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RELATIONAL CONTRACT:

APPLICABLE TO DEPARTMENT OF DEFENSE CONTRACTS

A Thesis in

Economics

by

Kenneth J. Reynolds

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

December 1989

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ABSTRACT

This paper examines the importance of time to (contractual) performance, technological uncertainty, and firms' reputation in determining contractual tightness of aircraft engine contracts negotiated between the Air Force and defense contractors. Utilizing the type of price selected by these contracts as a proxy for contractual tightness, I defined contractual tightness as a measure of ex ante specification or a measure of how much the price is "nailed down" at the outset of the contractual relationship. Using a relational approach to contracting, this paper seeks to test, using formal econometric procedures, the importance of time-to-performance, firms' reputation, and technological uncertainty in determining contractual tightness measured by the type of price selected ex ante between the Air Force and aircraft engine defense contractors. Forty-four data points for this analysis came from thirteen Air Force contracts that procure a certain type of aircraft engine from two defense contractors. The results significantly support the relational contracting argument that as time-to-performance and technological uncertainty increase, contractual tightness decreases but when a firm's reputation worsens, contractual tightness increases which suggests that Air Force engine contracts are being written in an economically feasible manner. The empirical results also are quite

robust to different estimating techniques. This suggests the relational approach to contracting does provide a useful framework for analyzing long-term contractual relationships and is worthy of further attention by economists.

TABLE OF CONTENTS

LIST OF TABLES

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VITA

I was born [redacted] attended high school in Rogers, Arkansas. I graduated from Rogers High School in May 1970 and enrolled in the University of Arkansas. In May 1974, I graduated from the University of Arkansas with a Bachelor of Science in Agriculture majoring in Agricultural Business. Also, I received a Master of Arts in Economics from the University of Arkansas in May 1975. I entered active duty with the United States Air Force in June 1975, serving as a pilot and as an aircraft maintenance officer until 1982. At this time, I was selected for duty at the United States Air Force Academy as an Instructor of Economics. I served in this capacity until 1986 when I entered The Pennsylvania State University to begin work on a doctorate in economics. After successfully defending my thesis in July 1989, I returned to the United States Air Force Academy where I am presently serving as an Assistant Professor of Economics.

Chapter 1

INTRODUCTION

Economists and lawyers have noted that many long-term contracts written today leave certain terms and conditions to future negotiation at the time of contractual performance (Crocker and Masten, 1988b). For example, it is quite common to see decisions relative to price or quantity intentionally deferred until contractual performance begins (Goldberg and Erickson, 1987). The reasoning behind this idea is a desire by parties to contracts to avoid constraining themselves at the outset of the contractual relationship to actions that may be inappropriate during contractual performance. When parties to contracts are disadvantaged in this manner, they may elect to pursue costly efforts to evade contractual performance (Goetz and Scott, 1981). Some examples of this noted in the economic and law literature on contracting include capitalizing on ambiguous terms, withholding irrelevant information, and failing to cooperate in the other party's performance (Crocker and Masten, 1988b, Goetz and Scott, 1981 and Summers, 1968). Unfortunately, when contracts leave terms and conditions to future negotiation, opportunistic behavior by parties to the contract may occur to effect a redistribution of the gains from trade. Bargaining on a

regular basis, in this case, may be very costly if parties engage in the strategic pursuit of rents.

The discussion above suggests a tradeoff must occur at the outset of the contractual relation in the design of these long-term contracts between flexibility and precision. Flexibility is needed to avoid constraining firms to inappropriate behavior at the time of contractual performance. Conversely, precision is needed to limit strategic pursuit of rents by parties during contractual performance. Utilizing data obtained from Air Force contracts, I hope to test some of these basic theories of contract design using the relational approach. Specifically, I am interested in whether or not firm reputation and technological uncertainty affect the trade off ex ante between contractual flexibility and precision, and if so, how they affect it.

There is substantial interest among economists and lawyers on the economics of contractual design. In particular, the economic and law literature notes that a class of long-term contracts have evolved as a mode of organization for firms doing business together (Williamson, 1979, Klein et.al., 1978 and Crocker and Masten, 1988b). Williamson (1979) notes: "if transaction costs are negligible, the organization of economic activity is irrelevant, since any advantage one mode of organization appears to hold over another will simply be eliminated by

costless contracting" (p. 233). He goes on to explain that firms identify and use the most economical governance structure where governance structure means an institutional framework within which the transaction is conducted. Klein et al. specifically identify the problem of opportunistic behavior as a form of transaction costs (Klein et al. 1978, p. 301). They give examples of opportunistic behavior, and show that it must be both acknowledged and dealt with by firms deciding on a mode of organization for conducting business. Why then, given the costs of opportunistic behavior, have long-term contracts evolved? Why not internalize all opportunistic behavior through vertical integration? As Williamson (1979) and Klein et al. (1978) point out, the efficient organization of economic activity entails matching governance structures with transactional characteristics in a discriminating way. This suggests long-term contracts have evolved because they are an efficient mode of organization for a particular type of transaction. They facilitate exchange, particularly when substantial complexity and uncertainty are characteristics of the transaction and the costs (both administrative and financial) of internalizing the transaction are prohibitive.

Most of the empirical work on contracting is recent and centers on contractual duration and design. Joskow (1987) first established a relationship between contract duration and relationship-specific investment in long-term coal

contracts. He found buyers and sellers do make longer commitments to the terms of future trade at the outset, and rely less on repeated bargaining, when relationship-specific investments are more important. Crocker and Masten (1985, 1988a) established that a tradeoff between the design and duration of long-term natural gas contracts does occur. They noted agents were more reluctant to enter into a long-term contractual agreement when faced with the prospect of inefficient adaptation, so that is an important consideration in the design of contractual terms in contracts between natural gas producers and pipeline owners. Goldberg and Erickson (1987) then provide a case study analyzing the design of pricing and quantity provisions in petroleum coke contracts. This article provides significant insight into solutions that contractual parties devise in resolving problems of coordinating across organizational boundaries.

Recently, Crocker and Masten (1988b) continued their research on contractual design by looking at the processes parties utilize to adjust prices in long-term natural gas contracts. They adopt a "relational" approach to analyzing contracts, where contractual terms are often left purposefully incomplete. The degree of incompleteness is determined by the characteristics of the transaction. In particular, they found that renegotiation provisions were generally selected over redetermination provisions the

longer the duration of the contract. They also found that the negative relationship between price and quantity flexibility is consistent with a reduction in evasion costs when the possibility of mutually advantageous price and quantity modifications exists within the contract.

This recent empirical work on contracts utilizing the relational approach has been successful in testing some of the assertions of relational contract--particularly the claim that contracts may be left incomplete at the outset intentionally. Unfortunately, the nature of the data set employed for this analysis primarily limited empirical work to the areas of contractual duration and pricing flexibility. Firm specific characteristics such as reputation and its effect on contract design have not been tested. Technological uncertainty and its effect on contract design has not been tested as well. It is in this area of relational contract that I seek to make a contribution.

This paper begins with a discussion of the relational approach to contracting and its applicability in analyzing Department of Defense weapons acquisition. A discussion of federal procurement regulations is included. The third chapter explains the compensation arrangement or price of these Air Force contracts and details my hypotheses. The fourth chapter describes the data collection process and the proxies used for measuring dependent and independent

variables. The fifth chapter discusses the methods and results of empirical estimation followed by the conclusion in the last chapter.

Chapter 2

CONTRACTING THEORIES: APPLICABILITY TO DEFENSE CONTRACTS

The first section briefly details the classical and neoclassical approaches to contracting. Next is a discussion of the relational approach to contracting followed by a brief description of Department of Defense weapons acquisition.

2.1. Review of Contracting Theories

Economic theory has led us to believe that contracts are very precise, mechanically-enforced documents; yet, we find in reality that contracts often leave many terms and conditions to future determination. Through experience, economists have learned that when uncertainty about what constitutes optimal behavior is great at the time of contractual performance, it may be better to leave aspects of that performance to future determination rather than constrain agents to specific yet possibly unsuitable actions at the outset.

For example, consider an individual planning to build a new home who must choose between two home building contractors whose quality of construction is equal. The first contractor has a "good" reputation in the community

and he is considered to be fair in adjusting price when homeowners change architectural drawings of their home after construction has started. In general, contractor one is considered by the community to be honest in dealings with customers. Conversely, contractor two has a "bad" reputation in the community even though his work is equal in quality to contractor one: he is very difficult to deal with (i.e., changes after construction begins means price substantially increases) relative to pricing adjustments, for example, when customers "change their minds" concerning quality or color of carpets, types of drapes and appliances, etc. In general, contractor two is considered by the community to be opportunistic in his dealings with customers. Certainly, a new home owner would feel more comfortable leaving certain terms and conditions such as price adjustment procedures to future determination with contractor one, but not with contractor two. With contractor two for example, one would expect to see in his contracts very specific procedures at the outset for price adjustments to contract price after contractual performance begins. With contractor one, one would not expect to find in his contracts price adjustment procedures as detailed relative to contractor two or perhaps not see price adjustment provisions at all.

In addition to reputational effects on contract design, temporal and technological uncertainties may also affect

contractual design. Continuing the house example, if one contracts now to build a new home five years from now, there is considerable temporal uncertainty regarding costs of labor and material, and consumer tastes which may change relative to the design of the home. Also, technology in new home construction may significantly change, thus necessitating a change in price at the time of contractual performance. In either case, one would expect to see contractual terms and conditions left to future determination rather than disadvantage either the new home contractor or the customer at the time of contractual performance. In summary, practical experience suggests that long-term contracts are not all precisely written, mechanically-enforced documents; instead, they are documents that have evolved into instruments which leave many contractual terms to future determination because of increased complexity and uncertainty in a long-term contracting environment. To more formally address this insight, we now examine the evolution of contract law and, in particular, the role of contractual incompleteness in exchange relationships.

2.1.1. The Classical Approach

Classical contract law facilitates exchange by separately detailing all aspects of the contracting process

at the outset by prespecification of all economically relevant contingencies. Specifically, the original agreement provides for all terms and conditions to be specified ex ante; thus, the original agreement clearly specifies all contractual parties intentions relative to the transaction at the outset, leaving few reasons for contractual modifications after contractual performance has begun. According to Williamson (1979), classical contract law implements prespecification through legal rules, formal documents (written) as opposed to informal (oral), and self-liquidating transactions (p. 236). Third party participation (e.g., arbitration) is discouraged because the original intentions of the contractual parties is specified ex ante and courts mechanically enforce those intentions in resolving disputes according to the classical approach. Finally, the identity of the parties to a transaction is irrelevant, because neither party to the contract makes substantial capital investments specific to this transaction (i.e., transaction-specific investments[1] imply the value of alternative uses of this capital ex post would be significantly lower than the value of the capital when used as originally intended); hence, classical contract law corresponds with the ideal market transaction in economics.

[1] Williamson (1979) provides a detailed discussion of classical contract law, and, in particular, transaction-specific investments.

2.1.2. The Neoclassical Approach

Unfortunately, in an economic world of ever increasing complexity and uncertainty, classical contract law does not fit the need of every transaction--particularly a transaction covering several time periods. In this instance, prespecification of all economically relevant contingencies may be prohibitively costly since all contingencies necessitating contract adaptation cannot be anticipated ex ante. Williamson (1979) notes this leaves economic agents with three alternatives: first, one could forgo such transactions altogether; a second alternative might be vertical integration; a third alternative might be a contracting relation which provides additional controls to prevent contractual firms from acting opportunistically during contractual performance yet preserves trading (p.237). The third alternative is referred to as neoclassical contracting by Williamson (1979). As Macneil (1978) observed: "two common characteristics of long-term contracts are the existence of gaps in their planning and the presence of a range of processes and techniques used by contract planners to create flexibility in lieu of either leaving gaps or trying to plan rigidly" (p. 865). In this case, third-party assistance, such as arbitration, may have advantages over litigation in resolving disputes and evaluating contractor performance while serving those

functions of flexibility and gap filling. Hence, neoclassical contract law recognizes that economic agents negotiate in a complex world, that agreements are improper due to bounded rationality[2], and that all parties to a contract have confidence in contractual clauses which are designed to settle disputes. Also, when arbitration is utilized, the neoclassical approach to contracting assumes that contractual performance will be completed, whereas if litigation is pursued in resolving disputes, contract completion is a much weaker assumption. Finally, the reference point for effecting contract adaptation is the original agreement, not the contractual relationship as it stands at the time of contractual adaptation.

2.1.3. The Relational Approach

"The pressure to sustain ongoing relations 'have led to the spin-off of many subject areas from the classical, and later the neoclassical, contract law system, e.g., much of corporate law and collective bargaining.' Thus, progressively increasing the 'duration and complexity' of contract has resulted in the displacement of even neoclassical adjustment processes by adjustment processes of

[2] See Williamson (1975) for a definition of bounded rationality which he characterizes as behavior that is intendedly rational, but only limitedly so. In other words, we cannot foresee all contingency claims.

a more thoroughly transaction-specific, ongoing-administrative kind" (Williamson, 1979, p. 238). Specifically, as the identities of contractual parties involved in a contractual relationship becomes important, more pressure is applied to the relationship according to the neoclassical approach to contracting to complete contractual performance. This is because one or both parties to the contract have substantially invested in both human and physical capital that is specific to this particularly transaction. The value of an alternative use of this capital is quite low since the capital was specific to a particular transaction; also, since the nature of the transaction is very specific, the buyer would find it difficult to locate alternative sources of supply quickly. Thus, contract completion is paramount to maintaining or improving each parties' financial positions. Therefore, a contractual relationship where the reference point is not predominantly on the original agreement as it is in neoclassical contracting, but rather on the entire relationship as it evolves over time is more appropriate to sustain long-term contractual relationships. As Williamson (1979) notes, "the fiction of discreetness is fully displaced as the relation takes on the properties of 'a minisociety with a vast array of norms beyond those centered on the exchange and its immediate process'" (Williamson, 1979, p. 238). Accordingly, my perception of the relational

approach to contracting is based upon this concept of relational exchange[3] which encompasses a transaction-specific investment thus having direct implications for long-term contract design and duration.

Even though relational contracts are designed to promote efficiency by securing appropriable quasi-rents[4] ex ante, opportunism[5] still abounds during contractual performance. Thus, contracts provide a framework or structure at the beginning of the relationship that (1) specifies procedures to be followed for future adaptation, and (2) sets the rules at the outset for the contracting parties competition ex post over transactional surpluses. Thus, the relational approach views contracts to be more than just instruments which define the terms and conditions at the outset of the contractual relation, but, in addition, are designed to reduce costs associated with resolving disputes and governing the exchange.

Viewing contracts from the relational exchange

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[3] Macneil (1985) formally defines relational exchange (in a behavior context) as the everyday working of exchange relations and transactions where actors voluntarily enter into the agreement to achieve the benefits of mutual cooperation (p. 486).

[4] Quasi-rents are the excess of the asset's value over its value in its next best use. The potentially appropriable specialized portion of the quasi-rent is that portion of the quasi-rent, if any, in excess of its value to the second-highest-valuing user (Klein et al., 1978, pp. 298-302).

[5] Williamson (1979) defines opportunism as self-interest seeking with guile (p. 234).

perspective, one finds that rational agents may leave terms and conditions of the contract to future determination. As the contracting environment becomes more complex and uncertain, contractual terms are often left unspecified ex ante to avoid constraining the contracting parties at the outset to actions that may be inappropriate at the time of contractual performance. Constraining a party to inappropriate actions at the time of contractual performance may lead to costly efforts to evade performance by the disadvantaged party. In many long-term contracts, it is common to see contractual terms and conditions such as price, quantity, procedures for acceptance of product by the buyer, and delivery destination of finished product by the buyer left to future determination. Leaving terms and conditions to future specification though invites various forms of strategic behavior during future renegotiations which dissipate rents accruing to the exchange. This may be particularly true if legal channels are pursued as a formal means of strategic behavior to effect a redistribution of the appropriable quasi-rents.[6]

At this point, it becomes important to ascertain what

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[6] This does not mean to imply that less formal means of strategic behavior such as capitalizing on ambiguous terms or withholding relevant information do not dissipate rents accruing to exchange. They in fact do; however, in these cases, contract performance may be somewhat evaded but perhaps not stopped completely. Contract performance, though, may be severely impaired or halted if disputes are resolved through litigated outcomes.

role litigation plays in relational contracting. Is it merely a (socially undesirable) negotiation tactic or in fact are litigated outcomes prevalent in relational contracting for effecting (efficient) contract adaptation? In the past, courts have not mechanically-enforced contractors' original intentions. For example, if a contractor is litigating a claim for damages, that contractor must provide "proof with reasonable certainty" that actual damages have occurred (Crocker and Masten, 1988b, p. 4). In the case of justifying lost income for example, it is sometimes quite difficult to quantify income that perhaps was earned but not actually received which suggests awards may at times be lower than optimal; in addition, adjudicating a claim can be very costly which suggests resources used for litigation may be more optimally spent in resolving disputes nonjudicially. This does suggest litigation is viewed more as a negotiation tactic which seems to be further supported by the fact that few disputes are totally resolved through litigated means.

Given the relational contract perspective of litigation being primarily a negotiation tactic, do disputes resolved by litigated outcomes between relational contracting parties imply that in these cases relational contracting is always suboptimal? To put this another way: can the relational approach to contracting in which optimal contracts are necessarily incomplete support litigated outcomes as an

efficient, effective method in solving contract adaptation disputes? If contracting parties can effectively separate this formal means of strategic behavior and the continuing contractual performance allowing performance of the contract to continue, then litigation could be a desirable method to resolve future disputes arising from contractual incompleteness. The attempt to effect a redistribution of the appropriable quasi-rents can be effectively "tied off" and separated from contractual performance through a contractual specification designed to identify disputes and to provide instructions or procedures on how contractual performance is to proceed during dispute resolutions, and how litigated decisions from such disputes will be incorporated into the contract at the appropriate time. In summary, litigation may be bad if it is a bargaining tactic; but, it may be good if it permits separation of performance and the division of transactional surpluses.[7]

It should be clearer now that the relational approach

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[7] For example, within major government agencies are administrative Board of Contractor Appeals which represent the first level of appeal (e.g., before using the United States Appellate Court) for a public contractor relative to a government contracting officer's decision concerning a dispute. These boards were authorized and designed by the government to specifically separate disputes from performance of contracts. According to Alston et. al., the Contract Disputes Act of 1978 authorized these boards to "grant any relief that would be available to a litigant asserting a contract claim in the Claims Court . . . . However, specific performance cannot be ordered" (p. 478).

to contracting, leaving some terms and conditions to future determination, invites various forms of strategic behavior (both formal and informal) in pursuit of appropriable quasi-rents. How then are relational contracts designed to economize on the costs associated with resolving disputes, adapting litigated outcomes into the relational exchange, and governing the exchange itself? To do this, a relational contract must effect a tradeoff between flexibility, which allows for contract adaptation, and opportunism, which calls for a more precise contract. Crocker & Masten (1988b) write:

> Generally, the value of flexible, more relational exchange is enhanced the more difficult it is to define obligations due to the complexity of the transaction or its environment. Conversely, environments where opportunism is expected to be rife or where economic conditions are relatively simple and static will tend to favor more precise agreements. Ultimately, the degree to which parties leave the details of performance to future resolution will reflect the nature of the transaction (p. 7).

This implies that contract design must limit the nature and scope of renegotiation in relatively open-ended agreements by restricting either the set of permissible adjustments or the process by which such changes are to be implemented. For example, long-term contracts frequently and intentionally defer decisions relative to price or quantity

ex ante, but specify at the outset frequency and interval of negotiations utilized in definitizing price or quantity.

In practice, contracting parties look at the attributes of the relational exchange environment when considering flexible (i.e., surplus-increasing adjustments) in contract design, or more precise terms and conditions to discourage opportunism, or rent-dissipating efforts to redistribute existing surpluses. Some examples of these attributes which continually affect relational exchange are economic, political and technological uncertainty, perceptions of contracting parties' "reputation" by other parties to the same contract, the degree of asset specificity[8] in a particular transaction by one or more parties to the contract, and the degree of competition ex ante. These attributes are exogenous to the relational exchange but have direct impact on the endogenous terms and conditions in the relational contract. For example, products produced under great technical or political uncertainty require more flexibility in contract design so gains from adaptation can be realized by all parties to the contract as the product matures or the political environment unfolds. On the other hand, if one party in this situation is perceived to

[8] Defined by Williamson (1983)--asset specificity is when one or both parties in a relational exchange make transaction-specific investments particular to that exchange. These types of investments have lower values in alternative uses (p. 522).

negotiate in "bad faith," then, ceteris paribus, contract design should be more precise relative to future renegotiations to limit opportunism. The story told of the new home builders in the beginning of this chapter specifically applies here. One contractor is considered honest by the small community in his dealings with customers while the other contractor is considered to behave opportunistically in his dealing with customers. In the case of the opportunistic contractor, I would expect to see more contractual precision at the outset in contracts utilizing the opportunistic contractor relative to contracts utilizing the "good" contractor; conversely, I would expect to see less precision at the outset in contracts with the "good" contractor thereby leaving more terms and conditions to future determination.

Economic uncertainty also requires flexibility which is often implemented through some type of economic price adjustment mechanism tied in some fashion to price or cost indices. Also, the higher the degree of asset specificity, generally the higher the appropriable quasi-rent which means opportunistic firms are willing to dissipate more rents to gain a larger piece of the "pie" (appropriable quasi-rents). This would suggest the appropriateness of a detailed and precisely written relational contract to make it more difficult for opportunistic firms to evade performance. In summary, relational contracting provides both contractual

terms and conditions as well as a structure that establishes procedures at the outset for adapting exchange and resolving disputes during contractual performance. Relational contracts then serve to secure the terms of trade ex ante while policing strategic behavior ex post. Finally, this implies that not only the length but the design of contracts may be influenced by contracting parties' desire to weaken strategic behavior thus reaping the benefits of a relational exchange.

2.2. Department of Defense Weapons Acquisition

The Department of Defense operates more than fifty-four hundred installations worldwide and employs nearly 10% of the U.S. work force making it one of the largest and most complex business organizations in the world (Fox, 1988, pp. 7-8). The Department of Defense executes more than fifteen million contracts per year (more than sixty thousand per day) in developing and producing the most sought after weapons and equipment in the free world (Fox, 1988, pp. 7-8). Dollar wise, this amounted to $36.7 billion on defense research and development and $85.8 billion on purchases of weapons and equipment in production (procurement) in fiscal year 1987 (Fox, 1988, pp. 7-8). Also, approximately $45 billion was spent on military construction, highly classified programs, supplies and equipment, operations and

maintenance, and some nuclear weapons development during the same fiscal year (Fox, 1988, pp. 7-8). Perhaps more importantly for my purposes, only a few firms can design and produce many of these systems. Even though billions of dollars are spent on weapons acquisition, only a few defense contracting firms are the recipients of this money. Since the Department of Defense does not build their own weapons[9], long-term contractual relationships are utilized repeatedly with the same contractors. Hence, Department of Defense weapons acquisition provides a rare opportunity for empirically testing relational contract theory.

Since weapons have become more complex, the magnitude and diverse sources of uncertainty in the weapons acquisition process have increased. To operationalize the definition of uncertainty, Peck and Scherer defined uncertainty as the relative unpredictability of the outcome of a contemplated action; hence, the emphasis is upon a contemplated action that can be taken by the party potentially experiencing uncertainty.[10] Peck and Scherer

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[9] Rarely does the government internalize a transaction--i.e., vertically integrate or buy-in with a contractor. Government procurement policies refer explicitly to the significant administrative burden incurred in acquiring, managing, and upkeep of facilities and equipment. See Masten (1984).

[10] It is appropriate to note that risk and uncertainty are not to be used interchangeably. Risk refers to the level of the consequences of a wrong prediction. For example, the chances of winning with a specific poker hand may be equally unpredictable whether the bet is ten dollars or ten thousand dollars. But the level of risk is greater with a ten

note that uncertainty is present in every phase of the weapon system cycle:

(1) Research and development

(2) Production for the operational inventory

(3) Actual operation

The greatest amount of uncertainty is in the research and development phase. Intuitively, this makes sense: the further ahead a decision maker must look (lead time), the more unreliable are his data on development possibilities, costs, enemy capability, and intentions, etc. Furthermore, as weapons become more complex in order that they may be better able to neutralize the potential enemy threat, uncertainty surrounding technical feasibility of these weapons will significantly increase. Also, the environment external to the weapons acquisition process such as enemy plans and technology plus continually changing United States defense policies significantly increase uncertainty in the research and development phase, and to a lesser extent, production and operational phases as well. If the external environment has changed, weapons' programs may be altered in scope or perhaps even terminated.[11] This usually leads to

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thousand dollar bet than a ten dollar bet. See Peck and Scherer for a more elaborate discussion of uncertainty versus risk in weapons acquisition.

[11] Peck and Scherer note these ideas prevail in the commercial economy as well, but not with the same level of significance. This is because the competitive superiority of the technically advanced equipment in the commercial field is usually not as overwhelming as it is in the weapons

significant increases in development time and costs.

Peck and Scherer's analysis of Department of Defense weapons acquisition in the early 1960s noted the following four conditions relating to weapons acquisition:

(a) Individual weapons projects require such large investments that private financing of their development is virtually impossible. This means the government must play both investor (through cost reimbursement) and buyer. In a market system, these two functions are generally separate.

(b) The prospect of a commercially organized weapons acquisition process is further reduced by the existence of the unique uncertainties described in the previous section. Private investment would be subject to great risks due to these uncertainties, whereas government funds at least distribute the risk among the general body of taxpayers.

(c) The problem of determining the product characteristics desired by the buyer. Simply put, it is the buyer (Department of Defense) who has the intelligence data to determine what the threat is, not the defense contractor. Thus, in this case, the buyer jointly with the supplier

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field. Furthermore, the marketing and production skills in the commercial field can temporarily offset technical inferiority. Hence, technical obsolescence would occur at a much slower rate in the commercial field. Also, changes in consumer tastes can be likened to changes in future defense policies, but uncertainty again will be less in the commercial field since they have the law of large numbers on their side.

determines the product characteristics, not just the supplier.

(d) Finally, the determination of a weapon systems' price would hardly correspond to that in a market system. Price is determined through negotiations between the Department of Defense and defense contractors both ex ante and ex post.[**]

Given these conditions and the arguments presented above relative to (1) small numbers of defense contractors engaged in long-term contracts with the Department of Defense, and (2) substantial uncertainty in the weapons acquisition process, the relation between transaction-specific investments and Department of Defense weapons acquisition becomes clearer. Condition one above relates directly to one of Williamson's (1983) types of transaction-specific investments, physical asset specificity, which implies that assets are acquired and dedicated specifically to a particular transaction. Also, conditions one, two and four (i.e., condition four states price may be determined ex post implying renegotiations ex post) indicate that

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[**] Because there is lack of price competition, this does not imply there is an absence of competition among defense contractors. Except for sole sourcing, competition exists until the contract is signed. At this point, however, the problem of small numbers bargaining arises since ex post, the Department of Defense can bargain only with the sole contracting supplier. This implies the possibility of strategic behavior by the contractor.

strategic behavior by both the Department of Defense and defense contractors may result. Finally, the fact that buyer and seller may agree upon the purchase before the product exists suggests a contracting approach for analysis of Department of Defense weapons acquisition rather than the more conventional market system approach. My advocation now is that the relational approach to contracting is the correct contracting approach to analyze the Department of Defense weapons acquisition process.

2.3. The Federal Procurement Regulations

Another divergence between contracting in the private and public sector is the existence of detailed procurement regulations or alternatively, a "constitution," in public contracting that provides extensive contractual guidance to defense contractors and military departments. There are three primary reasons for these regulations: (1) economies of scale in repetitive contracting, (2) political and social policies implemented through procurement, and, finally, (3) mitigating strategic behavior by contracting parties.

The federal government functions as a buyer of goods and services from the private sector in the marketplace. Many of these transactions are repetitive in nature, and economies of scale in the writing of contracts can be gained by simply referencing applicable parts of the constitution

in the contracts, rather than making each individual regulation explicit in each contract, as is often done in the private sector where transactions are more heterogenous in nature. The administrative burden associated with the selection, governance, and paying of numerous private contractors has been substantially reduced through the development of highly specific procurement regulations.

The federal procurement process is further complicated because the federal government often uses its buying power to achieve certain social and economic goals which are perceived to be in the public's interest. Social and economic legislation is passed by Congress and then implemented through procurement regulations by making compliance with the social and economic legislation a requirement for private firms doing business with the federal government. Even though this type of legislation has little to do directly with the economics of the procurement process, the federal government's rationale for making compliance with socioeconomic legislation a requirement in public contracting is that this is the most effective means of achieving socioeconomic objectives (Alston et al., 1988, pp. 3-14). To be more specific, the following is a list of the more notable socioeconomic legislative acts that must be included in federal contracts:

-Davis Bacon Act of 1931; Provided for the prevailing wage rates for construction for government purposes.

-Walsh-Healy Public Contracts Act of 1936; An agreement to working hours and minimum wage rates for contracts involving the manufacture or furnishing of materials, supplies, articles, and equipment in any amount exceeding $10,000.

-Service Contract Act of 1965; Provided for the payment of minimum wages and the observation of certain safety and health requirements.

-Work Hours Act of 1962; Applied to public contracts not subject to the Walsh-Healy Act and also provided for the payment of overtime for hours worked in excess of eight in one day and 40 in one week.

-Buy American Act of 1933; Promotes the use of United States produced supplies and United States manufacturers in public contracts. Also, it enhances opportunities for U.S. manufacturers and suppliers.

-Civil Rights Act of 1964; With respect to government contracts, this act required the inclusion of a clause to provide equal

employment opportunities for minorities.

-Executive Orders of 1965 (11246, 11375, 11741); Prohibits discrimination on the basis of race, creed, color, national origin, sex, and age.

-Rehabilitation Act of 1973; Prohibits discrimination against handicapped. This clause is considered to be applicable to government contracts even in the absence of this clause from the federal contract.

-Occupational Safety and Health Act of 1970; Allowed Secretary of Labor to set standards of health and safety for factories, construction sites, farms, and other places of business. Compliance with this act must occur to enter into and maintain a contract with the federal government. This clause is considered to be applicable to government contracts even in the absence of this clause from the federal contract.

-Clean Air Act of 1970; Controls air pollution caused by industry and motor vehicles' emissions. Private contractors must continually comply with this act to do business with the federal government.

-Small Business Act of 1963; Establishes

> national policy that government should assist small business in obtaining their fair share of the government's business. Specifically, it allows for agency officials to set aside certain partial or total procurements exclusively for small business (Culver, 1985).

All of the above mentioned socioeconomic legislation affects the design of contracts in our set. In summary, a part of the federal contracting constitution stems from implementing provisions for socioeconomic legislation into all federal contracts. Combining this concept with the concept of public contracting economies of scale, it simply is less burdensome administratively to reference a specific part of the constitution which defines federal contractors' requirements to comply with a certain socioeconomic piece of legislation rather than explicitly make each act a part of each individual public contract. For an example of this, see Table 2.1 which references clauses from section I--Contract Clauses, contract twelve. Another, and perhaps the most important, reason for the development of the constitution in public contracting is to thwart strategic behavior by government contractors, and in particular, defense contractors. Department of Defense weapons

Table 2.1

Contract Clauses Incorporated by Reference

A. 52.252-02 CLAUSES INCORPORATED BY REFERENCE

This contract incorporates the following clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available.

I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1) CLAUSES (Reference numbers show the titles' locations in the Federal Acquisition Regulation.)

REF	REF NO	TITLE
15	52.219-03	UTILIZATION OF SMALL BUSINESS CONCERNS AND SMALL DISADVANTAGED BUSINESS
16	52.219-09	SMALL BUSINESS AND SMALL DISADVANTAGED BUSINESS SUBCONTRACTING PLAN
18	52.220-03	UTILIZATION OF LABOR SURPLUS AREA CONCERNS
20A	52.222-04	CONTRACT WORKHOURS AND SAFETY STANDARDS ACT-OVERTIME COMPENSATION-GENERAL
21	52.222-20	WALSH-HEALY PUBLIC CONTRACTS ACT
22	52.222-26	EQUAL OPPORTUNITY
25	52.222-36	AFFIRMATIVE ACTION FOR HANDICAPPED WORKERS
26	52.223-02	CLEAN AIR AND WATER ACT

II. DEPARTMENT OF DEFENSE SUPPLEMENT (48 CFR CHAPTER 2) CLAUSES (Reference numbers refer to the titles' locations in this supplement to the federal acquisition regulation.)

REF	REF NO	TITLE
9	52.225-7001	BUY AMERICAN ACT AND BALANCE OF PAYMENTS PROGRAM

acquisition has grown astronomically both in complexity and dollar value since the end of World War II. Both the defense contractors and the Department of Defense have developed a large number of sophisticated procurement support organizations as well as procurement specialists who do not disappear at the signing of a contract. Instead, these large number of contracting specialists usually are involved in the negotiations, governance, and closures of one or more defense contracts simultaneously. Given the large cost of maintaining these support procurement organizations and specialists, plus the astronomical dollar value of weapon systems, the incentive for defense contractors to behave opportunistically is strong. When a defense contractor is dealing in billions of dollars with the government who works with very strict delivery schedules and few producers of large weapon systems, the defense contractor knows the actual cost to the government of contractual nonperformance[13] is very substantial. Hence, opportunistic behavior by a defense contractor, such as threatened contractual nonperformance if prices are not

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[13] Contractual nonperformance is to be interpreted as any conduct which the contractor might engage in to escape performance or force renegotiation of contractual terms. See Crocker and Masten (1988b), p.4. They provide a short list of tactics contractors might use to effect a redistribution of surpluses from exchange such as withholding relevant information, interfering with or failing to cooperate in the other party's performance, failing to mitigate damages where a breach has occurred, and capitalizing on ambiguous terms.

increased above ex ante negotiated prices, may be quite successful given the unacceptable high costs to the military of contractual nonperformance. Thus, successful strategic behavior by defense contractors ex post can mean substantial increases in profits above their ex ante negotiated levels of profit.

Given the substantial number of weapon systems being procured by all military departments through time plus strong defense contractor incentives to behave opportunistically, excessive profits by defense contractors have become a significant concern to the federal government. Strategic behavior by defense contractors in particular is well documented by Culver back to the Civil War (Culver, 1985, pp. 2, 3, 6, 7, 10, 11 and 15). Culver further notes that opportunistic behavior in public contracting existed during and after the American Revolution, but details of this are somewhat sketchy. This long history of strategic behavior by the defense contracting community has led Congress to enact many pieces of legislation in an attempt to thwart strategic behavior which results in excessive profits.[14] For example, the following pieces of legislation were enacted to deal with defense contractors' excessive profits:

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[14] Culver found in the twenty year period between World Wars I and II alone, more than 200 pieces of legislation to control profits were introduced in Congress.

-Civil Sundry Appropriations Act of 1861; Basic law under which the Civil War was fought. It was revised and amended (became Statute 3709) to preclude strategic behavior by defense firms which resulted in excessive profits.
-Excess Profits Tax Act of 1917; Act designed to thwart opportunistic behavior by defense contractors during World War I only. This act was reinstated slightly before and continued through World War II.
Vinson-Trammel Act of 1934; Regulated profits on shipbuilding and aircraft production for the Navy to ten percent. This act was later extended to Army aircraft. Act was repealed in 1981.
-Treasury Directive 5000 of 1940; Attempted to curb excessive profits by defense contractors. This directive constituted the first regulatory guidance relative to the allowability, allocability and reasonableness of costs. It is considered the predecessor of the Cost Principles section of today's federal procurement regulations.
-Armed Services Procurement Act of 1947; Detailed very specific procurement procedures to be followed by the military departments and defense contractors.
-Renegotiation Act of 1951; Expands profit limitation under Vinson-Trammel Act to all military procurement. Also set up the Renegotiation Board whose purpose was to determine whether the overall profits earned on Department of Defense contracts over a specified threshold were excessive. This Act stayed in effect until 1979 (Culver, 1985, pp. 2, 3, 7).

In an attempt to give the government, and, in particular, the military departments, more bargaining or negotiation power ex post to limit strategic behavior by defense contractors, the constitution provides greater unilateral authority to the government than what is normally

seen between contractual parties in private sector contracting. For example, the following changes clause must be included in all fixed price contracts:

> (a) The Contracting Officer may at any time, by written order, and without notice to the sureties, if any, make changes within the general scope of this contract in any one or more of the following:
>
> (1) Drawings, designs, or specifications when the supplies to be furnished are to be specially manufactured for the Government in accordance with the drawings, designs, or specifications.
>
> (2) Method of shipment or packing.
>
> (3) Place of delivery.
>
> (b) If any such change causes an increase or decrease in the cost of, or the time required for, performance of any part of the work under this contract, whether or not changed by the order, the Contracting Officer shall make an equitable adjustment in the contract price, the delivery schedule, or both, and shall modify the contract.
>
> (c) The Contractor must submit any "proposal for adjustment" (hereafter referred to as proposal) under this clause within 30 days from the date of receipt of the written order. However, if the Contracting Officer decided that the facts justify it, the Contracting Officer may receive and act upon a proposal submitted before final payment of the contract.
>
> (d) If the Contractor's proposal includes the cost of property made obsolete or excess by the change, the Contracting Officer shall have the right to prescribe the manner of the disposition of the property.
>
> (e) Failure to agree to any adjustment shall be a dispute under the Disputes clause. However, nothing in this clause shall excuse

> the Contractor from proceeding with the contract as changed (Federal Acquisition Regulation 1984, part 52.243-1).[15]

The changes clause makes explicit the fact that the government may at any time ex post unilaterally change the terms and conditions of the contract as long as those changes are within the general scope of the contract. Whether the contractor desires to effect these changes or not is immaterial: the contractor must immediately implement the change or be held in breach of contract. This unilateral authority, given to the government, facilitates contractual performance by removing the threat of "contractual nonperformance" by public contractors, and defense contractors in particular when changes are requested by the government. In major weapon systems' purchases, the government has few if any alternative suppliers to purchase from ex post due to an extensive time period for research and development, substantial costs involved in developing and producing these weapon systems, and the fact that there are few suppliers of major weapon systems to begin with, plus some major weapon acquisitions are sole source only. Given few or no alternative places of procurement ex post

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[15] Similar changes clauses must be included in cost reimbursement and some research and development contracts if the nature of the work lends itself to such change control. The main difference between these changes clauses is the definition of equitable adjustment in each case.

for the government, strong contractor incentives exist for the supplier under contract for a major weapon system to at least threaten or in fact effect contractual nonperformance to reap excessive profits, since the government has no other supplier; however, the changes clause in this particular case removed this incentive. If the government and the contractor failed to reach an agreement on all issues surrounding the change after it was enacted by the government, then the dispute or disputes were effectively tied off from contractual performance under the disputes clause enacted by the Contract Disputes Act described below.

On 1 November 1978, the Contract Disputes Act, Public Law 95-563, 92 Statute 2383 (1978), was signed by the President. The Act was based upon a report by the Commission on Government Procurement and the Act's purpose was to provide:

> a fair, balanced, and comprehensive statutory system of legal and administrative remedies in resolving Government contract claims. The Act's provisions help to induce resolution of more contract disputes by negotiation prior to litigation; equalize the bargaining power of the parties when a disputes exists; provide alternate forums suitable to handle the different types of disputes; and ensure fair and equitable treatment to contractors and Government agencies (Report of the Committee on Government Affairs and the Committee on the Judiciary, U.S. Senate 1978, p. 1).

The Act applies to public contracts signed after 1 March 1979 and requires through the disputes clause that both government and contractor claims be subject to a final decision by a contracting officer with the exception of claims that are statutorily assigned to other government agencies (e.g., Disputes falling under the Davis-Bacon Act are subject to review and decision by the Secretary of Labor--not a contracting officer). In effect, this act attempts to drive a wedge between disputes over the division of surplus and contractual performance.

Where the original intentions of the contractual parties are not clearly specified in the original agreement or may change over time, disagreements may arise that must be resolved. If these disagreements cannot be amicably resolved through negotiation, costly litigation may occur where costly refers to possible court costs, attorneys' fees and contractual nonperformance. The Contract Disputes Act provides both administrative and legal remedies that allow an equitable solution to a dispute while simultaneously blocking or significantly minimizing a dispute's impact on contractual performance. These disputes then can be effectively partitioned from contractual performance through "savings clauses" attached as special provisions to affected contracts. These savings clauses are bilateral agreements to contracts that describe disputes and how remedies to those disputes will be entered into affected contracts after

the rendering of a decision by an administrative or judicial judge. For an example of a savings clause, see Table 2.2 which contains a savings clause from one of the contracts. This savings clause affected three contracts; in addition, three other savings clauses were found that affected a total of four engine contracts.

Administratively, the Act provides for the establishment of Boards of Contract Appeals within an executive agency: the Department of Defense board is the Armed Services Board of Contract Appeals. Each board is comprised of three fulltime administrative judges who must have at least five years experience each in public contract law. These administrative judges decide any appeal from a decision of a contracting officer relative to a public contract. The Board's jurisdiction under the Act also includes breach of contract claims and claims arising under implied contracts. Alston et al. states that Board's are authorized:

> to grant any relief that would be available to a litigant asserting a contract claim in the claims court. While money damages is the ordinary form of relief available in the Claims Court, the boards have also been granted contract rescission and reformation authority. However, specific performance cannot be ordered (p. 478).[15]

[15] Claims mean a written demand by one of the contracting parties seeking, as a legal right, the payment of money, adjustment or interpretation of contract terms, or other relief, arising under or related to the contract (Alston et al., 1988, p. 472).

Table 2.2

Savings Clause

47. MAXIMUM ADJUSTMENT FOR CORPORATE AIRCRAFT COSTS

A. The parties disagree as to the inclusion in the contract price(s) of disputed amounts of overhead costs, namely certain Corporate Aircraft Costs. Issues underlying this contract and the equitable adjustment of this contract upon resolution of the disputed costs, the parties agree:

(1) That, in the pricing of the contract, all of the controverted costs have been excluded, together with any associated profit or fee allowance without prejudice to the Contractor's claim relative to the excluded amounts;

(2) That notwithstanding any other provisions of this contract, such pricing is subject to adjustment(s) based upon the final resolution(s) of the underlying controversy; and

(3) That the amount below quantifies the maximum pricing adjustment(s) that might be required upon resolution of the controversy. Such maximum pricing adjustment(s) are based on the data used at the time of the negotiation of this contractual instrument.

Price:

C. The parties shall diligently pursue the resolution of the controversy here involved and make appropriate equitable adjustments thereafter. To avoid the need for a formal Contracting Officer decision and Contractor appeal under this contract relating to those issues involved in the

Table 2 .2 continued

Armed Services Board of Contract Appeals (ASBCA) Docket #XXXXX, it is agreed that the Contracting Officer's decision and the Contractor's appeal hearing in ASBCA Docket #XXXXX apply to and control the disputed sums in this contract, and that the decisions of the ASBCA or the Courts, as the case may be, on the issues involved in the referenced dispute shall be binding on the parties under this contract. Simple interest shall be paid to the Contractor on amounts of any price adjustments due to resolution of controverted costs pursuant to this part. Such interest shall be at the rate established by the Secretary of the Treasury pursuant to Public Law 92-41; 85 Statute 97 for the Renegotiation Board and shall be applied to the aforementioned price adjustments, from the date these costs would have been payable by the Government had such amounts not previously been excluded from the contract, to the date of (I) a final judgement, relative to the disputed costs by a Court of competent jurisdiction, or (II) mailing to the Contractor of a Supplemental Agreement for execution either confirming completed negotiations between the parties, or carrying out a decision of a Board of Contract Appeals, relative to these disputed costs.

The Armed Services Board of Contract Appeals now has over thirty administrative judges on its staff and has averaged over the last four years approximately 1500 appeals filed per year for the Department of Defense and other federal agencies as well.[11] The next largest Board is the General Services Administration Board which has approximately 400 appeals filed per year (Bedingfield and Rosen, 1985, p. 2-17). Bedingfield and Rosen note "Other agency Boards of Contract Appeals are considerably smaller and have correspondingly smaller work loads" (Bedingfield and Rosen, 1985, p. 2-17). The Armed Services Board of Appeals disposed of 1,335 cases in fiscal year 1984, 1,293 cases in fiscal year 1985 and 1,938 cases in fiscal year 1986 (Alston et al., 1988, pp. 483-4). The principal issues in disputes were the changes and default clauses; however, allowable costs and contract specifications have been rising as principal issues in disputes (Alston et al., 1988, pp. 483-4). Alston et al. notes "that almost 50% of the cases disposed of are the result of a settlement prior to a decision, confirming the general desire to continue negotiations for a settlement even after a case is docketed" (p. 484). In summary, once a contracting officer issues a final decision relative to a dispute, the contractor has three options: (1) accept the final decision of the

[11] See Bedingfield and Rosen, pp. 2-16/17 and Alston et al., pp. 483-4 for a detailed discussion of this subject.

contracting officer, (2) appeal the decision of the contracting officer directly to the appropriate Board of Contract Appeals, (3) file suit directly in the Claims Court. The same procedures apply to the government as well. The federal court system of appeals may be used if either the contractor or the government desires to appeal a Board or Claims Court decision.

The evolution of the Department of Defense procurement constitution became prominent with the implementation of Title 10 of the United States Code[13] through the Armed Services Procurement Regulation in 1949. This regulation provided very specific procedures to be followed by the military departments when procuring goods and services. Culver states "the [Armed Services Procurement Regulation] was the most detailed regulation concerning procurement ever issued" (p. 18). This regulation was renamed the Defense Acquisition Regulation in 1978 and was eventually replaced by the Federal Acquisition Regulation in 1984. The Federal Acquisition Regulation is a procurement regulation that governs the procurement process for all federal agencies. See Table 2.3 for a table of contents to the Federal

[13] Title 10 is the Armed Services section of the United States Code. It makes explicit how the military departments are to organize and conduct business. A subsection is provided for each military department that deals exclusively with military procurement ranging from purchases that are non-complex and low in value such as paper supplies to purchases that are quite complex and high in value such as military weapons.

Table 2.3

Federal Acquisition Regulation

Table of Contents

Table 2.3 continued

Part 16	-	Types of Contracts
Part 17	-	Special Contracting Methods
Part 18	-	Reserved
SUBCHAPTER D	-	SOCIOECONOMIC PROGRAMS
Part 19	-	Small Business and Small Disadvantaged Business Concerns
Part 20	-	Labor Surplus Area Concerns
Part 21	-	Reserved
Part 22	-	Application of Labor Laws to Government Acquisitions
Part 23	-	Environment, Conservation and Occupational Safety
Part 24	-	Protection of Privacy and Freedom of Information
Part 25	-	Foreign Acquisition
Part 26	-	Reserved
SUBCHAPTER E	-	GENERAL CONTRACTING REQUIREMENTS
Part 27	-	Patents, Data and Copyrights
Part 28	-	Bonds and Insurance
Part 29	-	Taxes
Part 30	-	Cost Accounting Standards
Part 31	-	Contract Cost Principles and Procedures
Part 32	-	Contract Financing
Part 33	-	Protests, Disputes and Appeals
SUBCHAPTER F	-	SPECIAL CATEGORIES OF CONTRACTING
Part 34	-	Major System Acquisition
Part 35	-	Research and Development Contracting

Table 2.3 continued

Part 36	-	Construction and Architect-Engineer Contracts
Part 37	-	Service Contracting
Part 38	-	Federal Supply Schedule Contracting
Part 39	-	Management, Acquisition and Use of Information Resources
Part 40	-	Reserved
Part 41	-	Reserved
SUBCHAPTER G	-	CONTRACT MANAGEMENT
Part 42	-	Contract Administration
Part 43	-	Contract Modifications
Part 44	-	Subcontracting Policies and Procedures
Part 45	-	Government Property
Part 46	-	Quality Assurance
Part 47	-	Transportation
Part 48	-	Value Engineering
Part 49	-	Termination of Contracts
Part 50	-	Extraordinary Contractual Actions
Part 51	-	Use of Government Sources By Contractors
SUBCHAPTER H	-	CLAUSES AND FORMS
Part 52	-	Solicitation Provisions and Contract Clauses
Part 53	-	Forms

Acquisition Regulation.

The Federal Acquisition Regulation further allows various federal agencies the right to issue supplements to the Federal Acquisition Regulation when contracting conditions clearly show this need. In the case of the Department of Defense, the purchases of weapons has become both complex and astronomical in terms of dollars spent per weapon system; hence, a defense contractor may reap substantial financial gains through opportunistic behavior if that type of behavior is not successfully thwarted through contractual terms and conditions. Thus, the Department of Defense supplemented the Federal Acquisition Regulation with the Department of Defense Federal Acquisition Regulation Supplement. Included in the defense supplement is additional guidance to Department of Defense contracting officers and defense contractors on such items as overseas distribution of defense subcontracts, required sources for miniature and instrument ball bearings, and rights to technical data and computer software. This supplement plus each military departments' individual supplement to the Defense Federal Acquisition Regulation combined with the Federal Acquisition Regulation is the current constitution for all defense contractors and military departments.

In summary, development of the constitution for federal procurement has stemmed from the need to reduce the

administrative burden associated with the writing and governance of numerous federal contracts, to implement socioeconomic legislation, and the desire by Congress to thwart excessive profits by defense contractors. The main thrust of the constitution is to have more equal market power ex post between the government and federal contractors: this is attempted by the addition of certain clauses to federal contract such as the changes clause which gives the federal government more unilateral authority in the contracting process. If disputes arise, they are effectively "tied off" from contractual performance by administrative and judicial remedies enacted with the Contract Disputes Act and administered through the disputes clause required in all federal contracts. Finally, the current constitution is the Federal Acquisition Regulation as supplemented by the various government agencies. The Department of Defense's supplement is the Defense Federal Acquisition Regulation and is further supplemented by the various military departments.

Chapter 3

DESCRIPTION OF CONTRACTUAL TERMS

The relational view suggests a relationship between contractual design (prespecification of terms, etc.) and characteristics of the transaction. This section examines the contractual terms which we use as measures of design. Also, a brief discussion of the hypotheses to be tested follows.

3.1. Pricing Processes

Our goal is to develop a measure which would indicate how much the price is "nailed down" at the outset of the contractual relationship. The more firm a price is at the outset or the less it can respond to future events, the tighter are contractual terms and conditions; conversely, the less firm the price at the outset or the more price is allowed to respond to future events, the looser are contractual terms and conditions. In developing this measure, contractual terms and conditions dealing with price determination were sequentially ranked from the least stringent to the most stringent. Air Force engine contracting officers and federal procurement regulations (i.e., Federal Acquisition Regulation) were utilized in the

development of the sequential ranking.

As mentioned above, contractual "tightness" is measured sequentially through continuous and incremental changes in contractual terms and conditions. At this point, it is critical to distinguish between definitizations of preexisting terms and conditions which may purposefully be left open to future determination and contractual renegotiations of contingencies either not originally foreseen or purposely left for future determination. The former does not affect contractual tightness but simply reflects the fully anticipated implementation of prespecified contractual terms. For an example of the former, consider a contract where the price is specified subject to an economic price adjustment formula ex ante. As cost conditions rise, the economic price adjustment formula adjusts the price in a prespecified and formulaic manner. The individual parties have no control over price after the rule is specified, for it is actuated by the movement of (exogenous) price and cost indices.

Alternatively, a renegotiation gives the parties some individual control over future prices. As an example, consider a compensation arrangement including a not-to-exceed price (ceiling price) in the original agreement and a provision for a firm price to be determined through negotiations ex post. Here, the final price is constrained only by the contractual ceiling and depends on the relative

bargaining abilities of the contractual parties ex post.

The type of contracts by compensation arrangements[13] in the data are summarized in Table 3.1. Ranking from least stringent to most stringent, these types consist of the following: fixed-price incentive, not-to-exceed price with economic price adjustment, not-to-exceed price, fixed-price with economic price adjustment, and firm-fixed-price. We now discuss these pricing processes.

3.1.1. Fixed-price Incentive

A fixed-price incentive contract is an incentive contract where target cost, target profit, a profit adjustment formula, ceiling price, and a cost sharing ratio are all negotiated ex ante. The profit adjustment formula is utilized to establish firm target profit at contract completion based on the relationship of total final negotiated cost to total initial target cost. According to

[13] Contracts defined by compensation arrangements are explained in the Federal Acquisition Regulation, part 16, with the exception of not-to-exceed pricing. See the Federal Acquisition Regulation part, 16.403-2 for fixed-price incentive (successive targets), Federal Acquisition Regulation, part 16.403-1 for fixed-price incentive (firm target); Title 10 United States Code, paragraph 2304(a)(14), 1976 Edition and Secretary of the Air Force for not-to-exceed pricing with economic price adjustment; Title 10 of the United States Code, paragraph 2304(a)(14), 1976 Edition for not-to-exceed pricing; the Federal Acquisition Regulation, part 16.203 for fixed-price with economic price adjustment; and the Federal Acquisition Regulation, part 16.202 for firm-fixed-price.

Table 3.1

Basic Components of Federal Contract Prices*

1. Fixed-price incentive (successive targets)

-negotiated at outset
--initial target cost
--initial target profit
--initial profit adjustment formula
--cost share ratio
--production point at which the firm target cost and firm target profit will be negotiated.
--ceiling price that is the maximum amount paid to contractor.

-negotiated ex post
--when the production point specified in the contract is reached, the parties negotiate the firm target cost (apply cost share ratio) and the firm target profit is established by the formula.
---next, the parties either negotiate a firm-fixed-price using firm target cost plus firm target profit if appropriate or they negotiate a formula for establishing the final price using firm target cost and firm target profit. Finally, final cost is negotiated at completion and the final profit is established by formula.

2. Fixed-price incentive (firm target)

-negotiated at outset
--target cost
--target profit
--ceiling price
--cost share ratio
--profit adjustment formula

-negotiated ex post
--final cost (apply cost share ratio)
--final profit
---together the final cost and profit imply final price.

Table 3.1 continued

3. Not-to-exceed price

-negotiated at outset
--ceiling price that may not be exceeded in payment to contractor.
--production point where firm price will be negotiated.

-negotiated ex post
--a firm price which can be, for example, a fixed-price incentive (successive targets), fixed-price incentive (firm target), fixed-price with economic price adjustment or firm-fixed-price.

4. Not-to-exceed price with economic price adjustment

-negotiated at outset
--same as above plus the addition of an economic price adjustment clause.

-negotiated ex post
--same as above

5. Fixed-price with economic price adjustment

-negotiated at the outset
--fixed price
--economic price adjustment formula based on established price or actual costs of labor and material or cost indexes of labor or material.
---implies both upward and downward revision of the stated contract price upon the occurrence of specified contingencies. The frequency of adjustments and contingencies causing adjustments are specified ex ante.

-negotiated ex post
--there are no negotiations ex post to change price due to contractor's cost experience in performing the contract. The formulaic adjustment to price occurs as specified ex ante.

Table 3.1 continued

6. Firm-fixed-price

-negotiated at the outset
--price that is not subject to any adjustment on the basis of the contractor's cost experience in performing the contract.

-negotiated ex post
--there are no negotiations ex post to change price due to contractor's cost experience in performing the contract.

---

*Authority source is the Federal Acquisition Regulation, part 16.

the Federal Acquisition Regulation, part 16.403, the sharing ratio is designed to provide greater contractor incentive to cut contract costs when contractual performance involves substantial unforeseen contingencies. If costs are kept below the target cost, the contractor receives higher profits; if costs come in above target cost, the contractor's profits are lowered. For example, given a negotiated cost share ratio of 80/20 (government/contractor), if actual contractor costs are below target cost, the contractor receives 20% of the difference between actual and target costs in addition to firm target profit. If actual contractor costs are above target cost but at or below ceiling price, then the contractor's target profit is reduced by 20% of the difference between actual and target costs. Any actual costs above the ceiling price are borne in total by the

contractor. For more clarity, see Table 3.2 for a fixed-price incentive (firm target) cost share example.

Fixed-price incentive contracts are further partitioned by the Federal Acquisition Regulation, part 16.403, into fixed-price incentive (successive targets) and fixed-price incentive (firm target) contracts. According to the Federal Acquisition Regulation, part 16.403-2, a fixed-price incentive (successive targets) contract is used when there is reasonable assurance ex ante that reliable cost information will be available early on in the performance of the contract to permit negotiation of firm targets and a formula for establishing final profit. The contracting officer jointly with defense contractors must specify in the basic contract (original agreement) the initial target cost, initial target profit and the initial target price (initial target cost plus initial target profit) for each end item subject to incentive price revision. The successive targets aspect of this price directly implies that firm targets and thus price are left to future determination; hence negotiations will occur during and at the close of contractual performance to arrive at final cost, profit, and price. For example, in this data set, a fixed-price incentive (successive targets) contract was the first contract negotiated. After the engine was developed and flight tested, initial targets were then renegotiated since production costs had become more certain after the

Table 3.2

Fixed-price Incentive (firm target) Cost Share Example*

-Negotiated ex ante

Target Cost	$100,000	
Target Profit	$15,000	
Target Price	$115,000	(Target Cost+Target Profit)
Cost Share Ratio	60%/40%	(government/contractor)
Ceiling Price	$125,000	

-Calculation of point of total assumption for target cost by contractor: 0%/100% (government/contractor)

$$\text{Target Cost} + \frac{(\text{Ceiling Price} - \text{Target Price})}{\text{Government's Cost Share}} =$$

$$\$100{,}000 + \frac{(\$125{,}000 - \$115{,}000)}{.6} = \$100{,}000 + \frac{\$10{,}000}{.6}$$

$$\$100{,}000 + \$16{,}670 = \$116{,}670$$

$116,670 is the point of total assumption where cost is no longer shared between the government and the contractor. Specifically, a defense contractor's final profit is reduced by one dollar for each dollar of cost above $116,670. For final costs between $100,000 and $116,670, these costs are shared by the government and the defense contractor according to the share ratio. In this case, the contractor's final profit is reduced by forty percent of the difference between actual costs (not to exceed $116,670) and target cost ($100,000). If actual costs are less than the target cost of $100,000, the defense contractor would have forty percent of that difference (target cost - actual cost) added to his final profit.

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*Example taken from Contract Management (1986), Volume I (p. 23).

development and production of the flight-test engines.

According to the Federal Acquisition Regulation, part 16.402-1, a fixed-price incentive (firm target) contract is identical to a fixed-price incentive (successive targets) contract with one major exception: cost information is reliable enough at the outset that firm target cost, firm target profit and a ceiling price are negotiated ex ante. According to the Federal Acquisition Regulation, part 16.403 and Contract Administration, Volume I, unforeseen contingencies in this case are expected to be less than in the case of a fixed-price incentive (successive targets) contract rendering production costs more certain relative to the fixed-price incentive (successive targets) contract but still sufficient to warrant a contract with strong cost cutting incentives. Because the fixed-price incentive (firm target) contract nails down more of the price at the outset relative to a fixed-price incentive (successive targets) contract, it is contractually tighter than a fixed-price incentive (successive targets) contract.

3.1.2. Not-to-exceed Price (with and without Economic Price Adjustment)

A not-to-exceed price with economic price adjustment is used, according to Title 10 of the United States Code and Contract Administration, Volume I, when cost or pricing

information is sufficient to allow the negotiation of a ceiling price ex ante, when the contractual amount to be adjusted is large, and the economic variables for labor and material are unstable to adequately assign risk between the government and defense contractor at the outset. Not-to-exceed pricing requires a negotiation at some future date of a firm price at or below the not-to-exceed price. Not-to-exceed price implies no government obligation to procure engines until the not-to-exceed price is definitized into a firm price. There are contractual clauses in all but one contract in this data set that specify what type of contract ex post the initial not-to-exceed price will be negotiated or changed to. If doubt exists as to the stability of the material or labor conditions durin extended contractual performance, this known contingency is removed from the not-to-exceed price and made explicit through the economic-price-adjustment clause. The economic price adjustment clause allows for price adjustment to the not-to-exceed price based on an ex ante negotiated economic price adjustment formula that is activated by the occurrence of certain contingencies specified beforehand. The Air Force contracting officer ensures that contingency allowances are not duplicated by inclusion in both the not-to-exceed price and the economic price adjustment.

A <u>not-to-exceed price (without economic price adjustment)</u> is utilized when there is doubt as to the

stability of material and labor conditions according to Title 10 of the United States Code. This contract is contractually tighter than the not-to-exceed price with economic price adjustment, because the not-to-exceed price cannot be adjusted through price redetermination; however, the not-to-exceed price must be negotiated into a final price as unforeseen contingencies become explicit as in the case of the not-to-exceed price with economic price adjustment.

To summarize the main differences between not-to-exceed pricing and not-to-exceed pricing with economic price adjustment, the latter is used according to the Federal Acquisition Regulation, part 16.203, when a significant portion of contractual costs are to be incurred beyond one year after performance begins. Also, not-to-exceed pricing with economic price adjustment is selected over not-to-exceed pricing when the contractual amount subject to adjustment is large, and the economic variables for labor and material are too unstable to adequately assign cost risk between the Government and the contractor ex ante. Finally, one must keep in mind that in both types of not-to-exceed contracts, not-to-exceed pricing implies that a firm price at or below the not-to-exceed price must be negotiated ex post, however, there is no cost sharing ratio stipulated ex ante in contracts as in fixed-price incentive contracts to explicitly account for substantial unforeseen contingencies

ex post. As technological uncertainty decreases in the fixed-price incentive contractual environment, substantial contingencies are recognized and made explicit in the not-to-exceed environment implying less production cost uncertainty. hence, not-to-exceed pricing with economic price adjustment and not-to-exceed pricing is contractually "tighter" (i.e., more of the price is nailed down ex ante because there is no cost share ratio ex post) than fixed-price-incentive contracts.

3.1.3. Fixed-price (with and without Economic Price Adjustment)

A fixed-price with economic price adjustment is utilized, according to the Federal Acquisition Regulation, part 16.203, when the three following conditions are met: (1) when there is reasonable assurance that available cost or pricing information is reliable and sufficient to permit negotiation ex ante of a fixed-price; (2) when the contractual amount subject to adjustment is large; (3) when the economic variables for labor and material are too unstable to adequately assign risk between the government and the contractor ex ante. The economic price adjustment provides for the upward or downward adjustment of the fixed price upon the occurrence of certain contingencies designated in advance; hence, the economic price adjustment

removes from the fixed-price major allowances for identified contingencies.[11] The fixed-price then is contractually tighter than the not-to-exceed price with economic price adjustment or the not-to-exceed price because the fixed-price is not a price that is open to renegotiation (as is the not-to-exceed prices) but rather redetermination through the economic price adjustment clause determined ex ante. Thus, more of the fixed-price is nailed down at the outset rather than leaving more of it to future determination as in the case of both not-to-exceed prices. A firm-fixed-price contract is used, according to the Federal Acquisition Regulation, part 16.202, when the price is not subject to any adjustment on the basis of the contractor's cost experience in performing the contract because production costs or pricing information is considered sufficient to permit negotiation of a firm-fixed-price ex ante. This implies contingencies can be identified and reasonable estimates of their cost impact can be made and specified at the outset. A firm-fixed-price contract then is contractually tighter than a fixed-price with economic price

[11] It should be stated at this point that an economic price adjustment clause is used for the same purpose in a not-to-exceed or fixed-price contract--to remove from either price major allowances for identified contingencies. Also, under direction of the Federal Acquisition Regulation, an economic price adjustment does not imply a renegotiation of the original contract price, but rather a redetermination of that price by an economic price adjustment formula negotiated ex ante.

adjustment because a firm-fixed-price is not subject to redetermination ex post. To summarize, a fixed-price with economic price adjustment or a firm-fixed-price both imply available cost or pricing information which permits realistic estimates of the probable costs of performance. Thus in a firm-fixed-price contract, contingencies can be reasonably accounted for in the contract price and there is not serious doubt concerning the stability of market or labor conditions that will exist during contractual performance as there is in a fixed-price with economic price adjustment.

Before leaving this section, I think it is important for the sake of clarity to restate those characteristics of each contract by compensation type that imply a loosening or tightening of contractual terms and conditions (see Table 3.1 again). In the relational exchange environment, optimal behavior implies selecting that compensation arrangement or price which equitably shares the cost risk between the Air Force and defense contractor given an expected level of unforeseen contingencies ex ante. Fixed-price incentive (successive targets) contracts which allow initial targets to be renegotiated as production costs become more reliable during contractual performance. If cost or pricing information is reliable enough ex ante to negotiate firm targets, but the expected level of unforeseen contingencies is still substantial requiring a cost share ratio to

equitably share cost risk, then a fixed-price incentive (firm target) contract is appropriate. Such a contract is contractually tighter than the fixed-price incentive (successive targets), because initial target price is firm and not subject to renegotiation during contractual performance; hence, more of the price is nailed down ex ante in the fixed-price incentive (firm target) case.

When substantial contingencies can be made explicit ex ante allowing production costs or pricing information to be sufficient so that a ceiling price can be negotiated ex ante, plus there is some question as to the stability of market or labor conditions that will exist during an extended period of contractual performance, a not-to-exceed price with economic price adjustment is applicable. This contract is subject to ceiling price redetermination as well as negotiation of a firm price concurrent with contractual performance; yet, contractually it is tighter than both fixed-price incentive contracts, because substantial contingencies unforeseen in the fixed-price incentive environment are now explicit thus negating the need for a cost sharing ratio in not-to-exceed pricing. A not-to-exceed price is contractually tighter than a not-to-exceed price with economic price adjustment, because there is little doubt as to the stability of material and labor conditions ex ante. The not-to-exceed price is subject to negotiation of final price as remaining contingencies become

explicit but is not subject to ceiling price redetermination.

A fixed-price contract is used when cost or pricing information is reliable enough ex ante to negotiate a firm price. This contract is contractually tighter than either not-to-exceed pricing with economic price adjustment or not-to-exceed pricing, since all contingencies except market or labor instability are made explicit in the negotiated firm price; hence, there is fixed-price redetermination but no fixed-price renegotiation in a fixed-price with economic price adjustment on the basis of the contractor's cost experience in performing the contract.

Finally, a firm-fixed-price contract is the tightest contractually in the data set. It is contractually tighter than a fixed price with economic price adjustment, because the ex ante negotiated final price is not subject to any redetermination; hence, all contingencies are made explicit in the negotiated firm-fixed-price ex ante.

3.2. Hypotheses

3.2.1 Hypothesis 1

As time-to-performance increases, contractual tightness is reduced.

The relational approach to contracting argues that ex ante, if uncertainty is great as to what constitutes optimal behavior at the time of contractual performance, it may be better at the outset to leave certain terms and conditions of contractual performance open to negotiation to avoid substantial costs that may result from inefficiencies generated when contractual parties are constrained to actions that are inappropriate ex post (Crocker and Masten, 1988b, p. 5). For example, specifying firm-fixed-prices or firm quantities of a product ex ante, even though contractual performance does not occur for a substantial time period, may be inappropriate given unanticipated changes in economic conditions or technology that might occur. In this particular case, the cost to one or both contractual parties could be significant if, for example, costs to produce were to rise substantially or changes in technology rendered the product obsolete to the buyer by the time delivery occurs. This has the potential to disadvantage one of the contractual parties thus providing economic incentive for that party to evade contractual performance generating inefficiencies in the transaction; hence, the longer the time-to-performance, ceteris paribus, the looser contractual terms and conditions should be.

The drawback is that the looser are contractual terms and conditions, the greater is the incentive (and ability) for a firm to engage in strategic behavior to effect a

redistribution of the appropriable quasi-rents. Because of this, an efficient balance must be struck at the outset between flexibility and precision relative to contractual terms and conditions. Specifically, certain terms and conditions may be left to future determination but what may or may not be negotiated ex post can be specified at the outset. For example, a firm price relative to a future option to produce a product may be specified through negotiations at the time the option is exercised, rather than specifying it ex ante, but a not-to-exceed price or a price range may be specified at the outset to limit strategic behavior during contractual performance.

3.2.2 Hypothesis 2

The worse a firm's reputation becomes, the tighter contractual terms and conditions will become.

A firm entering a relational exchange with another firm whose reputation is perceived to be bad (i.e., one who engages in substantial opportunistic behavior) wants to "nail down" or specify more precisely terms and conditions ex ante as to future contractual performance. That is, in dealing with a firm whose reputation is perceived to be bad, the relational approach to contracting suggests more precise contractual terms and conditions ex ante which specify what

may or may not be negotiated or "argued" about at the time of contractual performance. For example, when price or quantity is left to future determination through negotiation, a framework that provides procedures to be followed in definitizing price or quantity ex post may be specified ex ante. This allows contractual flexibility (e.g. deferring price or quantity decisions until contractual performance occurs) to avoid disadvantaging one of the contractual parties ex post while simultaneously limiting strategic behavior by defining specific rules to be used in ex post negotiations, such as specifying the frequency of negotiations in determining price or quantity at the outset (Crocker and Masten, 1988b, pp. 6-7).

The drawback in this case is the antithesis of the first hypothesis. The relational approach to contracting suggests that the longer the time-to-performance, the less precise are contractual terms and conditions ex ante to avoid imposing distinct but inappropriate actions on contractual parties at the time of contractual performance; however, less precise contractual terms and conditions ex ante tend to invite opportunistic behavior ex post. Unfortunately, a firm that regularly engages in opportunistic behavior would be more successful the less precise contractual terms and conditions are ex post; thus a tradeoff between flexibility and precision of contractual terms and conditions must occur at the outset to promote

optimal firm behavior at the time of contractual performance when transacting with firms perceived to be opportunistic.

3.2.3 Hypothesis 3

As technological uncertainty increases, contractual tightness will loosen.

When technological uncertainty is great, many contractual terms and conditions are left to future determination rather than attempting to determine all contingencies and specify terms and conditions to resolve those contingencies ex ante. This avoids the possible problem of disadvantaging one or both firms at the time of contractual performance when prespecified terms and conditions may not be optimal ex post; hence, the need to evade performance by the disadvantaged firm is avoided, and gains from adaptation (i.e., surplus-increasing adjustments to relational contracts) may be realized in a technologically, complex contracting environment. Thus, in the relational contracting environment, a more flexible contract is designed at the outset in the face of substantial technological uncertainty to facilitate contractual performance by simply providing a framework or structure in the original agreement that specifies the procedures to be followed for future adaptations as

contractual performance occurs.

The drawback to be recognized here is the same as the drawback described in the first hypothesis. As contracts become less precise ex ante, the incentive to act opportunistically ex post to effect a redistribution of the appropriable quasi-rents becomes greater; thus, a tradeoff must occur between contractual flexibility and precision ex ante. For example, when technological uncertainty is great, price becomes more difficult to nail down ex ante, because future costs of production are uncertain. Also, when technological uncertainty is great, a cost index developed ex ante to adjust price through formulaic means at the time of contractual performance may prove quite difficult; however, if renegotiation procedures are developed at the outset that specify, for example, frequency of negotiations, who initiates negotiations and procedures to be followed if negotiations are not successfully completed; then, incentives for a firm to act opportunistically are reduced because negotiations may occur to alleviate extreme conditions that disadvantage a firm (Crocker and Masten, 1988b, pp. 5, 6, 7, 12, 13). The relational contract then can provide both the flexibility and precision needed in a technologically complex contracting environment.

Chapter 4

DATA DESCRIPTION

The following section describes in detail the collection of the data and the proxies used in measuring the dependent variable called TYPE. A discussion of the independent variables begins with TIMPERF which represents time-to-performance and is used as a proxy for temporal uncertainty. Next follows the variable DISPUTE which utilizes litigated outcomes to proxy for firm reputation. Finally, ECP proxies for technological uncertainty using engineering change proposals developed to correct engine deficiencies.

4.1. Data Collection

The data were collected at an Air Force installation whose primary function is to procure Air Force weapons. In particular, the data came from the engine contracting division at the above-mentioned installation who is responsible for the negotiations and governance of all aircraft engines procured by the Air Force. It is within this engine contracting division that I spent eighty-one days on site collecting data. Specifically, I read all basic contracts (initial or original agreements) utilized in

the procurement of a specific type of engine built for only one type of aircraft. This engine was developed specifically for military use at the request of the Air Force and was not an off-the-shelf commercial engine purchase. There are two contractors, A and B, who produce two separate engines, A1 and B1, respectively that are close substitutes--that is, either engine may be used in the aircraft without affecting the aircraft's performance characteristics. These contracts totalling thirteen in number were utilized in the total procurement of engine's A1 and B1; hence, the sample is the population as defined in this case. In other words, every A1 and B1 engine built and sold was built under and sold through one of the thirteen contracts or modifications to these contracts.

All of these contracts have modifications to them including some modifications which are complete rewrites of basic contracts or original agreements. A rewrite incorporates into the basic contract all modifications to the basic contract prior to the rewrite, plus new terms and conditions being negotiated at the time of the rewrite. The modifications may be unilaterally issued by the Air Force or bilaterally issued by the contractor and the Air Force together; however, both types of modifications must remain within the scope of the basic contract according to the Federal Acquisition Regulation, part 43.201. Authority for both types of modifications comes from clauses included in

the basic contract--primarily the changes clause which is required in all contracts by the Federal Acquisition Regulation, part 43.201. Bilateral agreements are called supplemental agreements and represent an agreement by both parties; hence, "bilateral agreements create new and different legal relations between the parties and are, in effect, new contracts. They must fulfill all the requirements necessary for a valid contract" (Contract Administration, Volume II, 1986, p. 50).[11] Thus, data points are developed from two areas; (1) terms and conditions for engine procurement in basic contracts; and (2) supplemental agreements or bilateral modifications to basic contracts designed specifically for the procurement of engines. Data points or observations are arranged by time series and cross-section in the data set beginning with the first event (where event means engine procurement--in other words, a contractual signing) in 1970, first calendar quarter, and the last event in 1987, first calendar quarter. Table 4.1 shows the date of each event for each data point.

The contracting period analyzed starts at the beginning of 1970 and runs through the end of 1988. Three of the thirteen contracts are still in effect--two contracts with contractor A and one with contractor B. Table 4.2 shows the chronology of these contracts. Of the thirteen original

[11] Authority source is Federal Acquisition Regulation, parts 43.101, 43.102, and 43.103.

Table 4.1

Data Points by Date of Occurrence (year:quarter)

Observation	Date
1	1970:1
2	1970:1
3	1970:1
4	1972:1
5	1972:1
6	1972:1
7	1975:1
8	1975:3
9	1975:3
10	1975:3
11	1975:4
12	1976:2
13	1976:2
14	1976:2
15	1976:2
16	1976:2
17	1977:4
18	1977:4
19	1978:4
20	1978:4
21	1979:3
22	1980:1
23	1980:2
24	1981:3
25	1981:3
26	1982:3
27	1984:1
28	1984:1
29	1984:1
30	1984:1
31	1984:1
32	1984:1
33	1984:1
34	1984:1
35	1984:1
36	1984:1
37	1984:1
38	1984:1
40	1984:4
41	1986:1
42	1987:1
43	1987:1
44	1987:1

Table 4.2

Chronology of Engine Contracts

Contract	Time Period Contract is in Effect
1	1970 to 1972
1A (rewrite)	1972 to 1975
1B (rewrite)	1975 to 1977
2	1976 to 1978
3	1975 to 1977
3A (rewrite)	1977 to 1981
4	1978 to 1981
5	1979 to 1981
6	1980 to 1982
7	1979 to 1981
7A (rewrite)	1981 to 1983
8	1980 to 1983
9	1982 to 1984
9A (rewrite)	1984
10	1983 to 1985
11	1984 to present
12	1984 to present
13	1984 to present

contracts, twelve are with contractor A, and one is with contractor B. Contractor A initially won the award in 1970 to design, develop, and test an engine according to military specifications--options for future production buys for the Air Force and the Navy were included as well.[22] Contractor A fulfilled 100 percent of all Air Force requirements for this engine through 1984. In 1984, a competitive bid was

[22] Initially, this was to be a joint buy with the Navy. The Navy was going to use the engine in a newly developed model of one of its older aircraft; however, due to monetary considerations, the Navy continued with the original engine that was utilized in the older model aircraft.

again held for Air Force procurement requirements for this engine for fiscal years' 1985 through 1990. This competition resulted in contractor A and B being awarded approximately 25 percent and 75 percent respectively for the Air Force's requirements for this engine for fiscal year 1985. approximately one-half each (i.e., fifty per cent to contractor A and fifty per cent to contractor B) of the Air Force's requirements for this engine for fiscal years' 1986, 1987 and 1988 were awarded to each contractor. These fiscal year buys are annual options that may be exercised by the Air Force each year.

In summary, eighty-one days were spent within the aircraft engine contracting division at an Air Force installation thoroughly reviewing thirteen contracts and five rewrites, plus approximately fifteen-hundred modifications (unilateral and bilateral combined). Many question and answer sessions were conducted with Air Force engine contracting officers relative to these engine contracts and their respective modifications as well as discussions centering on Air Force contracting in general. From this, forty-four data points were developed: data points are defined as events that represent actual contractual engine buys. The discussion that follows explains the dependent and independent variables utilized in each data point.

4.2. Description of Variables

4.2.1. Type

The dependent variable TYPE measures the contractual "tightness" of these contracts utilizing the type of price in each engine procurement or option to procure. Contractual tightness is a measure of ex ante specification; that is, it is a measure of how much the price is "nailed down" when the contract is being written and signed. In other words, contractual tightness gauges how deterministic the price is or how price changes in response to future events. For example, (1) is the price firmly fixed and specified thus being totally independent of future events (i.e., price does not change when contingencies occur that were unanticipated ex ante), or (2) is the price fixed and specified but responsive to contingencies not anticipated ex ante through formulaic means for example, or (3) is the price not fixed but flexible to any anticipated or unanticipated event through, for example, renegotiations. The last example implies a contract price that is "loose," while the second and first examples imply contract prices that are contractually tighter than the third example. The first pricing example is the tightest contractually of the three examples because more of the price is nailed down ex ante and not left to future determination.

Table 4.3 shows the types of contract categories by compensation arrangement or price and the values assigned to each type. Types of prices listed in Table 4.3 were the types of prices found in the thirteen contracts in either the basic contracts or modifications to the basic contracts. After several discussions with Air Force contracting officers within the engine contracting division, the sequence of price types and the numbering scheme used that reflects each specific type of price in the data set evolved using the definition of contractual tightness defined above which addresses how much the price is nailed down ex ante. More specifically, the Air Force engine contracting officers felt that changes in contractual tightness moving sequentially from one type of price to another was the same between each type of price. For example, a movement from a fixed-price with economic price adjustment to a firm-fixed-price has the same degrees of change in contractual tightness as a movement from a fixed-price incentive (successive targets) to a not-to-exceed fixed-price incentive (successive targets)[::] and vice versa.

[::] A not-to-exceed fixed-price incentive (successive targets) is contractually tighter than a fixed-price incentive (successive targets) because the former price assumes production cost (pricing information) is sufficient to allow for the negotiation of a not-to-exceed price ex ante to facilitate contractual performance while negotiations ensue to reach a fixed-price incentive (successive targets); however, production costs are not sufficient ex ante in the case of a fixed-price incentive (successive targets) to allow contractual performance to start before targets are established.

Table 4.3

Contract Prices by Type

TYPE	Numbers assigned to TYPE*
Firm-fixed price	9
Fixed-price with economic price adjustment	8
Fixed-price with partial economic price adjustment	7
Not-to-exceed price with economic price adjustment	6
Not-to-exceed price	5
Fixed-price incentive (firm target)	4
Not-to-exceed price/fixed-price incentive (firm target)	3
Not-to-exceed price/fixed-price incentive (successive targets)	2
Fixed-price incentive (successive targets)	1

*Prices are assigned continuous values that reflect movements in contractual tightness. Nine is the "tightest" price contractually while one is the "loosest" price contractually.

In summary, the dependent variable TYPE is a continuous variable that measures contractual tightness utilizing types of prices found in the thirteen basic contracts and their modifications. There are nine basic types of prices in this data set.

4.2.2. Temporal Uncertainty (TIMPERF)

The time-to-performance variable called TIMPERF attempts to measure temporal uncertainty in these contracts. That is, the further into the future a contract is in effect, the greater the probability that events unforeseen ex ante will occur. TIMPERF measures the time by calendar quarters from contract signing or the exercise date of an option by the Air Force to the first calendar quarter of the calendar year in which the engine is delivered. Air Force engine contracting officers view contractual performance to have occurred when an engine is received by the Air Force, and it is operationally ready to place in an aircraft.

There are some instances where TIMPERF is negative relative to contractor A. Specifically, the engine has been delivered to the Air Force before the type of price and a specific price was agreed to between the Air Force and contractor A. Not-to-exceed pricing was used in these cases, and firm prices were not negotiated until after the engines had been delivered. In the cases of firm prices

with negative time-to-performance, the TIMPERF variable is truncated at zero when using formal econometric procedures to test the significance of this variable, because there is no temporal uncertainty associated with a past event. A listing of TIMPERF is in Table 4.4.

4.2.3. Reputation (DISPUTE)

Air Force contracting officers within the engine contracting division view reputation of a defense contractor as a function of that firm's leadership, the leadership of the parent company[4], and the leadership of the parent companies' other subsidiaries. It has been their experience that when disputes arise with defense contracting firms in general and litigation is involved, parent companies tend to set litigation policy for all their subsidiaries; therefore, reviewing how other subsidiaries handle litigation and how their respective parent companies handle litigation, plus the direct past litigation history of the defense contracting firm itself, gives Air Force contracting officers an excellent idea ex ante of how defense contractors tend to handle disputes.

For example, according to Air Force engine contracting

[4] This of course assumes that a defense contracting firm is owned by a parent company. If this is not the case, then only the past history of the defense contracting firm is important in anticipating future means of dispute resolution ex ante.

Table 4.4

Time-to-Performance (TIMPERF)

Observation	TIMPERF
1	8
2	16
3	20
4	0
5	12
6	16
7	-5
8	6
9	10
10	14
11	5
12	-6
13	3
14	2
15	6
16	0
17	1
18	5
19	1
20	1
21	2
22	0
23	3
24	2
25	2
26	2
27	0
28	16
29	20
30	24
31	8
32	12
33	16
34	20
35	24
36	4
37	4
38	8
39	12
40	-4
41	0
42	4
43	8
44	12

officers, if a defense contracting firm has a history of settling disputes through administrative or judicial means rather than negotiation, and this also seems to be the case relative to that same firm's parent company and their respective subsidiaries, then Air Force contracting officers expect ex ante this type of behavior to continue. Conversely, if a defense contracting firm's history of settling disputes is through negotiation more than administrative or judicial means, plus this is also the case with that firm's parent company and other subsidiaries, then the Air Force contracting officers in the engine contracting division expect this ex ante to be the case in the future. The bottom line on firms' reputation according to Air Force engine contracting officers is this: the past history of disputes resolution of the defense contracting firm, its parent company, and the parent companies' other subsidiaries are all important indicators of a defense contractor's reputation ex ante.

To ensure that information on defense contractors, their respective parent companies, and the parent companies other subsidiaries gets to each contracting officer in the engine contracting division, each contracting officer who is in charge of contracts with a particular defense contracting firm is required by the Deputy Director of Contracting for the engine contracting division to read publications such as the Federal Contracts Report published weekly by the Bureau

of National Affairs. In this weekly publication are summaries of cases argued and determined[25] at various judicial levels such as the Armed Services Board of Contract Appeals, United States District Court system, and the Federal Appellate Court system. I found several articles describing decisions rendered relative to both contractor A and B, their respective parent companies, and their other subsidiaries as well. Past issues of this publication are kept on file in the engine contracting division for review by contracting officers when appropriate. Also, other similar publications are received by the engine contracting division such as Contract Management, Aerospace Daily, and news releases from the Public Affairs department of the Office of Assistant Secretary of Defense. These publications, like the Federal Contracts Report, include summaries of cases argued and decided relative to defense contracting firms, their parent companies, and their subsidiaries.

To construct this variable, I looked at cases argued and determined relative to contractor's A and B, their respective parent companies, and the parent companies' other subsidiaries as well. This included appeals to contracting

[25] Argued and determined implies the case has been previously argued and the decision has been rendered on a certain date. The date the decision is rendered is the date used in constructing this variable in time series by calendar quarters.

officer decisions filed by both defense contracting firms, their parent companies, and their subsidiaries, as well as appeals filed by the military departments in the Armed Services Board of Contract Appeals. Also, suits and appeals are used that were filed by private citizens and private firms against the defense firms and/or their respective parent companies and their subsidiaries and vice versa in the United States District Court system, the United States Claims Court, within the Comptroller General[4] and the Federal Appellate Court system. Suits and appeals filed by the government, private citizens, and private firms were considered, because these cases do represent a failure by both contractual parties to reach a solution to a dispute through negotiations.

Fifty-five cases were recorded involving contractor A, contractor A's parent company, and their subsidiaries, while thirty-four cases were recorded involving contractor B, contractor B's parent company, and their subsidiaries. Contractor A's team won twenty-four cases while losing twenty-six, and contractor B's team won fifteen and lost eighteen. It was not clear to me from reading summaries of

[4] Bid protests by defense contracting firms are filed with the Comptroller General. Specifically, when a public contracting firm feels their bid for a public contract was not fairly considered by the government, a "bid protest" may be filed with the Comptroller General. The case is informally argued before the Comptroller General who renders a final decision which may not be appealed.

the proceedings who won five of contractor A's cases and one of contractor B's cases. For a synopsis of all these cases, see Tables' 4.5 and 4.6 respectively for contractor A and B. Also, Table 4.7 shows the chronology and the actual number of cases argued and determined for both contractors annually from 1960 to 1980, inclusive. Given that Air Force contracting officers generally change assignments within five years and in addition periodically read publications that summarize cases argued and determined through administrative or judicial means relative to defense contracting firms, their respective parent companies and other subsidiaries, the reputation variable is constructed using the number of current plus past cases argued and determined for the current observation. For example, the first event in the data set occurred in the first calendar quarter, 1970: for contractor A, the reputation variable, DISPUTES, was constructed for the first event by adding together the number of cases argued and determined in the first calendar quarter, 1970, with the number of cases argued and determined for the last twenty calendar quarters or five years (i.e., 1965-1969 inclusive) involving contractor A, their parent company, and the parent companies subsidiaries. The same construction was used for all other observations for contractor A, and all observations for DISPUTE were constructed in the same manner for contractor B as well. Thus, an observation for DISPUTE for either

Table 4.5

Litigated Outcomes--Contractor A

Time Period: 1960, first quarter to 1988, last quarter

Contractor A - 55 total litigated outcomes

-Armed Services Board of Contract Appeals
--total - 3
---won - 1
---lost - 2

-Comptroller General (bid protests)
--total - 2
---won - 0
---lost - 2

-United States Court System

--United States Supreme Court
---total - 1
----won - 0
----lost - 1

--United States District Court System
---total - 30
----won - 17
----lost - 8
----could not determine - 5

--United States Appellate Court System
---total - 16
----won - 6
----lost - 10

--United States Court of Claims
---total - 3
----won - 0
----lost - 3

Table 4.6

Litigated Outcomes--Contractor B

Time Period: 1960, first quarter to 1988, last quarter

Contractor B - 34 litigated outcomes

-Armed Services Board of Contract Appeals
--total - 18
---won - 10
---lost - 7
---could not determine - 1

-Comptroller General (bid protests)
---total - 10
---won - 0
---lost - 10

-United States Court System

--United States District Court System
---total - 3
----won - 2
----lost - 1

--United States Appellate Court System
---total - 1
----won - 1
----lost - 0

--United States Court of Claims
---total - 2
----won - 2
----lost - 0

Table 4.7

Litigated Outcomes for Contractors' A and B

Time Period: 1960 to 1988 inclusive (annual data)

Date	Contractor A	Contractor B
1960	0	1
1961	0	2
1962	0	0
1963	1	2
1964	0	1
1965	1	1
1966	0	0
1967	0	2
1968	1	0
1969	0	3
1970	0	0
1971	1	0
1972	0	2
1973	1	1
1974	0	0
1975	0	2
1976	0	0
1977	1	1
1978	2	1
1979	3	1
1980	5	1
1981	1	0
1982	0	4
1983	4	0
1984	3	1
1985	6	0
1986	7	2
1987	6	1
1988	13	3

contractor consists of the number of cases argued and determined for twenty-one calendar quarters (i.e., the number of cases argued and determined in the calendar quarter of the current event plus the number of cases argued and determined during the last twenty calendar quarters).

In summary, the reputation variable is comprised of the number of cases argued and determined relating to contractors' A and B, their respective parent companies, and their parent companies other subsidiaries. Cases researched involved the Armed Services Board of Contract Appeals, the Comptroller General, the United States District Court system, the United States Claims Court, and the Federal Appellate Court system. A current observation for either contractor for the reputation variable, DISPUTE, includes the number of cases argued and determined in the calendar quarter of the current event plus the last twenty calendar quarters or the last five years of cases argued and determined for a total of twenty-one quarters of cases argued and decided for each observation. See Table 4.8 for a listing of DISPUTE.

4.2.4. Technological Uncertainty (ECP)

Technological uncertainty is measured by engineering change proposals that are directed and approved by the Air Force and developed by the defense contractor. Per

Table 4.8

Litigated Outcomes (DISPUTE)

Observation	DISPUTE
1	2
2	2
3	2
4	2
5	2
6	2
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
19	3
20	3
21	6
22	10
23	11
24	12
25	12
26	12
27	14
28	14
29	14
30	14
31	7
32	7
33	7
34	7
35	7
36	14
37	7
38	14
39	14
40	13
41	15
42	7
43	7
44	7

Department of Defense-Standard-480A dated 12 April 1978,[27] engineering change proposals are developed to correct deficiencies in the engine, the engine's support equipment[28] and other items such as documentation. Engineering change proposals are implemented through unilateral modifications to basic contracts authorized by the changes clause in the Federal Acquisition Regulation, part 52.243-1. As discussed in Chapter II, section C, the changes clause allows the contracting officer to make changes to "drawings, designs, or specifications when the supplies to be furnished are to be specifically manufactured for the government in accordance with the drawings, designs, or specifications" without contractor approval. There are two types of

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[27] This standard or military specification entitled Configuration Control Engine Changes, Deviations and Waivers, provides definitions and procedures for the development and implementation of engineering change proposals.

[28] Support equipment is any piece of equipment that is utilized in maintaining the readiness of the engine. An example would be engine test stands used to support engines removed from the aircraft for maintenance. Note: from this point on I'll refer to deficiencies relative to the engine or the engines' support equipment simply as engine deficiencies; however, this implies both engine or engine support equipment deficiencies. Approximately ninety-six percent of total Air Force approved engineering change proposals in this data set are for the engine and the remaining six percent for the engines' support equipment. Engine support equipment is considered part of the technological uncertainty variable, because it is an integral part of engine procurement--the Air Force does not buy the engine without the engine's support equipment because the engine cannot be maintained without the support equipment.

engineering change proposals according to Department of Defense-Standard-480A: Class I and Class II. Department of Defense-Standard-480A states: "An engineering change to a privately developed item shall be classified Class I when it affects the contractually specified form, fit or function of the item. . . . An engineering change shall be classified Class II when it does not fall within the definition of a Class I engineering change ... Examples of a Class II engineering change are: (a) a change in documentation only (e.g., correction of errors, addition of clarifying notes or views) or (b) a change in hardware (e.g., substitution of an alternative material) which does not affect any factor listed in [the Class I definition]" (p. 5). Only Class I engineering changes to the engine and the engine's support equipment were considered in the construction of this variable.

After several discussions with Air Force engine contracting officers, it became clear that past history of deficiencies with the engines and the engines' support equipment was not necessarily a good predictor of future technological problems ex ante as past firm behavior was relative to dispute resolution (reputation) ex ante. More specifically, the engine contracting officers stated they know when technological uncertainty will be high and when it will be low ex ante given the age of the engine where age is defined as the time period extending from engine development

(i.e., when an engine is fully assembled and ready to flight test for the first time) to the current event. They stated that when the age of an engine is relatively short or new, expectations ex ante of future deficiencies in engines and their support equipment are high. when the age of an engine is relatively long or old, expectations of future engine deficiencies are low. In the case of engine A1, it began flight testing in 1972 and operational flying (i.e., the start of day-to-day Air Force missions after the completion of the flight test phase) in 1973 and initially encountered substantial engine deficiencies that peaked in 1976 and slowly descended with some small peaks and valleys until 1986 where engine deficiencies sharply increased again through the end of 1988 (i.e., the end of the data set). Engine B1 ended flight test in 1985 and began operational flying in 1986 experiencing a gradual increase in engine deficiencies which peaked in 1987 and declined through 1988. Again, both engines' deficiencies were corrected through engineering change proposals directed by the Air Force, developed by defense contractors, and approved by the Air Force for implementation on engines in production as well as approval for retrofit to engines operationally flying utilizing contractor developed retrofit kits. Statistically speaking, Air Force engine contracting officers may not know the exact numbers of deficiencies which will occur on a newly developed engine, but they do have knowledge

concerning the distribution of the technological uncertainty variable ex ante. Because of this, the assumption of perfect foresight ex ante relative to technological uncertainty (i.e., number of engine deficiencies occurring up to the next event) was used in constructing this variable.

An observation for the variable technological uncertainty includes the number of Air Force approved engineering change proposals for the current time period plus the number of Air Force approved engineering change proposals for each calendar quarter up to but not including the next contracting event (where event is a contractual signing meaning engines were procured). For example, the first event in the data set is the first calendar quarter of 1970. For contractor A, the technological uncertainty variable for 1970, first calendar quarter, includes the number of Air Force approved engineering change proposals during the first calendar quarter, 1970, and the number of Air Force approved engineering change proposals for contractor A for every future calendar quarter up to but not including the calendar quarter of the next event. The date of the next event in the data set is the first calendar quarter, 1972; therefore, the observation for technological uncertainty relative to contractor A for the first quarter, 1970, includes the number of Air Force approved engineering change proposals for contractor A for the first calendar

quarter of 1970, plus the next three calendar quarters of 1970, plus all four calendar quarters for 1971 for a total of eight calendar quarters of Air Force approved engineering change proposals. The same procedure is used for contractor B's technological uncertainty observations as well beginning in 1984 when the engine was being developed and flight tested. Table 4.9 shows the number of annual Air Force approved engineering change proposals for both contractors.

In summary, the technological uncertainty variable is a forward looking variable that is measured using engineering change proposals which correct engine and engine support equipment deficiencies and are directed by the Air Force, developed by contractors' A and B, and approved by the Air Force. Only Class I engineering change proposals are considered in the construction of this variable since only class I engineering change proposals specifically change the form, fit, or function of the engine or its support equipment. An observation for this variable for either contractor consists of the number of Air Force approved engineering change proposals that occurred during the calendar quarter of the event, plus the number of Air Force approved engineering change proposals occurring in all future calendar quarters up to but not including the calendar quarter of the next event. See Table 4.10 for a listing of ECP.

Table 4.9

Engineering Change Proposals for Contractor's A and B

Time Period: 1970 to 1988 inclusive (annual data)

Date	Contractor A	Contractor B*
1970	1	.
1971	4	.
1972	7	.
1973	51	.
1974	75	.
1975	146	.
1976	147	.
1977	90	.
1978	77	.
1979	66	.
1980	58	.
1981	59	.
1982	62	.
1983	63	.
1984	47	1
1985	53	8
1986	19	42
1987	32	56
1988	99	40

*Contractor B did not receive a contract for its engine until 1984.

Table 4.10

Technological Uncertainty (ECP)

Observation	ECP
1	5
2	5
3	5
4	133
5	133
6	133
7	60
8	12
9	12
10	12
11	116
12	161
13	161
14	161
15	161
16	161
17	103
18	103
19	43
20	43
21	31
22	10
23	76
24	67
25	67
26	89
27	43
28	43
29	43
30	43
31	51
32	51
33	51
34	51
35	51
36	43
37	51
38	43
39	43
40	57
41	150
42	96
43	96
44	96

Chapter 5

EMPIRICAL ESTIMATION

In this section I estimate the relationship between contractual tightness (TYPE) and time-to-performance (TIMPERF), reputation (DISPUTE), and technological uncertainty (ECP) given by the following equation:

$$TYPE_{it} = \beta_0 + \beta_1 TIMPERF + \beta_2 DISPUTE + \beta_3 ECP_{it} + \varepsilon_{it}$$

where i = 1, 2, (firm specific: contractor A or B)
t = 1, 2, 3, ... , 44 (data points in time series)
ε is an independently distributed random error term

According to the hypotheses presented above, β_1 and β_3 should be negative while β_2 is positive. I estimated this relationship using three different estimating techniques on a personal computer using LIMDEP (Version 5) by William Greene: ordinary least squares, two-stage least squares, and ordered probit.

5.1. Ordinary Least Squares

Ordinary least squares yields unbiased estimators when the error term is random and is independently and identically distributed. Also, it must be drawn from a normal distribution with mean zero and not be

contemporaneously correlated with the right-hand-side variables. Using ordinary least squares, the estimates in Table 5.1 were obtained. The two columns in Table 5.1 are the estimates for two different regressions run using ordinary least squares. The first column is estimates of the basic model while the second column represents the basic model plus a time trend (QTRELP) added to the right-hand-side variables. The time trend may proxy for a learning curve relative to technological uncertainty. Specifically, when a new engine is developed, problems with that engine generally occur initially because engineers are limited in their ability to build new engines that are on the leading edge of technology, "perfectly". As time passes, problems that develop with the engine are corrected as engineers learn what causes the problems and then learn how to fix these problems. The time trend was constructed using the number of calendar quarters that have elapsed from the first event or contractual signing to the calendar quarter of the current event inclusive. For example, the last observation occurred in 1987, the first calendar quarter. The time trend observation for that event was sixty-nine. Specifically, seventeen years plus one calendar quarter had elapsed from the first event of 1970, first calendar quarter. That is a total of sixty-eight calendar quarters plus one for the current observation making a total of sixty-nine. The time trend observation for the first event

Table 5.1

Ordinary Least Squares Estimates

{Standard Errors in Brackets}

(T-ratios in Parentheses)

[Significance Levels in Boxes]

INDEPENDENT VARIABLES	REGRESSIONS (1)	(2)
CONSTANT	3.1067 {0.7033} (4.4170) [0.0001]	1.8307 {0.5436} (3.3680) [0.0017]
TIMPERF	-0.0676 {0.0351} (-1.9220) [0.0617]	-0.0729 {0.0252} (-2.8930) [0.0062]
DISPUTE	0.5379 {0.0478} (11.2440) [0.0000]	0.2835 {0.0532} (5.3250) [0.0000]
DCP	-0.0080 {0.0054} (-1.4840) [0.1457]	-0.0124 {0.0039} (-3.1740) [0.0029]
QTRELP		0.0821 {0.0131} (6.2430) [0.0000]

which occurred in 1970, first calendar quarter, is one. The time trend variable (QTRELP) was constructed in this manner to specifically measure a learning curve effect on technological uncertainty by taking into account the time periods between contractual events. That is, the longer the gap between contractual events, the greater the learning curve effect on technological uncertainty. Table 5.2 lists the time trend variable.

In both regressions, the ordinary least squares estimates are consistent with the hypotheses presented in Chapter 3. β_1 and β_3 are negative and β_2 is positive. The time trend is very significant and substantially improves the significance of TIMPERF and ECP. This also seems to suggest there is a learning curve effect relative to technological uncertainty. This implies that as technological uncertainty decreases, less contractual terms are left to future determination, which tightens the contract. The time trend's affect on the coefficient of TIMPERF is controlling for the effect of less technological uncertainty on duration. The fact that longer contracts are more recent implies there is less technological uncertainty, which tends to tighten contractual stringency. This works opposite the direct effect of duration on contractual stringency: as duration increases, contractual stringency decreases. Thus, the time trend is controlling for an opposite, indirect effect of technological uncertainty on

Table 5.2

Time Trend Variable

Observation	QTRELP
1	1
2	1
3	1
4	9
5	9
6	9
7	21
8	23
9	23
10	23
11	24
12	26
13	26
14	26
15	26
16	26
17	32
18	32
19	36
20	36
21	39
22	41
23	42
24	47
25	47
26	51
27	57
28	57
29	57
30	57
31	57
32	57
33	57
34	57
35	57
36	57
37	57
38	57
39	57
40	60
41	65
42	69
43	69
44	69

the coefficient of TIMPERF. Finally, I think it is important to note that the reputation variable, DISPUTE, is significant at the one percent level in both regressions.

To further test the original specification of the model, a dummy variable was utilized in an attempt to capture additional firm-specific effects beyond those already specified in the model. A dummy variable was created which utilized one's for contractor A's events and zeros for contractor B's events. The omitted category was contractor B's firm-specific effects. If this dummy variable was significant, this would imply there are firm-specific effects (i.e., contractor A is significantly different from contractor B) beyond those already specified in the model. The dummy variable was both positive and significant at the one percent level when included in the original model without the time trend. Its effect on the other variables was the same as the time trend's effect shown in Table 5.1. That is, coefficient signs and levels of significance were the same for time-to-performance and reputation using either the firm-specific dummy variable or the time trend in the regression. Technological uncertainty was negative but only significant at the four percent level using the dummy variable versus being significant at the one percent level when using the time trend only. Using the time trend in conjunction with the firm-specific dummy variable rendered the firm-specific dummy variable

insignificant. The time trend was still significant at the one percent level as were all other variables.

A third specification of the model was run using ordinary least squares to control for the switch from a sole source environment (1970 to 1984 where contractor A only provided the engines) to a competitive environment (1984 to 1988 where contractor A and B both provided engines). In this case, as technological uncertainty decreased over time, contract price should become looser; however, the opposite occurred. Contract prices from 1984 to 1988 became tighter because the Air Force was in a stronger bargaining position at the end of 1983 due to the introduction of contractor B into the engine procurement process. After the engine sourcing environment became competitive, the Air Force was better able to "nail down" more pricing terms and conditions ex ante because both contractors were more conciliatory towards the Air Force in this competitive environment. Specifically, both contractors feared loosing "business" to the other contractor if concessions the Air Force wanted from one or the other contractor was not granted.

A dummy variable was constructed to control for the market change in sourcing where all events (data points) prior to 1984 were zeros and all events from 1984 to 1988 were ones. The zeros represent the single sourcing period for the engine and the ones represent the dual sourcing for the engine. The results were basically the same as in the

case of the firm-specific dummy variables. When the regression included time-to-performance, reputation, technological uncertainty and the dummy variable controlling for competitive effects (period from 1984 to 1988), technological uncertainty and reputation were significant at the one percent level and of the correct sign. The dummy variable was positive and significant at the three percent level while technological uncertainty was negative and significant at the seven percent level. When the competitive effects dummy variable was run with the time trend, it was negative and significant at the one percent level while the time trend was positive and significant at the one percent level. All other variables were of the correct sign and significant at the one percent level except time-to-performance which was insignificant due to multicollinearity with the competitive effects dummy variable (i.e., both variables are picking up the effects of competitive sourcing). The negative sign and the significance of the competitive effects dummy variable in conjunction with the positive sign and significance of the time trend suggests the original model was misspecified. The negative sign and the significance of the competitive effects dummy variable suggests that in competitive markets, firms find it more difficult to appropriate quasi-rents

implying contracts can be less stringent.[19] The positive sign and the significance of the time trend in conjunction with the significance of the competitive effects sourcing dummy variable may suggest there is a learning curve and that the time trend is not just controlling for the switch in the type of engine procuring markets (i.e., from sole source to competitive). This further suggests the firm-specific dummy variable is performing the same function as the time trend described above but is not designed to capture the learning curve from technological uncertainty as well as the time trend. Also, this provides evidence the model should be specified with the time trend included to capture learning curve effects. What is important to notice, however, is that in the three different testings of the original specification of the basic model (i.e. time trend, firm-specific dummy variable and competitive effects dummy variable), time-to-performance, reputation and technological uncertainty were always of the correct sign and significant at or below the four percent level.

The drawback to using ordinary least squares, in this case, is TIMPERF and ECP are endogenously determined. Both variables are contemporaneously correlated with the error term which violates the error term assumptions expressed above. Specifically, TIMPERF, measures the time period from

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[19] This conclusion was suggested by Professor Crocker, my committee supervisor.

the date of contract signing to the date of contractual performance. This time period, however, is a negotiated or endogenously determined time period between the Air Force and contractors' A and E. Conversely, the fact that an engineering change proposal occurs is exogenously determined, but the way I constructed this variable makes it contemporaneously correlated with the error term as well. Recall, a technological uncertainty observation includes engineering change proposals for the current calendar quarter plus all future calendar quarters up to but not including the next event or contractual signing. It is the time period form the current observation to the next event that is negotiated or endogenously determined which makes technological uncertainty contemporaneously correlated with the error term. Because of this problem caused by endogenous right-hand-side variables, ordinary least squares yields biased and inconsistent estimates. However, I still ran ordinary least squares as a preliminary or exploratory estimator.

In addition to the problem caused by endogenous right-hand-side variables, the dependent variable, TYPE, is a discrete choice variable. Using ordinary least squares as an estimating technique in this case may be inappropriate. Ordinary least squares assumes that the underlying dependent variable contract stringency has been categorized into equally spaced intervals (Kaplan and Urwitz, 1979). That

is, the change in contract stringency between a firm-fixed price and a firm-fixed price with economic price adjustment is the same as between a not-to-exceed price and a not-to-exceed price with economic price adjustment when in fact this may not be the case. McKelvey and Zavoina (1975) have shown that when the dependent variable of an ordinary least squares regression is measured ordinally rather than on an interval scale, the expected value of the error term does not equal zero, the variance of the error term is not constant as a function of the independent variables and the error term is not normally distributed. This directly implies the ordinary least squares estimator, in this case, will not be fully efficient (i.e., best linear unbiased estimator). This suggests further research using different estimating techniques. Two stage least squares will be used to correct for the problem of endogenous right-hand-side variables and ordered probit will be used to correct for the ordinal measurement of the dependent variable. In the latter case, the coefficient and t-statistics will still be biased due to the endogenous variables time-to-performance (TIMPERF) and technological uncertainty (ECP). Corrections for this problem may be found in Murphy and Topel (1985) and Rivers and Quong (1988).

5.2. Two-stage Least Squares

To correct for the problem caused by endogenous right-hand-side variables described above, two-stage least squares was used. Table 5.3 shows the two-stage least squares estimates. The first column of estimates is the basic equation and the second column of estimates is the basic equation plus the time trend described above. In the first column of estimates, TIMPERF, and DISPUTE are of the correct sign but only DISPUTE is significant. ECP is neither significant nor of the right sign. The second column of estimates is consistent with my hypotheses showing β_1 and β_3 as negative and β_2 as positive. The time trend is very significant and ECP is now significant at the ten percent level suggesting that a learning curve is present relative to technological uncertainty. TIMPERF is significant at the one percent level after the time trend controlled for the indirect effect of technological uncertainty on the coefficient of TIMPERF. As in the ordinary least squares case, disputes is significant at the one percent level in both regressions.

The two-stage least squares estimator corrects, to a certain extent, for the problem caused by endogenous right-hand-side variables. Because the two-stage least squares estimator is a legitimate instrumental variable estimator, it will be consistent. But due to the small sample size

Table 5.3

Two-stage Least Squares Estimates*

{Standard Errors in Brackets}

(T-ratios in Parentheses)

[Significance Levels in Boxes]

INDEPENDENT VARIABLES	REGRESSIONS (1)	(2)
CONSTANT	1.2323 {1.8538} (0.6650) [0.5062]	3.1425 {1.3391} (2.3470) [0.0189]
TIMPERF	-0.0421 {0.0749} (-0.5620) [0.5739]	-0.1436 {0.0554} (-2.5910) [0.0096]
DISPUTE	0.5826 {0.0613} (9.5090) [0.0000]	0.2476 {0.0741} (3.3420) [0.0008]
ECP	0.0115 {0.0162} (0.7090) [0.4786]	-0.0234 {0.0129} (-1.8050) [0.0711]
QTRELP		0.0880 {0.0159} (5.5360) [0.0000]

*Instruments are exogenous right-hand-side variables: QTRELP, DISPUTE, contractor A disputes, contractor B disputes, ECP current observation plus the next two years (two years arbitrarily selected), contractor A and B ECP current observations plus the next two years, dummy variable where zero reflects an event for contractor B and one is an event for contractor A, dummy variable for competitive sourcing environment where zero implies sole sourcing time period and one implies a competitive sourcing time period.

used here, the two-stage least squares estimator may still be biased (i.e., the two-stage least squares estimator is assumed to be unbiased as the number of observations approach infinity). The two-stage least squares estimator does not correct for the discrete choice problem.

Two additional specification tests described in the ordinary least squares section were run using two stage least squares. The firm-specific dummy variable was run with the original model and was significant at the one percent level while TIMPERF and DISPUTE were of the correct sign and significant at the one percent level. ECP was of the correct sign but not significant. When the firm-specific dummy variable was run with the time trend, it was not significant. The competitive effects dummy variable was utilized with the original model and was positive and significant at the three percent level while TIMPERF and DISPUTE were of the correct sign and significant at the four percent and five percent levels respectively. When the firm-specific dummy variable was run in conjunction with the time trend, it was both negative and significant at the seven percent level while the time trend was positive and significant at the one percent level. These results are basically the same as in the ordinary least squares section.

5.3. Ordered Probit

The ordered probit estimator was used to correct for the discrete choice problem described in the ordinary least squares section above. The ordered probit estimator does not correct the problem caused by endogenous right-hand-side variables, which means the estimator is potentially both biased and inconsistent. The dependent variable (TYPE) categories were changed from nine categories (see Table 4.3 above) to five to reduce the number of cells required in running this model. This allows the ordered probit model, which must be estimated using maximum likelihood techniques, to converge and yield estimates. See Table 5.4 for a list of the new categories for the dependent variable, TYPE.

Table 5.5 shows the estimates from the ordered probit estimator. The first column is the basic equation while the second column is the basic equation plus a time trend. In both cases, my hypothesis are supported because β_1 and β_2 are negative and β_3 is positive. The time trend in column two is significant at the one percent level. It improves the significance of TIMPERF and ECP from the five percent level of significance to the two percent and one percent level of significance respectively. As described above, the significance of the time trend provides evidence that a learning curve is present relative to technological uncertainty. The time trend also controls for the indirect

Table 5.4

Dependent Variable (TYPE) Categories for Ordered Probit

TYPE	Numbers Assigned to TYPE*
Firm-fixed-price	4
Fixed-price with economic price adjustment	3
Not-to-exceed price	2
Fixed-price incentive (firm target)	1
Fixed-price incentive (successive targets)	0

*Prices are assigned continuous values that reflect movements in contractual tightness. Four is the "tightest" price contractually while zero is the "loosest" price contractually.

effect of technological uncertainty on the coefficient of TIMPERF in this case as well. Finally, DISPUTE is significant at the one percent level as in the previous two cases using the ordinary least squares and the two-stage least squares estimators.

The firm-specific dummy variable and the competitive effects dummy variable described in the ordinary least squares section were run with the original model to test different specifications of the original model. The firm-specific dummy variable was negative and significant at the eight percent level while all other variables were of the correct sign and significant at the one percent level. The

Table 5.5

Ordered Probit Estimates

{Standard Errors in Brackets}

(T-ratios in Parentheses)

[Significance Levels in Boxes]

INDEPENDENT VARIABLES	REGRESSIONS (1)	(2)
CONSTANT	0.9154	0.1225
	{0.5705}	{0.8245}
	(1.6050)	(0.1490)
	[0.1086]	[0.8819]
TIMPERF	-0.1218	-0.1690
	{0.0513}	{0.0600}
	(-2.3740)	(-2.8150)
	[0.0176]	[0.0049]
DISPUTE	0.4281	0.3130
	{0.1045}	{0.1003}
	(4.0970)	(3.1220)
	[0.0000]	[0.0018]
ECP	-0.0104	-0.0213
	{0.0054}	{0.0071}
	(-1.9240)	(-3.0190)
	[0.0543]	[0.0025]
QTRELP		0.0921
		{0.0352}
		(2.6140)
		[0.0090]

competitive effects dummy variable was insignificant while all other variables were of the correct sign and significant at the one percent level. When run in conjunction with the time trend, the firm-specific dummy variable and the time trend were not significant. The competitive effects dummy variable was negative but not significant when run with the time trend which was positive and significant at the seven percent level.

Chapter 6

CONCLUSION

This paper examines the importance of time to (contractual) performance, technological uncertainty, and firms' reputation in determining contractual tightness of aircraft engine contracts negotiated between the Air Force and defense contractors. Utilizing the type of price selected by these contracts as a proxy for contractual tightness, I defined contractual tightness as a measure of ex ante specification or a measure of how much the price is "nailed down" at the outset of the contractual relationship. Using a relational approach to contracting, this paper seeks to test, using formal econometric procedures, the importance of time-to-performance, firms' reputation, and technological uncertainty in determining contractual tightness measured by the type of price selected ex ante between the Air Force and aircraft engine defense contractors. The relational approach to contracting emphasizes that when contractors transact in complex or uncertain environments, many terms and conditions of contracts are often left to future determination. Using this relational approach to contracting, rather than specifying all obligations under the contract at the outset, avoids constraining a firm to actions that may not be optimal when contractual performance

secure; thus, incentives for firms to utilize costly efforts to evade contractual performance ex post are substantially reduced. Forty-four data points for this analysis came from thirteen Air Force contracts that procure a certain type of aircraft engine from two defense contractors. The results significantly support the relational contracting argument that as time-to-performance and technological uncertainty increase, contractual tightness decreases but when a firm's reputation worsens, contractual tightness increases which suggests that Air Force engine contracts are being written in an economically feasible manner. The empirical results also are quite robust to different estimating techniques. This suggests the relational approach to contracting does provide a useful framework for analyzing long-term contractual relationships and is worthy of further attention by economists.

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