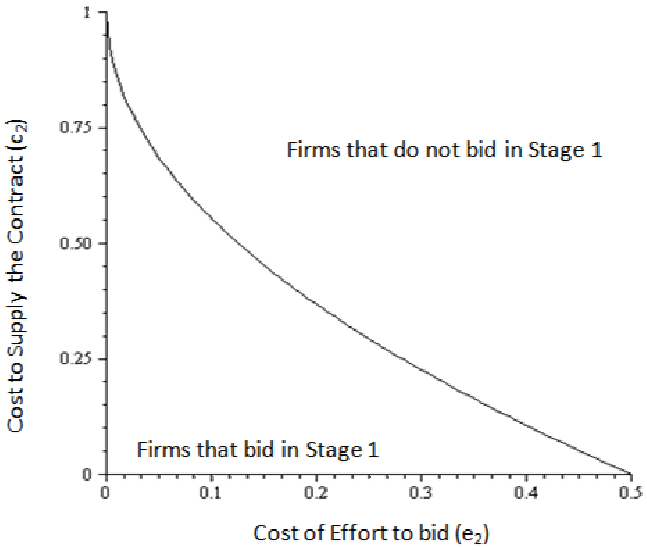

Figure 6: The area under the curve in this graph represents the effort-cost combinations where Firm 2 bids in the first stage under the case of $i = 0$.

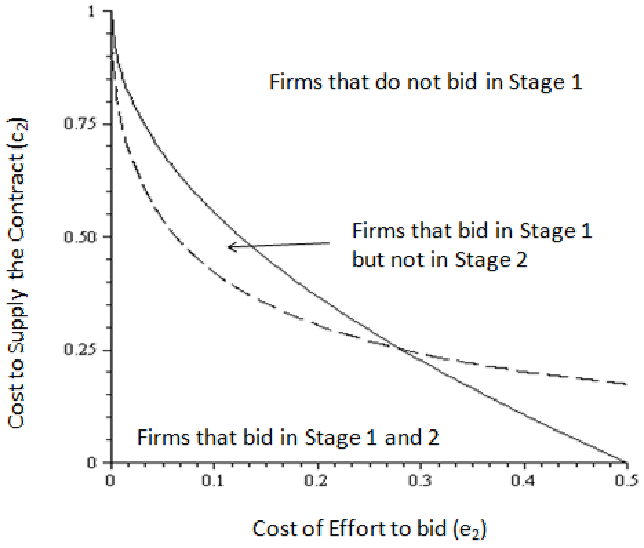

Figure 7: The area between the curves represents the fraction of effort-cost combinations where Firm 2 bids in the first stage but not the second stage for the case of $i = 0$.

has a negative expected profit. In such a case, he does not invest the effort to compete in future stages. This finding provides an analytical explanation for the empirical findings of Jap [53, 54], who finds that entrants that believe they are not competitive will either defect from future stages or provide an unaggressive bid. The idea of an "unaggressive bid" could be conceptualized as an entrant that invests little or no effort by issuing a standardized, highly conservative bid.

From Lemma 2, we see that when an entrant wins in the second stage, Firm 1, who knows that he is the low cost supplier from Stage 1, reacts by greatly reducing his bid in Stage 3 relative to the previous stages. Firm 2, anticipating this reaction from Firm 1, reduces his bid in Stage 3 in response. Thus, only when the low cost bidder feels that a credible threat exists from another bidder, he reacts by reducing prices. Otherwise, the incumbent maintains his initial bidding strategy and waits for an entrant to pose a threat. From this analysis we conclude that the practice of repeat incumbent awarding in this setting is counter-productive: rather than using the entrants to place pricing pressure on the incumbent, the incumbent does not reduce his price and the frequent contract awarding acts to drive away entrants that perceive a substantially lower cost (relative to their cost) incumbent.

In Figure 8, we show the impact of the awarding decision in Stage 2 (either an incumbent award or an entrant award) on the decision of Firm 2 to participate in Stage 3. Region [1] represents a high cost and high effort combination for the entrant. In this region, Firm 2 will not bid in Stage 3 regardless of the awarding decision in Stage 2. Region [2] represents a high cost and low effort combination for the entrant. In this region, awarding to an incumbent results in Firm 2 defection in Stage 3. Region [3] represents a low cost and high effort combination for Firm 2. In this region, awarding to the entrant results in defection in Stage 3. Finally, Region [4] represents a relatively low cost and low effort combination for the entrant where defection does not occur regardless of the awarding decision.

The existence of Regions [2] and [3] are counterintuitive. One may conjecture that to maintain competition, a high effort bidder should periodically be awarded a contract. This would "motivate" the bidder to remain during future stages. Similarly, one may also

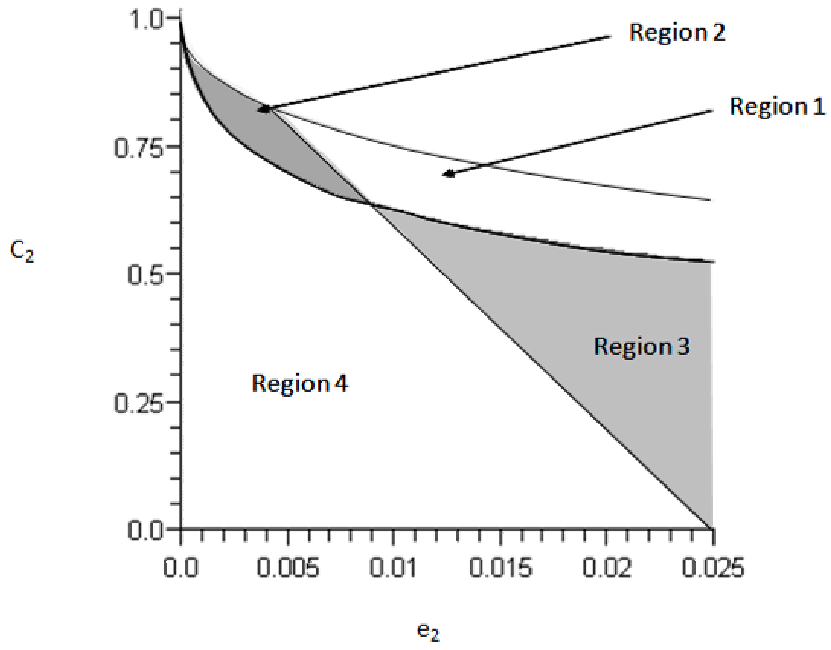

Figure 8: This figure shows the impact of the awarding decision in Stage 2 on the participation of Firm 2 in Stage 3. In Region [1], Firm 2 will defect regardless of the awarding decision. In Region [2], Firm 2 will defect if the incumbent is awarded the contract in Stage 2. In Region [3], Firm 2 will defect if the entrant is awarded the contract in Stage 2. In Region [4], Firm 2 will participate regardless of the awarding decision in Stage 2. This figure is for the case of $i = 0$.

conjecture that a low effort bidder would not need as much "motivation" to participate in future stages, so there is no reason to bias the awards toward that bidder. We show in Figure 8, however, that this is not the case. Since it is known that the incumbent is the low cost provider (based on previous stage results), if an entrant is awarded the contract, the entrant knows that the incumbent will reduce his bid in future stages to regain incumbency. So awarding to an entrant is more profitable if the entrant is more likely to participate in future stages despite the price reduction (low e_2). Similarly, repeat incumbent awarding is preferred in the case of high e_2 because it prevents the future price reduction in the incumbent's bid that would deter an entrant from participating in future stages. As long as c_2 is sufficiently low, the entrant will continue to participate with the assumption that he's "just missing" with his bids in each stage.

However, the above analysis is for a given value of i. The primary concern in this paper is the optimal value of i given the other factors. As such, we consider how i affects the outcome of the model. The biasing factor has two functions in this model. First, i is present in the functions that determine whether or not defection occurs. If defection occurs, i is no longer involved in the model as the monopoly price prevails. If defection does not occur, i impacts the bids. First we investigate the impact of i on defection.

Lemma 4 *It is suboptimal to allow defection to occur.*

From Lemma 4 we can see that when defection can be avoided, it should be avoided. From Lemma 3 we see that the factors that influence defection are i, e_2, and c_2. In some cases, it may be possible to manipulate defection by modifying c_2 or e_2 (i.e. subsidizing a bidder). These cases are discussed in section §3.4.2.

For now, we are concerned with the choice of i on the outcome of defection. Figure 9 shows how increasing or decreasing the value of i impacts the determination to defect for a high cost bidder. We can see the impact of changing i on the regions of Figure 8 in Figure 9. In summary, as i increases (more biasing to the incumbent) Region [4] increases in size along the x-axis (entrant effort to bid) but decreases in size along the y-axis (entrant cost). This action decreases the combinations of cost and effort that fall into Region [3]. Conversely, as

i decreases, Region [4] decreases in size along the x-axis (entrant effort to bid) but increases in size along the y-axis (entrant cost). This action decreases the combinations of cost and effort that fall into Region [2]. Therefore, if a high cost firm has c_2 and e_2 that places it in Region [3], increasing i (biasing toward an incumbent) can prevent defection and if a high cost firm has c_2 and e_2 that fall into Region [2], decreasing i (biasing toward an entrant) can prevent defection.

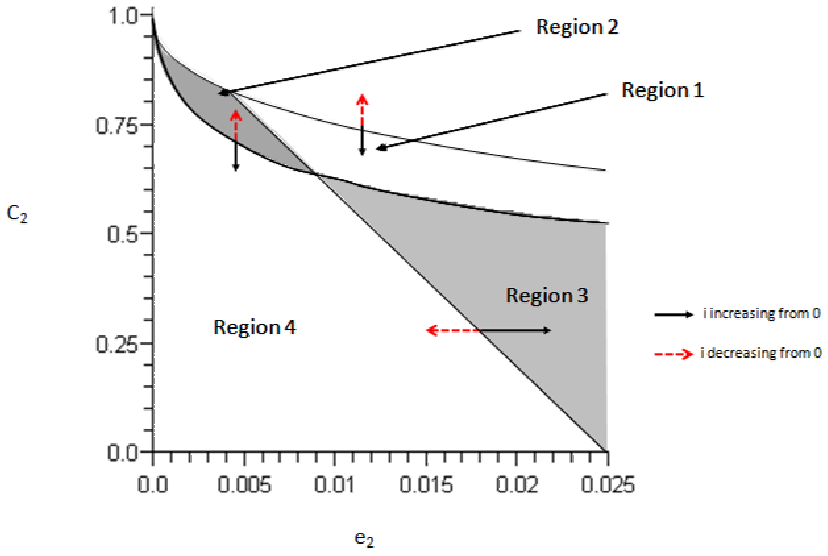

Figure 9: How the isometric lines change as the biasing factor changes from 0.

The impact on of Region [4] when i is modified leads to the optimal choice for how much to bias as shown in Proposition 5:

Proposition 5 *The optimal value of i when biasing is found by selecting i such that high cost bidder (Firm 2) lies on a boundary of Region [4], i.e. such that $e_2 = e_{2,3}^{threshold}$.*

From Figure 8 and 9 we can see how i must be modified for a high cost bidder (Firm 2) in the entire range of e_2 and c_2. We also can see from Lemma 4 that defection should never be allowed and in Proposition 5 how i should be manipulated to minimize the total cost for the buyer. In the case of a high cost of effort and low cost to supply the contract, a buyer should bias toward an incumbent in Stage 2 (increasing i). In the complementary case (low cost of effort and high cost), the buyer should bias toward the entrant in Stage 2

(decreasing i). In all other cases, the bids themselves should be taken into account when determining how to bias and award.

So far, we have only considered the case where two bidders compete. In §3.3.2, we have a more generalized case of n bidders. We show that, except for the case of a decreased starting bid (which depends on n) in Stage 1, the properties are identical to those found in §3.3.1.

3.3.2 The Presence of Multiple Entrants

To continue our analysis, we examine the impact of multiple entrants in the bidding pool. For clarity, we show the case where $i = 0$ and demonstrate how the multiple bidders impact that solution. We incorporate multiple entrants by modifying the probability of winning with a given bid. This is done by recognizing that for Firm 1 to win, he must be lower in cost than all competitors. For Firm 1 competing against n other bidders in Stage 1:

$$E[\Pi_{1,1}(b_{1,1})] = (b_{1,1} - c_1)Pr\{b_{1,1} < b_{2,1}\}Pr\{b_{1,1} < b_{3,1}\}...Pr\{b_{1,1} < b_{n+1,1}\} - e_1 \qquad (5)$$

In the first stage, all bidders have the same belief about all other firms' cost, so we are able to simplify to:

$$E[\Pi_{k,1}(b_{k,1})] = (b_{k,1} - c_k)Pr\{b_{k,1} < b_{-k,1}\}^n - e_k \qquad (6)$$

for bidder k. Where the subscript"$-k$" indicates firms that are not Firm k. Given the initial belief that $c_{-k} \sim U[0,1]$, we can solve for the bids in Stage 1:

Lemma 6 *(a) In the case of n bidders, in the first stage, the bid for Firm k is* $b_{k,1}(c_k, n) = \frac{n}{1+n}c_k + \frac{1}{1+n}$

(b) In Stage 2, the incumbent bids $b_{inc,2}(c_{inc}, n) = \frac{n}{n+1}c_{inc} + \frac{1}{1+n}$ *while the entrants bid* $b_{ent,2}(c_{ent}, n) = \frac{2n+1}{2(n+1)}c_{ent} + \frac{1}{2(1+n)}$*, where "inc" corresponds to the incumbent and "ent" corresponds to an entrant*

(c) The incumbent bid following an incumbent award in Stage 2 is $b_{inc,3}(c_{inc}, n) = \frac{n}{n+1}c_{inc} + \frac{1}{1+n}$ *while the entrants bid* $b_{ent,3}(c_{ent}, n) = \frac{4n+3}{4(n+1)}c_{ent} + \frac{1}{4(1+n)}$

Note that in the first stage, increased competition has the intended effect of decreasing bids. After the awarding decisions are announced, the incumbent (subscript *inc*) updates his belief about the entrants' (subscript *ent*) cost distribution to be $\sim U[c_{inc}, 1]$ while each entrants updates their belief about the incumbent's cost to be $\sim [0, c_{ent}]$, where c_{ent} is the cost of a particular entrant.

In the second stage, we see the incumbent and entrants now have asymmetric beliefs regarding the range for the other firm's cost. The incumbent is competing against a pool of (to him) bidders with the same belief. Thus, his expected profit is:

$$E[\Pi_{inc,2}(b_{inc,2})] = (b_{inc,2} - c_{inc})Pr\{b_{k,2} < b_{-k,2}\}^n - e_{inc} \tag{7}$$

while the entrants bid from the function

$$E[\Pi_{ent,2}(b_{ent,2})] = (b_{ent,2} - c_{ent})Pr(c_{ent} < c_{-ent})^{n-1}Pr\{b_{ent,2} < b_{inc,2}\} - e_{ent} \tag{8}$$

where subscript $-ent$ represents all other entrants. To win, a given entrant must bid below the incumbent and be the lowest cost entrant, since all entrants will bid similarly in a function that's monotonically increasing as a function of their cost. Note that in Lemma 6(b), the incumbent's bid and entrants' bids decrease as n increases. Thus, as entrants are driven away, the incumbent and the entrants both raise their prices.

In Lemma 6(c), as the incumbent is re-awarded, some bidders are driven away. This scenario is an amplification of the result found in the base model with two bidders but generates the same results.

3.4 Extensions

In this section, we discuss several extensions for out model. First, we explain the impact of switching cost on our model. Second, we discuss the alternative of subsidizing a bidder instead of biasing to prevent defection.

3.4.1 Switching Cost

Our previous analysis in §3.3 did not explicitly mention the potential for the presence of switching cost. Switching cost is defined as the "need for compatibility with existing equipment, transaction costs of switching suppliers, costs of learning to use new brands, uncertainty about the quality of untested brands... and psychological effects of switching" [63]. From this definition, we see two different aspects of switching cost: the first is a physical cost and the second is an intangible cost derived from risk and the "psychological effects of switching." In our model, the term "bias" can be considered as a model of the intangible aspects of switching.

Incorporating a physical switching cost in our model only requires a change in semantics. Instead of i representing only biasing, it would represent the sum of the biasing and the switching cost. For example, if the switching cost is s, the case of $i = 0$ is the same as biasing by $-s$. Similarly, "no bias" would mean that $i = s$. This does not change the results of our model.

3.4.2 Alternative Methods to Prevent Defection

In our model, we presented the case where to prevent defection, a biasing factor, i, was used. Another means to prevent defection would be to artificially decrease e_2 by subsidizing all or a portion of the bidder's cost of effort to bid. For example, if a portion of the cost to bid is the cost for bidders to travel to the buyer's location, the buyer might subsidize this cost to encourage participation. What this process does is shift Firm 2 along the x-axis of Figure 8, as shown in Figure 10.

The process of subsidizing all or a portion of the bidder's cost of effort to bid differs from the method described in §3.3.1, which is graphically shown in Figure 11, because subsidizing e_2 does not impact the bids offered by Firm 1 or Firm 2. In contrast, i factors into the bids. However, i can lower bids. For example, in Stage 2 the incumbent's (entrant's) bid decreases with a negative (positive) i. Even if i increases a bid, the bid increases by a fraction of i.

Example 1 *Consider a case of* $c_1 = 0.3$, $c_2 = 0.4$, $e_1 = e_2 = 0.02$. *First, consider a*

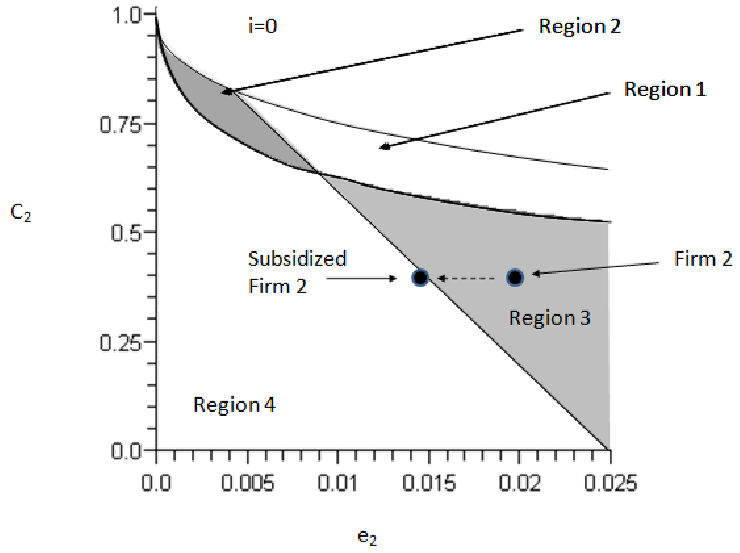

Figure 10: This figure shows how a Firm in Region [3] can be subsidized to Region [4]. In this case, Firm 2 has $c_2 = 0.4$ and $e_2 = 0.02$ and is subsidized to $e_2 = 0.015$ to reach Region [4].

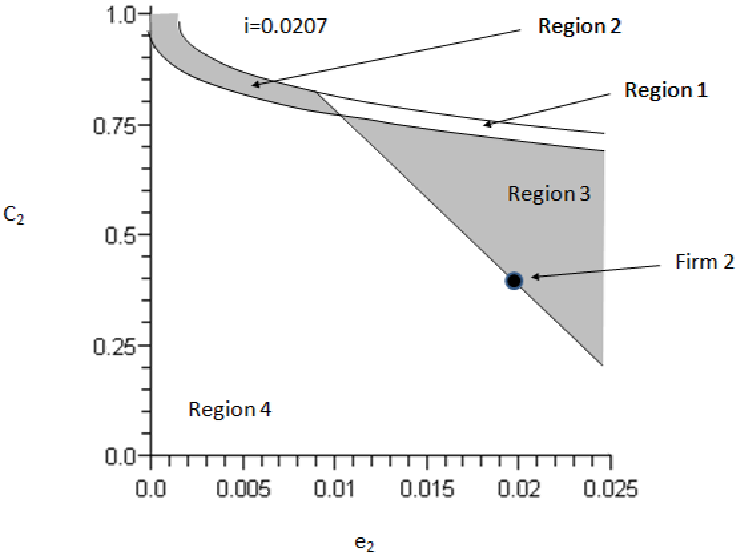

Figure 11: In this figure, rather than subsidizing Firm 2, a value of $i = 0.0206$ is applied, which shifts the boundary of Region [4] such that Firm 2 falls within this region.

case where $i = 0$ *and the buyer awards to the low bidder in each stage (myopic buyer). In that case, the bids in Stage* 1 *are* $b_{1,1} = 0.65$ *and* $b_{2,1} = 0.70$ *and Firm* 1 *wins. The bids in Stage* 2 *are then* $b_{1,2} = 0.65$ *and* $b_{2,2} = 0.55$ *and Firm* 2 *wins. Because Firm* 2 *is in Region* [3]*, Firm* 2 *defects and Firm* 1 *wins with* $b_{1,3} = 1$*. The total cost is therefore* $b_{1,1} + b_{2,2} + b_{1,3} = 2.2$*.*

As an alternative, the buyer could subsidize e_2 *to prevent defection. In that case, the bids in Stages* 1 *and* 2 *are the same. However, to prevent defection in Stage* 3*, the buyer subsidizes Firm* 2 *so that he participates. The maximum* e_2 *that will participate in Stage* 3 *is* $e_2 = 0.015$*. Therefore, the buyer incurs cost* 0.05*. The bids in Stage* 3 *are then* $b_{1,3} = 0.44$ *and* $b_{2,3} = 0.46$ *and Firm* 1 *is selected. The total cost is therefore* $b_{1,1} + b_{2,2} + b_{1,3} + 0.05 = 1.69$*.*

Alternatively, the buyer can bias instead of subsidizing e_2*. The biasing factor that would move the boundary of Region* [4] *to include Firm* 2 *is* $i = 0.0206$*. Incorporating this factor leads to the same bids in Stage* 1*. The bids in Stage* 2 *are then* $b_{1,2} = 0.657$ *and* $b_{2,2} = 0.543$ *and Firm* 2 *wins at a lower bid than in previous alternatives. The bids in Stage* 3 *are then* $b_{1,3} = 0.444$ *and* $b_{2,3} = 0.472$ *and Firm* 1 *is selected at a higher cost than in the subsidization alternative. The total cost is therefore* $b_{1,1}+b_{2,2}+b_{1,3}+0.05 = 1.637$*, which is approximately* 3% *less than in the case of subsidization.*

Another method of subsidization that the buyer could use would be to subsidize c_2. Instead of moving a firm in Regions [2] or [3] along the x-axis in Figure 8, subsidizing c_2 moves a supplier along the y-axis. This subsidization could occur two ways: it could be unknown or known to the high cost bidder.

In the case where it is unknown to the high-cost bidder, there is no difference between this method and the case with announced bias, where the amount of subsidization is equal to i. In such a case, subsidization would not be preferred as the subsidy is a cost to the buyer, while a bias is not.

In the case where it is known by all bidders that subsidization of the high-cost bidder will occur, the subsidy will decrease the learning of the bidders. The first stage will occur as specified in §3.3 so that the high- and low-cost firms can be identified. Then, based on the

costs, the subsidy may or may not be applied in Stage 2. If no subsidy is applied, the bidding is identical to the model in §3.3 for the second stage. If a subsidy is applied, Firm 1 has no information about the newly subsidized cost of Firm 2 and has a belief that the subsidized cost of Firm 2 (hereafter c_2^s) is distributed $U[0,1]$. Firm 2 still has information about c_1 relative to the unsubsidized c_2, and therefore bids as a function of c_2^s and c_2. In practice, there are examples of buyers that actively attempt to reduce the cost of suppliers. Toyota, for example, will send engineers to suppliers and may spend a year or more evaluating and recommending cost reduction measures (Dyer 1996). However, that process is restricted to suppliers that innovate and in cases where there is already a long-term commitment in place such that a reduction in supplier's cost is also a reduction in buyer's cost. This is not the case in our model.

In our setting, it is unlikely that the buying firm will choose a cost subsidy over biasing. First, the cost subsidy will be costly to the buying firm since it will require the allocation of process improvement personnel to assist with the higher cost supplier's process. Second, the low cost supplier could react negatively to this type of involvement with a competitive firm, perhaps even bringing legal action if they suspect the buying firm is sharing some of the low cost supplier's technology or trade secrets. Thus, we defer any further exploration of this option to future work.

3.5 Discussion

In this work, we have reviewed the case of repeat interaction bidding between a low cost and high cost bidders that periodically compete to supply the same contract. Previous literature has suggested either biasing toward an incumbent to reduce risk (i.e. cost) or biasing toward an entrant to encourage entrants to continue to participate and to place pressure on the incumbent. We bridge these recommendations by showing that either entrant or incumbent biasing may be preferred based on the characteristics of the entrant. We characterize entrants by their cost of effort to bid in a stage and their cost to supply the contract (relative to some maximum allowable bid). We find the counterintuitive result that an high cost bidder may defect in the future even if he is awarded the contract. This

result leads to the following findings:

While the intuitive approach would be to entrant bias if the entrant has a high effort to bid and incumbent bias if the entrant has a low effort to bid, we find the opposite. This answers our first research question of whether incumbent or entrant biasing is effective. We show that both can be effective and give the conditions for this: when the entrant has a low effort and high cost, the buyer should bias toward the entrant. This is done because the entrant risks defection in future stages since his high cost means that the incumbent is likely to have a large advantage. Biasing toward an entrant decreases the potential advantage of the incumbent and encourages further participation of the entrant for future bids. In the case of a high cost of effort to bid and a low cost entrant, the buyer should bias toward the incumbent. This is done because once an incumbent loses, he "slashes" his price in future stages. Knowing that the incumbent will slash his price, the entrant will opt out of future stages leaving the incumbent to charge monopoly prices.

One aspect of our model which was also evaluated involved the announcement of the biasing factor i. To evaluate the assumption that i was announced and publicly known, we evaluated an alternative model where biasing was not announced but could be identified by the bidders through the awarding decisions. This model resulted in bidders reducing the support of other bidder's cost distribution at a slower rate, but did not change the results of our model. Details concerning this alternative model are available from the authors upon request.

3.5.1 Managerial Insights

In this paper, we have provided clear insights for managers when repeated interaction procurement occurs. First, we indicate whether to incumbent or entrant bias, then we provide strategies for how this biasing should occur. Our results, resolve conflicting advice in the literature. Rather than recommending a standard "bias toward an incumbent" or "bias toward an entrant" recommendation, we show that both strategies can be correct, depending on the cost to supply the contract and the effort to bid for the entrant bidders.

In Figure 12, we show the counterintuitive result that biasing toward the entrant and

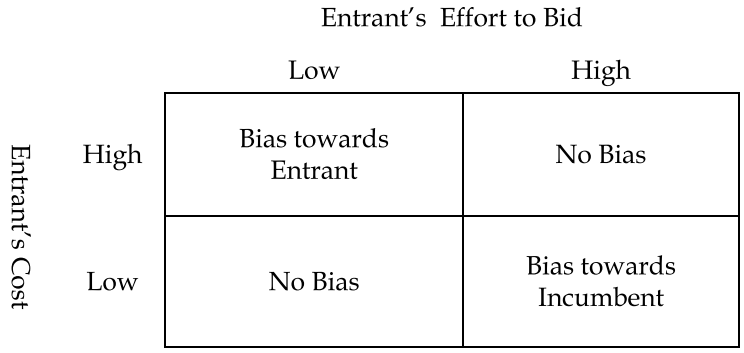

Figure 12: How the buyer should bias based on Firm 2's cost to supply the contract and cost of effort to bid

biasing toward the incumbent can both be optimal, depending on the effort to bid and the cost to supply the contract for the high cost bidder (Firm 2). In the case where the cost of effort to bid is high and costs are relatively low compared to the maximum potential bid, biasing toward an incumbent is preferred. In the case where the cost of effort to bid is low and the entrant cost is close to the reservation price, biasing toward an entrant is preferred. Thus, the simple framework above bridges the previous recommendations from practice and academia.

CHAPTER IV

CONCLUSIONS

In this work, we have shown the impact of Proposed Commitment on Procurement Performance. Specifically, that Proposed Commitment is positively correlated with Procurement Performance and that this relationship is fully mediated by Focused Commitment Strategy. Simultaneously, we have shown that the practice of Incumbent Biasing impacts Proposed Commitment through two mechanisms: a negative relationship mediated by Bidding Competitiveness and a positive relationship by moderating the relationship between Proposed Commitment and Focused Commitment Strategy. We have shown that neither relationship strictly dominates: the net effect shifts from positive to negative based on the level of Proposed Commitment. At high levels of Proposed Commitment (e.g. longer contracts or more joint investment), the net effect is positive: the benefit of Incumbent Biasing on incentive-alignment outweighs the detrimental effect Incumbent Biasing has on bidding competitiveness. When Proposed Commitment is lower, the opposite effect is seen. This result provides guidance for managers to foster their chosen relationship. If they choose to establish long-term relationships they should Incumbent Bias. If they choose to establish short-term, competitive relationships they should not Incumbent Bias. This is the first work to show that Incumbent Biasing can be an effective policy and under what conditions this is the case.

In conjunction with the analysis of incumbent biasing, we also tested the impact of Multi-Sourcing on a procurement relationship. We found that Multi-Sourcing has no interaction with Incumbent Biasing and the two strategies can be viewed independently. Further, we found that Multi-Sourcing has no impact on the overall Procurement Performance. This lack of a relationship, which was shown with high statistical power, indicates that the benefits of Multi-Sourcing found in the JIT literature primarily arise from events such as the failure of a supplier. During an existing relationship, there is no impact on the

Competitiveness of Bidding for a contract or on a Buyer's Power.

Further, this work is the first to relate the perceptual metric of Procurement Performance to overall firm performance via a secondary data analysis. We demonstrate that a firm's perception of their procurement relationship has a statistically significant impact on overall firm performance over time. This validates our perceptual metric and demonstrates the importance of procurement to a firm's financial performance.

In addition to empirically showing the relationship between Incumbent Biasing and Procurement Performance via the Competitiveness of Bidding, we analytically model the relationship between a buyer and a series of suppliers to see how such a biasing policy should be used. Our results resolve conflicting advice in the literature and show that either biasing towards an incumbent or biasing towards an entrant can be optimal, depending on the cost to supply the contract and the effort to bid for the entrant bidders. Using the information presented in Figure 12, managers will be able to determine their best strategy for biasing, whether towards an entrant or towards an incumbent.

To summarize, this dissertation shows managers when and why incumbent biasing will have a positive impact on procurement performance, how to bias if they choose to do so, and that success in procurement performance has a positive impact on firm performance.

APPENDIX A

PROOFS

Proof of Lemma 1 Before the first bids are placed, Firm 1 has the belief that $c_2 \sim U[0,1]$ and Firm 2 has the belief that $c_1 \sim U[0,1]$. Firm 1 has the objective:

$$\mathop{\mathbb{E}}_{b_{2,1}}[\Pi_{1,1}(b_{1,1})] = (b_{1,1} - c_1)Pr(b_{1,1} < b_{2,1}) - e_1 \tag{9}$$

We state that firms bid as a linear function of their cost and that this leads to a stable equilibrium. To show that this is a stable equilibrium, we first begin with the assumption that each firm bids as a linear function of his cost (i.e. $b_{k,1} = \alpha_{k,1} + \beta_{k,1}c_k$ for $k\epsilon\{1,2\}$, where $\alpha_{k,1}$ and $\beta_{k,1}$ are constants) and solve for the parameters of that function (i.e. $\alpha_{k,1}$, $\beta_{k,1}$). We then show that the resulting $\alpha_{k,1}$ and $\beta_{k,1}$ values are independent of c_k and thus that the initial assumption of a linear bid function is stable.

To show this, we insert the linear bidding function for Firm 2 in Stage 1 ($b_{2,1} = \alpha_{2,1} + \beta_{2,1}c_2$) into Firm 1's objective function shown in 9. This leads to Firm 1's objective of $\mathbb{E}_{c_2}[\Pi_{1,1}(b_{1,1})] = (b_{1,1} - c_1)(1 - Pr(c_2 < \frac{b_{1,1}-\alpha_{2,1}}{\beta_{2,1}})) - e_1$. Since we have a distribution for c_2, we can use the CDF to solve for the probability that c_2 is less than the value in the expectation. This yields:

$$\mathop{\mathbb{E}}_{c_2}[\Pi_{1,1}(b_{1,1})] = (b_{1,1} - c_1)(1 - \frac{b_{1,1} - \alpha_{2,1}}{\beta_{2,1}}) - e_1 \tag{10}$$

The first derivative of 10 is $\frac{d}{db_{1,1}}\mathbb{E}_{c_2}[\Pi_{1,1}(b_{1,1})] = \frac{\beta_{2,1}-2b_{1,1}+\alpha_{2,1}+c_1}{\beta_{2,1}}$. Solving for the first order condition for $b_{1,1}$ yields $b_{1,1} = \frac{1}{2}\beta_{2,1} + \frac{1}{2}\alpha_{2,1} + \frac{1}{2}c_1$. Since Firm 1 also bids from a linear function of his cost ($b_{1,1} = \alpha_{1,1} + \beta_{1,1}c_1$), we find that $\alpha_{1,1} = \frac{1}{2}\beta_{2,1} + \frac{1}{2}\alpha_{2,1}$ and $\beta_{1,1} = \frac{1}{2}$.

To show that the expected profit for Firm 1 is concave in the bid of Firm 1, and thus that the above is an expected profit maximizer, we solve for the second order condition. We find that $\frac{d^2}{db_{1,1}^2}\mathbb{E}_{c_2}[\Pi_{1,1}(b_{1,1})] = \frac{-2}{\beta_{2,1}}$. This function is negative for all positive values of $\beta_{2,1}$. Thus if $\beta_{2,1} > 0$, the above bid is an expected profit maximizer for Firm 1.

Because Firm 1 and Firm 2 have symmetric beliefs of the other bidder's cost, the solution for Firm 2 follows from Firm 1: $\alpha_{2,1} = \frac{1}{2}\beta_{1,1} + \frac{1}{2}\alpha_{1,1}$ and $\beta_{2,1} = \frac{1}{2}$. Firm 2 also has the condition that these parameters maximize expected profit if $\beta_{1,1} > 0$.

Solving simultaneously for $\alpha_{1,1}$, $\beta_{1,1}$, $\alpha_{2,1}$, and $\beta_{2,1}$ leads to $\alpha_{1,1} = \beta_{1,1} = \alpha_{2,1} = \beta_{2,1} = \frac{1}{2}$, which leads to bids $b_{1,1} = \frac{1}{2} + \frac{1}{2}c_1$ and $b_{2,1} = \frac{1}{2} + \frac{1}{2}c_2$. Since $\beta_{1,1} = \beta_{2,1} > 0$, these parameters maximize the expected profit of Firm 1 and Firm 2. Also, since $\alpha_{1,1}$, $\beta_{1,1}$, $\alpha_{2,1}$, and $\beta_{2,1}$ are all independent of c_1 and c_2, the use of linear bid structures leads to a stable equilibrium. ■

Proof of Lemma 2 (a) From Lemma 1, we see that the bids in Stage 1 are $b_{1,1} = \frac{1}{2} + \frac{1}{2}c_1$ and $b_{2,1} = \frac{1}{2} + \frac{1}{2}c_2$. Based on this, $b_{1,1} = \frac{1}{2} + \frac{1}{2}c_1 < b_{2,1} = \frac{1}{2} + \frac{1}{2}c_2$, leading to the information updating that both firms believe that $c_1 < c_2$.

Incorporating the resulting bids from this section and calculating the total cost for the buyer, it can be seen that if $2c_2 + c_1 > 1 + \frac{2}{3}i$, then the buyer would always award to the low cost bidder in Stage 1. There are a wide range of values of c_2, c_1, and i that satisfy this inequality.

Continuing, the belief that the low cost bidder wins in Stage 1 results in the updated belief of Firm 1 that $c_2 \sim U[c_1, 1]$ and the updated belief of Firm 2 that $c_1 \sim U[0, c_2]$. Using these beliefs, Firm 1 now has the objective to maximize $\mathbb{E}_{c_2}[\Pi_{1,2}(b_{1,2})] = (b_{1,2} - c_1)Pr(b_{1,2} < b_{2,2} + i) - e_1$.

We again assume that each firm bids as a linear function of cost. For the sake of exposition, we do not state this in future proofs, however the assumption that a linear bid function is stable is proven by the fact that the resulting bid parameters ($\alpha_{k,j}$ and $\beta_{k,j}$ for Firm k in Stage j) are independent of c_k.

The expected profit of Firm 1 can be augmented with Firm 2's bid parameters to be $\mathbb{E}_{c_2}[\Pi_{1,2}(b_{1,2})] = (b_{1,2} - c_1)(1 - Pr(c_2 < \frac{b_{1,2} - \alpha_{2,2} - i}{\beta_{2,2}})) - e_1$. Substituting the CDF of a $U[c_1, 1]$ distributed variable for c_2 yields: $\mathbb{E}_{c_2}[\Pi_{1,2}(b_{1,2})] = (b_{1,2} - c_1)(1 - \frac{b_{1,2} - \alpha_{2,2} - i}{\beta_{2,2}(1 - c_1)} + \frac{c_1}{1 - c_1}) - e_1$. Solving the first order condition for this function for $b_{1,2}$ yields $b_{1,2} = \frac{1}{2}\beta_{2,2} + \frac{1}{2}\alpha_{2,2} + \frac{1}{2}i + \frac{1}{2}c_1$, which leads to $\alpha_{1,2} = \frac{1}{2}\beta_{2,2} + \frac{1}{2}\alpha_{2,2} + \frac{1}{2}i$ and $\beta_{1,2} = \frac{1}{2}$.

To verify that the first order condition leads to an expected profit maximizer for Firm 1,

we solve for the second order condition. $\frac{d^2}{db_{1,2}^2}\mathbb{E}_{c_2}[\Pi_{1,2}(b_{1,2})] = \frac{-2}{\beta_{2,2}c_1}$. Since c_1 is positive and we will show later that $\beta_{2,2}$ is positive, the second order condition shows that the expected profit function for Firm 1 in Stage 2 is concave.

We solve for the parameters of $b_{2,2}$ similarly, except we begin with the expected profit function of $\mathbb{E}_{c_1}[\Pi_{2,2}(b_{2,2})] = (b_{2,2} - c_2)Pr(b_{2,2} + i < b_{1,2}) - e_2$ and use the CDF of a $U[0, c_2]$ variable in place of c_1. This yields $\alpha_{2,2} = \frac{1}{2}\alpha_{1,2} - \frac{1}{2}i$ and $\beta_{2,2} = \frac{\beta_{1,2}+1}{2}$.

Solving simultaneously for $\alpha_{1,2}$, $\beta_{1,2}$, $\alpha_{2,2}$, and $\beta_{2,2}$ leads to $\alpha_{1,2} = \frac{1}{2} + \frac{1}{3}i$, $\beta_{1,2} = \frac{1}{2}$, $\alpha_{2,2} = \frac{1}{4} - \frac{1}{3}i$, and $\beta_{2,2} = \frac{3}{4}$, which leads to bids $b_{1,2} = \frac{1}{2} + \frac{1}{2}c_1 + \frac{1}{3}i$ and $b_{2,2} = \frac{1}{4} + \frac{3}{4}c_2 - \frac{1}{3}i$.

(b) From Part (a), we see that the bids in Stage 2 are $b_{1,2} = \frac{1}{2} + \frac{1}{2}c_1 + \frac{1}{3}i$ and $b_{2,2} = \frac{1}{4} + \frac{3}{4}c_2 - \frac{1}{3}i$. Based on this, $b_{1,2} = \frac{1}{2} + \frac{1}{2}c_1 + \frac{1}{3}i < b_{2,2} = \frac{1}{4} + \frac{3}{4}c_2 - \frac{‘}{3}i$ if $c_1 < -\frac{1}{2} - \frac{4}{3}i + \frac{3}{2}c_2$, leading to the information updating that both firms believe that $c_1 < \frac{-1}{2} - \frac{4}{3}i + \frac{3}{2}c_2$. This results in a belief of Firm 1 that $c_2 \sim U[\frac{6c_1+8i+3}{9}, 1]$ and the belief of Firm 2 that $c_1 \sim U[0, \frac{9c_2-8i-3}{6}]$.

This solution leads to the bids of $b_{1,3} = \frac{1}{2} + \frac{1}{2}c_1 + \frac{1}{9}i$ and $b_{2,3} = \frac{1}{8} + \frac{7}{8}c_2 - \frac{7}{9}i$.

(c) From Part (a), we see that the bids in Stage 2 are $b_{1,2} = \frac{1}{2} + \frac{1}{2}c_1 + \frac{1}{3}i$ and $b_{2,2} = \frac{1}{4} + \frac{3}{4}c_2 - \frac{1}{3}i$. Based on this, $b_{2,2} = \frac{1}{4} + \frac{3}{4}c_2 - \frac{1}{3}i < b_{1,2} = \frac{1}{2} + \frac{1}{2}c_1 + \frac{1}{3}i$ if $c_1 < -\frac{1}{2} - \frac{4}{3}i + \frac{3}{2}c_2$, leading to the information updating that both firms believe that $c_2 < \frac{9c_2-8i-3}{6}$. This results in a belief of Firm 1 that $c_2 \sim U[c_1, \frac{6c_1+8i+3}{9}]$ and the belief of Firm 2 that $c_1 \sim U[\frac{9c_2-8i-3}{6}, c_2]$.

This solution leads to the bids of $b_{1,3} = \frac{1}{5} + \frac{4}{5}c_1 + \frac{1}{5}i$ and $b_{2,3} = \frac{1}{10} + \frac{9}{10}c_2 + \frac{3}{5}i$.■

Proof of Lemma 3 (a) The threshold effort is determined by setting the expected profit function in Lemma 1 for Firm 1 to zero, then solving for the range of e_2 that leads to no defection.

From Lemma 1, $\mathbb{E}_{c_1}[\Pi_{2,1}(b_{2,1})] = (b_{2,1} - c_2)(1 - \frac{b_{2,1}-\alpha_{1,1}}{\beta_{1,1}}) - e_2$. Also from Lemma 1, we see that $b_{2,1} = \frac{1}{2} + \frac{1}{2}c_2$, $\alpha_{1,1} = \frac{1}{2}$, and $\beta_{1,1} = \frac{1}{2}$. Substituting these values leads to a function of $\mathbb{E}_{c_1}[\Pi_{2,1}(b_{2,1})] = \frac{(1-c_2)^2}{2} - e_2$. With our previous assumption that bids only occur for a positive expected profit, $\frac{(1-c_2)^2}{2} - e_2 \geq 0$ and solve for e_2.

Parts (b), (c), and (d) follow directly from Part (a).■

Proof of Lemma 4 To prove this lemma, we first assume the case that awarding to one of the two bidders leads to defection after the second stage. Then we show that given this

outcome, there is a higher cost over all three stages to choose the low cost bidder in Stage 2 and allow defection than to choose the high cost bidder in the second stage to prevent defection. Part (a) shows this for the assumption that an incumbent award in Stage 2 leads to defection in Stage 3 and Part (b) shows this for the assumption that an entrant award in Stage 2 leads to defection in Stage 3.

(a) To review, our model provides the following limits for each variable: $0 \leq c_1 \leq c_2 \leq 1$, $0 \leq e_2 \leq 1$, $-1 \leq i \leq 1$.

First, we assume that after awarding to Firm 1 in Stage 1, an award to Firm 1 leads to defection of Firm 2 in Stage 3. Therefore, over three stages the buyer would pay $b_{1,1}(c_1) = \frac{1}{2} + \frac{1}{2}c_1$ in the first stage, $b_{1,2}(c_1) = \frac{1}{2} + \frac{1}{2}c_1 + \frac{1}{3}i$ in the second stage and $b_{1,3} = 1$ in the third stage (the reservation price since there is only one bidder). These are added to be $2 + c_1 + \frac{1}{9}i$.

The alternative to awarding to Firm 1 in Stage 2 is to award to Firm 2. If this occurs, the buyer would pay $b_{1,1}(c_1) = \frac{1}{2} + \frac{1}{2}c_1$ in Stage 1, $b_{2,2}(c_2) = \frac{3}{4} + \frac{1}{4}c_2 - \frac{1}{3}i$ in Stage 2, and $\min\{b_{1,3}(c_1) = \frac{1}{5} + \frac{4}{5}c_1 + \frac{1}{5}i, b_{2,3}(c_2) = \frac{1}{10} + \frac{9}{10}c_1 + \frac{3}{5}i\}$ in Stage 3. These combine to be $\min\{\frac{19}{20} + \frac{13}{10}c_1 + \frac{3}{4}c_2 - \frac{2}{15}i, \frac{17}{20} + \frac{1}{2}c_1 + \frac{33}{20}c_2 + \frac{4}{15}i\}$.

If we prove that either term in the MIN function is always less $2 + c_1 + \frac{1}{9}i$, we prove our argument. Therefore, we choose to evaluate the first term ($\frac{19}{20} + \frac{13}{10}c_1 + \frac{3}{4}c_2 - \frac{2}{15}i$).

For defection to be optimal, $2 + c_1 + \frac{1}{9}i < \frac{19}{20} + \frac{13}{10}c_1 + \frac{3}{4}c_2 - \frac{2}{15}i$ must hold. This function can be rearranged to $c_2 > \frac{7}{5} - \frac{2}{5}c_1 + \frac{28}{45}i$. For all values of $i > 0$ and $0 \leq c_1 \leq 1$, $\frac{7}{5} - \frac{2}{5}c_1 + \frac{28}{45}i > 1$, leading to the condition $c_2 > \frac{7}{5} - \frac{2}{5}c_1 + \frac{28}{45}i > 1$ or $c_2 > 1$. Since $c_2 \leq 1$, this condition does not hold. Therefore, it is not optimal to allow defection if defection is caused by awarding to the incumbent in Stage 2 if $i > 0$.

Another requirement for c_2 can be found from Lemma 3: rearranging the $e_{2,2}^{threshold}$ equation and solving for the maximum value of c_2 (as a function of e_2) that would participate, we see that to participate $c_2 \leq 1 + 4e_2 - \frac{4}{3}i - \frac{2}{3}\sqrt{36e_2^2 + 18e_2 - 24e_2 i}$. If this requirement does not hold, Firm 2 does not participate in Stage 2, violating the original assumption that there are two bidders in Stage 2. Thus, if $1 + 4e_2 - \frac{4}{3}i - \frac{2}{3}\sqrt{36e_2^2 + 18e_2 - 24e_2 i} \leq \frac{7}{5} - \frac{2}{5}c_1 + \frac{28}{45}i$, all values of c_2 that participate in Stage 2 would yield the same or higher cost if defection

occurs rather than awarding to the high cost bidder in Stage 2. Rearranging this inequality yields $c_1 \leq 1 - \frac{16}{9}i - 10e_2 + \frac{5}{3}\sqrt{36e_2^2 + 18e_2 - 24e_2 i}$. For all values of $i \leq 0$ and $0 \leq e_2 \leq 1$, the right side of the inequality is greater than or equal to 1. Since $c_1 \leq 1$ by definition, the condition $1 + 4e_2 - \frac{4}{3}i - \frac{2}{3}\sqrt{36e_2^2 + 18e_2 - 24e_2 i} \leq \frac{7}{5} - \frac{2}{5}c_1 + \frac{28}{45}i$ holds, and it is not optimal to allow defection if defection is caused by awarding to the incumbent in Stage 2 if $i \leq 0$. Thus, it is not optimal to allow defection if defection is caused by awarding to the incumbent in Stage 2.

(b) Continuing with our proof, we now consider the case of defection caused by awarding to the entrant in Stage 2.

We assume that after awarding to Firm 1 in Stage 1, an award to the entrant (Firm 2) leads to defection of Firm 2 in Stage 3. Therefore, the buyer would pay $b_{1,1}(c_1) = \frac{1}{2} + \frac{1}{2}c_1$ in the first stage, $b_{2,2}(c_2) = \frac{1}{4} + \frac{3}{4}c_2 - \frac{1}{3}i$ in the second stage and $b_{1,3} = 1$ in the third stage (the reservation price since there is only one bidder). These are added to be $\frac{7}{4} + \frac{1}{2}c_1 + \frac{3}{4}c_2 - \frac{1}{3}i$.

The alternative to awarding to Firm 2 in Stage 2 is to award to Firm 1 in Stage 2. If this occurs, the buyer would pay $b_{1,1}(c_1) = \frac{1}{2} + \frac{1}{2}c_1$ in Stage 1, $b_{1,2}(c_1) = \frac{1}{2} + \frac{1}{2}c_1 + \frac{1}{3}i$ in Stage 2, and $\min\{b_{1,3}(c_1) = \frac{1}{2} + \frac{1}{2}c_1 + \frac{1}{9}i, b_{2,3}(c_2) = \frac{1}{8} + \frac{7}{8}c_2 - \frac{7}{9}i\}$ in Stage 3. These combine to be $\min\{\frac{3}{2} + \frac{3}{2}c_1 + \frac{4}{9}i, \frac{9}{8} + c_1 + \frac{7}{8}c_2 - \frac{4}{9}i\}$.

If we prove that either term in the MIN function is always less $\frac{7}{4} + \frac{1}{2}c_1 + \frac{3}{4}c_2 - \frac{1}{3}i$, we prove our argument. Therefore, we choose to evaluate the second term ($\frac{9}{8} + c_1 + \frac{7}{8}c_2 - \frac{4}{9}i$).

For defection to be optimal, $\frac{7}{4} + \frac{1}{2}c_1 + \frac{3}{4}c_2 - \frac{1}{3}i < \frac{9}{8} + c_1 + \frac{7}{8}c_2 - \frac{4}{9}i$ must hold. This function can be rearranged to $c_2 > 5 - 4c_1 + \frac{8}{9}i$. Since c_1 $leq1$, $5 - 4c_1 + \frac{8}{9}i > 1$ for all values of $i > 0$. Since $c_2 \leq 1$ by definition, $\frac{7}{4} + \frac{1}{2}c_1 + \frac{3}{4}c_2 - \frac{1}{3}i < \frac{9}{8} + c_1 + \frac{7}{8}c_2 - \frac{4}{9}i$ does not hold if $i > 0$ and thus it is not optimal to allow defection if defection is caused by awarding to an entrant in Stage 2 and $i > 0$.

Another requirement for c_2 is that, from Lemma 3 (using the logic as in section (a)), $c_2 \leq 1 + 24e_2 + \frac{56}{9}i - \frac{4}{3}\sqrt{324e_2^2 + 18e_2 - 192e_2 i}$. If this requirement does not hold, Firm 2 does not participate in Stage 3, violating the original assumption that there are two bidders in Stage 3. Thus, if $1 + 24e_2 + \frac{56}{9}i - \frac{4}{3}\sqrt{324e_2^2 + 18e_2 - 192e_2 i} \leq 5 - 4c_1 + \frac{8}{9}i$, all values of c_2 that participate in Stage 3 would yield the same or higher cost if defection occurs

rather than awarding to the high cost bidder in Stage 2. Rearranging this inequality yields $c_1 \leq 1 - \frac{4}{3}i - 6e_2 + \frac{1}{3}\sqrt{324e_2^2 + 18e_2 - 192e_2 i}$. For all values of $i \leq 0$ and $0 \leq e_2 \leq 1$, the right side of the inequality is greater than or equal to 1. Since $c_1 \leq 1$ by definition, the condition $1 + 24e_2 + \frac{56}{9}i - \frac{4}{3}\sqrt{324e_2^2 + 18e_2 - 192e_2 i} \leq 5 - 4c_1 + \frac{8}{9}i$ holds, and it is not optimal to allow defection if defection is caused by awarding to the incumbent in Stage 2 if $i \leq 0$. Thus, it is not optimal to allow defection if defection is caused by awarding to the incumbent in Stage 2.

Combining the findings of Part (a) and Part (b) show that if awarding to one bidder in Stage 2 leads to defection, it leads to lower cost to award to the other bidder in Stage 2, even if that leads to a higher cost in Stage 2.■

Proof of Proposition 1 This proof follows directly from the fact that it is never optimal to allow defection in Stage 3 (Lemma 4). To prevent defection, the high cost bidder (Firm 2) must have a c_2 and e_2 such that Firm 2 falls into Region [4]. For a given effort, a firm can only be in Region [4] if his cost c_2 is below both below the cost for a corresponding threshold effort threshold values from Lemma 3(c) from Lemma 3(d).

The reason a boundary condition for Region [4] will be optimal is because, from Lemma 2, all bids are linear with respect to i. Since the total cost of the buyer is a sum of these bids, the total cost of the buyer is linear with respect to i. A total cost function that is linear with respect to i will be minimized at a boundary condition.■

Proof of Lemma 5 (a) Firm k earns profit $(b_{k,1} - c_k)$ if Firm k wins. Firm k wins if he underbids the competition, i.e. if $b_{k,1} < b_{-k,1} \forall \{-k \epsilon 1, 2, .., n+1 : -k \neq k\}$. This translates to $\mathbb{E}_{c_{-k}}[\Pi_{k,1}(b_{k,1})] = (b_{k,1} - c_k) Pr\{b_{k,1}(c_1) < b_{2,1}(c_2)\} Pr\{b_{k,1}(c_1) < b_{3,1}(c_3)\} ... Pr\{b_{k,1}(c_1) < b_{n+1,1}(c_{n+1})\} - e_k$.

In the first stage, each firm has symmetric belief about his competitors, specifically that c_{-k}, where the subscript $-k$ denotes all other firms, is uniformly distributed with support in $[0, 1]$. This leads to the simplification that $\mathbb{E}_{c_{-1}}[\Pi_{k,1}(b_{k,1})] = (b_{k,1} - c_k) Pr\{b_{k,1}(c_k) < b_{-k,1}(c_{-k})\}^n - e_k$. Using the method from Lemma 1, we assume that firms bid from a function $b_{-k,1} = \alpha_{-k,1} + \beta_{-k,1} c_{-k}$. Taking first order condition relative to $b_{k,1}$, leads to $b_{k,1} = \frac{\beta_{-k,1} + \alpha_{-k,1} + n c_k}{1-n}$. Since all firms have symmetric beliefs at this stage, $\alpha_{k,1} = \alpha_{-k,1}$ and

$\beta_{k,1} = \beta_{-k,1}$. Solving for these values therefore leads to the bid of $b_{k,1}(c_k) = \frac{1}{1+n} + \frac{n}{1+n}c_k$.

To show concavity of the expected profit function, the second order condition with respect to $b_{k,1}$ after substituting $\beta_{-k,1} = \frac{n}{1+n}$, $\alpha_{-k,1} = \frac{1}{1+n}$, and $b_{k,1}(c_k) = \frac{1}{1+n} + \frac{n}{1+n}c_k$ is $\frac{d^2}{db_{k,1}^2}\mathbb{E}_{c_{-k}}[\Pi_{k,1}(b_{k,1})] = -\frac{(1+n)^2(1-c_k)^{n-1}}{n}$. Since n is always positive, $(1+n)^2$ is always positive, and $(1-c_k)$ is always positive, the second order condition shows expected profit function is concave.

(b) This proof follows directly from Lemma 2. Following an award to Firm *inc*, Firm *inc* has a belief that all other firms have a cost distributed $c_{ent} \sim U[c_{inc}, 1]$ and all other firms have a belief that Firm *inc* has a cost distributed $c_{inc} \sim U[0, c_{ent}]$. The firms that did not win do not have updated information about the other firms that did not win.

Given these beliefs, Firm *inc* has an expected profit $\mathbb{E}_{c_{ent}}[\Pi_{inc,2}(b_{inc,2})] = (b_{inc,2} - c_{inc})Pr\{b_{inc,2}(c_{inc}) < b_{ent,2}(c_{ent})\}^n - e_{inc} = (b_{inc,2} - c_{inc})(1 - \frac{b_{inc,2}-\alpha_{ent,2}}{(1-c_{inc})\beta_{ent,2}} + \frac{c_{inc}}{1-c_{inc}})^n - e_{inc}$ and all other firms have expected profit that consists of a component of bidding lower than the incumbent and being lower cost than the other non-incumbents (since all non-incumbents would bid from the same bidding function that is monotonically increasing in cost) $\mathbb{E}_{c_{inc}}[\Pi_{ent,2}(b_{ent,2})] = (b_{ent,2} - c_{ent})Pr\{b_{ent,2}(c_{ent}) < b_{inc,2}(c_{inc})\}(1 - c_{ent})^{n-1} - e_{ent} = (b_{ent,2} - c_{ent})(1 - \frac{b_{ent,2}-\alpha_{inc,2}}{\beta_{inc,2}c_{ent,2}})(1 - c_{ent})^{n-1} - e_{ent}$.

We then follow the solution procedure outlined in Lemma 2 to obtain the bids $b_{inc,2}(c_{inc}, n) = \frac{n}{n+1}c_{inc} + \frac{1}{1+n}$ and $b_{ent,2}(c_{ent}, n) = \frac{2n+1}{2(n+1)}c_{ent} + \frac{1}{2(1+n)}$.

(c) This proof follows directly Part (b). ■

APPENDIX B

SURVEY INSTRUMENT

CONSENT DOCUMENT FOR ENROLLING ADULT PARTICIPANTS IN A RESEARCH STUDY

Georgia Institute of Technology

Project Title: Factors for Procurement Success and the Role of Repeat Incumbent Awarding

Investigator: Soumen Ghosh and Christopher Held

Protocol and Consent Title: Factors for Procurement Success and the Role of Repeat

You are being asked to be a volunteer in a research study.

Purpose: The purpose of this study is to investigate long-term vs. short-term buyer-supplier relationships in procurement, specifically the phenomenon of using a short-term strategy but repeatedly awarding contracts to one incumbent supplier.

Exclusion/Inclusion Criteria: This study is limited to procurement managers and executives directly involved in the contract awarding decision in a business-to-business setting.

Procedures: You will be asked to answer 24 questions regarding procurement awarding decisions. It is anticipated that this survey will take 10 minutes to complete.

Risks or Discomforts: The risks involved are no greater than those involved in daily activities such as using a computer to complete forms.

Benefits: There is no direct benefit to you, however at your request, you will be sent a copy of a white paper discussing the results from this study and how the results can benefit procurement managers.

Compensation to You: Following the completion of this survey, you may request a benchmarking report comparing your responses to other respondents in your industry. You may also be randomly selected to receive a $20 gift certificate usable at Amazon.com. Participation in this survey is not required to be entered in the drawing. To enter the drawing without completing the survey, please send an email, including your name, email address, telephone number, and mailing address to Christopher.Held@mgt.gatech.edu requesting to be entered in the 2011 Procurement Survey drawing. Only one entry is allowed per person.

Your contact information including email address may be collected for compensation purposes only. This information will be shared only with the Georgia Tech department that issues compensation for your participation.

Confidentiality: To ensure confidentiality, no information about you will be collected by the researchers associated with this study. Following completion of the study, you may volunteer to submit your name and contact information to receive a benchmarking study. If you choose to enter your contact information, your name and contact information will not be associated with your answers in order to identify your industry and answers to prepare the benchmarking report. Your privacy will be protected to the extent allowed by law. To make sure that this research is being carried out in the proper way, the Georgia Institute of Technology IRB may review study records. The Office of Human Research Protections and/or the Food and Drug Administration may also look over study records during required reviews.

You should be aware that the experiment is not being run from a 'secure' https server of the kind typically used to handle credit card transactions, so there is a small possibility that responses could be viewed by unauthorized third parties such as computer hackers. In general, the web page software will log as header lines the IP address of the machine you use to access this page, e.g.,102.403.506.807, but otherwise no other information will be stored unless you explicitly enter it.

Costs to You: There are no costs to you, other than your time and the cost of

internet access, for being in this study.

In Case of Injury/Harm: If you are injured as a result of being in this study, please contact Principal Investigator, Soumen Ghosh, at telephone (404) 385-4927. Neither the Principal Investigator nor Georgia Institute of Technology has made provision for payment of costs associated with any injury resulting from participation in this study.

Participant Rights:

· Your participation in this study is voluntary. You do not have to be in this study if you don't want to be.

· You have the right to change your mind and leave the study at any time without giving any reason and without penalty.

· Any new information that may make you change your mind about being in this study will be given to you.

· You will be given a copy of this consent form to keep.

· You do not waive any of your legal rights by signing this consent form.

Questions about the Study: If you have any questions about the study, you may contact Soumen Ghosh at telephone (404) 385-4927 or Soumen.Ghosh@mgt.gatech.edu or Christopher Held at telephone (404) 385-4887 or Christopher.Held@mgt.gatech.edu.

Questions about Your Rights as a Research Participant: If you have any questions about your rights as a research participant, you may contact: Ms. Melanie Clark, Georgia Institute of Technology, Office of Research Compliance, at (404) 894-6942 or Ms. Kelly Winn, Georgia Institute of Technology, Office of Research Compliance, at (404) 385-2175.

By completing the online survey, you indicate your consent to be in the study.

Instructions

To answer this survey, please consider one specific area of substantial procurement need, such as a key raw material, service, or intermediate product. This need should be something that you have competitively bid multiple times and can have one or more supplier that fulfills this need.

An example of a "key raw material, service, or intermediate product" would be a need such as procurement of tires by an auto manufacturer, procurement of catalyst by a chemical manufacturer, procurement of advertising services by a retailer, or procurement of printers by a document services company.

Please answer all questions with respect to that one specific procurement need unless otherwise instructed.

If you would like to receive a benchmarking report and be entered in the drawing, please fill out the information below. This information will be kept confidential and will not be shared with any third party for any reason.

Name:

Email Address:

Company:

__I would like to be entered into the random gift certificate drawing

__I would like to receive a free benchmarking report comparing my answers to my competitors (Note: this paper survey is an example of what will actually be released. A copy of the actual survey in the actual software is available here: http://www.gtsurvey.com)

Table 19: (Note not Released to Respondents: Control Questions)

1. What industry best describes the one in which your firm competes:	Variety of Options from Drop Down Menu				
	Less than $\$100MM$	$\$100MM$ to $\$500MM$	$\$500MM$ to \$1 billion	\$1 billion to \$5 billion	\$5 billion or more
2. The total annual revenue of your entire company last year was (in US dollars):					
	Less than 250	250 to 1000	1000 to 20000	20000 to 100000	More than 100000
3. The total number of employees your company employs is approximately:					
	Less than 1 year	1 to 5 years	5 to 25 years	25 to 50 years	More than 50 years
4. Your company has been in business for approximately:					
To what extent do you agree with the following statements. Please answer considering your current company wide procurement practices.	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree
5. In general, our company rarely contacts our suppliers other than to discuss pricing, to place orders, or to inform them of product problems.					
6. In general, most of our total cost (COGS) is what we pay our suppliers, not our internal costs.					
7. In general, our firm's role in our final product is primarily assembly, packaging, design, or marketing and not actual manufacturing.					
8. When communicating with suppliers, in general our firm primarily transmits a fixed design, specifications, or set of requirements and the supplier manufacturers directly to our design. In other words, we do the innovation, not the suppliers.					
To what extent do you agree with the following statement? Please answer considering just one specific, substantial need with which you are involved in the procurement.	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree
9. For this specific procurement need, the buyer or buying team has the ability to use his/her/their best judgment in selecting the supplier. In other words, our buyer or buying team are not forced to choose a supplier based on cost or another rigid rule.					
Choose one of the following options:					
10. How does your firm qualify bidders for this procurement need (in other words, how does your firm confirm that the winning bidder can satisfactorily meet the requirements of the contract)? 1, We pre-qualify firms before they are allowed to bid; 2, We post-qualify firms after bidding; 3, We only allow potential suppliers to bid if we have experience with their performance in the past; 4, We do not qualify bidders; 5, Our contract is sufficiently simple that we believe virtually all suppliers can satisfactorily meet the requirements of the contract					

Table 20: (Note not Released to Respondents: Environment Derived Buyer's Power - Control Variable)

Please answer considering just one specific, substantial need with which you are involved in the procurement.	Low	Somewhat Low	Neither High nor Low	Somewhat High	High
11. Your cost to switch suppliers for this procurement need is:					
12. The loss of your account would have a(n) ___negative effect on your supplier(s) for this procurement need.					
13. The supplier(s) for this procurement need represent a(n) ___percentage of your total cost for the final product or products.					
14. Your firm represents a(n) ___percentage of the supplier or suppliers' total sales.					
15. For just this specific procurement need, the complexity of the product or service the supplier(s) must provide is:					
	Weak	Somewhat Weak	Neither Strong nor Weak	Somewhat Strong	Strong
16. The impact of this procurement need on your final product or service's differentiation (how the product differs from your competitor's product) is:					
	Smaller	Somewhat Smaller	About the Same Size	Somewhat Larger	Larger
17. Compared to your supplier(s) for this need, your firm is (in terms of revenue):					
	No Impact	Minimal Impact	Some Impact	An Impact	A Major Impact
18. If your supplier greatly improved the design of the good or service they provide you to fulfill this need, it will have ___on how your customers view your final product.					

Table 21: (Note not Released to Respondents: Relationship Derived Buyer's Power)

	Low	Somewhat Low	Neither High nor Low	Somewhat High	High
19. The bargaining power (the capacity to impose their pricing conditions) of your supplier(s) for this procurement need is					
20. If your supplier's cost to supply this procurement need suddenly reduced mid-contract, the probability that you could force your supplier to reduce price is					
21. If the price of your final product increased greatly, the probability that your supplier for this procurement need would be able to force you to share some of your increased profit is					
22. If a superior technology was developed that your supplier could use to improve the quality of the good or service provided to you to fulfill this need, the probability that you could influence your supplier to invest in this technology is					
23. If your firm needed a rush shipment for this procurement need, your ability to force your supplier to prioritize your shipment over their other customers is					
24. Your ability to affect change on your supplier (to change their way of manufacturing or otherwise doing business) is					

Table 22: (Note not Released to Respondents: Procurement Performance)

Please answer considering just one specific, substantial need with which you are involved in the procurement.	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree
25. Since our last contract negotiation, we have seen significant improvement in the conformance quality (the percentage the supplier meets specification) of the good or service procured to fulfill this need.					
26. Since our last contract negotiation, we have seen a significant increase in the performance quality (the functionality or appearance) of the good or service procured to fulfill this need.					
27. Since our last contract negotiation, we have seen a decrease in price our suppliers charge or more favorable quantity discounts associated with this procurement need.					
Please answer considering just one specific, substantial need with which you are involved in the procurement.	Dissatisfied	Somewhat Dissatisfied	Neither Satisfied nor Dissatisfied	Somewhat Satisfied	Satisfied
28. How satisfied have you been with the performance of the current supplier(s) that have fulfilled this need?					
Please answer considering just one specific, substantial need with which you are involved in the procurement.	Decreased by more than 5%	Decreased by 0% to 5%	No Change	Increased by 0% to 5%	Increased by more than 5%
29. Over the last five years, by approximately how much have you seen an increase or decrease in your procurement cost for this good or service?					

Table 23: (Note not Released to Respondents: Focused Commitment Strategy)

Please answer considering just one specific, substantial need with which you are involved in the procurement.	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree
30. For this procurement need, our firm establishes long-term contracts with our supplier(s).					
31. For this procurement need, our firm frequently sources from (a) supplier(s) that also service other needs in our firm.					
32. We have a high degree of mutual trust with our supplier(s) for this procurement need.					
33. Our firm has joint investments (factories, machines, etc) with our supplier(s) that satisfy this procurement need.					
34. For this procurement need, our firm has a collaborative relationship with our supplier(s).					

Table 24: (Note not Released to Respondents: Proposed Commitment)

	Every year or less	Every 18 months or less	Every 2 years or less	Every 3 years or less	Every 3 years or more
35. How often does your firm rebid the contract for this procurement need?					
	Less	Slightly less	No more or less	Slightly more	More
36. Compared to your competitors, your firm re-bids ___frequently for this procurement need.					
37. When requesting bids for this procurement need, your firm signals that you are ___likely to jointly invest in technology and/or design with potential suppliers than your competitors.					
38. When requesting bids for this procurement need, it is ___difficult for a bidder to qualify to supply a contract for you than your competitors.					
39. When requesting bids for this procurement need, it takes ___time to qualify to be a supplier to your company than your competitors.					

Table 25: (Note not Released to Respondents: Competitiveness of Bidding)

	Less than 5	5 to 13	14 to 20	21 to 50	More than 50
40. The number of suppliers that last responded to you last request for bid/quote (RFB /RFQ) for this procurement need was:					
Please answer considering just one specific, substantial need with which you are involved in the procurement.	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree
41. Bidding for this contract is more competitive (more bids) than for our other contracts.					
42. We need to repeatedly post bid requests or seek out additional bidders to participate in our bidding process.					
43. For this procurement need, bidders are highly engaged in the bidding process.					
44. For this procurement need, bidders spend considerable time and effort preparing their bids.					

Table 26: (Note not Released to Respondents: Incumbent Biasing)

	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree
45. In our firm's process for choosing the winning bid for this procurement need, the incumbent supplier has an advantage over non-incumbents, for a given bid price.					
46. Prior to receiving the bids for this procurement need, it is expected that the incumbent will win the contract.					
47. When awarding a contract for this procurement need, the incumbent supplier may win even if he is not the lowest cost option.					
48. My primary goal for rebidding a contract for this procurement need is to place pressure on the incumbent to lower or maintain his price, not to find the low cost supplier.					
49. Our firm switches supplier(s) for this procurement need frequently.					

Table 27: (Note not Released to Respondents: Multi-Sourcing)

	Less than 25%	Between 25% to 50%	Between 50% and 75%	Between 75% and 100%	We Sole Source (one supplier at a time)
50. Of the total suppliers that satisfy this procurement need, the largest supplier is:					
	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree
51. We contract with multiple suppliers in order to create internal competition.					
52. We maintain a pool of potential suppliers that we can switch to quickly if there is an issue with our current supplier.					
53. We shift our demand among suppliers to find the low cost supplier at the time.					

Table 28: (Note not Released to Respondents: Additional Questions)

	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree
54. We know the cost to fulfill the contract for incumbent suppliers (those who have supplied this need in the past).					
55. We know the cost to fulfill the contract for new bidders (those that have never supplied this need).					
56. We know how much it costs our bidders to prepare their bids.					

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VITA

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