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Methodological note

Transaction cost framework in operations and supply chain management research: theory and measurement

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Abstract

Over the past decade, transaction cost theory (TCT) has received considerable attention from researchers in various disciplines of business. Unfortunately, the rich theoretical base of TCT has seen limited application in the operations and supply chain management research. This article seeks to change that by providing a cogent synthesis of TCT, its assumptions, constructs, and propositions. It also summarizes existing empirical work in management and other disciplines that draws from the TCT perspective and examines relationships in manufacturing organizations. A measurement model of transaction costs is subsequently presented using data from 203 manufacturing firms in the OEM electronics industry. Guidelines and recommendations for researchers are then presented regarding both the uses of the theory and its measurement. It is hoped that this study will stimulate work in the important areas of inter-firm relationships that draw from this rich but underutilized theoretical lens, and thereby add another perspective to the knowledge base in related areas of the operations and supply chain management fields.

Keywords: Empirical research; Transaction cost theory; Financial/economic analysis; Supply chain and operations management

1. Introduction

The transaction cost theory (TCT) has been around for nearly seven decades, and it received quite a bit of prominence recently when Ronald Coase was awarded the Nobel Prize in Economics for his early work on transaction costs (Coase, 1937). This interest was catalyzed by the work of Williamson (1975) who in his seminal book *Markets and Hierarchies* took an inter-disciplinary approach to studying transaction costs as a social science phenomenon. As a result of this work, researchers in sociology, organizational theory, law, finance, information systems, and marketing have gained insights into a variety of issues through a transaction cost lens (Barney, 1990). In their comprehensive conceptual review on transaction cost analysis, Rindfleisch and Heide (1997) have listed a number of empirical studies that test hypotheses based on TCT using data from business organizations. So while originating from the economics discipline, it has generated considerable debate among scholars beyond the economics discipline (Ghoshal and Moran, 1996). Yet, little use has been made of this theory in the operations management (OM) literature. In particular, with the growing importance of supply chain management within the OM discipline, considerable opportunities exist for better understanding and application of TCT to OM problems and methodologies. Within OM itself, greater potential exists for application of

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TCT to manufacturing rather than services, as also evidenced by a preponderance of TCT studies that have been conducted in the past using data gathered from manufacturing firms (Rindfleisch and Heide, 1997). So we will retain in our study a focus on the manufacturing sector within the broader rubric of OM discipline, and investigate the application of TCT to operations and supply chain management problems.

TCT, as discussed by Williamson (1975), puts the notion of "transactions" or units of exchange as the focal point of the theory. He provides a carefully crafted perspective on the nature of governance structures that can exist between organizations under various exogenous conditions. A popular perspective espoused by Williamson (1975) argues for market versus hierarchical governance structures based on the level of opportunism present in the relationships. Markets and hierarchies (or firm) are proposed as alternative instruments for completing a set of transactions. The choice of instrument (alternatively also known as governance mechanism) depends on the relational efficiency of each. A number of antecedent conditions can influence governance mechanisms through the level of transaction costs.

TCT, while representing an economic perspective differs from classical economics by incorporating the concept of a *firm* as germane to its analysis. A firm is viewed as a governance structure as opposed to a production function. TCT's basic premise is that the cost of doing transactions (i.e. the cost of economic exchange) could be too high under certain conditions. In those cases, organizing the economic transaction within the firm or *hierarchy* governance structure might be superior to organizing it as a *market*-based governance structure. The basic tenets of this theory are based on assumptions about human behavior that have been refined by Williamson (Williamson, 1975, 1985) from Coase's original work.

It is unfortunate that despite the rich perspectives offered by TCT, its use by researchers in OM has been limited at best. In particular, considerable opportunities exist within the OM discipline for evaluating many supply chain management related issues from the TCT perspective. Why this has not occurred may partially be due to the relatively recent attention paid to social science representations and methods as applied to OM, the limited use of economics as a reference discipline, the unique and occasionally opaque vocabulary associated with the theory, and the lack of clear direction on applicability of TCT to OM issues. We seek to change this by making a case for TCT specifically within the OM arena and attempting to provide conceptual and empirical facilitation for future research. Specifically, this study has five objectives:

- To provide a cogent discourse on TCT, its key assumptions, constructs, and propositions.
- To summarize empirical studies in other disciplines which have obtained data within a manufacturing or operations context.
- To provide a general description and overview of TCT-based constructs that are available in the literature to OM researchers for future research.
- To describe the empirical measurement of the central transaction cost construct that has not been as well operationalized in prior literature.
- To describe implications of the conceptual, empirical, and operational synthesis for future research in OM and supply chain management in particular.

The next section develops the assumptions, constructs and propositions of TCT. This is followed by a summary of empirical research that uses the TCT perspective and is relevant to OM research since the data in these studies are from manufacturing firms. The final section builds upon the first four sections by describing implications for future work in operations and supply chain management research.

2. Transaction cost theory

Since TCT is a complex theory, it is useful to demarcate its key assumptions, constructs, and propositions in a manner that facilitates its application to a variety of OM issues.

2.1. Key assumptions

Two key assumptions characterize TCT (Rindfleisch and Heide, 1997). These can be summarized under the titles of *bounded rationality* and *opportunism*. Bounded rationality, a concept first articulated by Herbert Simon in 1957, refers to the neurophysiological and language limits of individuals (Simon, 1957). In an organizational context, while decision-makers might want to act rationally, they are limited in their

ability to receive, store, retrieve, and communicate information without error. This limits the extent to which rational behavior can be conducted. TCT views bounded rationality as a problem under conditions of uncertainty. These conditions make it difficult to fully specify the conditions surrounding an exchange, thereby occasioning an economic problem. Given unbounded rationality, all contingencies can be incorporated into a contract (i.e. through full specification of the decision tree) and the players involved in the exchange will not have to incur ongoing renegotiation costs. When the rationality constraint is binding however, it gives rise to transaction costs that need to be minimized through a correct choice of governance.

For instance, let's take the case of a manufacturer and a supplier that have an ongoing relationship between them, and which also has been the setting for several research studies in the supply chain context within the OM literature. Under conditions of high turbulence in the demand environment, the inputs into the manufacturing process (say) need to be modified on an ongoing basis. If the inputs were deterministic and their complexity and change could be predicted with precision, a comprehensive contingent contract could be specified between the manufacturer and supplier. Under uncertainty however, bounded rationality forces the need for the two parties to incur considerable transaction costs associated with ongoing negotiations on specifications and prices.

The second assumption, opportunism, indicates that human actors in the exchange relationship will be guided by considerations of self-interest with guile. This includes behaviors such as cheating, lying, and subtle forms of violation of agreements. In TCT, the existence of opportunism gives rise to transaction costs in the form of monitoring behavior, safeguarding assets, and making sure that the other party does not engage in opportunistic behavior.

In sum, assumptions of bounded rationality and opportunism are distinctly different facets of TCT, and together will give rise to transaction costs. Subsequently, governance mechanisms like the firm and the market offer ways to organize these transactions.

2.2. Key constructs

While a number of constructs pertaining to TCT have been discussed in the literature, we have chosen three of the most important ones to reflect the fundamental representation of the theory: asset specificity, uncertainty, and governance mechanisms or structures. The latter serves as the dependent variable in TCT.

Transaction costs can generally be represented in terms of two major components (Clemons et al., 1993):

$$\text{Transaction costs} = \text{coordination costs} + \text{transactions risk}$$

Co-ordination costs are the cost of exchanging information and incorporating that information into the decision process. In the case of a manufacturer–supplier dyad it might include costs of exchanging information on products, price, availability, demand, as well as the costs to exchange design changes rapidly with the supplier. Transaction risk includes the risk that other parties in the transaction will shirk their agreed upon responsibilities. Information asymmetry augments this risk. For instance, in the dyad above, the supplier might deliver an inferior product if it knows the manufacturer may not be able to prove the violation. In addition, transaction risk might also include asset-specific investments made by one party in the relationship. As soon as a supplier (say) makes the investment, the manufacturer may demand price and other concessions in order to take advantage of the supplier's sunken investment. Clemons et al. (1993) highlight two other aspects related to transaction risk. The first is "small numbers bargaining," whereby if there are only a few suppliers capable of supplying the product and the firm decides to procure from the market, it exposes itself to opportunistic behavior. In addition, "loss of resource control" may be another aspect of transaction risk, which relates to outsourcing a product that may be proprietary in nature and which may again increase the probability of opportunistic behavior.

Asset specificity refers to the transferability of assets that support a given transaction. Highly asset-specific investments (also called relationship-specific investments) represent costs that have little or no value outside the exchange relationship. These costs are mainly in the form of human specificity (e.g. training of salespeople specifically for a certain partner) or physical specificity (e.g. investment by a supplier in equipment, tools, jigs, and fixtures to cater to idiosyncratic needs of a manufacturer). Investments in information

systems that primarily serve the needs of one unique customer and cannot be leveraged across other external parties would also be another form of asset-specific investment. Zaheer and Venkatraman (1994) suggest that using proprietary systems increases business process asset specificity. Inducement of IT into the relationship reconfigures the existing processes and creates procedural specificity (Mukhopadhyay and Kekre, 2002), whereby firms develop processes (with or without IT, JIT etc.) that are unique to the relationship and which may require learning time if developed with other suppliers.

Uncertainty refers to the unanticipated changes in circumstances surrounding a transaction. This uncertainty could preclude both the formulation of a contract ex ante and/or the ability to verify compliance ex post. The former (environmental uncertainty) can be reflected in constructs such as unpredictability of the environment, technology, and demand volume and variety. The latter (behavioral uncertainty) includes performance evaluation and information asymmetry problems. As discussed earlier, the effects of the bounded rationality constraint are accentuated by conditions of uncertainty.

Markets and hierarchy (alternately *the firm*) represent governance mechanisms in their purest mode. Each one has different mechanisms for co-ordinating the flow of materials and services through steps in the value chain (Malone et al., 1987). Hierarchies, firms, or vertically integrated entities control and direct this flow at a higher level in the management hierarchy. Characteristics of hierarchical governance can be achieved without ownership or completely vertically integrated entities. For instance in a supplier–buyer dyad characterized as a hierarchical relationship, the supplier manages the authority relations, control procedures, and incentives available through such structures and enables decisions on design, price, delivery, and quantity (Heide, 1994). Markets on the other hand co-ordinate flow through demand and supply forces, where in true competitive environments the buyer will have a choice of products and chooses the one with the best attributes.

While the theory is clearer with respect to pure forms of governance, various intermediate forms have also been conceptualized. These can be represented (for example) by the "degree" of vertical integration and the "extent" of cooperative behavior in the relationship. For instance, Bowen and Jones (1986) describe a typology of governance mechanisms for service organization exchanges that include relational markets and hierarchies that include cooperative behavior within their governance. Similarly, Heide (1994) describes markets, hierarchies and bilateral governance and their dimensions. Others (e.g. Heide and John, 1992; Bensaou, 1997) have examined the degree of cooperative or relational governance as hybrid structures between markets and hierarchies.

2.3. Key propositions

With the assumptions and constructs of TCT defined, we can build the logic behind the theory (Williamson, 1975, 1985). It can be stated compactly as a collection of three propositions.

> Bounded rationality and opportunism give rise to transaction costs. These costs are higher under conditions of high asset specificity and high uncertainty. The most efficient governance mechanism (markets or firm) needs to be chosen to organize economic activity. In general, lower transaction costs favor markets, while higher transaction costs favor hierarchies.

Proposition 1. *Bounded rationality and opportunism give rise to transaction costs.*

As described earlier, bounded rationality of individuals in some cases limits the ability to specify all conditions of the decision tree ex ante, thereby occasioning the necessity of specifying an incomplete contract between parties and the economic costs of managing the contract. The presence of opportunism where some parties are assumed to engage in behavior that requires monitoring increases the cost of transactions.

Proposition 2. *Transaction costs are higher under conditions of high asset specificity and high uncertainty.*

TCT argues that asset-specific investments that are made in a party within a transactional relationship give rise to higher transaction costs. Specifically, the transaction risk goes up for the party that makes the investment as the other party can engage in opportunistic

behavior (e.g. demand lower prices). Similarly, high uncertainty taxes bounded rationality and can increase the possibility of opportunistic behavior and increase the co-ordination costs required. In other words, high relationship-specific investments and uncertainty can increase the costs required to have an efficient relationship under conditions of bounded rationality and opportunism.

Proposition 3. *The most efficient governance mechanism* (*markets or hierarchy*) *needs to be chosen to organize economic activity. In general, lower transaction costs favor markets, while higher transaction costs favor hierarchies.*

This proposition represents the major predictive aspect of TCT with respect to governance structures. Williamson argues that internal organizations (firms) have certain properties that minimize transaction costs. These include powerful control and monitoring mechanisms due to their ability to measure and reward behavior and output, cultural and social norms that create convergent goals, and the ability to provide long-term rewards like promotion opportunities. These factors make it difficult to appropriate or subvert subgroup gains at the expense of the organization. Therefore, opportunistic behavior and subsequently transaction costs are attenuated. Of course, internalization of activities should only take place if the cost reduction exceeds incremental costs due to additional administrative burdens and losses in production efficiencies.

In summary, if transaction costs are low due to low asset specificity and uncertainty, then market governance will be preferred. Production costs are generally lower in markets due to the economies of scale and scope available to external service providers, which are subsequently reflected in the market prices. If on the other hand, transaction costs are high enough to exceed the production cost advantages of the market, then the hierarchical governance will be the more appropriate governing mechanism.

2.4. Critique of TCT

It is useful to note that while TCT offers a powerful basis for governance choice, both its assumptions and tenets have been challenged. Ghoshal and Moran (1996) argue that TCT fails to recognize that hierarchical control could foster opportunistic behavior rather than constrain it (as the theory posits). In some cases, rational controls in firms can enhance feelings of bias, inequity, unfairness, which in turn can create more subtle forms of opportunism in the form of "gaming." They also argue that TCT does not account for the efficacy of social controls, where the members imbibe the goals of the organization, limiting the threat of opportunism. Similarly, many have argued that "trust," due to social norms or personal relations is underrepresented in TCT and can serve as a substitute for formal contracts and controls (Griesinger, 1990; Hill, 1990; Nooteboom et al., 1997). The concept of uncertainty and its role in necessitating hierarchical governance has also been questioned. High levels of uncertainty could create information-processing problems in firms that might make markets more preferable (Schelanski and Klein, 1995). Several researchers have also argued that the hierarchy-market continuum is too simplistic to represent various hybrid forms of governance (Rindfleisch and Heide, 1997). Jones et al. (1997) tried to integrate TCT with other theories like social network theory in order to obtain stronger predictions of other governance modes like network governance.

Despite these criticisms, TCT has endured and continues to be an important anchor for a wide range of issues important to managers. At worst, TCT offers an important theoretical lens for a number of problems relevant to OM. It is our contention that failure to fully recognize this lens will limit the quality of discourse in the field. Below, we highlight relevant empirical work that can guide the use of TCT in manufacturing and supply chain management research.

3. Empirical studies on manufacturing firms that use TCT

While studies drawing on TCT in the OM area are limited, there have been a number of empirical investigations in related fields, particularly marketing and management that have obtained data from manufacturing firms and industries as well as other contexts. A broad based search by Rindfleisch and Heide (1997) including manufacturers, exporters, foreign market entry decisions, joint ventures, and alliances, revealed 45 such studies falling into the four contextual domains of vertical integration, inter-organizational

relationships (horizontal and vertical), and test of assumptions of TCT. However, given the objectives of our study, we were more focused in our review and its analysis. We first review some of the key constructs and measures used in TCT, which is then followed by a description of studies conducted in the manufacturing context.

3.1. Constructs used in empirical TCT-based research

Even though there is high analytical diversity in TCT-based work, researchers in OM would need to be cognizant of all the constructs that may be available to them in conducting TCT-based research. With this objective in mind, we briefly review here the literature on TCT-based constructs. In addition, except for an occasional instance, we mostly review those constructs that have multi-item operationalizations, since such scales are more robust and capture the construct domain better than single item scales.

According to Rindfleisch and Heide (1997), TCT's key dependent construct is governance structure, while the independent constructs are asset specificity, environmental uncertainty, and behavioral uncertainty. These authors provide a comprehensive review of these constructs, salient details of which are abstracted and summarized below. In addition, the central construct of transaction cost itself is germane to conducting empirical research in this area.

Governance structure pertains to market, hierarchy, or intermediate mechanisms. It can be measured as the degree of vertical integration (e.g. Balakrishnan and Wernerfelt, 1986; Levy, 1985; Hu and Chen, 1993, among others), various types of control mechanisms (e.g. Stump and Heide, 1996; Parkhe, 1993), the market versus hierarchy construct (e.g. Walker and Weber, 1987; Masten et al., 1989; Walker and Poppo, 1991, among others), and hybrid forms of governance (e.g. Klein et al., 1989; Heide and John, 1990).

Asset specificity has by and large been measured as a latent construct in the context of human asset specificity. Multi-item scales for human asset specificity can be found in the work of Anderson (1985), Heide and John (1990), Klein et al. (1989), and Sriram et al. (1992) among others. Scales for other types of asset specificity such as physical asset specificity or brand name capital are less readily available due to difficulty associated with their measurement and operationalization.

Environmental uncertainty can be measured in several different ways. A multidimensional operationalization of environmental uncertainty that recognizes both dynamism and complexity has been provided by Klein (1989). In contrast, several other researchers have by passed the complexity dimension altogether and focused mostly on the unpredictability of the external environment (e.g. Anderson, 1985; Heide and John, 1990; Stump and Heide, 1996, among others). Rindfleisch and Heide (1997) recommend that either form of this measure can be used depending upon the study context.

Behavioral uncertainty relates to difficulties associated with monitoring the contractual performance of exchange partners (Williamson, 1985). Anderson (1985) initially operationalized this measure as a seven-point scale. According to Rindfleisch and Heide (1997), several other researchers have also built on this measure and assessed behavioral uncertainty as an issue of performance assessment (e.g. Heide and John, 1990; Stump and Heide, 1996; Weiss and Anderson, 1992, among others).

Finally, empirical work on direct measurement of transaction costs has been more nascent and limited, and has mostly been treated at the conceptual rather than at the measurement level. Our review of the literature revealed few empirical measures for transaction cost. Based on a limited testing from 51 subjects, Pilling et al. (1994) categorized transaction costs associated with "ex ante costs of developing and setting up an exchange relationship, and ex post costs of monitoring performance, and dealing with opportunistic behavior (Rindfleisch and Heide, 1997)." According to Rindfleisch and Heide (1997), other researchers who have provided measures of perceived or actual transaction costs are Gates (1989), Leffler and Rucker (1991), Noordweir et al. (1990), Sriram et al. (1992) and Walker and Poppo (1991).

3.2. Manufacturing context studies

A search for manufacturing or operations context studies revealed 19 studies, which are summarized in Table 1. It should be noted that while these studies might not represent a comprehensive profile of all the empirical TCT work that has been conducted in

Table 1
Summary of key manufacturing studies using transaction cost theory (TCT)

Reference	Sample	Key independent variable(s)	Key dependent variable(s)	Key findings
Levy (1985)	69 manufacturing firms	Asset specificity, environmental uncertainty	The degree of vertical integration	Higher assets specificity and uncertainty is related to greater vertical integration.
Anderson (1985)	159 sales managers in the electronics industry	Asset specificity, uncertainty, transaction frequency	The use of direct sales force vs. manufacturing reps.	Behavioral uncertainty, asset specificity, and interactions are related to the use of direct (in-house) sales force.
Balakrishnan and Wernerfelt (1986)	93 manufacturing industries	Technological obsolescence	Vertical integration	Technological obsolescence has a negative impact on vertical integration.
Walker and Weber (1987)	60 outsourcing decisions in US auto manufacturer	Market competition, environmental uncertainty	Outsourcing	Interaction of uncertainty and competition affects outsourcing.
Heide and John (1988)	199 manufacturers agents in electrical equipment industries	Asset specificity of agency	Replacement of principal	Specific investments by agents are negatively related to replicability of the principal.
John and Weitz (1988)	88 industrial manufacturers	Asset specificity, environmental and behavioral uncertainty	Percentage of manufacturer sales through direct distribution channels	All variables are positively related to manufacturer's forward integration.
Noordweir et al. (1990)	140 manufacturers	Environmental uncertainty	Level of possession and acquisition cost	High relational governance lowers acquisition costs under conditions of high uncertainty.
Heide and John (1990)	155 manufacturing firms	Asset specificity, environmental and behavioral uncertainty	Joint action and relationship continuity	Both party asset specificity are related to joint action. Supplier-specific investments are related to expectations of continuity.
Walker and Poppo (1991)	99 supplier dyads of a large manufacturer	Asset specificity, competition	Transaction costs	Asset specificity is related to lower in-firm transaction costs.
Lieberman (1991)	203 manufacturers of chemical products	Supplier concentration, asset specificity, cost inputs	As related to integration vs. contractual arrangement	Higher cost inputs are related to higher backward integration
Sriram et al. (1992)	65 purchasing managers in large manufacturing firms	Asset specificity, perceived transaction costs	Buyer dependence, collaboration	Supplier-specific investments are negatively related to perceived buyer dependence. Transaction costs are positively related to collaboration propensity.
Heide and John (1992)	155 manufacturing and 60 supplier firms	Asset specificity, relational norms	Buyer's control over supplier's decisions	Buyer specific investments are positively related to control over supplier decisions only when both parties share relational norms.
Anderson and Weitz (1992)	378 large manufacturer–distributor relationships	Relationship-specific investments (actual and perceived)	Commitment to the relationship	Idiosyncratic investments are positively associated with both manufacturer and distributor commitment.
Parkhe (1993)	111 manufacturers	Perceptions of opportunistic behavior, history of cooperation	Performance of alliance, specific investments, contractual safeguards, perceptions of opportunistic behavior	Perceptions of opportunistic behavior are negatively related to alliance performance, specific investments and contractual safeguards. History of cooperation negatively related to perceptions of opportunism.
Maltz (1994)	147 manufacturing firms	Assets specificity, transactional frequency	Probability of outsourcing warehousing	Asset specificity has a negative and frequency has a positive relationship with outsourcing.

Table 1 (*Continued*).

Reference	Sample	Key independent variable(s)	Key dependent variable(s)	Key findings
Stump and Heide (1996)	165 chemical manufacturers	Asset specificity	Incentive design and monitoring	Specific investments by buyers protected through specific investments by suppliers.
Bensaou (1997)	447 relationships in US and Japanese auto industry	Switching costs, ownership ration, contract length, goal compatibility, fairness, technological unpredictability, use of it	Cooperation	Most relationships significant for Japanese but not for US relationships. Behavioral conditions important for cooperation.
Azoulay (2000)	Over 5000 clinical trials in six major drug manufacturers	Complex knowledge production activities vs. generic data production activities	Outsourcing probability	Costly to monitor knowledge intensive trials tend to be managed in-house rather than outsourced.
Novak and Eppinger (2001)	7 key automotive systems from eight luxury car manufacturers	Product complexity	Sourcing decision	Significant positive relationship between product complexity and vertical integration.

a manufacturing setting, they do provide an adequate representation of the application of the theory. A review of these studies can provide insight into the various problems and results' specifically pertaining to an industry set that is pivotal to OM and supply chain management researchers.

As can be seen from the table, a variety of dependent variables are studied. While these include the market versus firm structures operationalized in various forms, they also include sets of hybrid structures. The governance mechanisms include the use of direct sales force versus manufacturing representatives, commitment to the relationship, vertical integration, forward integration, backward integration, outsourcing, and collaboration.

The results pertaining to asset specificity are fairly supportive of TCT's propositions. In general, asset-specific investments lead to the use of in-house sales force rather than manufacturing representatives (Anderson, 1985), vertical integration (Levy, 1985), forward integration (John and Weitz, 1988), in-sourcing (Maltz, 1994), and lower in-firm transaction costs (Walker and Poppo, 1991). Uncertainty however is not as consistent. TCT proposes that higher uncertainty in the context of the transaction would increase opportunism (and transaction costs), thereby making firms more efficient than markets. Evidence for this is found in Levy (1985) who related uncertainty with vertical integration. Anderson (1985) found similar results with respect to uncertainty in monitoring behavior. Azoulay (2000) found that complex projects that require more monitoring tend to be conducted in-house, while Novak and Eppinger (2001) related product complexity to vertical integration. In contrast however, Balakrishnan and Wernerfelt (1986) found a negative relationship between technological obsolescence (an attribute of uncertainty) and vertical integration. Their arguments suggest that firms would rather have markets handle a technology that could quickly be obsolete, rather than committing to it through vertical integration.

Other studies have examined specific TCT issues related to opportunism. For instance Parkhe (1993) observed that perceptions of opportunistic behavior in alliances have a negative impact on performance. Also, Heide and John (1992) found that buyers could protect their investment in a relationship and reduce opportunism by establishing relational norms with the supplier. Finally, Bensaou (1997) draws from TCT in examining cooperative governance (somewhere between hierarchies and markets) among buyer–supplier dyads in Japan and US automobile firms. He found that in addition to structural factors (asset specificity, uncertainty, use of information technology) the behavioral climate in both countries is a robust predictor of cooperation. Collectively, even though some limitations exist (below), these studies provide a rich repertoire of issues, measures, and relationships that have been studied in the context of manufacturing firms being the unit of analysis.

3.3. Summary

Based on our review of prior empirical literature, there are two limitations in this work that can provide opportunities for OM and supply chain management researchers who wish to add value. First, none of the studies explicitly measure the central construct of TCT, which are the transaction costs themselves. This could partially be attributed to the complexity in defining this construct. Therefore, studies implicitly assume its existence (mediating effect) in the theoretical justification of their hypotheses.

Second, most studies view the operations context as a black box, focusing exclusively on the dyadic relationship. However, rich set of issues could be examined by looking at operations perspectives of the key construct involved. For instance, asset specificity can be examined in terms of its production-specific components like investments in MRP, CAD, FMS, ERP, and other planning and control systems that are tied into specific external relationships (this has been termed as business process asset specificity by Zaheer and Venkatraman, 1994 and later as procedural specificity by Mukhopadhyay and Kekre, 2002). Environmental uncertainty could be examined with respect to the product process context. It could be viewed in terms of product or process complexity, as also how rapidly products and processes evolve and change (dynamism). Transaction costs could be studied in relation to efficiency and performance metrics within the supply chain. Factors pertaining to changing influences of the demand environment on the supplier–buyer dyad could add to our understanding of buyer–supplier relationships and flexibility. Finally, the influences of technology, particularly information technology, as a

means to reducing transaction costs and facilitating outsourcing, all offer tremendous opportunities to extend and enhance existing work in the operations and supply chain management arena.

To facilitate this line of inquiry, we provide a possible metric for the transaction cost construct. The measure is described and refined using structural equation modeling. It is hoped that this measure will facilitate the use of TCT in the OM area.

4. The measurement of transaction costs

Transaction costs are directly related to all the three independent constructs we reviewed previously—asset specificity and uncertainty (both behavioral as well as environmental). Rindfleisch and Heide (1997) posit that direct transaction costs may arise in the form of direct costs that would include costs of crafting safeguards; communication, negotiation and co-ordination costs; screening and selection costs (ex ante) and measurement costs (ex post).

Transferring the concept of transaction costs to the operational domain remains elusive. Ideally, objective measures of these costs as reflected in the dollar costs of co-ordination and coping with transaction risk would greatly facilitate empirical work in the area. However, it is almost impossible to obtain an accurate representation of these costs from financial data. Strassman (1997) discusses the use of selling and general administrative (SGA) costs as reflected in financial statements as a proxy for co-ordination costs. Firms incur SGA expenses in the process of managing, planning, promoting and co-ordinating their organizations for the purpose of effective delivery of goods and services to customers. However, at best these costs reflect the costs of both internal and external co-ordination and do not capture the costs involved in managing transaction risk. Another alternative is to assess transaction costs as perceived by an informed party. To our knowledge, Pilling et al. (1994) is one of the few studies that attempted such a measure. However, Pilling et al.'s (1994) measure was evaluated in an experimental setting with a limited set of 51 subjects, and has not been subjected to the rigors of wide scale empirical validation. Consequently we undertook such a scale validation and refinement process in this paper.

Given the operations and supply chain related context of our own work, we chose to focus on long-term buyer–supplier relationships and drew upon Pilling et al.'s measure to create a rich multidimensional conceptualization of transaction costs. Four dimensions were operationalized: (a) effort required in developing the relationship (effort), (b) monitoring the performance of Supplier S (monitor), (c) addressing problems that might arise in the relationship with Supplier S (problem), and (d) the likelihood of Supplier S taking advantage of the relationship (advantage). Each dimension was measured using multi-item scales adapted from Pilling et al. (1994). Some scales were reversed to reduce method bias. Collectively, the dimensions adequately reflected elements of co-ordination and transaction risk discussed earlier. The complete set of items for each of these dimensions is provided in Table 2.

A survey-based measure was developed to measure transaction costs. Survey instrumentation allows for a rich assessment of constructs and facilitates statistical testing of the relationships using a large sample. The unit of analysis for this study was the buyer–supplier dyad. Since the actual manifestation of behavior or governance is predicated on perceptions of transaction costs, the construct of interest measures "perceived transaction costs." Data were gathered from organizational buyers within a dyadic relationship. Data on these exchange relationships was gathered from purchasing agents within the electronics OEM industry. This industry is reflective of a wide range of purchasing arrangements and provides a sampling frame of adequate size. Within the set of buying organizations, the person most knowledgeable about supplier relationships would be the senior most purchasing manager. Consistent with the guidelines of Huber and Power (1985), these individuals were targeted.

An initial set of 1000 purchasing managers, obtained from a professional information service, was targeted. These individuals were asked to identify a single supplier that provides an important input (electronic component) to the production process and has an ongoing relationship with the company. Respondents were then asked to fill out a carefully designed instrument specifically with respect to the dyadic relationship involving the selected supplier (Supplier S) and component (Component C). Of the 730 organizations that satisfied these criteria, 203 (27%) responded.

Table 2
Items used to measure transaction costs

This discusses issues on *how you established and are maintaining your working relationship* with Supplier S. We want to measure the amount of effort and costs that were required to set up and maintain this relationship. Please indicate the extent to which you agree with the following statements by circling the appropriate number:
In developing an association with Supplier S (with respect to Component C)
It was understood in advance what this relationship would involve (Mang01)
Significant effort was required to gather the information necessary to outline the working relationship with Supplier S (Mang02)
It was straightforward and easy to work out the main issues and necessary details of the relationship with Supplier S (Mang03)
There were many unspecified terms which had to be worked out as the relationship with Supplier S developed (Mang04)
It required significant effort to determine individual roles to be performed by our firm and Supplier S (Mang05)
In monitoring the performance of Supplier S
It is easy to tell if we were receiving fair treatment from Supplier S (Mang06)
It takes significant effort to detect whether or not Supplier S conforms to specifications and quality standards (Mang07)
We are in a good position to evaluate how fairly our Supplier S deals with us (Mang08)
Accurately evaluating Supplier S requires a lot of effort (Mang09)
There is not much concern about Supplier S taking advantage of this Relationship (Mang10)
It is costly, in time and effort, to clearly monitor the performance of Supplier S (Mang11)
In addressing problems that might arise in the relationship with Supplier S
The approach to solving problems in our relationship with Supplier S is clear-cut (Mang12)
There are standard solutions or approaches to problems that might occur with Supplier S (Mang13)
Problem solving is often challenging, due to the nature of Component C (Mang14)
Although solutions to problems can be achieved, they would often need to be highly customized (Mang15)
Concerning the likelihood of Supplier S taking advantage of its relationship with our firm
There are no incentives for Supplier S to pursue their interests at the expense of our interests (Mang16)
It is easy for Supplier S to alter the facts in order to get what they wanted (Mang17)
There is a strong temptation for Supplier S to withhold or distort information for their benefit (Mang18)
It is difficult for Supplier S to promise to do things and get away without actually doing them later (Mang19)
There exists, from Supplier S's perspective, a significant motivation to take advantage of unspecified or unenforceable contract terms (Mang20)

To assess non-response bias, difference tests were conducted on sales volume, product type and component type, between early and late respondents. No differences were significant.

Table 3 illustrates the profile of the sample used for data analysis, including characterization of component C. The majority of respondents (66%) were responsible for the management of purchasing activities within the firm, as reflected by their title. Eleven percent were in the top management cadre. Thirty-one percent included other managers (IS, case, supplier relationship, etc.) who would be in a position to respond to the instrument. The components purchased were all electronic components, with a large proportion of them being classical components like integrated circuits, semiconductors, etc. Finally, as shown in Table 3b, the sample reflects a wide range of sizes, with about half the sample organizations having sales exceeding US$ 50 million.

All 20 items shown in Table 2 and corresponding to the four latent variables of effort, monitor, problem, and advantage were subjected to confirmatory factor analysis (Lichtenstein et al., 1993). Items were examined for low standardized loadings (less than 0.35) and evidence of cross loading (based on modification indices). Using these criteria, items Mang01, Mang10, Mang12, Mang16, and Mang19 were dropped from further consideration. Item loadings and the fit indices for the resultant CFA model are shown in Table 4. The chi-square value of 152.977 is statistically significant suggesting that the model does not fit the data. However, this is not unusual as the chi-square test statistic is sensitive to sample size. At the same time, the chi-square value adjusted for the degrees of freedom is less than 2, and values of other goodness-of-fit indices such as GFI (0.90), NNFI (0.93), TLI (0.93), RMSEA (0.06) are all within acceptable limits, thereby indicating good model fit (Sharma, 1996).

Table 3
Sample profile

Value of variable	Actual meaning	Percentage
(a) Characterization of component		
1	Instruments, equipment	4.9
2	Electrical goods (relays, transformers, etc.)	19.2
3	Mechanical devices (lifts, valves, etc.)	4.4
4	Electronic goods (e.g. integrated circuits, electronic components, semiconductors, etc.)—occurring most frequently	36.9
5	Materials, metals, etc.	5.9
6	Chemicals, plastics, moulded articles	4.4
7	Related to computers, software, motherboards, peripherals, etc.	12.8
8	Others (e.g. education, medical services, etc.)	4.9
Missing		6.4
Sales volume (million dollars)	Percentage	
(b) Size of responding firms		
Less than 10	20.2	
10–50	29.6	
50–100	8.9	
100–500	10.3	
More than 500	18.2	
Missing	12.8	

Table 4
Confirmatory factor analysis results

Item	Effort	Monitor	Problem	Advantage
Mang02	0.633			
Mang03	0.491			
Mang04	0.875			
Mang05	0.859			
Mang06		0.530		
Mang07		0.718		
Mang08		0.413		
Mang09		0.878		
Mang11		0.802		
Mang13			0.349	
Mang14			0.830	
Mang15			0.890	
Mang17				0.750
Mang18				0.699
Mang20				0.817
Coefficient alpha	0.799	0.805	0.707	0.800
Chi-square	RMSEA	RMSR	GFI	AGFI
Goodness-of-fit indices				
152.977 d.f. = 84 $P = 0.000$	0.0646[a] (0.048–0.081)	0.0645	0.902	0.861
Non-normed fit index	Comparative fit index	Relative normed fit index	Tucker Lewis index	Adjusted chi-square
0.934	0.947	0.947	0.933	1.82

[a] 90% confidence interval for RMSEA suggesting that the RMSEA is not significantly different than 0.05.

Table 5
Correlations among the constructs for discriminant validity

Constructs	Effort	Monitor	Problem	Advantage
Effort	0.491[a]	0.379	0.383	0.307
Monitor	0.616	0.453	0.326	0.539
Problem	0.619	0.571	0.505	0.301
Advantage	0.554	0.734	0.549	0.522

[a] Values on the diagonal are shared variances within a construct, values below the diagonal are correlations, and values above the diagonal are variances between the constructs.

In order to assess discriminant validity, variations between the constructs as well as shared variances within a construct were computed and examined (Fornell and Larcker, 1981). These results are shown in Table 5. In most of the cases (except monitor and advantage), shared variances within a construct exceed variances between the constructs, thereby providing evidence of good discriminant validity. Discriminant validity was also assessed by testing whether the correlations among pairs of constructs were significantly different from 1. In all cases, the chi-square difference tests suggested that indeed the correlations were significantly different from 1, lending support of discriminant validity for all the constructs.

Table 4 also reports the Cronbach's coefficient alphas for the four scales. Alphas of all the constructs have acceptable values that exceed 0.6 (Churchill, 1979; Nunnaly, 1978). Overall, each of the four purified scales of effort, monitor, problem and advantage containing four, five, three, and three items, respectively, are psychometrically sound. Cumulatively, they represent four different facets of transaction costs. Since, the objective was to capture the common variance among first-order constructs in a higher order latent measure called transaction costs, a second-order model was tested.

After the second-order factor model was estimated, the difference in the chi-square values of the first- and second-order factor models was equal to 8.003 with two degrees of freedom. This difference is not statistically significant, suggesting that *statistically* the two models are equivalent. Based on the parsimony principle and theoretical support, we think it is more appropriate to use the second-order factor model. Fig. 1 presents the second-order factor model and the loadings of the first-order factors. This model provides a reliable and valid metric for direct type of transaction costs that can be used in future work for studying long-term buyer–supplier relationships and other managerial scenarios related to this context.

4.1. Interpretation and use of the TCT measure

It must be pointed out that the second-order measure for transaction cost presented here specifically looks at only the direct type of transaction costs that consider a limited set of facets which characterize the long-term relationships between buyers and suppliers in a supply chain context. These facets include the effort

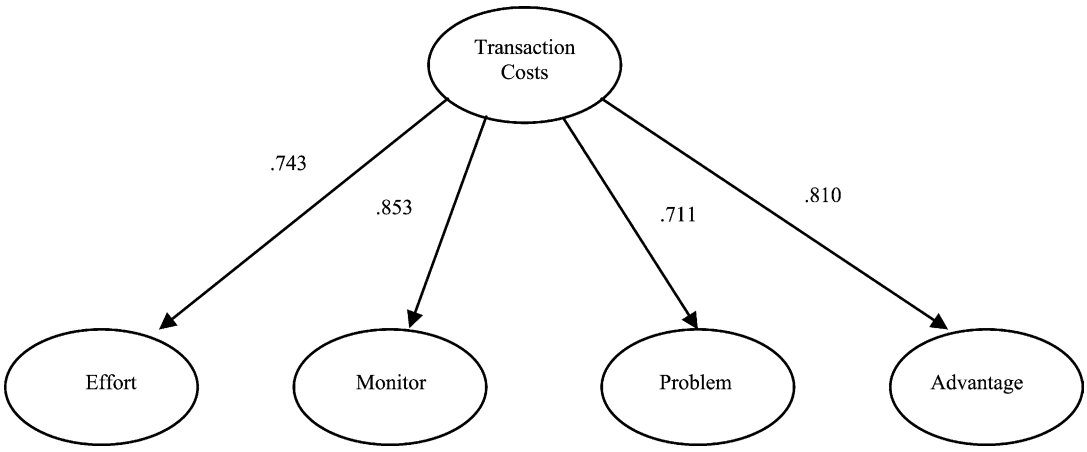

Fig. 1. Second-order factor model for transaction costs.

required to build and maintain the relationship, effort required to monitor the performance of the supplier, how problems arising in the relationship are resolved, and whether suppliers engage in an opportunistic behavior. Fortunately, many issues explored currently within the supply chain management research in operations and supply chain management cover these aspects of transaction costs, and hence can benefit from the measure presented. However, it does not include the measurement of transaction costs associated with governance problems (safeguarding, adaptation, and performance evaluation) or opportunity costs (failure to invest in productive resources, maladaptation, and failure to identify alternate partners) (Rindfleisch and Heide (1997)). Future studies should keep this consideration in mind, as also look for investigating these other aspects of transactions costs that have not been specifically reflected in the measure presented here.

5. Recommendations for future research

As is evident from prior discussion, major use and application of TCT theory in the OM field lies in examining inter-firm relationships evident in the buyer–supplier linkages and other downstream transactions between manufacturers and distributors. These macro level relationships, when viewed through the TCT lens, provide rich opportunities for studying various operations, purchasing, logistics, and supply chain management phenomena from a different perspective. We outline below several supply chain management research projects that can be carried out with the application of rich lens of TCT.

5.1. Outsourcing and make versus buy decisions

Outsourcing can create opportunities for improving a firm's performance, and yet not as much is known about what strategies can be pursued by the buying firms to improve and better measure buyer–supplier relationships and performance (Carr and Pearson, 1999). While resource-based and internalization theories have been applied to study this issue (Krause et al., 2000), TCT can be used to evaluate the quality and richness of the relationships between buyers and seller, as well as the true value of developing partnership and trust between them. The transaction cost measure presented in this study evaluates different aspects of relationship between inter-firm entities including problem solving approaches, performance monitoring, and propensity for opportunistic behavior. As such, it adds another tool in the domain of evaluating supplier performance and better understanding whether it would be more profitable to make the item internally or outsourcing it to the suppliers. In contrast (and while not totally unrelated), performance has traditionally been measured only in terms of suppliers' cost, quality, delivery, and associated capabilities (Giunipero, 1990; Hahn et al., 1990). Consequently, an assessment can be made of the alternative strategies and action plans that can be pursued by the buyer to lower overall transaction costs.

5.2. Allocation of investments

TCT can be used to evaluate how various types of investments within manufacturing firms can build long-term capabilities, and what is their impact on performance. These investments can be internal to the firm (such as buying machines) or external (invest in supplier's operations). Are some types of external investments (such as training supplier's personnel) better than others (such as investment in an order management system that can be used with other suppliers as well), since they would all have a different degree of asset specificity? How should limited resources be allocated and distributed between internal and external investments, especially since there may also be an interaction effect between them? While researchers such as Narasimhan and Das (1999) have used structural equation modeling to assess relationships between strategic sourcing (external), advanced manufacturing technologies (which result from internal investments), manufacturing flexibility (internal), and cost reduction, TCT can provide an alternative perspective on answering some of the questions posed above. Such studies on various sourcing strategies and investments within the broader context of creating manufacturing capabilities will be a useful addition to the growing operations and supply chain management literature in this area.

5.3. Supply chain co-ordination

Supply chains are increasingly becoming more dispersed and global in their orientation, and have thereby

given rise to the problem of co-ordinating flow of information and materials across organizations that are linked together through these supply chains. Stock et al. (2000) have argued that tools such as enterprise logistics are needed to co-ordinate geographically dispersed supply chain operations. TCT can be used to evaluate enterprise logistics as well as other supply chain co-ordination mechanisms (such as creating electronic proximity) for their effectiveness in improving supply chain performance. Such studies can be conducted for various configurations of product and supply chain architectures (Fine, 1998) under conditions characterized by high or low levels of environmental uncertainty.

5.4. Supply chain integration

Supply chain integration, which is related to the issue mentioned above, has been the subject of several studies in OM (e.g. Frohlich and Westbrook, 2001), and also forms the basis of supply chain operation reference (SCOR) model put forth by Supply Chain Council. Effectiveness of different integration strategies and mechanisms such as backward integration (e.g. Trent and Monczka, 1998), forward/delivery integration in the form of product postponement (e.g. Feitzinger and Lee, 1997) or just-in-time strategies (e.g. Chapman and Carter, 1990; Sakakibara et al., 1997) can be examined by measuring their impact on different dimensions of transaction costs outlined in this paper. Information technology integration through EDI (e.g. Walton and Maruchek, 1998), or inter-organizational systems (e.g. Johnston and Vitale, 1988; Choudhury, 1997; Edwards et al., 2001) and B2B electronic markets (e.g. Dai and Kauffman, 2002) can be similarly evaluated.

5.5. Supply chain distribution

Much of the prior work related to TCT has been in the supply side rather than downstream or distribution side of the supply chains, perhaps because the notion of transaction costs is better understood in the supply context. Along with the forward delivery integration mechanisms discussed above, TCT could also be used to clarify and improve our understanding of other downstream management concepts and programs such as JIT II, collaborative forecasting and replenishment (CFAR), efficient consumer response (ECR), and vendor managed inventories (VMI), among others. Additional downstream issues that can be examined using TCT include process design and value of vertical integration in hierarchical supply chains, and effectiveness of third party logistics (3PL).

6. Conclusion

We have argued in this paper that researchers in the OM field need to take advantage of TCT and the repertoire of knowledge bases vested within this theory. We think that TCT is relevant for studying supply chain management and other relevant issues within the OM discipline, and therefore should be explicitly recognized in our future research and teaching endeavors to create more holistic perspectives. Consequently, we have evaluated and summarized prior TCT research in manufacturing organizations that has been conducted from the vantage point of disciplines other than OM, with the hope that OM researchers will integrate these results with prior findings in their own field in related areas. We have also developed and presented a psychometrically sound measure of transaction costs, which we believe will be very useful in actually conducting TCT-based empirical studies. Finally, we have outlined a sampling of future work in operations and supply chain management that can be pegged to the TCT framework. These future research directions point towards the holes and opportunities, and the issues contained within it outline an agenda for TCT-based research. The subheadings for research projects, when taken together, represent the framework within which future TCT work can occur.

We believe that it is both appropriate and important for OM researchers to draw from important referential theories in order to guide their hypotheses. The summary of prior work listed in Table 1 comes from other disciplines, and should be integrated with the existing OM literature to propose new hypotheses. Future studies that utilize TCT to propose and test such hypothesis and related theories will provide alternative interpretations of empirically observed phenomenon in these areas, and thereby enrich operations and supply chain management literature. We hope that this article acts as a catalyst in facilitating this process and promoting

research that is meaningful for both researchers and practitioners alike.

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