A Multivariate Investigation Of Transaction Cost Analysis Dimensions: Do Contract Types Differ?

Terry R. Adler, (E-mail: tadler@afit.af.mil), Air Force Institute of Technology
Robert F. Scherer, (E-mail: robert.scherer@wright.edu), Wright State University

Abstract

Our study explored the effects of contract type on transaction cost analysis dimensions for research and development projects. Hypotheses from transaction cost analysis theory were tested using archival data from completed contracts used to govern the procurement of defense products. Our results indicate that the type of contract used in an economic exchange is associated with differences in asset specificity, uncertainty, and contract incompleteness. Two underlying dimensions were evident at the multivariate level that indicate how individual transaction cost indicators combine as a set based on the degree of contract impediments and human asset specificity. Results are also discussed in the context of contract type differences on each transaction cost analysis indicator.

Introduction

The concept of transaction cost analysis (TCA) is prominent in strategy and organizational theory research. In essence, TCA incorporates the premise that transactions are governed by market, hybrid, or hierarchy forms of governance based on the degree of asset specificity, uncertainty, bounded rationality, and opportunism present in the transaction (Coase, 1952; Klein, Crawford, & Alchian, 1978; Williamson, 1975; Williamson, 1985). The TCA premise is used to explain organizational boundaries in strategy and organizational theory, especially with regard to why firms diversify, engage in joint ventures and multinational alliances, buy goods and services in the open market, and rely on informal

agreements in conducting business transactions (Masten, Meehan, & Snyder, 1989; Monteverde & Teece, 1982a; 1982b; Osborn & Baughn, 1990; Palay, 1984; 1985; Walker & Weber, 1984).

The theory of TCA is especially important in contracting research (Crocker & Reynolds, 1993; Goldberg & Erickson, 1987; Joskow, 1985; 1987; Masten, 1988; Stinchcombe, 1985; Walker & Poppo, 1991). The primary utility of TCA is that it explains why firms use contracts and offers insight into the conditions which embody the transaction, most notably in the safeguarding of an organization's assets (Heide & John, 1988; Joskow, 1985; 1987; Masten & Crocker, 1985; Pisano, 1989) or as a response to uncertainty about the future (Crocker & Reynolds, 1993; Harrigan, 1986; John & Weitz, 1988; Osborn & Baughn, 1990;

Readers with comments or questions are encouraged to contact the authors via e-mail.

Walker & Weber, 1987). TCA theory offers an advantage over pure economic models like neoclassical competition (Alchian & Demsetz, 1972) or industrial-organization economics (Bain, 1954) which disregard behavioral considerations of contracting leading to contract incompleteness (e.g., bounded rationality) (Crocker & Reynolds, 1993; Hackett, 1993; Posner, 1992; Williamson, 1985).

In spite of these theoretical strengths, research into the TCA framework presents several challenges to researchers. First, the study of actual contracts has been limited. Primarily for proprietary reasons, many researchers maintain that pricing and contract information are confidential and difficult to acquire. For instance, Mosakowski (1991) used a dichotomous variable to indicate whether contracting was used as a form of governance. However, this research could not investigate the extent to which firms are involved in contracting because that was considered proprietary information. Many empirical studies thus rely on public sources of information to investigate governance-performance theories because confidential cost information is not available (Armour & Teece, 1980; Noordewier, John, & Nevin, 1990; Osborn & Baughn, 1993).

Second, the lack of consensual meaning of contract incompleteness has led to studies of asset specificity and uncertainty instead. Many studies assume contract incompleteness in the transaction or simulate it in experimental designs without actually measuring the affect on the governance decision (Al-Najjar, 1995; Anderlini & Felli, 1994; Crocker & Reynolds, 1993; Hackett, 1993). Third, how the complete governance continuum affects the set of TCA indicators (e.g., asset specificity, uncertainty, and contract incompleteness) in a particular transaction is unclear. Studies typically test only one or two governance choices at a time that reduces the governance choice to a binary decision (i.e., 'make' or 'buy' decisions). Since governance choices are generally not binary, additional research is required to investigate the full governance continuum. Specifically, the most basic premise that there are differences between distinct alternatives in the full con-

tract continuum and the set of TCA indicators, a fundamental underpinning of the theory, requires empirical verification (Peck & Scherer, 1962; Williamson, 1985).

Thus, the purpose of our study is to examine how different types of contracts, as governance mechanisms, are associated with TCA dimensions for an individual transaction. The source of this question stems from the microeconomic rationale of TCA theory where transactions are matched with governance structures to produce the most efficient organization (Dyer, 1993; Monteverde & Teece, 1982; Osborn & Baughn, 1990; Williamson, 1975; Williamson, 1985). Our investigation into the differences between unique contract types is based on the assumption that some contracts are more market like than others and differ in their relationships with TCA dimensions (Brittelli, Lynch, & Emmelhainz, 1983; Scherer, 1964; Williamson, 1991).

Literature Review and Hypotheses

A tenet of TCA theory maintains that a transaction, the unit of analysis, will tend to be organized by structural arrangement (i.e., governance structure) that can execute the transaction most efficiently (Williamson, 1985). Dimensions that pertain to contract agreements are asset specificity, uncertainty, and contract incompleteness. Williamson (1979; 1985) emphasized asset specificity as the critical factor in determining choice of governance structure. Based upon the work of Klein, Crawford and Alchian (1978), asset specificity reflects investments undertaken in support of an individual transaction (Williamson, 1985). The more specific the assets, the more likely parties in the transaction will choose a hierarchical form of governance.

A second TCA dimension is uncertainty that affects the ability of parties in a transaction to fully specify the range of future contingencies. Uncertainty is based on Thompson's (1967) hypothesis that firms faced with uncertainty will vertically integrate, whereas firms faced with lower uncertainty will choose market-like structures.

The third dimension, contract incompleteness, is central to TCA theory (Williamson, 1985; Masten, 1988) because incomplete contracts lead to ex post negotiations of contract terms as contingencies arise. Although researchers agree that incomplete contracts are the norm in business transactions (Macauley, 1963; Holmstrom & Hart, 1985; Williamson, 1985; Masten, 1988; Adler, 1994), development of the contract incompleteness construct and empirical testing of the complete contracting continuum should provide insight into how governance choices differ.

Types of contracts

Much of the work on contract agreements indicates that contracts have unique types, levels of technological uncertainty, contract controls, duration, and degrees of relationship-specific investments (DeCanio & Frech, 1993; Dornheim, 1992; Joskow, 1987; Mankarious & Nehmer, 1992; Peeters & Veld, 1989; Sloan, Shayne, & Conover, 1995). As transactions differ, so do contracts with regard to content, performance incentives, and division of gains (Ciborra, 1987; Masten & Crocker, 1985). TCA theory provides strategists with a set of normative rules for choosing between alternate governance structures (Rubin, 1993).

Contract Continuum

The contract continuum includes three basic contract types that differ based on the manager's perception of the transaction costs: cost-plus fixed fee, firm-fixed price, and incentive contracts. The most hierarchy-like contract is the cost-plus fixed fee (CPFF). This type of contract is similar to what Goldberg and Erickson (1987) refer to as a contract that stops short of full vertical integration. Under a CPFF contract, the buyer agrees to reimburse the seller for all binding costs that are incurred during performance of the contract (Brittelli et al., 1983). Buyers substitute administrative control mechanisms and a plethora of contract administrators for market mechanisms to counter higher levels of uncertainty and asset specificity (Peck & Scherer, 1962).

The most market-like contract type, according to Crocker and Reynolds (1993), is the firm-fixed price (FFP). In this type of contract, the price for the seller's work is not adjusted after award regardless of the seller's actual costs. Fixed-price contracts for well-specified items are akin to a market system transaction (Peck & Scherer, 1962; Templin, 1988). FFP contracts are similar to Goldberg and Erickson's (1987) commission pricing contract where standardized products are bought and sold. A FFP type of contract is appropriate when specifications are stable and when a price can be fairly and reasonably determined at the time of contract formulation.

When future contingencies are not quantifiable enough to determine price, parties may seek flexibility by adopting an incentive arrangement designed to promote cost control (Brittelli et al., 1983). Incentive arrangements are used when uncertainty warrants a cost-plus type contract but, instead, contract terms provide the seller with positive motivation to control costs. These contracts are typically used to acquire the first or second production unit of a newly developed item. Incentive contracts fall between FFP and CPFF arrangements in the governance spectrum with regard to performance.

Hypotheses

Despite these unique governance choices, research on the contract continuum presents several dilemmas. Studies of the complete continuum have not been empirically investigated to date. While Crocker and Reynolds (1993) found differences between incentive and FFP contracts on contract incompleteness and ex post opportunism, the study's sample did not include CPFF arrangements. Other studies have aggregated contracts by function, origin, or purpose (Masten & Crocker, 1985; Noordewier et al., 1990; Osborn & Baughn, 1990) but fail to test for contract type effects. Clearly, contract types represent unique governance choices that differ in the degree of asset specificity, uncertainty, and contract incompleteness.

Each contract type is distinct because each has a different set of administrative controls and hierarchical content that are intended to be tailored for governance through TCA indicators (Johnston, 1993; Stinchcombe, 1985). Measures of asset specificity, uncertainty, and contract incompleteness as a set should be different among contract types because the methods of coordination, control, and adaptation are different for each type (Williamson, 1991).

A review of the TCA literature indicated that as these dimensions increase, so does the propensity to use hierarchical governance structures.

For example, organizations that contract under conditions of uncertainty will most likely have exhaustive contract mechanisms for performance relief, dispute resolution, and administrative guidance in maintaining stability of the contract. Lower values of uncertainty, asset specificity, and contract incompleteness should lead to more market-like structures. Differences between contract types form the basis for the first hypothesis.

H1: The set of transaction cost analysis indicators differ by contract type.

Individual TCA dimensions also differ by contract type. For instance, three components of contract incompleteness are complexity, explicitness, and the number of design additions. Since FFP contracts are the most complete according to Crocker and Reynolds (1993), they should have the least amount of design additions. CPFF contracts should have the most design additions since these contracts are the most incomplete. Contracts which are market-like will also be the most complete with regard to explicitness and complexity of the contract since more is known about the products being developed. Conversely, hierarchy-type contracts are better for products with less design stability and lower complexity and explicitness since less is known about product content (Brittelli et al., 1983; Peck & Scherer, 1962; Scherer, 1964).

TCA theory also predicts that when asset specificity is high, internalization occurs due to the

benefits it offers over market exchanges. Three forms of asset specificity are physical, dedicated, and human asset specificity. Physical asset specificity binds parties together due to the uniqueness of the assets associated with the relationship. In general, the more unique the tasks, equipment, or materials associated with the transaction, the higher the physical asset specificity. Dedicated asset specificity refers to assets that are generated contingent upon particular supply agreements (Williamson, 1975; 1983). Human asset specificity reflects transaction-specific knowledge accumulated by parties through long standing exchange relationships (Dyer, 1993). In general, the higher the asset specificity, the more likely hierarchy forms of governance will be chosen.

The type of uncertainty is also important in the determination of governance structure. Technological and environmental uncertainty have both been found to lead to differences in the type of governance used in individual transactions (Crocker & Reynolds, 1993; John & Weitz, 1988; Walker & Weber, 1984; 1987). Results support TCA theory in that the greater the uncertainty in a transaction, the more CPFF contracts are pursued.

The following hypotheses were used to investigate how individual TCA dimensions differ among the three contract types:

H2: Individual transaction cost analysis indicators differ by contract type.

H2a: Physical Asset Specificity will differ by type of contract.

H2b: Dedicated Asset Specificity will differ by type of contract

H2c: Human Asset Specificity will differ by type of contract.

H2d: Technological Uncertainty will differ by type of contract.

H2e: Environmental Uncertainty will differ by type of contract.

H2f: Contract Complexity will differ by type of contract.

H2g: Contract Explicitness will differ by type of contract.

H2h: Contract Design Additions will differ by type of contract.

Method*Data*

Data were gathered from two sources to test the hypotheses. First, completed contracts were retrieved from the files of the Air Force Material Command (AFMC) located at Wright-Patterson Air Force Base in Dayton, Ohio.

AFMC serves as the primary center for the acquisition of weapon systems by the Air Force. AFMC works in conjunction with other Air Force organizations to determine what needs exist and how to proceed in designing, developing, and producing new weapons systems. After the needs analysis is conducted and the general requirements of a system are understood, AFMC negotiates with a prime contractor to develop and produce the weapon system. Contracts are considered completed when a system has been delivered to the Air Force. Contract files are rich sources of data as they contain all pertinent program documentation over the life cycle of the contract.

In addition, sales data were gathered from Moody's Industrial Manual (Moody's Investor's Service, 1970 - 1995) and Million Dollar Directory (Dun's Marketing Services, 1986 - 1995). Private sales information was collected from government contract files and telephone calls either directly with the seller or through the appropriate regional defense contract administrator.

The use of government data for research purposes has been questioned by some theorists (Fox, 1974; Gansler, 1980). Typical criticisms range from inefficiencies of government control to a lack of adequate competition in the marketplace.

However, Evanchik (1989) argues that the Air Force has not "nationalized," or internalized, aircraft firms because of the great need for innovation due to high levels of human asset specificity. In general, hierarchies stifle creativity, relative to a market structure, through additional bureaucratic controls. Contracts have been used instead to maintain high levels of innovation without incurring many of the bureaucratic inefficiencies of internalization. Dominance of innovation makes the

Air Force procurement an unusual case (Williamson, 1985).

Grouping and Sample Selection

Within the continuum contracts were grouped according to three distinct types: Firm-Fixed Price (FFP), incentives, and Cost-Plus Fixed Fee (CPFF). Contracts were selected at random for inclusion in the sample from among the 4,581 closed contracts awarded between 1974 and 1993 (the complete contract database). Eighty contracts from each of the three groups were selected at random for inclusion in the sample. We reviewed the distributions of TCA indicators for the set of 240 contracts (TCA indicators are described below under the section labeled "Measures"). Those contracts that had one or more TCA indicators with values greater than three standard deviations from the mean were excluded from the sample to preclude distortion of the results due to these outliers. This procedure resulted in a total final sample size of 181 contracts which met the criteria for inclusion (FFP: $n = 69$; Incentives: $n = 49$; CPFF: $n = 63$).

A review of contract characteristics revealed that the majority were awarded between 1985 and 1993 (61.3%) with the median contract award year being 1986. Contract duration was spread from 6 months to 156 months with a mean contract duration time of 50.99 months. The value of the contracts included in the sample ranged from \$48,115 to approximately \$499 million with a mean value of \$15 million. These characteristics demonstrated the breadth and depth of contracts among the three types.

Measures

A review of the transaction cost analysis literature led to operationalization of eight indicators for the current study. These measures were grouped into the Asset Specificity, Uncertainty, and Contract Incompleteness subsets. We describe each of the eight measures, by subset, below. The Appendix contains complete operational definitions used for the construction of each indicator.

Asset Specificity

Three types of asset specificity indicators were included in this study: physical, dedicated, and human. Physical asset specificity encompasses the unique nature of the contract tasks (Palay, 1984; Argyres, 1993). Physical asset specificity is based on studies that have used research and development divided by sales and defined as the percentage of final contract value divided by the contractor's firm sales in the year the contract was completed (Armour & Teece, 1980; Levy, 1985; Osborn & Baughn, 1990). Dedicated asset specificity refers to assets which are assigned for the purpose of the current contract only and would result in significant excess capacity if the contract terminated prematurely (Williamson, 1983). Given this definition, dedicated asset specificity was operationalized as the time to meet the buyer's requirements from contract start date to the acceptance of the product.

Transaction-specific knowledge accumulated by contractual agents over long standing buyer-seller relationships is referred to as human asset specificity (Dyer, 1993; John & Weitz, 1988; Masten et al., 1989). This definition of human asset specificity captures the element of human capital required to complete the transaction. For the current study human asset specificity was defined as the total contractual labor hours estimated by the seller to complete the contract divided by the estimated cost of the contract. Dividing by the estimated cost of the contract provides a labor hour per dollar comparison among the contract types.

Uncertainty

The uncertainty set included two indicators: technological and environmental. Uncertainty in the change of contract terms associated with disturbances in the business relationship, leads to technological uncertainty, which results in technical changes and terms of a contract (Crocker & Reynolds, 1993). To measure the cost of these changes we defined technological uncertainty as the total cost of engineering changes divided by the number of engineering changes between contract

start and end dates (Blacken, 1986). Environmental uncertainty is a factor in the choice of governance structure and affects the choice of contract type. Environmental uncertainty was measured as the difference between contractor sales in the year the contract was awarded and the year the contract was closed (John & Weitz, 1988; Harrigan, 1986).

Contract Incompleteness

Although contracts vary by their degree of incompleteness (Stinchcombe, 1985; Williamson, 1991; Hackett, 1993; Anderlini & Felli, 1994; Al-Najjar, 1995), the concept has not been adequately developed. Thus, the contract incompleteness measures were developed in two steps. In the first step, we sought the advice of ten procurement experts that have developed multiple research and development contracts. Narratives that describe the basic definition of contract incompleteness were created based on their inputs. We developed three measures of contract incompleteness because it was apparent that there were three unique dimensions of contract incompleteness described in the narratives. These measures were presented to over 100 Air Force contract/program managers responsible for developing contracts and subsequently revised to their current definition. For this set of TCA indicators we operationalized measures of complexity, explicitness, and design additions.

Complexity was designed to measure the breadth of the content requirements of the contract while explicitness was designed to measure the depth of the content section. Complexity is measured by the number of paragraphs in the tasking section of the contract divided by the estimated cost of the contract. The result provides a paragraph per dollar ratio and an indication of the breadth of contract requirements. Explicitness is measured by the number of lines in the tasking section divided by the estimated contract cost. The larger the ratio, the more complex and explicit the requirements are while a lower ratio indicates less breadth and depth. To ensure reliability of the data collection process of the complexity and explicitness measures (designed for the current study), 24 of the initial 240 sample contracts were randomly

selected so that three contract management professionals from the Air Force Institute of Technology in Dayton, Ohio could count statement of work lines and paragraphs. Results indicated that the data collection process was highly reliable with less than 0.7% error in the number of paragraphs and less than 0.5% error in the number of lines counted.

Design additions occur when contracts are incomplete. The fewer the number of additions the more complete the contract. Design additions are measured by the number of engineering changes that occur between contract start and end date and measures how often the contract was changed.

Analytic Plan

A two-tiered approach was used to test the hypotheses at the multivariate and univariate levels. First, to test hypothesis one, we employed multivariate analysis of variance (MANOVA) to determine if differences existed between the three contract groups on the entire set of eight TCA indicators. MANOVA was appropriate because the technique is able to simultaneously evaluate a set of outcome indicators through construction of a linear combination of those indicators which maximizes group differences. Given a significant multivariate effect a follow up analysis was performed to identify the underlying structure of the eight indicator set. We reviewed the canonical discriminant loadings (correlations) and their contributions to the composite set. A minimum value cut-point of .32 for interpretation of a indicator's loading as contributing to the dimension was set (Tabachnick & Fidell, 1996). After inspection of the loadings matrix, differences between groups on the composite set of TCA indicators were identified using a multivariate extension of the Scheffé test (Stevens, 1992). The procedure is performed post hoc on the group centroids.

Second, analysis of variance (ANOVA) tests on each individual TCA indicator were conducted to test hypothesis two, which posed differences at the univariate level. Following a significant ANOVA result a Scheffé test was performed.

These tests allowed for identification of differences in magnitude and direction between pairs of control groups on each TCA indicator.

Results

Prior to hypothesis testing a preliminary analysis was conducted to assess the relationships between pairs of the TCA indicators. Bivariate correlations for each pair are shown in Table 1. Strength of the relationships ranged (in absolute value) from .00 for the correlation between explicitness and human asset specificity to .64 for the correlation between explicitness and complexity. The majority of the correlations were less than .40. This analysis indicated very weak to moderate overlaps in variance. Each TCA indicator appeared to represent a relatively unique TCA aspect. After this review attention shifted to substantive tests of the two hypotheses.

Hypothesis one stated that contract type would have an effect on the set of TCA indicators. Results of the omnibus MANOVA test revealed that in fact contract type significantly ($F = 20.12$; $df = 16$ and 344 ; $p < .01$) affected the set. Two significant ($p < .01$ for each dimension) and distinct underlying dimensions were extracted using a varimax rotation to aid in interpretation. Canonical correlations showed a moderate to moderately strong strength of association ($rc = .74$ for dimension one; $rc = .64$ for dimension two) between each of the dimensions and the contract groups. Thus, each dimension was contributing to differentiation among groups.

Closer inspection of the loadings assisted in understanding how the set of indicators went together to define transaction cost. Loadings are displayed in the two columns on the far right of Table 1. On the first dimension five of the eight TCA indicators loaded above the cut-point for interpretation. Dedicated asset specificity loaded the strongest followed by moderate loadings for the incompleteness indicators complexity, explicitness (both negative), and design additions. One uncertainty indicator, environment, had a moderately low loading. Given this structure we labeled the

Table 1
Pooled Within Groups Correlations Between Pairs of Transaction Cost Indicators

Transaction Indicator	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Contract Impediments ^{a,b}	Human Asset Specificity ^c
A. Asset Specificity									
1. Physical								-.01	.13
2. Dedicated	-.03							<u>.73</u>	.07
3. Human	.10	-.05						-.02	<u>.92</u>
B. Uncertainty									
4. Technology	.34	.54	-.09					.28	-.25
5. Environment	-.02	.35	.01	.43				<u>.43</u>	-.15
C. Incompleteness									
6. Complexity	-.09	-.36	.05	-.24	-.15			-. <u>.69</u>	.16
7. Explicitness	-.01	-.32	.00	-.21	-.14	.64		-. <u>.61</u>	-.03
8. Design Additions	.12	.33	-.12	.52	.24	-.14	-.11	<u>.51</u>	-.22

^aCorrelations (loadings) between Contract Impediments dimension and transaction cost indicators (varimax rotated). ^bUnderlined values indicate loading interpreted as part of the dimension. ^cCorrelations (loadings) between Human Asset Specificity dimension and transaction cost indicators (varimax rotated).

first dimension Contract Impediments because when dedicating specific assets to a longer duration relationship, requirements change to meet buyer needs and seller capabilities. Thus, longer-term contracts are necessarily more incomplete.

Human asset specificity dominated the second dimension with a strong positive loading. None of the other seven TCA indicators contributed to this dimension. Consequently, we labeled this dimension to account for the transaction specific knowledge required to meet contract requirements. Physical asset specificity and technological uncertainty made negligible contributions to both the Contract Impediments and Human Asset Specificity dimensions. Following identification of these two underlying dimensions post hoc tests on the centroids were conducted.

Table 2 shows the centroids for the Contract Impediments and Human Asset Specificity centroid values by group. For Contract Impediments, incentive contracts had the highest composite score followed by CPFF and FFP with a negative centroid value. Significant ($p < .05$) differences were observed between FFP and the other

two contract types and between incentive contracts and CPFF. On the Human Asset Specificity dimension the CPFF group centroid exhibited the highest value followed by negative centroids for incentives and FFP contracts (lowest value centroid). These three groups differed significantly ($p < .05$) similarly as they did on the Contract Impediments dimension. These results provide evidence that hierarchical forms of governance, like CPFF contracts, are higher in asset specificity than other forms. However, incentive contracts appear to be more hierarchical in that they are typically more incomplete possibly because the transaction tends to evolve over time. Overall, these results provided support for hypothesis one.

The second set of analyses were targeted at the univariate level to investigate hypothesis two which stated there would be differences between contract type groups on the eight individual TCA indicators. Results of these analyses are displayed in Table 2. Univariate tests were performed on each set of asset specificity, uncertainty, and contract incompleteness TCA indicators.

F-tests performed on the dedicated and

Table 2
Means and Univariate Tests by Contract Type and Transaction Cost Indicators

Transaction Cost Indicator	Group			$\bar{F}^a$	p-value	Groups Differing ^{b,c} (post hoc tests)
	FFP (n = 69) Mean	Incentives (n = 49) Mean	CPFF (n = 63) Mean			
A. Asset Specificity						
1. Physical	10,463.70	11,186.81	23,441.85	1.42	.2431	None
2. Dedicated	23.94	80.61	57.59	49.83	.0000	FFP from Incentives; Incentives from CPFF
3. Human	9,977.72	11,552.74	20,114.54	70.21	.0000	CPFF from FFP and Incentives
B. Uncertainty						
4. Technology	62,550.81	187,248.03	22,096.68	8.85	.0002	Incentives from FFP and CPFF
5. Environment	.19	.75	.32	15.03	.0000	Incentives from FFP and CPFF
C. Incompleteness						
6. Complexity	110.25	15.00	79.60	38.53	.0000	Incentives from FFP and CPFF; FFP from CPFF
7. Explicitness	1,141.01	123.16	575.34	34.15	.0000	Incentives from FFP and CPFF; FFP from CPFF
8. Design Additions	5.46	47.61	11.55	22.05	.0000	Incentives from FFP and CPFF
Contract Impediments ^d	- 1.08	1.36	.12	86.76	.0000	FFP from Incentives and CPFF; Incentives from CPFF
Human Asset Specificity ^e	- .89	- .42	1.30	85.57	.0000	FFP from Incentives and CPFF; Incentives from CPFF

^aFor all $\bar{F}$ -tests: $df = 2$ and 209. ^bScheffé test used for post hoc comparisons for all difference tests. ^cGroup labels: FFP = Firm Fixed Price; CPFF = Cost Plus Fixed Fee. ^dMean values reflect the group centroid for Contract Impediments dimension. ^eMean values reflect the group centroid from Human Asset Specificity dimension.

human asset specificity indicators were significant ($p < .01$) and support H2b and H2c. A nonsignificant test resulted on physical asset specificity. Thus, H2a was not supported. Post hoc inspection revealed where the significant ($p < .05$) differences lied. FFP contracts had the lowest mean value and differed from CPFF and incentive contracts on dedicated and human asset

specificity. In addition, CPFF contracts differed from incentives and had the highest mean value on human asset specificity. This confirms that FFP contracts are the most market like with regard to lower levels of asset specificity and that CPFF contracts are on the other end of the contract continuum with regard to human asset requirements.

The uncertainty set was tested next and -tests on technology and environment were both significant ($p < .01$) supporting subhypotheses H2d and H2e. The two post hoc tests showed incentive contracts to be significantly ($p < .05$) different from FFP and CPFF contracts. Incentive contracts had the highest mean value on both uncertainty indicators. On technology CPFF had the lowest mean and on environment FFP had the lowest mean. These results do not support Scherer's (1964) and Peck and Scherer's (1962) claim that CPFF contracts are appropriate governance mechanisms in high uncertainty conditions. In fact, incentive contracts are associated with higher levels of uncertainty, even though incentives are designed to alleviate contingencies.

The final univariate analyses were conducted on the three incompleteness indicators of complexity, explicitness, and design additions. All three F-tests were significant ($p < .01$) and, thus, subhypotheses H2f, H2g, and H2h were supported.

The same significant ($p < .05$) group differences were identified post hoc on complexity and explicitness. Specifically, incentive contracts had the lowest mean value and were different from FFP and CPFF contracts, while FFP contracts had the highest mean value and were different from CPFF contracts. For the design additions indicator, incentive contracts had the highest mean value and were significantly ($p < .05$) different from CPFF and FFP contracts which had the lowest mean value. These results support the claim that FFP contracts are used to buy market-like goods since they appear to be the most complete of all contract forms. Incentive contracts, however, are the most incomplete on all contract incompleteness measures which supports Crocker and Reynolds' (1993) findings, but counters traditional contract theory (Peck & Scherer, 1962).

Discussion

The objective of the current study was to examine how different types of contracts, as governance mechanisms, are associated with transaction cost analysis dimensions for a particular transaction. The types of contracts studied typically

embody contracts found within the complete contract continuum. In general, our results indicated that the type of contract used in an economic exchange is associated with differences in transaction cost analysis dimensions.

Moreover, results suggest that contract type does matter. Contracts do demonstrate different levels of control, coordination, and adaptation as proposed in transaction cost analysis theory (Williamson, 1975; 1985). Our results refute the argument proposed by Robins (1987) that hybrid forms of governance, like contracting, are merely degrees of either the market or hierarchy alternatives. This study demonstrates that contracts not only display different levels of asset specificity, uncertainty, and contract incompleteness within the contract continuum, but that contracts are distinct governance mechanisms in and of themselves. Thus, the study provides evidence to assist validating the use of hybrid forms in the TCA governance framework.

Within the contract continuum, it appears that CPFF contracts are the most hierarchical relative to asset specificity, and more specifically, the Human Asset Specificity dimension. As proposed by Peck and Scherer (1962), the use of CPFF contracts is most appropriate when the seller invests more transaction-specific knowledge into the relationship to complete the transaction. These results have been supported in many other studies (Dyer, 1993; John & Weitz, 1988; Levy, 1985; Masten et al., 1989; Pisano, 1989). In addition, FFP contracts performed as expected since they had the lowest values for all asset specificity measures and expected values by being the most complete.

The results for incentive contracts, however, surprisingly indicate that they are the most hierarchy like on six of the seven TCA indicators that were operationalized in this study. Incentive agreements are the most incomplete, require more dedicated assets, and have the highest technological and environmental uncertainty associated with them. The Contract Impediments dimension strongly indicates that cost sharing arrangements require more resources to handle an increasing

number of future contingencies than other contract types. Incentive contracts appear to be the most hierarchical in the sense of additional control, coordination, and adaptation required to complete the contract. This is an important finding for researchers and practitioners who select contract types based on perceived transaction costs and agreement conditions. Incentive agreement decisions should be carefully examined before being implemented because other alternatives may be better suited for a particular transaction.

Future Research and Related Issues

Clearly, we need to further investigate hybrid governance structures and relationships in the context of economic theory and business contracting. While this study has provided initial insight into the underlying structures that differentiate types of long-term contracting, additional research is needed. Variations within contract types may add further to our understanding of the complete governance continuum. Variations within market-like or hierarchy-like contracts should provide additional insight into how firms structure transactions.

The generalizability of the findings could be enhanced with the study of contract types used in other industries. Research designs like Spiller's (1985) cross-sectional study might shed light on how contracts are used in lieu of traditional market and hierarchy governance structures. Retrieving and examining contracts may be difficult, however, since many contracts are not open for public review.

A limitation to the results of our study is the use of government contracts in the aerospace industry. Conclusions and inferences about the results may be limited to this setting and may not address research and development contracting in other industries. However, we believe many of the dimensions that are associated with the different contract types in the current study can be found in other settings. For instance, industries that constrain the 'make' or 'buy' decision are likely to use other means, namely formal contracts, to emulate

polar governance mechanisms. Applicable settings include Palay's (1984; 1985) study of the rail-freight industry, Joskow's (1985; 1987) study of the coal industry and Hennart's (1988) examination of the aluminum and tin industries, for instance.

The inaccessibility to proprietary contract information limits our study of contracts as governance mechanisms. Our study fills this void in the literature by providing an analysis of the contract continuum and contract type association with TCA indicators. While our results moderately support TCA theory, incentive type contracts are more hierarchical than other contract types. Further research into why incentive agreements, a mid-range type of governance structure, have higher values of asset specificity, uncertainty, and dedicated asset specificity is required to assist researchers and practitioners in understanding the contract continuum.

References

1. Adler, T. R. (1994). The innovative process: Interpreting customer requirements. *IEEE Aeronautical and Electronic Systems*, 9, 17-25.
2. Alchian, A. & Demsetz, H. (1972). Production, information costs, and economic organization. *American Economic Review*, 62, 777-95.
3. Al-Najjar, N. I. (1995). Incomplete contracts and the governance of complex contractual relationships. *American Economic Association Papers and Proceedings*, 85, 432-436.
4. Armour, H. O. & Teece, D. J. (1980). Vertical integration and technological innovation. *Review of Economics and Statistics*, 62, 470-474.
5. Anderlini, L. & Felli, L. (1994). Incomplete written contracts: Undescribable states of nature. *The Quarterly Journal of Economics*, November, 1085-1124.
6. Argyres, N. S. (1993). *Essays on technology, strategy and organization*. Doctoral dissertation, University of California at

Appendix Operational Definitions for Transaction Cost Indicators

Transaction Cost Indicator	Definition
A. Asset Specificity	
1. Physical	Final contract value divided by seller-firm sales in year contract completed.
2. Dedicated	Time to meet buyer's requirements (i.e., the time in months between contract start date and acceptance of product).
3. Human	Total contractual labor hours estimated by seller to complete the contract divided by the estimated cost of the contract.
B. Uncertainty	
4. Technological	Total cost of engineering changes divided by number of engineering change proposals between contract start and end date.
5. Environmental	The change in firm sales between sales in the year of contract award and sales in the year of contract close-out.
C. Contract Incompleteness	
6. Complexity	The number of statement of work paragraphs (tasking section) of the contract divided by the estimated contract cost.
7. Explicitness	The number of lines in the statement of work (tasking section) of the contract divided by the estimated contract cost.
8. Design Additions	The total number of engineering changes (tasking section) between contract start and end date.

-
7. Bain, J. S. (1954). Economies of scale, concentration, and the condition of entry in twenty manufacturing industries. <i>American Economic Review</i>, 44, 15-39. 8. Blacken, J. E. (1986). <i>An investigation of the impact of contract changes on cost growth within the LANTIRN system program office</i>. Master's thesis, Air Force Institute of Technology. 9. Brittelli, J. L., Lynch, P. L. & Emmelhainz, P. (1983). <i>Principles of contract pricing</i>. Montgomery, Alabama: Extensions Course Institute Press. 10. Ciborra, C. U. (1987). Research agenda for a transaction costs approach to information systems. In R. Boland & R. Hirschheim (eds.). <i>Critical issues in information systems research</i>. New York: John Wiley and Sons. 11. Coase, R. H. (1952). The nature of the	firm. In G. Stigler & K. Boulding (eds.), <i>Readings in price theory</i>. Homewood, IL: Richard D. Irwin. 12. Crocker, K. J. & Reynolds, K. J. (1993). The efficiency of incomplete contracts: An empirical analysis of Air Force engine procurement. <i>RAND Journal of Economics</i>, 24, 126-146. 13. DeCanio, S. J. & Frech, H. E. (1993). Vertical contracts: Natural experiment in natural gas pipeline regulation. <i>Journal of Institutional and Theoretical Economics</i>, 149, 370-392. 14. Dornheim, M. (1992). NASA hopes to slash contract costs 5-10% by using TQM in procurement. <i>Aviation Week and Space Technology</i>, 137, 22-23. 15. Dun's Marketing Services. (1986-1995). <i>Million dollar directory</i>. Parsippany, NJ: Dun's Marketing Services.

16. Dyer, J. H. (1993). *Four papers on governance, asset specialization, and performance: A comparative study of supplier-automaker relationships in the U.S. and Japan*. Doctoral dissertation, University of California at Los Angeles.
17. Evanchik, M. A. (1989). *A transaction cost analysis of defense contracting*. Doctoral dissertation, University of Washington.
18. Fox, R. (1974). *Arming America: How the U.S. buys weapons*. Boston, MA: Harvard University Press.
19. Gansler, J. S. (1980). *The defense industry*. Cambridge, MA: MIT Press.
20. Goldberg, V. & Erickson, J. R. (1987). Quantity and price adjustment in long-term contracts: A case study of petroleum coke. *Journal of Law and Economics*, 30, 369-398.
21. Hackett, S. C. (1993). Incomplete contracting: A laboratory experimental analysis. *Economic Inquiry*, 31, 274-297.
22. Harrigan, K. (1986). Vertical integration and corporate strategy. *Academy of Management Journal*, 28, 397-425.
23. Heide, J. & John, G. (1988). The role of dependence balancing in safeguarding transaction-specific assets in conventional channels. *Journal of Marketing*, 52, 20-35.
24. Hennart, J. (1988). Upstream vertical integration in the aluminum and tin industries. *Journal of Economic Behavior and Organization*, 9, 281-299.
25. Holmstrom, B. & Hart, O. (1985). *The theory of contracts*. Photocopy. Boston: MIT Working Paper.
26. John, G. & Weitz, B. A. (1988). Forward integration into distribution: An empirical test of transaction cost analysis. *Journal of Law, Economics and Organization*, 4, 337-355.
27. Johnston, T. C. (1993). *Governing transactions in business markets: Implications for prediction and performance*. Doctoral dissertation, University of California at Berkeley.
28. Joskow, P. L. (1985). Vertical integration and long term contracts: The case of coal-burning electric generating plants. *Journal of Law, Economics and Organization*, 1, 33-80.
29. Joskow, P. L. (1987). Contract duration and relationship-specific investments: Empirical evidence from coal markets. *The American Economic Review*, 77, 168-185.
30. Klein, B., Crawford, R. A., & Alchian, A. (1978). Vertical integration, appropriable rents, and the competitive contracting process. *Journal of Law and Economics*, 21, 297-326.
31. Levy, D. (1985). The transaction cost approach to vertical integration: An empirical examination. *Review of Economics and Statistics*, 67, 438-445.
32. Macauley, S. (1963). Non-contractual relations in business. *American Sociological Review*, 28, 55-70.
33. Mankarious, R., & Nehmer, J. (1992). Structuring the contractual relationship in a hotel renovation project. *Real Estate Finance Journal*, 7, 91-93.
34. Masten, S. E. (1988). Minimum bill contracts: Theory and policy. *Journal of Industrial Economics*, 32, 85-97.
35. Masten, S. E. & Crocker, K. J. (1985). Efficient adaptation in long-term contracts: Take-or-pay provisions for natural gas. *The American Economic Review*, 75, 1083-1093.
36. Masten, S. E., Meehan, J. W., & Snyder, E. A. (1989). Vertical integration in the U.S. auto industry. *Journal of Economic Behavior and Organization*, 12, 265-273.
37. Moody's Investors Service. (1970-1995). *Moody's industrial manual*. New York: Moody's Investors Service.
38. Monteverde, K. & Teece, D. J. (1982a). Supplier switching costs and vertical integration in the automobile industry. *Bell Journal of Economics*, 13, 206-213.
39. Monteverde, K. & Teece, D. J. (1982b). Appropriable rents and quasi-vertical integration in the automobile industry. *Journal of Law and Economics*, 25, 321-328.
40. Mosakowski, E. (1991). Organizational boundaries and economic performance: An empirical study of entrepreneurial computer

- firms. *Strategic Management Journal*, 12, 115-133.
41. Noordeweir, T., John, G., & Nevin, J. (1990). Performance outcomes of purchasing arrangements in industrial buyer-vendor relationships. *Journal of Marketing*, 54, 80-93.
 42. Osborn, R. N. & Baughn, C. C. (1990). Forms of interorganizational governance for multinational alliances. *Academy of Management Journal*, 33, 503-519.
 43. Palay, T. M. (1984). Comparative institutional economics: The governance of rail freight contracting. *Journal of Legal Studies*, 13, 265-288.
 44. Palay, T. M. (1985). Avoiding regulatory constraints: Contracting safeguards and the role of informal agreements. *Journal of Law, Economics and Organization*, 1, 155-176.
 45. Peck, M. J. & Scherer, F. M. (1962). *The weapons acquisition process: An economic analysis*. Boston, MA: Harvard University Press.
 46. Peeters, W. & Veld, J. (1989). The use of alternate contract types in Europe as protection against overruns. *National Contract Management Journal*, 23, 23-35.
 47. Pisano, G. P. (1989). Using equity participation to support exchange: Evidence from the biotechnology industry. *Journal of Law, Economics and Organization*, 5, 109-127.
 48. Posner, R. (1992). *Economic analysis of law*. Boston, MA: Little, Brown.
 49. Robins, J. A. (1987). Organizational economics: Notes on the use of transaction cost theory in the study of organizations. *Administrative Science Quarterly*, 32, 68-86.
 50. Rubin, P. H. (1993). Introduction. *Managerial and decision economics*, 14, 95.
 51. Scherer, F. M. (1964). *The weapons acquisition process: Economic incentives*. Division of Research, Graduate School of Business Administration, Boston, Harvard Business University Press.
 52. Sloan, F. A., Shayne, M. W. & Conover, C. J. (1995). Continuing care retirement communities: Prospects for reducing institutional long-term care. *Journal of Health Politics*, 20, 75-98.
 53. Spiller, P. (1985). On vertical mergers. *Journal of Law, Economics and Organization*, 1, 25-44.
 54. Stevens, J. (1992). *Applied Multivariate statistics for the Social Sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates.
 55. Stinchcombe, A. L. (1985). Contracts as hierarchical documents. In *Organizational theory and project management*, (eds. A. Stinchcombe & C. Heimer), Oslo: Norwegian University Press.
 56. Tabachnick, B. G. & Fidell, L. S. (1996). *Using multivariate statistics*. New York: Harper Collins.
 57. Teece, D. J. (1982). Towards an economic theory of the multiproduct firm. *Journal of Economic Behavior and Organization*, 3, 39-64.
 58. Templin, C. R. (1988). *The effect of defense contracting requirements on just-in-time implementation*. Doctoral dissertation, Arizona State University.
 59. Thompson, J. (1967). *Organizations In action*. New York: McGraw-Hill.
 60. Walker, G. & Poppo, L. (1991). Profit centers, single-source suppliers and transaction costs. *Administrative Science Quarterly*, 36, 66-87.
 61. Walker, G. & Weber, D. (1984). A transaction cost approach to make or buy decisions. *Administrative Science Quarterly*, 29, 330-354.
 62. Walker, G. & Weber, D. (1987). Supplier competition, uncertainty, and make-or-buy decisions. *Academy of Management Journal*, 30, 589-596.
 63. Williamson, O. E. (1975). *Markets and hierarchies*. New York: Free Press.
 64. Williamson, O. E. (1979). Transaction cost economics: The governance of contractual relations. *Journal of Law and Economics*, 22, 233-261.
 65. Williamson, O. E. (1983). Credible commitments: Using hostages to support exchange. *The American Economic Review*, 73, 519-535.

66. Williamson, O. E. (1985). *The economic institutions of capitalism*. New York: Free Press.
67. Williamson, O. E. (1991). Comparative economic organization: The analysis of discrete structural alternatives. *Administrative Science Quarterly*, 36, 269-296.

Reader's Comments