WHEN DOES THE NETWORK ORGANIZATIONAL FORM FAIL?

EXAMINING THE IMPACT OF PROJECT CHARACTERISTICS ON

ORGANIZATIONAL STRUCTURE AND PERFORMANCE

by

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This dissertation integrates economic and sociological approaches to network

organizing to explain the structure and performance of network organizational forms.

Previous theorizing from economics and sociology linked network organizational

structure to "pairwise" or dyadic assessments of transaction efficiency and relational

efficacy. Research based on these theories offered only partial understanding of network

organizational performance because this work ignores the impact of multiple dyads

interacting simultaneously, which occurs at the network level of analysis.

This study integrates economic and sociological theories, treating them as

interdependent explanations of network structure and performance. Theory is developed

at the network level of analysis, which is necessary to explain the structure and

performance of network organizations. Taking a network governance perspective, I

formulate a theoretical model predicting the impact of exchange conditions upon the structure and performance of network organizations. I focus upon a specific variant of network organizations, "temporary interorganizational networks" (TINs), and develop and test hypotheses derived from transaction cost economics and from the sociological perspective focusing on relational embeddedness. I test these hypotheses by constructing a unique dataset containing comprehensive financial, organizational, and performance information regarding a population of network organizations during the years 2000-2007. Each observation in this dataset constitutes a network form designed to address a specific project, and these observations include both those networks that succeeded and those that failed.

The study's design overcomes a limitation of prior cross-sectional analyses: Most prior analyses treat network ties as durable and assume that all ties add value to an organization. This assumption is challenged by empirical findings suggesting that the value of a relational tie decays rapidly with time. In contrast, the transient relationships common in TINs repeatedly form and dissolve over time. By observing both the formation and dissolution of ties and both successful and unsuccessful interorganizational networks, this study is among the first to test the full range of network organizational performance.

My results indicate that exchange conditions significantly affect both the structure and performance of the network organizational form. Additionally, analyses reliably predict failure of the network form, which amends and extends prior theory.

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To my wife, Robin.

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CHAPTER I

INTRODUCTION

The large, vertically integrated companies that arose during the first three-quarters of the 20th century were organized to deliver efficiently produced goods to a growing domestic market (Snow, Miles, & Coleman, 1992). The prevailing organizational structures gained efficiencies through centralized planning and control mechanisms and firm boundaries were determined according to whether a transaction was governed more efficiently inside the firm or in the external market (Coase, 1937; Williamson, 1975). Since about 1980, advances in information technology, deregulation and privatization have changed the rules for strategy (Evans & Wurster, 2000) and allowed companies access to new forms of capital, technology and skills that simply were not available previously (Prahalad & Oosterveld, 1999). These changes challenged the traditional rules of competition (Hitt, Ireland, Camp, & Sexton, 2001) and an increasing number of firms are reducing their scope of internal activities in favor of network organizations (Snow, Miles, & Coleman, 1992).

Network organizations link competitive success with doing fewer things better instead of advocating resource accumulation and control (Snow, Miles, & Coleman, 1992). Such organizations require radically different business models and new scholarly

theorizing about how network organizations interact and how more hierarchical organizations can transform their business models to compete in a networked economy. However, the majority of theories used to explain organizational structure and performance were developed under different economic conditions (Hitt, Ireland, Camp, & Sexton, 2001). Prior economic conditions were characterized by long-term relationships between partners, which facilitated the design of more permanent organizational structures. These organizational structures were characterized by large manufacturing operations, brick and mortar buildings, long-term contractual relationships, and extended time horizons. The networked economy has caused a dramatic reduction in the occurrence of these older organizational structures. Brick and mortar have been replaced with virtual organizations. Long-term contracts have been replaced with temporary contracts. Finally, long-term alliances composed of durable relationships have been replaced by network alliances that last only as long as the current task. This rapid change in the economic environment suggests our old theories may not apply or at least need serious revision to explain organizational economics in more temporary industrial settings.

Due to the disconnect between theories developed for long term organizational structures and the more temporary nature of some network organizations, we know very little about the design and performance of these temporary organizational structures (Jones, Hesterly, & Borgatti, 1997; Kim, Oh, & Swaminathan, 2006; Snow, Miles, & Coleman, 1992). Furthermore, due to scholars' anticipation of the positive benefits derived from a networked economy, there is a bias among researchers that suggests any

network relationship is positive and results in increasing returns to cooperating parties (Kim, Oh, & Swaminathan, 2006; Podolny & Page, 1998). Due to this bias in research, we know very little about any negative performance or failure associated with network organizing. Only by examining the full range of network organizational performance can we be certain about the costs *and* benefits to network organizations (Podolny & Page, 1998) and begin to adapt existing theories to the emerging networked economy. This gap in understanding provides the rationale for the dissertation.

Rationale for the Study

The notion that governance structures are designed according to exchange conditions is not new and has been empirically supported across a wide range of industries. Even when applied to less permanent organizations, such as strategic alliances or equity joint ventures, theories of organizational governance consistently held when studying these less permanent governance structures. However, dramatic changes in the last twenty years have shortened the temporal duration of many governance structures. Whereas strategic alliances and joint ventures may shorten the time window from several decades to several years, these emerging governance structures may last only a few days (music video production), weeks (film and housing construction), or months (highway construction). New terminology arose to describe these more ephemeral governance structures, such as virtual organizations (Davidow & Malone, 1992), temporary project originations (Bechky, 2006; Jones & Lichtenstein, 2008), quasifirms (R.G. Eccles, 1981),

and modular organizations (Hoetker, 2006; Schilling & Steensma, 2001). The question remains, do the older theories still apply despite a dramatic reduction in the lifespan of more temporary organizational forms?

In addition to the shorter temporal duration of network relationships, researchers have noted a bias in studies of network organizational performance. The overwhelming majority of research on network organizational forms highlights their functionality and ignores any dysfunctionality (Podolny & Page, 1998). This has created a selection bias among organization scholars; namely, scholars report only the beneficial aspects of the network form at the expense of any costs (Kim, Oh, & Swaminathan, 2006; Podolny & Page, 1998).

Researchers have suggested that our lack of understanding about the performance of network organizational forms stems from a lack of data (Podolny & Page, 1998). Podolny and Page (1998) suggest that in order to examine the *full range* of performance, including poor performance and failure, comprehensive data on a population of network organizations is needed. While I agree with these authors that such data are difficult to obtain, I disagree with their assertion that the empirical gap constitutes the primary limitation to our understanding of network organizational performance.

The more limiting characteristic is theoretical, and arises from a mismatch between levels of analysis. Scholars continue to explain network level performance using dyad-level relationships. This is likely due to the availability of reliable data at the dyad level, but in order to advance a more robust theory of networks, we must think differently about networks (Salancik, 1995) and move the level of analysis up to the

network level (Gulati & Gargiulo, 1999; Walter W. Powell, White, Koput, & Jason, 2005; Rosenkopf & Schilling, 2007). The network level of analysis involves the aggregation of multiple dyads interacting simultaneously (Provan, Fish, & Sydow, 2007). This dissertation introduces a new construct, *Aggregate Tie Strength (ATS)*, that resolves the inconsistency between levels of analysis, and it leverages a unique dataset that contains a broad range of financial, organizational and performance data across a population of network organizations.

To summarize, my research design finesses a conundrum that has plagued prior research, the fact that only those organizations that succeeded and survived are usually available to be studied. In contrast, I will observe the entire set of potential network designs – viable and nonviable alike. These data will allow me to bring an empirical test to a series of hypotheses linking the design of network organizations to fine-grained measures of their performance. This study has the potential to significantly advance our understanding of the costs and benefits of network organizations. Through a series of research questions, I unpack the design and performance of the network organizational form. The next section presents these questions and objectives for the study.

Research Questions and Objectives for the Study

For a governance form to persist, it must address the problems of adapting, coordinating and safeguarding exchanges more efficiently than other governance forms (Williamson, 1991). Transaction cost economics (TCE) has been the dominant theoretical perspective to examine the structure and performance of governance forms.

TCE "is grounded upon a legal understanding of organizations as governance mechanisms distinct from markets" (Santos & Eisenhardt, 2005, p. 492). Under TCE, the firm boundary is determined by asking whether conducting a transaction inside the firm or externally in the market most reduces the sum of production costs and governance costs (Williamson, 1985b). Governance costs include monitoring operations, allocating requirements for production, initial contractual agreements, and setting up initial procedures for exchange (Mayer & Salomon, 2006).

However, TCE has come under fire from sociologists, who argue that transaction efficiency arguments are "under socialized" (M. Granovetter, 1985). Sociologists argue that all economic transactions are embedded within a wider network of social relationships and that governance structures arise from these embedded relationships in addition to economic considerations (M. Granovetter, 1985). This is particularly the case in networked economies, where the shorter temporal duration of economic exchanges increases the influence of social relationships (Jones, Hesterly, & Borgatti, 1997; Walter W. Powell, 1990). Sociologists define the quality of relationships between firms according to the level of relational embeddedness between partners. Relational embeddedness refers to the degree to which exchange parties know of and consider one another's needs and goals (M. Granovetter, 1992). From a sociological perspective, relational embeddedness drives organizational form at least as much as economic concerns. Reconciling these competing theories is necessary to fully explain the structure and performance of network governance.

By treating economic and sociological explanations of organizational structure as interdependent, this dissertation develops a new theoretical framework capable of explaining network governance. I begin with a research question that investigates how exchange conditions affect the structure of temporary interorganizational networks. From an economic perspective, exchange conditions drive the design of network structures, which involves selecting network partners to match an opportunity. Economic perspectives suggest that firms select partners to reduce production and transaction costs according to factors that align exchange conditions with the cumulative capabilities found among a network's partners. Examining the effect of exchange conditions on network structure supports the following research question.

RQ: How do exchange conditions affect the structure of the network organizational form?

Once these antecedents of network organizational structure are determined, investigating the effectiveness of these structures is the next goal of the study. Exchange conditions will drive partner selection initially, and the resulting network structures will vary in their relational embeddedness. The next research question examines how network structure interacts with exchange conditions to affect the performance of these governance structures. By examining variation in network governance structure across a population of network organizational forms, I unpack the interactions between exchange conditions, network governance structure, and performance. Examining these interactions supports the following research question.

RQ: **How do exchange conditions and network organizational structure interact to affect the performance of networks as a form of governance?**

My final research question examines the longitudinal impact of learning across a population of network organizations. Several scholars have touted the learning benefits of network organizational forms (Dore, 1983; Hamel, 1991a; Walter W. Powell, 1990; Uzzi, 1997), but these studies attribute benefits to individual firms participating in a network and largely ignore learning behaviors among and between networks. Studying learning at the network level of analysis ties with behavioral learning (Starbuck & Hedberg, 2001) and with population level learning (J. A. Baum & Berta, 1999; Miner & Anderson, 1999; Miner & Haunschild, 1995). Behavioral learning theories suggest learning arises from automatic reactions to performance feedback. Behavioral approaches portray learning as a mechanistic and involuntary process, where learners continue behaviors that produce pleasant outcomes and discontinue behaviors that lead to unpleasant outcomes (Starbuck & Hedberg, 2001). A primary advantage to behavioral learning is that behavioral theories can explain how learning occurs even when information about individual managers' perceptions is unavailable. For this reason, behavioral learning is often used to explain population level learning. Population level learning investigates how behaviors by firms with shared experience may affect a transformation of behaviors across that population of firms (Miner & Haunschild, 1995). For this study, I examine whether and how a population of network organizations learns over time.

RQ: **How does learning by individual organizations affect a transformation of behaviors across a population of network organizations?**

Defining Network Governance

Contrary to purely sociological treatments of network organizational forms that emphasize informal agreements between cooperating parties with shared norms and values (for detailed reviews, see Podolny and Page, 1998; Borgatti and Foster, 2003), network governance refers to contractual agreements between autonomous parties that may have entirely different norms and values. Additionally, network governance structures vary in their temporal dimensions. Some structures are designed for longer periods, such as R&D alliances, while others are designed for much shorter durations, such as film production, construction projects, and disaster relief (Jones & Lichtenstein, 2008). Since governance structures aim to match the characteristics of a project with those of the firm and the external environment, these structures are designed for specific opportunities and re-designed for others. This study defines network governance according to Jones et al., (1997) and their definition and rationale are offered below.

Network governance involves a "select, persistent, and structured set of autonomous firms engaged in creating products or services based on implicit and open ended contracts to adapt to environmental contingencies and to coordinate and safeguard exchanges" (Jones, Hesterly, & Borgatti, 1997). These authors clarify what they mean by "implicit and open-ended contracts" as follows (Page 916):

> To be sure, formal contracts may exist between some pairs of members, but those do not define the relationships between all parties. For example, in a film project, both the cinematographer and the editor may have contracts with the studio, but these contracts do not specify the relationship between the two subcontractors.

These authors go on to clarify the nature of these project specific relationships:

"Network governance is composed of firms that operate like a single entity (when required) ... in other domains these firms may be fierce competitors" (Jones et al. 1997: 916). These authors cite the film industry as emblematic of network governance (page 916):

> Here, film studios, producers, directors, cinematographers, and a host of other contractors join, disband, and rejoin in varying combinations to make films. Network governance comprises a select subset of film studios and subcontractors. The seven major film studios repeatedly use and share among their films an elite set of subcontractors who constitute 3 percent (459 of the 12,400) of those registered in guilds (Jones & Hesterly, 1993). ... Structured relations among subcontractors and film studios are based on a division of labor: film studios finance, market, and distribute films, whereas numerous subcontractors with clearly defined roles and professions (e.g., producer, director, cinematographer, and editor) create the film.

To summarize, network governance is an organizational form that persists under specific exchange conditions (Jones, Hesterly, & Borgatti, 1997), involves autonomous firms that join, disband and rejoin in varying combinations over time, and involves specific coordination mechanisms guided by contractual relationships between some firms (a studio and a cinematographer) and socially embedded (non-contractual) relationships among others (a cinematographer and an editor). In order to empirically examine the structure and performance of these organizational forms, data on a population of network organizations is needed (Podolny & Page, 1998). Below I briefly

describe a population of network organizations, bridge construction organizations in Oregon, from which I obtained organizational, financial, and performance data down to the level of each individual network partner.

Describing the Research Setting and Previewing Results

The ideal setting to investigate network governance, as defined for this study, would include a persistent and structured set of autonomous firms that join, disband and rejoin network organizations according to the characteristics of an opportunity (Jones, Hesterly, & Borgatti, 1997). While Jones et al. (1997) choose the film industry as emblematic of many of the requirements for network governance, I choose the bridge construction industry in Oregon. Much like the film industry, bridge construction firms and their subcontractors are autonomous units that regularly join, disband and rejoin networks; however, the bridge construction industry introduces an additional industry-wide control that facilitates testing the performance of these governance structures. Because bridge construction is largely funded by the federal government, federal regulations only permit a contract to be awarded to a general contractor with the lowest overall cost for completing a bridge. This low-cost requirement enhances this empirical setting by controlling for strategy across all organizations.

In addition to the low cost requirement imposed on bridge construction organizations in Oregon, several other controls are present in this research setting. First, there is no product variation and each competing organization has near perfect information of product characteristics in the form of engineering blue-prints and project

specifications. Second, there is only one customer – the Oregon Department of Transportation. Third, technology does not vary widely within the industry – cranes and bulldozers are uniformly available and their functionality has remained consistent for decades. Thus, organizations within this industry do not vary widely due to product innovation, customer innovations, technology innovations, or strategy. The largest source of variation among organizations in this industry is *how they organize their governance structure.*

In closing, I will reinforce one final and unique feature of this research setting – its data. These data include comprehensive financial, organizational, and performance information (down to the level of each individual network partner) on over 1600 detailed proposals that bridge construction firms submitted in response to requests for proposals to construct approximately 330 state highway bridges during the years 2000-2007. Each of the 1600 proposals in this dataset specifies a network governance structure for addressing a specific project, and these data cover both those proposals that succeeded in being selected, and those that failed to be selected. Thus, my research design addresses a shortcoming that has plagued prior research, the fact that only those organizations that succeeded and survived are usually available to be studied. In contrast, I observe the entire set of potential network designs – viable and nonviable alike.

To preview my results, exchange conditions significantly affect both the performance and structure of network governance. Regarding learning, it appears network organizations learn more from failure than from success, echoing earlier findings about individuals and firms (Starbuck & Hedberg, 2001). Perhaps most interesting to

network organization scholars, the design of network governance structures does have a dark side. Failure among network organizations occurs when they disregard exchange conditions and fall victim to network inertia. Repeated network structures that become rigid and do not adapt to exchange conditions are significantly and negatively related to performance.

Organization and Outline of the Study

This study proceeds as follows. I begin with a review of the literature on organizational forms. This literature has its roots in organizational economics (Coase, 1937; Williamson, 1975), but economic viewpoints are becoming increasingly challenged by sociological perspectives. These perspectives include how relational embeddedness (Ghoshal & Moran, 1996; M. Granovetter, 1985, 1992) affects economic transactions and how changes in economies have caused new organizational forms to emerge (Walter W. Powell, 1990). I conclude by emphasizing three prominent gaps in the literature and how this study closes them. Next, Chapter III provides a theoretical framework to investigate how exchange conditions affect network organizational structure and performance. Chapter III also presents hypotheses to test these relationships. Chapter IV outlines the research methodology. Chapter IV begins with a detailed description of the research method, empirical setting, sample design, and data collection that allow me to bring the hypotheses to a valid empirical test. I describe the operationalization of variables and conclude Chapter IV with a framework for statistical analysis. Chapter V offers the results from empirical testing, the findings from the study, and discusses

limitations. I conclude with Chapter VI where I review the findings and discuss both research and managerial implications.

CHAPTER II

LITERATURE REVIEW

As mentioned in the previous chapter, the last twenty years or so has seen rapid changes in economic environments that have altered the rules for strategy (Evans & Wurster, 2000) and allowed companies access to new forms of capital, technology and skills that simply were not available previously (Prahalad & Oosterveld, 1999). These new economic conditions challenge the traditional rules of competition (Hitt, Ireland, Camp, & Sexton, 2001) and an increasing number of network organizational forms are emerging in response to these changes in competitive environments (Bradach & Eccles, 1989; Snow, Miles, & Coleman, 1992). These organizations are de-layered, downsized, and operated through a network of market-sensitive business units, rather than through large hierarchies (Snow, Miles, & Coleman, 1992). Such organizations require radically different organizational structures and new scholarly theorizing about the emergence, persistence and performance of network organizational forms.

This chapter summarizes three theoretical perspectives that provide the conceptual underpinnings of this dissertation: Organization Theory, Transaction Cost Economics and Sociology. Each of these perspectives explains why organizations may exist, and why we observe variation in organizational forms. However, each does so

from a different viewpoint, with different theoretical foundations, and largely in competition with the other two perspectives. Due to these differences, we know quite a bit about how these perspectives independently explain organizational forms (Walter W. Powell, 1990), but we know much less about any interdependence between these perspectives (Jones, Hesterly, & Borgatti, 1997). This literature review revisits prior, independent explanations of organizational forms and investigates how integrating prior theorizing can explain the emergence, persistence and performance of the network organizational form.

This chapter is organized into five main sections. The first section explains the selection of these three perspectives, arguing they are particularly well suited to an exploration of the processes and outcomes of the network form of organization. The second, third and fourth sections review past theorizing about organizational forms from organization theory (OT), transaction cost economics (TCE), and sociology. The conclusion of section four introduces Jones, Hesterly and Borgatti's (1997) concept of network governance. Network governance integrates theoretical components from OT, TCE and sociology to explain the emergence, persistence and performance of the network form of organization. Section five amends and extends Jones et al. (1997). Section five begins by summarizing important gaps in understanding and then describes how this dissertation aims to close them.

Three Perspectives on Organizational Forms

In the early twentieth century, scholars began theorizing about universal concepts in organizing. For example, Taylor (1911) featured an engineering approach and proposed formulating work systems from the bottom up. By beginning with the nuts and bolts and gradually addressing the motion of workers, sequencing of tasks, packaging of tasks into jobs and the arrangement of jobs into departments, early "engineers" of organization science, like Taylor provided a foundation for studying operations that is still used today (Scott, 2004). Next, managerial scientists, such as Fayol (1919) viewed organizations from the top down and began devising principles for subdividing and organizing complex tasks (Scott, 2004). Weber (1947) first articulated the characteristics of bureaucracy, such as clearly defined hierarchies, positions and rules. Each of these scholars promoted a universalistic agenda and believed their ideas should translate to all organizations. Additionally, a common characteristic of this early theorizing was to ignore the influence of the external environment or at least to hold it constant (Miles & Snow, 1978). While ignoring the environment simplified early conceptions of bureaucracy, it did not explain organizational adaptation and change very well. This practice began to change when social scientists viewed the organization itself as an interesting variable.

Social scientists who study organizations and management have devoted much thought to the impact of organizational structures (and organizational forms) upon the attitudes and work performance of organizational members. Largely classified as organization theorists, this field was interdisciplinary from the outset. Two academic

centers drove the emergence of organization theory, the Carnegie Institute of Technology and Columbia University (Scott, 2004). The Carnegie Institute was composed of political scientists, economists and psychologists. Led by the work of Herbert Simon (1947) and March and Simon (1958), among others, their contributions raised the level of analysis to the organization. Their ideas were grounded in "bounded rationality," which nicely linked arguments of purpose and intended rationality with the recognition that cognitive and social constraints restricted rational action (Scott, 2004). Columbia University, led by Merton (1949), promoted an idea of the "unintended consequences of purposive action," which Merton's junior scholars expanded to include differences between public and private organizing (Selznick, 1949) and how individual bureaucracies designed to solve one problem give rise to other problems (Blau, 1955). Collectively, these scholars theorized that an interaction between intended economic rationality and social constraints affected both the structure and performance of organizations.

Beginning in the late 1950s and into the 1960s, contingency theorists promoted that the proper alignment between an organization and its environment (Burns & Stalker, 1961; Lawrence & Lorsch, 1967) affects organizational performance. Rather than treating the internal mechanisms as independent variables that can be easily manipulated (Taylor, 1911; Weber, 1947), contingency theorists treat internal structures as dependent variables whose structure is largely determined by factors in the environment (Miles & Snow, 1978). The incorporation of an organization's environment as a critical predictor of organizational form continues to be a major thrust within organization theory, economics and sociology. By changing organizational forms into an *outcome* of interest,

organization scholars cemented their perspective as critical to future discussions of organizational forms.

Scholars in the area of strategic management have an overriding interest in one particular outcome – organizational performance. Organizational performance is largely a study about firm boundaries and determining the proper location of a organization's boundary is critical to performance (Coase, 1937; Williamson, 1975). Transaction cost economics is the dominant theoretical perspective that explains the locus of firm boundaries. TCE "is grounded upon a legal understanding of organizations as governance mechanisms distinct from markets" (Santos & Eisenhardt, 2005, p. 492). Under TCE, the firm boundary is determined by asking whether conducting a transaction inside the firm or externally in the market most reduces governance costs. Governance costs include monitoring operations, allocating requirements for production, setting up initial contractual agreements, and setting up initial procedures for exchange (Mayer & Salomon, 2006; Williamson, 1975).

While transaction cost economics has been the dominant theoretical platform for determining the boundary of the firm, scholars increasingly believe that determining the locus of firm boundaries is less dependent on economics than previously theorized. Increasingly, scholars recognize that determining firm boundaries is more nuanced and socially motivated (Santos & Eisenhardt, 2005). By incorporating social elements into firm boundary decisions, scholars can better explain why organizational boundaries may differ under similar economic conditions. For example, Granovetter criticizes TCE as "under socialized" (M. Granovetter, 1985) and argues that economic transactions are

highly constrained by ongoing social relations and should not be viewed solely as an attempt by atomistic actors to maximize transaction efficiency. Granovetter cemented his position that economic and social motivations are interdependent, stating: "to construe them as independent is a grievous misunderstanding" (1985, p. 482). Thus, transaction cost economics and social relationships represent two critical theoretical platforms to study organizational boundaries. In particular, the interdependence of economics and sociology may better explain why there is variation in organizational form, and how this variation affects organizational performance.

To summarize, organization theory, transaction cost economics, and sociology each explains why organizational forms exist and why there is variation among organizations operating in similar environments. Each of these theoretical perspectives on organizational forms began more than fifty years ago and none of them could have predicted the changes in the economic environment over the last twenty years (Achrol & Kotler, 1999; Evans & Wurster, 2000; Hitt, Ireland, Camp, & Sexton, 2001; Prahalad & Oosterveld, 1999). In order to explain how these radical and recent changes in the competitive environment affect organizational structure and performance, this dissertation borrows critical ideas from each perspective. A combination of these perspectives is necessary to explain the emergence and performance of network forms of organization (Jones, Hesterly, & Borgatti, 1997). In sections two, three, and four, I provide a history of organizational forms from each perspective, followed by a new theoretical perspective that integrates components from each theory – network governance.

Organization Theory: Early Perspectives, Contingency Theory, and Neo-Contingency Perspectives

The history of organization theory can be generally understood as beginning with a search for universalistic rules – all organizations are the same (Fayol, 1919; Weber, 1947) – and evolving into a search for variation among organizations – all organizations are different (Burns & Stalker, 1961; Lawrence & Lorsch, 1967). The search for variation among organizational forms began with contingency theory (Burns & Stalker, 1961), which suggests that proper organizational form "depends on the situation." Early contingency theorists offered a deterministic view of alignment between organizational structure and its task environment as predicting success. While interesting, this perspective largely ignored the decision making of managers. Subsequent theorizing increased the importance of managerial decisions and promoted a coalignment between environment and organization, which led to the development of organizational strategy as a field of research. Below I describe this journey from environmental determinism to organizational strategy and the ascendance of decision-making as a key component of organization structure and performance.

In the early twentieth century, scholars began theorizing about universal concepts in organizing, which largely ignored any environmental influences. For example, Taylor (1911) featured an engineering approach and proposed formulating work systems from the bottom up. By beginning with the nuts and bolts and gradually addressing the motion of workers, sequencing of tasks, packaging of tasks into jobs and the arrangement of jobs into departments, these early "engineers" of organization science provide a foundation for

studying operations that is still used today (Scott, 2004). Next, managerial scientists, such as Fayol (1919) viewed organizations from the top down and began devising principles for subdividing and organizing complex tasks (Scott, 2004). Weber (1947) first articulated the characteristics of bureaucracy, such as clearly defined hierarchies, positions and rules. Each of these scholars promoted a universalistic agenda and believed their ideas should translate to all organizations. Further, a common characteristic of this early theorizing was to ignore the influence of the external environment or to at least hold it constant (Miles & Snow, 1978). This practice began to change when social scientists viewed the organization itself as an interesting variable.

A primary criticism of universalistic theories of organizing was the inability of bureaucracies to explain organizational adaptations to individuals and the external environment (Miles & Snow, 1978). Burns and Stalker (1961) offered a contingent model of organizational forms. These authors noticed that organizations operating in stable environments generally had a mechanistic structure while successful organizations in more dynamic environments had flexible or organic organizational structures (Burns & Stalker, 1961). Spurred by these findings, contingency theorists in the 1960s promoted that proper alignment between an organization and its environment leads to greater organizational performance (Lawrence & Lorsch, 1967). Rather than treating the internal mechanisms as independent variables that can be easily manipulated (Taylor, 1911; Weber, 1947), contingency theorists treat internal structures as dependent variables whose structure is largely determined by factors in the environment (Miles & Snow, 1978). By changing organizational form into an *outcome* of interest, organization

scholars cemented their perspective as critical to future discussions of organizational forms.

Contingency Theory and the Role of Organizational Environment

The incorporation of an organization's environment as a critical predictor of organizational form continues to be a major thrust of organization theory. An organization's environment was originally conceptualized by Emery and Trist (1965) according to the degree of interconnectedness and the extent of change in an environment. Emery and Trist (1965) classified organizational environments in ascending order of environmental change and uncertainty: (1) placid-randomized, (2) placid-clustered, (3) disturbed-reactive, and (4) turbulent. Subsequent theorizing further developed the interplay between an organization's environment and decision-making by managers; including the role of environmental uncertainty on decision-making (Duncan, 1972) and how an organization's task environment (Thompson, 1967) or specific environment (Dill, 1958) affect the types of goal setting and goal attainment pursued. Over time, the task environment emerged as the primary determinant of organizational form as it contains "the primary set of forces to which an organization must respond" (Miles & Snow, 1978, p. 253). This important step in understanding challenged deterministic viewpoints that managers did not matter and opened the door for fresh theorizing about causes of variation in organizational form.

In addition to environmental variables that predict organizational forms, contingency theorists have suggested that technology is a contingency variable worth studying. Beginning with Woodward (1965), organization scholars aligned contingent

organizational structures with the presence of technologies. For example, Woodward (1965) suggested that small-batch technologies facilitate adaptation because they required lower amounts of labor and capital intensity. Mass-production technologies require an interim amount of labor and capital intensity. In contrast, she theorized that continuous process-technology was highly labor and capital intensive. The amount of organizational structure increases with capital and labor intensity, with the less administrative control in small-batch processes and the greatest administrative or hierarchical control in continuous volume production (Woodward, 1965).

Technology introduces specific coordination demands for organizations. Each type of technology must be coordinated differently and these coordination demands are reflected in an organization's structure (Miles & Snow, 1978). Additionally, the degree of task uncertainty, work flow interdependence (Thompson, 1967) and sub-unit size affect the type of coordination that is most effective (Van de Ven, Delbecq, & Koenig, 1976). In sum, contingency theories that emphasize technology suggest coordination mechanisms are driven by technological features, and these coordination mechanisms drive organizational structure (Miles & Snow, 1978).

To summarize, the contingency perspective arose from a dissatisfaction with universalistic theories of organizational forms (Miles & Snow, 1978). Contingency perspectives espouse an "it depends" mantra for correct organizational form: The characteristics of the external task environment and internal technologies drive the structure of organizations. However, the contingency perspective's explanatory power is limited by its laissez fair attitude about organizational forms. The "it depends" mantra

suggests that 'every situation is different' making contingency theory atheoretical in that it provides even less guidance than the universalistic assumptions that 'every situation is the same' (Miles & Snow, 1978, p. 259). While contingency theory made the important leap to incorporate a firm's task environment into the discussion, the deterministic nature of contingency theory ignores the role of managerial choice in the structure and design of organizational forms. This shortcoming led to neo-contingency theories that highlight the role of managerial choice in the structure of organizations (Miles & Snow, 1978).

Neo-Contingency Theory and the Role of Managerial Choice

Neo-contingency theory aims to elucidate the roles that managers and decision-making have in the structure of organizations. Beginning with Thompson (1967), scholars suggested the deterministic nature of contingency theory did not fully explain organizational structure nor did it effectively explain variation in organizational structure under similar environmental and technological conditions (C. R. Anderson & Paine, 1975; Child, 1972; Miles, Snow, & Pfeffer, 1974). Rather than emphasizing environmental alignment or technological coordination mechanisms as key determinants of organizational structure, these authors suggested that managerial decision making is the key link between external environmental characteristics and internal organizational structure.

For example, Weick (1977) suggested organizational environments are shaped by managerial decisions or managerial enactment. Because of bounded rationality, Weick (1977) argued that managers focus on a limited portion of their environment, interpret

what information they can, and then make decisions that simultaneously transform their organization while also changing the organizational environment via feedback mechanisms. The process of creating an organizational environment through enactment is never-ending and involves "the coalignment of the organization with a continually evolving network of environmental constraints and opportunities" (Miles and Snow, 1978: 261). The concept of organizational strategy, which began at Harvard Business School in the late 1950s, directly examines this coalignment between organizations and their environment (Miles and Snow, 1978).

As described above, the outcome of greatest interest to strategy scholars is organizational performance. Early ideas centered on the performance of individual organizations and included studies of long-range planning and organizational performance (Rue & Fulmer, 1972; Steiner, 1969; Thune & House, 1970; Warren, 1966), the impact of an incremental approach to policy-making and budgeting on performance (Wildavsky, 1964; Wildavsky & Hammond, 1965), decision-making among dominant coalitions (Aguilar, 1967; Bower, 1970; Mintzberg, Raisinghani, & Theoret, 1976), and the relationship between a manager's personal values and strategy (Guth & Tagiuri, 1965; Hage & Dewar, 1973). As the concept of organizational strategy matured, the concept of coalignment between the organizational environment, technology, and firm capabilities came to prominence. Critical extensions of OT-based coalignment were made by Mintzberg (1978) who theorized that strategy was a pattern of decisions that affect both the structure and performance of organizations. Mintzberg also linked the power of managerial decision to the pattern of strategy formulation, stating: "the strategy

maker may formulate his strategy through a conscious process, or strategy may form gradually as he makes decisions one by one" (Mintzberg, 1978).

The importance of Mintzberg's (1978) conceptualization is emphasized in Miles and Snow (1978:262): "This view of strategy emphasizes the dynamics of organizational behavior, admits the possibility of multiple causation among organizational characteristics and environmental conditions and focuses attention on the role of managerial choice in achieving coalignment – something conspicuously absent in (previous) contingency theories." The conceptualization of organizational strategy as coalignment of multiple organizational and environmental characteristics allowed the science of strategy to become "a tangible and researchable phenomenon" (Miles and Snow, 1978: 262).

To summarize, the contributions of organization theory to the study of organizational forms, four critical contributions stand out: (1) organizational structure as an outcome variable that can be predicted from a variety of environmental, technological and strategic factors, (2) the task environment as a driver of organizational structure, (3) the interplay between environmental change and organizational enactment, and (4) the role of managerial decision-making in organizational structure, strategy, and process.

In the years since neo-contingency theory, scholars increasingly explained organizational performance from the lens of economics, with transaction cost economics being the dominant perspective (Coase, 1937; Williamson, 1975). Transaction cost economics bases the locus of a firm's boundary with its task environment upon a

manager's discretion, and provides link between organization theory and neoclassical economics.

In the next section, I introduce transaction cost economics, the second theoretical foundation upon which I draw. Transaction cost economics shares many similarities with organization theory, but also has fundamental differences. Whereas organization theory largely defines organizations via their technological, environmental, and decision-making characteristics, TCE promotes a legal view of firms as a nexus of contracts, a result of property rights considerations, and a legal structure distinct from its external environment.

Transaction Cost Economics: Organizing for Economic Efficiency

Transaction costs economics promotes an efficiency perspective for organizational forms and is grounded upon a legal understanding of organizations as governance mechanisms distinct from markets (Williamson, 1975). Under the efficiency perspective, the firm boundary is determined by asking whether conducting a transaction inside the firm or externally in the market most reduces the sum of production and governance costs. Governance costs include monitoring operations, allocating requirements for production, initial contractual agreements, and setting up initial procedures for exchange (Mayer & Salomon, 2006; Williamson, 1975). Hierarchical governance has advantages over market governance, such as decision and property rights that enable the use of fiat, alignment of incentives, and monitoring of managerial actions to efficiently govern transactions (S.E. Masten, 1991). Markets offer competitive

pressures to reduce production costs (M. E. Porter, 1985), but also increase monitoring costs (Williamson, 1985b) and can increase fears of misappropriation (Oxley, 1999). In sum, the firm boundary should be set at the point that minimizes the cost of governing activities (Coase, 1937).

Beginning with the writings of Coase (1937) and Commons (1934), scholars began to recognize the transaction as the fundamental unit of microeconomic analysis (Mahoney, 2005). Coase (1937) viewed firms and markets as alternative means for organizing similar types of transactions. Coase (1937) argued that the operation of markets costs something, and by organizing transactions within a firm, entrepreneurs can reduce some of the costs of market contracting. Commons (1934) extended theorizing of economic organization beyond being a mere response to technological features – economies of scale, economies of scope, and other physical or technical aspects of markets. Commons disagreed and suggested organizations "often have the purpose of harmonizing relations between parties who are otherwise in actual or potential conflict" (Commons, 1934, p. 6). Although these ideas went largely unnoticed until the 1970s, subsequent theorizing by Williamson and others promoted the idea that "economic organization has the purpose of promoting continuity of relationships by devising specialized governance structures, rather than permitting relationships to fracture under the hammer of unassisted market contracting" (Williamson, 1985b, p. 3). These discussions established that "organizational form matters a great deal, and in doing so moved the economics of organization much closer to the fields of law, organization theory, and business history" (Walter W. Powell, 1990, p. 296).

Initial extensions of Coase (1937) and Commons (1934) focused on organizations as substitutes for failures in the price mechanism of markets – which puzzled leading scholars of the time. Chester Barnard (1938, p. 4) suggested organizational forms were not simply a substitute for market failures, but rather a "conscious, deliberate and purposeful" cooperation among men. The cooperative efforts were intendedly rational, but limited due to physical, biological and social factors (Barnard, 1938, pp. 12-45). Friederich Hayek (1945) challenged a prevailing view that market prices served as signals carrying sufficient information to allow managers to rationally assess and complete transactions. Hayek (1945, pp. 523-524) believed that organizations served as adaptive systems to protect exchanges, and that simply focusing on "statistical aggregates (prices) ignored the impact of idiosyncratic knowledge" that serves as the basis for adaptive action. These authors anticipated the subsequent theoretical formulation of bounded rationality (Simon, 1947), a critical element in the emergence and persistence of organizational forms (Williamson, 1975).

Building on the work of Hayek and Barnard, Arrow (1963) described firms and markets as alternative instruments for organizing economic activity. Arrow noted that while the boundary of the firm is commonly theorized as a line across which only price-mediated transactions take place, the economic content of both price-mediated (market) and internal transactions are often similar (Kenneth J Arrow, 1971). Arrow (1971) further conceived of the locus of a firm's boundary as a decision variable. The decision of where to locate boundaries considers economic variables *and* the context within which the integrity of trading parties is considered (Kenneth Joseph Arrow, 1974).

Williamson (1975) built upon Arrow's insight and extended his arguments. By considering the integrity of trading parties, transaction efficiency is inextricably linked to behavioral uncertainty in the form of opportunism. Williamson (1975:255) describes opportunism as "self-interest seeking with guile; agents who are skilled at dissembling realize transaction advantages. Economic man … is thus a more subtle and devious creature than the usual self-interest seeking assumption reveals." Due to risks of opportunism associated with market contracting, specific investment, and uncertainty; several governance costs arise including monitoring operations, allocating requirements for production, setting up initial contractual agreements, and setting up initial procedures for exchange (Mayer & Salomon, 2006; Williamson, 1975). Williamson (1975) suggested that due to the interdependence of pricing, uncertainty, and opportunism, it is not enough to simply question whether internal or market organization of transactions is preferred, but also which type of organizational form is to be employed (Mahoney, 2005).

Williamson (1991) conceived a continuum of organizational forms, with market and hierarchical governance at opposite poles. Using a comparative approach to economic organization, Williamson noted that organizational forms should not be examined separately, but rather in relation to alternative forms (Williamson, 1991, p. 269). He noted that "a hierarchy is not merely a contractual act but is also a contractual instrument, a continuation of market relations by other means" (Williamson, 1991, p. 271). Williamson conceived of three generic governance structures – market, hierarchy and hybrid – and each form is characterized by a "syndrome of attributes that bear a supporting relation to one another" (Williamson, 1991, p. 271).

Williamson (1991) described the differences between market, hierarchical and hybrid forms as follows. Hierarchies have advantages due to internal administrative controls within firms as compared to between firms: "Markets and hierarchies are polar modes" with market governance focused on classic contract law and hierarchies focused on forbearance contract law (Williamson, 1991, p. 280). "Classic contract law applies to the ideal transaction in law and economics – 'sharp in by clear agreement; sharp out by clear performance' (Macneil, 1974, p. 738) – in which the identity of the parties is irrelevant" (Williamson, 1991, p. 271). Forbearance contract law relies on the assumption of a superior-subordinate relationship (Williamson, 1975). Whereas market disputes will be settled in a court of law, Williamson broadly classified the hierarchy as a last resort to markets and as "its own court of ultimate appeal" (Williamson, 1991, p. 274).

Hybrid governance modes rely on neo-classical contract law and excuse doctrine, which relieves parties from strict enforcement. Cooperating parties in hybrid modes "reject classical contract law and move into a neoclassical contract regime because this better facilitates continuity and promotes efficient adaptation" (Williamson, 1991, p. 271). Under neoclassical law tenets, the parties maintain autonomy, but their contract is mediated by an elastic contracting mechanism characterized by exchange agreements, reciprocal trading , and long-term, incomplete contracts (Williamson, 1991). To summarize these differences, Williamson offered a table of distinguishing attributes for each generic governance mode, recreated as Table 1 below (Williamson, 1991: 281):

> Summarizing, the hybrid mode is characterized by semi-strong incentives, an intermediate degree of administrative apparatus, displays semi-strong adaptations

of both kinds, and works out of a semi-legalistic contract law regime. As compared with market and hierarchy, which are polar opposites, the hybrid mode is located between the two of these in all five attribute respects.

Table 1: Market, Hierarchy, and Hybrid Governance Modes, Recreated

from Williamson (1991), Page 281

Distinguishing Attributes of Market, Hybrid, and Hierarchy Governance Structures			
Attributes	Governance Structure		
	Market	Hybrid	Hierarchy
Incentive Intensity	+ +	+	0
Administrative Controls	0	+	+ +
Autonomous Adaptation to Market/Price changes	+ +	+	0
Coordinated Adaptation to Market/Price Changes	0	+	+ +
Contract Law	+ +	+	0
+ + = strong; + = semi-strong; 0 = weak			

Williamson (1991) concluded that in order to choose the most efficient governance form, managers must assess an opportunity according to its exchange conditions. These exchange conditions include (1) the frequency with which transactions occur, (2) the uncertainty with which transactions are subject, and (3) the type and degree of asset specificity involved in supplying the good or service in question most reduces the sum or transaction and production costs (Williamson, 1979).

Choosing a Governance Form: Discriminating Alignment under Exchange Conditions

Whether a set of transactions ought to be executed across markets or within a firm depends on the relative efficiency of each governance mode (Williamson, 1975). Williamson (1991) referred to making these choices as the "discriminating alignment approach," arguing that proper governance aligns the firm/market boundary according to an alignment that will minimize transaction and production costs. In the TCE perspective, three exchange conditions –asset specificity, frequency, and uncertainty – are seen to determine which governance mode is most efficient (Williamson, 1975, 1985b). Below I briefly describe these exchange conditions.

Asset Specificity

Asset specificity refers to the transferability of assets to alternative uses and is the key driver of governance mode choice (Williamson, 1975). High asset specificity means the assets are dedicated to a single purpose and are impossible or costly to redeploy. The presence of high asset specificity intensifies coordination between parties "and requires safeguarding of exchanges" (Jones, Hesterly, & Borgatti, 1997, p. 916) to reduce uncertainty and opportunism. Firms can create detailed contracts and other safeguards to prevent these behaviors, but these safeguards are often costly to construct, which encourages firms to internalize such transactions (Hart, 1995; Mayer & Salomon, 2006). In sum, the more idiosyncratic the investments required, the more likely the firm will

organize the transaction internally, since the costs of protecting against potentially opportunistic suppliers is greater than the cost of internal production (Williamson, 1975).

Four types of asset specificity are common among transactions – site specificity, physical asset specificity, human asset specificity, and dedicated assets (Williamson, 1985b, p. 55). Site specificity has to do with an asset's spatial immobility or the high costs of set-up and relocation: "Once such assets are located, the parties thereafter are operating on a bilateral exchange relation for the useful life of such assets" (Williamson, 1985b, p. 95). Physical asset specificity refers to assets with greater mobility than site specific assets (Williamson, 1985b) and includes "specialized production equipment, computer technology, and related inter-organizational systems that facilitate coordination between cooperating parties" (Artz & Brush, 2000, p. 343). Human asset specificity constitutes specific technical knowledge about a product or service or the learning required to understand a potential supplier's requirements (Noordewier, John, & Nevin, 1990). Human assets also facilitate the transfer of knowledge in information-rich settings that require face-to-face communications (Nohria & Eccles, 1992). Further, since human assets are mobile, they may quit an exchange or reduce their efforts (Coff, 1993). Dedicated assets involve "expanding the plant on behalf of the buyer" (Williamson, 1985b, p. 96). Finally, Masten et al. (1991) position temporal specificity as an additional dimension to the four originally proposed by Williamson (1985). Temporal asset specificity refers to the extent to which timely execution by a partner is critical to success (Scott E. Masten, Meehan Jr., & Snyder, 1991, p. 9): "When timely execution is critical, delay becomes a potentially effective strategy for exacting price concessions."

Frequency of Exchange

Frequency refers to how often specific parties transact with one another. Frequency transforms the orientation that parties have toward an exchange and increases the amount of informal control that can be exerted over exchanges. Williamson notes "repeated personal contacts across organizational boundaries support some minimum level of courtesy and consideration between parties and discourages efforts to seek a narrow advantage in any particular transaction" (Williamson, 1975, p. 107). Another aspect of frequency is reciprocity, which "transforms a unilateral relationship into a bilateral one" (Williamson, 1985b, p. 191) and creates the perception of a similar "destiny" with greater "mutual interest" (Williamson, 1985b, p. 155). Jones et al. (1997:242) suggest frequency is increasingly important as economies shift to alternative governance forms and offers three potential benefits to frequent exchange:

> First, frequency facilitates transferring tacit knowledge in customized exchanges, especially for specialized processes or knowledge. Second, frequent interactions establish the conditions for relational and structural embeddedness, which provide the social mechanisms to adapt, coordinate, and safeguard exchanges effectively. Third, frequent interactions provide cost efficiency in using specialized governance structures.

Uncertainty

Environmental uncertainty triggers adaptation, "which is the central problem of economic organization," because environments are rarely stable and predictable (Williamson, 1991: 278). Uncertainty arises due the need for continuous adaptation by contracting parties, and "the impossibility (or costliness) of enumerating all possible

contingencies and/or stipulating appropriate adaptations to them in advance"
(Williamson, 1985b, p. 79). Adverse affects from uncertainty are most salient when
uncertainty interacts with asset specificity: "Failure to support transaction specific assets
with protective governance structures predictably results in costly haggling and
maladaptiveness" (Williamson, 1985b, p. 79). Demand uncertainty is another problem,
and refers to anticipated volume of use for a particular technology, asset, or transaction
component, and the confidence placed upon estimates of this demand (Walker & Weber,
1984). When volume uncertainty is high, firms will tend to use internal governance to
reduce the need for mid-contract renegotiation associated with excess capacity and
inventory (Walker & Weber, 1984). Technological uncertainty results from fears that
highly specific assets will have a low salvage value if a major technological innovation
renders a transaction-specific asset obsolete. Specialized assets may have to be scrapped
and replaced with new assets associated with the new innovations (Dyer, 1996a). This
type of uncertainty moderates efficiency gains from hierarchical governance and vertical
integration: "The risk of technological obsolescence would consequently moderate the
incentives to integrate ex ante. A highly volatile industry characterized by frequent
technological changes, therefore, will be unattractive for high levels of integration"
(Williamson, 1979, p. 352). This assertion has been supported empirically in multiple
industries (Walker & Weber, 1984).

      To summarize, the efficiency perspective of governance "is grounded upon a legal
understanding of organizations as governance mechanisms distinct from markets"
(Santos & Eisenhardt, 2005, p. 492). Under the efficiency perspective, the firm boundary

is determined by asking whether conducting a transaction inside the firm or externally in the market most reduces governance costs. Governance costs include monitoring operations, allocating requirements for production, setting up initial contractual agreements, and setting up initial procedures for exchange (Mayer & Salomon, 2006). Hierarchical governance has advantages over market governance, such as decision and property rights that enable the use of fiat, alignment of incentives, and monitoring of managerial actions to efficiently govern transactions (S.E. Masten, 1991). Markets offer competitive pressures to reduce production costs (M. E. Porter, 1985), but also increase monitoring costs (Williamson, 1985b) and can increase fears of misappropriation (Oxley, 1999). In sum, the firm boundary should be set at the point that minimizes the total cost production and of governing activities (Coase, 1937).

In the next section, I summarize theoretical and empirical work since the 1970s that has both supported and refuted TCE logic for optimal governance form. I conclude with specific gaps in the economic perspective of governance, which have opened a new, non-efficiency driven, scholarly conversation of organizational governance.

Efficiency Driven Governance: From Williamson (1975) to Today

For many years, transaction cost economics (TCE) has been the driving logic behind firm boundary decisions. In TCE, the firm considers the ex ante and ex post costs of exchange as the primary determinants of whether to conduct an activity internally or externally, as these are distinct governance structures (Coase, 1937; Williamson, 1975). Due to bounded rationality, asset specificity and opportunism are key transaction cost

drivers, prompting Williamson to suggest that every stage of production should undergo assessment of the make-or-buy choice to reduce governance costs (1985a). This has led to widespread treatment of the make-or-buy decision modes as dichotomous choices that, once selected are difficult to change (Nickerson & Zenger, 2002).

When designing governance structures, firms interact with outside suppliers and iteratively determine the most efficient governance structure for a given product. Firms will differ in the number of external suppliers they choose due to differences in their existing resources (J. Barney, 1991) and in their perceptions of how outsourcing may lower the total cost of production. Some studies suggest that improving quality via sole sourcing can minimize production costs (e.g. Deming, 1986) while others suggest that multiple sourcing minimizes costs by engendering competition between potential suppliers (e.g. M. E. Porter, 1985). Recently, scholars have touted the benefits of tapered integration or concurrent sourcing, in which firms both make and buy the same products (Parmigiani, 2007; Rothaermel, Hitt, & Jobe, 2006). Richardson and Roumasset (1995, p. 73) conclude that no single sourcing strategy will apply across all firms stating, "the best sourcing arrangement depends on the situation."

More recently, TCE has come under attack as being too static and too strongly dependent upon equilibrium assumptions (Ghoshal & Moran, 1996), reducing its applicability in more dynamic environments (Conner & Prahalad, 1996; Santos & Eisenhardt, 2005). TCE scholars have responded with a more contingent view of how TCE tenets inform the design of governance structures (Williamson, 1999). Scholars are combining Williamson's treatment of the make-or-buy choice with the capabilities

literatures (e.g. Eisenhardt & Martin, 2000; David J. Teece, Pisano, & Shuen, 2000) to incorporate resource- and knowledge-based views of the firm. These views suggest a firm internally produce goods that are close to its area of expertise, core to its business, and related to items it already produces (J. B. Barney, 1986; Prahalad & Hamel, 1990; Wernerfelt, 1984). Williamson (1999, p. 1097) agrees with the potential for capabilities arguments to inform TCE arguments, stating: "transaction cost economics informs the *generic* decision to make or buy, while competence brings in *particulars*" (emphasis in original).

Under this contingent TCE logic, characteristics of the product, environment and firm will jointly inform governance choice. Internal production is preferred when products require a high degree of specific investment. Potential suppliers may be hesitant to commit vast resources to specific investments and even if suppliers initially agree, fears of opportunism increase in these situations because supply chain firms may seek raise prices to justify the high investment cost (Krause, Handfield, & Tyler, 2007). Additionally, products that are difficult to evaluate prior to production may be better produced internally. This may be due to high technological uncertainty or appropriability concerns (Oxley, 1999) or product complexity concerns (S. W. Anderson, Glenn, & Sedatole, 2000). Still, while internal production facilitates adaptation and coordination, outsourcing will push risks of obsolescence onto suppliers. Firms will outsource when fears of opportunism are low, external assets and resources are autonomous and less re-deployable (David J. Teece, 1984), and to take advantage of other firms' expertise (Argyres, 1996; Kogut & Zander, 1992; Rubin, 1973). This indicates that when

technological or demand uncertainties are highest, hybrid governance such as alliances or market governance through outsourcing may be a better choice (e.g. Gulati, Lawrence, & Puranam, 2005). Finally, scope economies can drive a firm's decision to outsource. Economies of scope arise when the cost of performing several functions simultaneously proves more efficient than conducting each activity individually (Helfat & Eisenhardt, 2004; Panzar & Willig, 1981). Economies of scope can be attained through market exchange when governance costs created by indivisibility and nontradability of assets are low (Monteverde & Teece, 1982). Conversely, if a firm has considerable knowledge and experience related to the product and can exploit internal scope economies, it will be motivated to internally produce the product (Conner & Prahalad, 1996; D.J. Teece, 1986).

Despite widespread agreement on the theoretical underpinnings of transaction cost and capabilities arguments for efficient governance mode choice, recent empirical studies have produced results that question these basic, agreed upon tenets. For example, Anderson, Glen and Sedatole (2000) found highly complex products changed the rules regarding fears of asset specificity and opportunism among outside suppliers. They found the greater the complexity of a product and its sub-processes, the greater the use of outsourcing. This directly conflicts with the early governance literature about the roles specific assets, opportunism and bounded rationality play in sourcing decisions based on transaction efficiency (Coase 1937, Williamson 1975). Additional empirical work has questioned the role of uncertainty in make-or-buy decisions. Behavioral uncertainty caused by exchange partners negatively affects the efficiency of market governance

(Dyer, 1996b; Walker & Weber, 1984) while technological uncertainty seems to reverse the causal arrow, favoring market governance over hierarchical governance (Richardson, 1996). Finally, Nickerson and Zenger (2002) argue that interdependence between transactions affects governance structure. High interdependence may favor hierarchical governance because of fiat and incentive advantages found internal to the firm (Nickerson & Zenger, 2002). These inconsistencies imply that the efficiency perspective of governance does not capture all firm-level strategies or decisions to make-or-buy, prompting Conner and Prahalad (1996, p. 491) to suggest: "Maybe opportunism isn't the only reason firms with seemingly similar transaction cost situations choose different forms of governance."

To summarize, the efficiency perspective has several limitations. First, despite recent attempts to link TCE and capabilities literatures, the efficiency conception remains a discussion about the most efficient location of a transaction. Further, as described above, introducing capabilities arguments can actually confound findings from TCE (Dyer, 1996b). These limitations constrain the efficiency perspective to static analyses and equilibrium conditions. These limitations have caused scholars from the fields of sociology, network theory and organization theory to challenge the efficiency perspective of governance. Next, I review these challenges and describe the contention that network governance constitutes a distinct new organizational form that is neither market nor hierarchy, not simply a hybrid combination of the two (Jones, Hesterly, & Borgatti, 1997; Podolny & Page, 1998; Walter W. Powell, 1990).

Sociology: The Role of Embeddedness

Spurred largely by Granovetter's (1985) argument that economic theorizing is "under-socialized," sociologists began to criticize the efficiency perspective of markets and hierarchies in the 1980s (Podolny & Page, 1998). Granovetter's central argument is that economic transactions are highly constrained by ongoing social relations and should not be viewed solely as an attempt by atomistic actors to maximize transaction efficiency. Granovetter cemented his position that economic and social motivations are interdependent, stating: "to construe them as independent is a grievous misunderstanding" (1985, p. 482).

Granovetter puts forth an argument of economic embeddedness and systematically challenges Williamson's neo-classical economic assumptions about markets and hierarchies. Embeddedness refers to "the extent to which dyadic (economic) relations are embedded in a broader system of social relations" (M. Granovetter, 1985, p. 482). While Williamson (1975: 106) does acknowledge that the influence of social relations on repeated market transactions supports "some minimum level of courtesy and consideration between parties," Granovetter (1985) argues this does not go far enough. Granovetter cites the work of Macauley (1963, pp. 63-64) and the relationships between internal sales people and external clients as having deeply social relationships, including salesman that have "gossip about competitors, shortages and price increases to give purchasing agents who treat them well." These deeply embedded social relationships help settle disputes, even in the presence of detailed contracts (M. Granovetter, 1985).

Granovetter (1985) also cites extensive use of subcontracting as creating opportunities for sustained relationships among firms that are not organized hierarchically within one corporate unit. Common in construction projects and within the garment industry (Uzzi, 1996), this type of quasi-integration (R.G. Eccles, 1981) results in a quasi-firm that is a mode of organizing preferred to pure market transactions or formal vertical integration" (R.G. Eccles, 1981, pp. 339-340). Granovetter (1985: 498) argues these long-term relationships and their embeddedness in a wider community of construction personnel "generate standards of expected behavior that not only obviate the need for but are superior to pure authority relations (found in hierarchies)."

Granovetter concludes with salient arguments against the use of fiat, efficiencies of internal labor markets, and communication efficiencies within hierarchies. His general conclusion is that social relations between firms are more important than the market relations proposed by economists; while social relations within firms are less important than as hypothesized in the market and hierarchy line of thinking (M. Granovetter, 1985, p. 501). His direct challenge to Williamson's market and hierarchy description of organizational forms fomented an outpouring of sociological research aiming to elucidate and extend the embeddedness hypothesis, which resulted in inter-organizational networks as a form of governance (Podolny and Page, 1998). In the next section, I describe these papers, summarize their impact, and detail the emergence the network form of governance.

The Emergence of Networks as a Form of Governance

Beginning in the 1980s, sociologists became increasingly intrigued by a plethora of organizational forms that failed to conform to traditional market or hierarchy archetypes (Podolny & Page, 1998). Empirically, changes in the US regulatory environment allowed US firms to engage in cooperative activities with market competitors (Achrol & Kotler, 1999; Podolny & Page, 1998; Snow, Miles, & Coleman, 1992). Theoretically, Granovetter (1985) challenged neo-classical economics and its dichotomous market and hierarchy classification of organizational forms. Williamson (1991) countered with descriptions of the hybrid organizational form, but suggested that hybrid forms were rare and that the distribution of organizational forms along the markets and hierarchies continuum was "thick in the tails" (Williamson, 1985b).

Initial attempts to distinguish network organizations from pure markets and hierarchies led to their being defined by social relationships between firms. Led by Powell (1990), sociologists argued that network organizational forms are indeed distinct and possess their own logics. Powell (1990:301) suggested, "markets, hierarchies and networks are all part of a larger puzzle that is the economy. The properties of the parts of this system are defined by the kinds of interaction that takes place among them." Chief among these interactions is a norm of reciprocity among cooperating network partners that protects transactions and reduces their costs. Below I recreate Powell's table (Table 2) that summarizes the differences between these forms of economic organization (1990: 300):

Table 2: Summary of Forms of Organizing, Recreated from Powell (1990), Page 300

| Key Features | *Forms* | | |
	Market	*Hierarchy*	*Network*
Normative Basis	Contract – Property Rights	Employment Relationship	Complementary Strengths
Means of Communication	Prices	Routines	Relational
Methods of Conflict Resolution	Haggling – resort to courts for enforcement	Administrative fiat – Supervision	Norm of reciprocity – Reputational concerns
Degree of Flexibility	High	Low	Medium
Amount of Commitment Among the Parties	Low	Medium to High	Medium to High
Tone of Climate	Precision and/or Suspicion	Formal, bureaucratic	Open-ended, mutual benefits
Actor Preferences or Choices	Independent	Dependent	Interdependent
Mixing of Forms	Repeat Transactions (Geertz, 1978) Contracts as hierarchical documents (Stinchcombe, 1985)	Informal Organization (Dalton, 1957) Market-like features: profit centers, transfer pricing (Eccles, 1985)	Status Hierarchies Multiple Partners Formal Rules

Powell (1990) went on to describe the differences between market, hierarchy, and network forms of organizing. Powell (1990: 302-03) described: "Markets ... are a spontaneous coordination of mechanisms that imparts rationality anu consistency to the self-interested actions of individuals and firms ... Hierarchies offer clear departmental boundaries, clean lines of authority, detailed reporting mechanisms and formal decision-making procedures." Network organizations differ. These organizations offer some of the flexibility found in markets but also some of the control found in hierarchies.

Powell explained (1990: 302): "In network modes … transactions occur neither through discrete exchanges nor by administrative fiat … rather, the parties in a network agree to forego the right to pursue their own interests at the expense of others." Powell borrowed from Axelrod (1984) to explain how network relationships are formed around expectations of future interactions. Axelrod (1984) coined the term "shadow of the future" to describe how the likelihood of future interactions constrains the pursuit of immediate payoffs from current interactions. In these cases, cooperation emerges out of mutual interests and behaviors are based on standards that no single participant can determine alone (Powell, 1990). Powell's (1990) final foundation for the efficacy of network forms is trust. Trust is a remarkable lubricant to economic exchange (Arrow, 1974) as it reduces complex realities "far more quickly than prediction, authority, or bargaining" (Powell, 1990: 305).

To summarize, Powell's conception of network organizational forms explains their emergence due to norms of reciprocity (Powell, 1990), goals of cooperation (Axelrod, 1984), and increasing returns to trust (Kenneth Joseph Arrow, 1974). His insight supports that network forms of organization are indeed "Neither Market Nor Hierarchy" and his work elicited a plethora of papers asserting the benefits of network organizations. These benefits include learning (Dore, 1983; Hamel, 1991b; Walter W. Powell, 1990; Uzzi, 1997), legitimation and status (J. Baum & Oliver, 1992; Podolny, 1993; Stuart, Hoang, & Hybels, 1999) and economic benefits (Bradach & Eccles, 1989; Dore, 1983; Kanter, 1991; Parkhe, 1991; Walter W. Powell; Uzzi, 1997; Williamson,

1991), as well as benefits explained by resource dependence (J. Pfeffer & Nowak, 1976; Selznick, 1949) and social welfare theories (Perrow, 1993).

I began this section by describing sociologists' interest in distancing their conception of network organizations from the economic conception of pure markets and hierarchies (Williamson, 1991). Judging by the wealth of studies touting the social and learning benefits to network organizations, it is safe to say they succeeded. However, by presenting such a convincing and polarizing argument to the existence and persistence of network organizing via social mechanisms, these scholars backed themselves into a corner. Their enthusiasm for the positive benefits of network organizations largely removed any discussion of their negative consequences or costs (Podolny & Page, 1998). Only by pursuing a middle-ground incorporating both economic and social mechanisms for governance can we recognize both functional and dysfunctional aspects of the network organization (Kim, Oh, & Swaminathan, 2006; Podolny & Page, 1998). Recognizing this need, a multi-disciplinary team of authors, one each from organization theory (Candace Jones), transaction cost economics (William Hesterly) and social networks (Stephen Borgatti), developed a general theory of network governance that includes both economic and social mechanisms, which represents a major step in our understanding (Jones, Hesterly, & Borgatti, 1997). Next, I present their conception of network governance, which is the basis for the remainder of this dissertation.

Reconciling Economic and Sociological Governance: Exchange Conditions and Social Mechanisms

In contrast to purely sociological treatments of network organizational forms emphasizing informal agreements between cooperating parties who share norms and values (for detailed reviews, see Podolny and Page, 1998; Borgatti and Foster, 2003), network governance includes contractual agreements between autonomous parties that may have entirely different norms and values. This study defines network governance according to Jones et al., (1997) and their definition and rationale are offered below.

Network governance involves a "select, persistent, and structured set of autonomous firms engaged in creating products or services based on implicit and open ended contracts to adapt to environmental contingencies and to coordinate and safeguard exchanges" (Jones, Hesterly, & Borgatti, 1997). These authors clarify what they mean by "implicit and open-ended contracts" as follows (Page 916):

> To be sure, formal contracts may exist between some pairs of members, but those do not define the relationships between all parties. For example, in a film project, both the cinematographer and the editor may have contracts with the studio, but these contracts do not specify the relationship between the two subcontractors.

These authors go on to clarify the nature of these project-specific relationships: "Network governance is composed of firms that operate like a single entity (when required) ... in other domains these firms may be fierce competitors" (Jones et al. 1997: 916). These authors cite the film industry as emblematic of network governance (pp. 916):

Here, film studios, producers, directors, cinematographers, and a host of other contractors join, disband, and rejoin in varying combinations to make films. Network governance comprises a select subset of film studios and subcontractors. The seven major film studios repeatedly use and share among their films an elite set of subcontractors who constitute 3 percent (459 of the 12,400) of those registered in guilds (Jones & Hesterly, 1993). ... Structured relations among subcontractors and film studios are based on a division of labor: film studios finance, market, and distribute films, whereas numerous subcontractors with clearly defined roles and professions (e.g., producer, director, cinematographer, and editor) create the film.

For a governance form to persist, it must address the problems of adapting, coordinating and safeguarding exchanges more efficiently than other governance forms (Williamson, 1991). In the TCE perspective, three exchange conditions – uncertainty, asset specificity, and frequency – determine which governance form is most efficient (Jones, Hesterly, & Borgatti, 1997). Williamson (1994, p. 85) acknowledges that "network relations are given short shrift" in the governance conversation, partially because of TCE's preoccupation with dyadic relations. By combining TCE's reliance on exchange conditions with social network theory, scholars can move the level of analysis above dyadic relations. Combining these theoretical platforms allows Jones et al.(1997:913) to provide a "simple, yet coherent framework for identifying the (exchange) conditions under which network governance is likely to emerge and the social mechanisms that allow network governance to coordinate and safeguard customized exchanges" better than other governance forms. These authors make a critical distinction about network governance. Rather than positioning network governance as a generic structure in competition with Williamson or with sociologists, these authors limit the emergence of network governance to specific exchange conditions and rapidly changing

markets. Next, I review these exchange conditions and markets that commonly exhibit rapid change.

Jones et al. (1997) begin by identifying specific forms of uncertainty and asset specificity that give rise to network governance. Next, they extend TCE by incorporating *task complexity* (Walter W. Powell, 1990; W. W. Powell, Koput, & Smith-Doerr, 1996) into the explanation of governance form. Jones et al. (1997:917) suggest the incorporation of task complexity "is important because it moves theory beyond a dyadic focus." Third, Jones et al. (1997:917) show how Williamson's notion of frequency, "which is underspecified and underdeveloped in TCE, provides a link with social network constructs of relational and structural embeddedness" (M. Granovetter, 1985, 1992; Uzzi, 1996, 1997). Frequency is important for several reasons (Jones, Hesterly, & Borgatti, 1997, p. 917):

> First, frequency facilitates transferring tacit knowledge in customized exchanges, especially for specialized processes or knowledge. Second, frequent interactions establish the conditions for relational and structural embeddedness, which provide the social mechanisms to adapt, coordinate, and safeguard exchanges effectively. Third, frequent interactions provide cost efficiency in using specialized governance structures (Williamson, 1985b).

By combining TCE with social network theory (Powell, 1990), Jones and her coauthors (1997:918) identify four conditions necessary for network governance to emerge and thrive: "(1) demand uncertainty with stable supply, (2) customized exchanges high in human asset specificity, (3) complex tasks under time pressure and (4) frequent exchanges among parties comprising the network." Since I have reviewed three of these

four exchange conditions elsewhere in this manuscript, I will review task complexity under time pressure presently.

Task complexity is defined as follows: "Task complexity refers to the number of specialized inputs needed to complete a product or service" (Jones et al., 1997: 921). As complex projects increase in their need for specialized inputs, greater behavioral interdependence results (Jeffrey Pfeffer & Salancik, 1978). This will often require different specialists be incorporated into the task, due to the increased scope of activities found in complex projects. When task complexity is combined with high time pressure, coordination through a series of sequential exchanges becomes infeasible (Jones et al., 1997). High time pressure forces firms to reduce lead times and increase coordination, as is common in industries such as semiconductors, computers, film and fashion. Greater coordination and adaptation can reduce some of the effects of time pressure, which supports an increasing need for network governance when the exchange conditions of high time pressure and task complexity coincide.

To summarize, network governance is an organizational form that emerges and thrives under specific exchange conditions (Jones, Hesterly, & Borgatti, 1997), involves autonomous firms that join, disband and rejoin in varying combinations over time, and involves specific coordination mechanisms guided by contractual relationships between some firms (a studio and a cinematographer) and socially embedded (non-contractual) relationships among others (a cinematographer and an editor). In the next section, I review the literature that has examined performance related to network governance. These studies combine both economic and social mechanisms in their analyses by

relating the presence and strength of social/network ties to the economic performance of the network organizational form. While innovative, these studies suffer from many of the same problems that plague prior research by sociologists – their bias is toward studying the positive and beneficial aspects of network organizing. I begin the next section by examining the sources of this bias, and explaining how conceptual arguments at the network level of analysis are based upon empirical evidence at the dyad-level of analysis. This mismatch between conceptual theorizing and empirical practice is a primary barrier to our understanding of network organizations. I conclude the next section by emphasizing both theoretical and empirical gaps in the literature that relates the presence and strength of network ties to the performance of networks as a form of governance.

The Performance of Networks as a Form of Governance

The effects of network ties on performance can be traced back to Granovetter's influential studies of job seekers and their ego-networks (M. Granovetter, 1995; M. S. Granovetter, 1973). He defines tie strength as a "(probably linear) combination of the amount of time, the emotional intensity, the intimacy (mutual confiding) , and the reciprocal services which characterize the tie" (M. S. Granovetter, 1973, p. 1361). Building off Granovetter's definition, several scholars began to question how an ego's (individual or firm) collection of dyadic ties might interact to affect the performance of the network as a whole (See Table 3).

Table 3: Research Relating Tie Strength to Organizational Performance

Past Research on the Performance of Networks (Dyad level of analysis)	
Qualitative	Quantitative
Granovetter (1973, 1995)	Baker (1990)
Parkhe (1991)	Gulati (1995)
Larson (1992)	Stuart, Hoang & Hybels (1999)
Grabher (1993)	Shane & Cable (2002)
Doz (1996)	Goerzen (2007)
Liebeskind et al (1996)	
Uzzi (1997)	
Capaldo (2007)	

However, a critical flaw arose between these authors' conceptual arguments about whole networks, their ability to gather data, and their conclusions about how a whole-network of ties might impact performance. Despite an increasing acknowledgement of the benefits derived from whole-networks (Gulati & Gargiulo, 1999; Walter W. Powell, White, Koput, & Jason, 2005; Provan, Fish, & Sydow, 2007; Rosenkopf & Schilling, 2007), data gathering and analysis remained at the dyad level. Even more concerning, scholars acknowledged their inability to collect network level data (Podolny & Page, 1998), but this did not keep them from publishing findings about whole networks based on individual dyads. Next, I review these studies that relate the presence and strength of dyadic ties to the overall performance of a network – highlighting their common emphasis of dyad-level relationships.

With Granovetter's (1973, 1995) definition of tie strength as a baseline, several scholars have investigated the impact of tie strength on organizational performance. At the organization level, more frequent ties, a greater number of repeated ties, greater resource commitments, and longer durations for a particular tie characterize strong ties

(Capaldo, 2007). Conversely, fewer repeated ties, more ties with a greater number of partners, ties with fewer resource commitments, and ties lasting for shorter durations characterize weak ties (Capaldo, 2007). Qualitatively, tie strength has been linked to learning and adaptation (Parkhe, 1991), to task integration and the effects of similar cultures and norms between dyadic partners (Doz, 1996), and to ties with prominent network partners, which can impact a focal organization's status and legitimacy (Larson, 1992). Liebeskind et al. (1996) suggested that an absence of network ties led to pharmaceutical companies being unable to enter the nascent biotechnology industry. Finally, Uzzi (1997) suggested that there exists an optimal number of strong versus weak ties. In his study of the New York City garment industry, he found that firms relying too heavily on strong ties (over-embedded) or on weak ties (under-embedded) perform worse than firms with a blend of strong and weak ties.

Empirically, most research on the performance of network organizations has been limited to studies of dyadic relationships between partners. Building on Larson's (1992) study of the effects of ties to prominent network partners on performance, Stuart Hoang and Hybels (1999) studied the effects of ties to prominent partners on the performance of entrepreneurial firms. Likewise, Shane and Cable (2002) studied how ties to prominent partners affect the ability of start-up ventures to attract funding. Baker (1990) began to theorize about variation in performance from network ties and looked at the dyadic relationships between corporations and their banks. He found that a mixture of strong and weak ties leads to optimal performance, echoing Uzzi's (1997) qualitative findings in the garment industry. Gulati (1995) studied patterns of tie formation between dyadic

partners and found that not only do strong ties enhance performance, but also that these benefits decay rapidly over time. Gulati (1995) found that only the four most recently formed ties affect performance between alliance partners positively.

Researchers have suggested that our lack of understanding about the performance of network organizational forms stems from a lack of network-level data (Podolny & Page, 1998). Podolny and Page (1998) suggest that in order to examine the *full range* of performance, including poor performance and failure, comprehensive data on a population of network organizations is needed. While I agree with these authors that such data are difficult to obtain, I disagree with their assertion that the empirical gap constitutes the primary limitation to our understanding of network organizational performance.

The more limiting characteristic is theoretical, and arises from a mismatch between levels of analysis. Scholars continue to conceptualize network level performance using dyad-level relationships. In order to advance a more robust theory of networks, we must think differently about networks (Salancik, 1995) and move the level of analysis up to the network level (Gulati & Gargiulo, 1999; Walter W. Powell, White, Koput, & Jason, 2005; Rosenkopf & Schilling, 2007). The network level of analysis involves the aggregation of multiple dyads interacting simultaneously (Goerzen, 2007; Provan, Fish, & Sydow, 2007).

To summarize, past literature relating organizational performance to the presence and strength of network ties is largely qualitative and conceptual and nearly all quantitative work is at the dyad level of analysis. Additionally, scholars have touted the

benefits to network organizing while largely ignoring any costs, which has led scholars to frame network ties as durable and to frame changes in network partners as easy and always leading to positive outcomes (Kim, Oh, & Swaminathan, 2006). Podolny and Page (1998, p. 73) offer a direct criticism of scholars' biased studies of interorganizational networks: "researchers must counterbalance the focus on prevalence and functionality (of networks) with an equally strong focus on constraint and dysfunctionality." These issues create three noticeable barriers to our understanding of network organizations and performance: (1) Network ties are studied largely at the dyad level, (2) network ties are largely assumed to be stable and durable over time, and (3) network performance measures are not robust.

Narrowing the Gaps in Understanding

Narrowing these gaps in understanding requires three things. First, scholars need to revisit the construct of tie strength and its preoccupation with dyadic ties between individuals. The first logical step, as suggested by Capaldo (2007), is to move the level of analysis to interorganizational ties between firms. Capaldo (2007) extends tie strength to the inter-organizational level as follows. He begins by reviewing the three critical dimensions of tie strength as conceived by Granovetter (1973): frequency of interaction, intensity of interaction, and duration of interaction. Next, Capaldo (2007) extends these dimensions to the inter-organizational level. Capaldo (2007) links frequency and intensity of interaction to a resource commitment and a social commitment between cooperating firms. Regarding duration, he links these interactions to the amount of time

associated with a particular tie. Collectively, these interfirm ties describe a temporal

dimension, a resource dimension, and a social dimension, which represents a critical

advancement of the tie strength construct (Capaldo, 2007: 589):

> Coherently, I frame tie strength as a three dimensional concept composed of a temporal dimension, a resource dimension, and a social dimension. Thus, strong(er) interfirm ties are characterized by long(er) time-frames and high(er) resource commitments when compared to weak(er) ties, as well as by tight(er) interpersonal relations and trust-based interorganizational linkages. I argue that the following three variables should be employed to express the strength of an interorganizational relationship: (1) the relationship's overall duration; (2) the frequency of collaboration; and (3) the intensity of collaboration. The higher the relationship's duration, and the higher the frequency and intensity of collaboration, the higher the strength of the relationship.

While Capaldo's (2007) extension of the tie strength construct to an inter-organizational

construct is important, a limitation of his study is its reliance on inter-organizational

dyads. This dissertation extends Capaldo (2007) by aggregating multiple interfirm dyads

up to the network level of analysis, which Provan et al. (2007) in their review of the

network literature, identify as a critical area for future research.

Second, scholars need to recognize that network ties can be unstable, short-lived,

and that the transformation of network ties is associated with costs (Gulati, 1995; Kim,

Oh, & Swaminathan, 2006). As mentioned by Kim et al. (2006), a selection bias exists

among scholars studying these ties due to their comparing returns to organizational

performance with the presence of current and new partners. Because these comparisons

treat tie formation and dissolution as discrete events, rather than as a series of unfolding

events that occur over time, changes in network ties always seem to result in positive

outcomes (Kim, Oh, & Swaminathan, 2006). Empirical evidence suggests otherwise. Uzzi (1996) conceptualized tie formation and dissolution as a series of unfolding events, and found these changes are more difficult than previously theorized. Further, Gulati (1995) found that the benefits from previous ties decays rapidly and Goerzen (2007) found that repeated alliance network ties actually reduce economic performance. Clearly, there exists an opportunity to study tie formation and dissolution over time and with an eye toward any negative consequences.

Following these scholars, I introduce a new construct, *Aggregate Tie Strength*, to address gaps one and two in our understanding. Narrowing Gap 1 requires changing the level of analysis. To accomplish this, I build off Capaldo's (2007) notion of tie strength as a relationship between firms by aggregating all of a lead-firm's dyadic ties, thus raising the level of analysis to the network (e.g. Provan et al. 2007). Next, I need to address that the value of ties changes over time. Aggregate Tie Strength (ATS) is a composite measure that accounts for both the presence and sum of ties between a lead-firm and its cooperating partners, as well as incorporating the recency of their formation. ATS, incorporates Gulati's (1995) finding that the benefits from ties decays rapidly over time by using a "moving window" approach. By incorporating current *and* past behaviors into ATS, I narrow Gap 2 in the literature. This construct allows me to capture variation of a cross-sectional nature, as in Goerzen (2007), but also over time, which represents a critical extension to both Goerzen (2007) and Gulati (1995).

Finally, to narrow Gap 3 in understanding, I need robust data on the *full range* of performance (Podolny and Page, 1998). Prior network performance measures were not

robust, due to the unavailability of data across a population of networks (Podolny and Page, 1998) and across time (Goerzen, 2007). I solve both of these problems by leveraging a unique panel data set that contains information across a population of network organizations during the years 2000 – 2007. In the next section, I describe my contribution and conclude this literature review.

Network Performance at the Network Level

In order to examine the performance of at the network level, I link back to theory about lead-firm networks and introduce the construct *Aggregate Tie Strength (ATS)*. Lead-firm networks focus our attention on a single focal firm (ego) and the set of nodes that firm has ties with (alters) (Borgatti & Foster, 2003; Provan, Fish, & Sydow, 2007). "Lead-firm governance occurs in networks in which all organizations share a common purpose … but there is a more powerful, perhaps larger organization that has sufficient resources and legitimacy to play a lead role" (Provan, Fish, & Sydow, 2007, p. 504). Lead-firm networks represent a promising avenue to examine whole-networks, where network governance is the rule rather than the exception (Gulati & Gargiulo, 1999; Walter W. Powell, White, Koput, & Jason, 2005; Rosenkopf & Schilling, 2007).

ATS accounts for the simultaneous interaction of multiple dyadic ties between an ego and its alters, but also incorporates Gulati's (1995) empirical finding that the value derived from network ties decays over time. This construct represents one of my theoretical contributions to the literature on network organizations because it takes into

account both the occurrence of multiple simultaneous ties between an ego and its alters and the recency of their formation.

Next, in order to study the full range of performance, I need reliable information on both network tie formation and tie dissolution (Podolny and Page, 1998). Jones and Lichtenstein (2008) suggest alliance networks formed in response to temporary projects address this need. Temporary interorganizational projects are defined as: "projects in which multiple organizations work jointly on a shared activity for a limited period of time" (Jones & Lichtenstein, 2008, p. 230). Due to their limited duration, temporary interorganizational projects have specific start and end dates, and these dates are known among alliance partners and often published in trades journals and industry artifacts (Jones & Lichtenstein, 2008). Additionally, temporary projects are characterized by clearly stated goals and performance outcomes. These goals generally come in the form of industry artifacts or documents, such as a movie script, architectural and engineering request for proposals, construction blue prints, or Broadway Playbills, for example (Jones & Lichtenstein, 2008).

Thus, firms collaborating on temporary interorganizational projects fit Jones et al.'s (1997) definition of network governance. Due to their temporary nature, there is high time pressure. Temporary projects have sufficient task complexity to warrant the creation of detailed artifacts like blue prints and scripts to facilitate coordination (Jones, Hesterly, & Borgatti, 1997; Jones & Lichtenstein, 2008). Temporary projects also occur in industries of rapid change, but with a stable network of autonomous firms that regularly form and dissolve ties according to exchange conditions. Finally, in industries

where temporary projects are common, information on tie formation and dissolution dates are more readily available. Please see Table 4 for examples of temporary interorganizational projects.

Table 4: Examples of Scholarly Work That Studies Temporary Interorganizational Projects (Adapted from Jones and Lichtenstein, 2008)

Project Description (authors)
• Film production (Bechky, 2006; Faulkner & Anderson, 1987; Jones & DeFillippi, 1996)
• Music video production (Bechky, 2006; Jones & DeFillippi, 1996)
• Architecture and Construction Projects (R.G. Eccles, 1981)
• Fashion (Uzzi, 1996, 1997)
• Broadway Musicals (Uzzi & Spiro, 2005)
• Emergency and Crisis Response (e.g. Hurricane Katrina) (Brandstrom, Bynander, & 'T Hart, 2004)

This concludes Chapter II. Chapter III presents a theoretical framework and a series of hypotheses that test how exchange conditions interact with Aggregate Tie Strength to affect the performance of network governance.

CHAPTER III

THEORETICAL FRAMEWORK AND HYPOTHESES

As reviewed in the last chapter, research indicates organizational forms are shaped by exchange conditions and embedded social relationships. Researchers from economics, organization theory and sociology have explored the emergence, persistence and performance of organizational forms and these scholars tend to explain organizational forms from their own perspectives, with their own theories, and in competition with other perspectives and theories. For example, economists use the transaction as their primary unit of analysis and describe how the structure of organizational forms results from a pursuit of transaction efficiencies that reduce the costs of organizing (Scott E. Masten, Meehan Jr., & Snyder, 1991; Williamson, 1975, 1985b). Sociologists largely use dyadic relationships between social actors as their unit of analysis and explain the structure of organizational forms according to how embedded dyadic relationships affect the social and economic costs of organizing (M. Granovetter, 1985, 1992; Walter W. Powell, 1990).

Due to these differences in perspective and measurement, we know quite a bit about the independent effects of economic and sociological explanations of organizational forms (Walter W. Powell, 1990), but we know much less about any interdependence among these theoretical traditions (Jones, Hesterly, & Borgatti,

1997). In order to unpack the interdependence of these perspectives, scholars have suggested network organizational forms are a fruitful theoretical setting that deserves further attention (Jones, Hesterly, & Borgatti, 1997; Podolny & Page, 1998; Walter W. Powell, 1990).

The previous chapter outlined three specific gaps that arise from attempts to explain the structure and performance of network organizational forms. First, both economic and sociological traditions view transactions/relationships at the dyad level of analysis, which limits our understanding of how multiple dyads interact in a network of relationships to affect structure and performance at the network level of analysis (Gulati & Gargiulo, 1999; Walter W. Powell, White, Koput, & Jason, 2005; Provan, Fish, & Sydow, 2007). Second, relationships between cooperating firms are largely theorized as stable, with changes in network partners seen as easy and resulting in positive benefits, which ignores any difficulties and negative benefits (Kim, Oh, & Swaminathan, 2006; Podolny & Page, 1998). Third, reliable data on the *full range* of performance, including poor performance and failure, is often unavailable (Podolny & Page, 1998). This study addresses these gaps by empirically examining the structure and performance of network organizational forms using robust data that includes the full range of organizational performance.

In the preceding literature review, I used Jones et al.'s (1997) definition of network governance as a conceptual framework to integrate previous theorizing by economists and sociologists. These authors do not characterize network governance as a generic governance structure in competition with other structures. Rather, this

framework postulates that the collective effects of specific exchange conditions account for the emergence, structure and performance of network governance: "No single exchange condition gives rise to network governance; rather a combination of specific conditions is required for network governance to emerge and thrive as an organizational form"(Jones, Hesterly, & Borgatti, 1997, p. 923). These exchange conditions occur in settings that require high adaptation due to changes in product demand, high coordination costs associated with integrating diverse specialists in complex tasks, and needs for safeguarding due to overseeing and coordinating customized exchanges (Jones, Hesterly, & Borgatti, 1997). The need to safeguard these exchanges inhibits market governance and the need for adapting exchanges inhibits the use of pure hierarchies. Network governance balances these competing demands as it integrates the most applicable arguments from TCE and social networks when these exchange conditions are present (Jones, Hesterly, & Borgatti, 1997).

By arguing that the network form of governance emerges and persists only under specific exchange conditions, Jones et al. (1997) begin a new conversation about the interdependence of economic and sociological explanations for organizational structure and performance. This study builds upon the work of Jones et al. (1997) and asks the following research question: *How do exchange conditions and interfirm partnerships interact to affect the structure and performance of temporary network organizational forms?*

Linking Alliance Design to Organizational Forms

Research suggests the alliance literature offers a fruitful setting to study the interdependence of economic and sociological explanations of organizational forms (Dyer & Singh, 1998; Goerzen, 2007; Gulati & Singh, 1998; Jones & Lichtenstein, 2008; Lorenzoni & Lipparini, 1999; Poppo, Zhou, & Ryu, 2008). In economics, alliance networks have been treated as a variant of the make-or-buy decision (Gulati & Singh, 1998; Lorenzoni & Lipparini, 1999). The same logic by which firms choose between the extremes of make-or-buy (Scott E. Masten, Meehan Jr., & Snyder, 1991; Monteverde & Teece, 1982; Walker & Weber, 1984) is expected to continue once firms elect to form an alliance (Gulati & Singh, 1998). Further, as in sociology, alliance networks exhibit both relational and structural embeddedness (Jones & Lichtenstein, 2008) – the key sociological measures of variation among organizational forms (M. Granovetter, 1992).

Alliance networks are deliberately designed networks, often led by lead firms, that aim to create competitive advantage through cooperative advantage (Ring, 1996), through idiosyncratic combinations of complementary resources (Kogut, 1991; Kogut & Zander, 1992), and through relational advantages (Dyer & Singh, 1998). To create these advantages, alliance networks tend to involve repeated partnerships or repeated alliances. Research from the automotive industry highlights the advantages derived from repeated alliances including reduced development risks, reduced time-to-market, and reduced quality defect rates (Clark & Fujimoto, 1991; Nishiguchi, 1994; Womack, Jones, & Ross, 1990). Research by Helper (1991) shows that repeated

alliances enhance innovation and strategic flexibility. These findings have led scholars to suggest that the ability to design networks, interact, and share knowledge with other companies is a distinctive organizational competence (Lorenzoni & Lipparini, 1999, p. 320).

Scholars interested in knowledge, innovation and learning make broad claims that repeated alliances lead to better outcomes: "tight, repeated, trust-based relationships … are likely to bring sustained competitive advantages in terms of innovation and cost economics" (Lorenzoni & Lipparini, 1999, p. 332),

> Lead firms deliberately act to create an architecture of capabilities where expertise is located both internally and externally, and partnered organizations are seen as intelligent units [wherein] the internal knowledge should help a lead firm to appreciate, select, and mobilize external capabilities (firms). Simultaneously, lead firms should learn to interact with others to better manage internal competencies" (Lorenzoni & Lipparini, 1999, p. 332)

These statements are in sharp contrast to some empirical findings about the effects of repeated partnerships. For example, Gulati (1995) found the value from repeated partnerships decays rapidly – only the four previous partnerships benefit performance. Further, Goerzen (2007) found that firms often do enter into repeated partnerships, but doing so actually decreased economic performance. Thus, it appears the relationship between repeated partnerships in alliance networks and economic performance is more nuanced than previously theorized.

Social network scholars address variation in network form along two fundamental dimensions: relational embeddedness and structural embeddedness (M. Granovetter, 1992). The differences between these types of embeddedness can be understood by the differences between their operational definitions. Relational

embeddedness refers to the quality of dyadic exchanges – the degree to which exchange parties know of and consider one another's needs and goals (M. Granovetter, 1992). Operationally, the number of repeated partnerships often measures relational embeddedness. Empirical studies show that relational embeddedness attenuates transactional uncertainty as alliance partners playing specific roles come to know and understand each other's preferences through repeated interactions and exchanges (Grabher, 2002; Levinthal & Fichman, 1988; Uzzi, 1996). These characteristics prompted Borgatti and Foster (2003) to characterize relational embeddedness as "the pipes" within a network because relational embeddedness increases information *flow* between cooperating parties. Depending on the size of the "pipes," information flows are enhanced or reduced through relational embeddedness.

Structural embeddedness is the extent to which mutual contacts within a network are connected to one another (Granovetter, 1992: 35), framed as "the girders" within a network by Borgatti and Foster (2003). Operationally, structural embeddedness refers to the amount of indirect communication between third parties and how this communication affects the overall network structure. A greater amount of communication between third parties enhances structural embeddedness because organizational actors "will not only have direct relations, but also are linked indirectly to third parties, who are likely to have future interactions and talk about their interactions with one another" (Jones & Lichtenstein, 2008, p. 239). In the lead firm network case, structural embeddedness is more a measure of subcontractors and

their movement within and between lead firms than a direct measure of a particular lead firm's structure. Borgatti and Foster (2003) characterize structural embeddedness as "the girders" linking parties within the overall network, rather than "the pipes" which deal more with the quality and intensity of relationships. Overall, structural embeddedness tends to reduce transaction uncertainty and facilitate coordination in alliances as it "facilitates shared understandings and rules for collaboration that distinct organizations bring to their joint activities" (Jones & Lichtenstein, 2008, p. 239).

To summarize, choosing alliance partners can be viewed as a specific instance of Williamson's make-or-buy decision (Lorenzoni & Lipparini, 1999) with alliance networks exhibiting both relational and structural embeddedness (Jones & Lichtenstein, 2008). By integrating TCE with social network theory, "we can enhance our understanding of the origins and persistence of structural embeddedness and social mechanisms that allow network governance to emerge and thrive" (Jones, Hesterly, & Borgatti, 1997). Alliance networks are deliberately designed networks (Lorenzoni & Lipparini, 1999), which fits with Williamson's discriminating alignment hypothesis (Williamson, 1991). Finally, alliance networks incorporate the economic decisions at the dyad level associated with TCE and aggregate them up to the network level – with lead firm networks being a salient example (Lorenzoni & Lipparini, 1999; Provan, Fish, & Sydow, 2007).

Next, I describe a particular type of lead firm networks – those designed for temporary interorganizational projects. Temporary interorganizational projects

combine high time pressure, project complexity, multiple network partners, and a high need for coordination (Jones & Lichtenstein, 2008) – all of which are necessary for network governance to emerge and thrive (Jones, Hesterly, & Borgatti, 1997).

Temporary Interorganizational Projects

Interorganizational projects, "in which multiple organizations work jointly on a shared activity for a limited period of time, are increasingly used to coordinate complex products/services in uncertain and competitive environments" (Jones and Lichtenstein, 2008: 232). This type of joint collaboration has been studied in industries such as advertising, (Grabher, 2002), construction (R.G. Eccles, 1981), biotechnology (W. W. Powell, Koput, & Smith-Doerr, 1996) and financial services (Eccles & Crane, 1988; Podolny, 1993, 1994). Interorganizational projects thrive in both the public and private sectors. Jones and Lichtenstein (2008) cite several examples in the public sector, including large public infrastructure projects (Altshuler & Luberoff, 2003) and urgent responses to natural disasters and social crises (2005a; Moynihan, 2005b, 2005c). Interorganizational projects require governance forms that align with lead firm networks (R.G. Eccles, 1981; Provan, Fish, & Sydow, 2007). Jones and Lichtenstein (2008: 234) describe how firms intermingle in the temporary project space as lead firms and subordinates:

> In some cases, the (lead firm) is a coordinator of multiple independent entities, as for example a construction contractor working with dozens of individual contractors in 'quasi-firms' (Eccles, 1981), or large engineering firms that may employ hundreds of subcontracting companies in 'mega-projects' (Berggren, Soderlund, & Anderson, 2001). In a similar sense, the (lead firm) may represent multiple actors. In complex cases, multiple clients work with

multiple (lead firms) in large scale infrastructure projects (Morris & Hough, 1987).

In temporary organizing, the pool of potential partners that a lead firm can select from is stable, though partner firms often move among and between lead firms. This unique characteristic to temporary organizing increases structural embeddedness (M. Granovetter, 1992; Jones & Lichtenstein, 2008). Within this pool of structurally embedded network partners, subcontracting firms are more specialized and end up performing a similar task for multiple lead firms, sometimes engaging multiple lead firms in the same industry simultaneously (Bechky, 2006; R.G. Eccles, 1981; Jones & Lichtenstein, 2008).

In her study titled "Gaffers, Gophers, and Grips: Role Based Coordination in Temporary Organizations," Bechky (2006) studied structural embeddedness directly by examining the intermingling of subcontractors that serve the film industry. Due to the highly complex tasks and short time durations, subcontractors in the film industry are selected and monitored more through social mechanisms than formal contracts (Jones, Hesterly, & Borgatti, 1997; Walter W. Powell, 1990). Eccles (1981, p. 340) also found this in his study of construction firms, noting that relations between subcontractors and general contractors are generally stable and continuous over long periods of time. The effect of these highly embedded relationships suggests temporary projects are governed with more informal mechanisms. This contrasts with traditional hierarchies that view external relationships through arms-length contracts (Bechky, 2006, p. 3).

A key distinction of interorganizational project collaborations from more commonly studied interorganizational collaborations like joint ventures and strategic alliances, is that projects by definition are *temporary* (Jones and Lichtenstein, 2008: 232):

> Interorganizational projects exist for a limited period of time designated by pre-established end point in order to carry out pre-specified goals; when these goals are completed, the project organization literally dissolves … In contrast, joint ventures and alliances, at least in the literature that uses them, rarely specify an expected end date.

Eccles (1981) noted these conditions in his study of construction firms. Since temporary organizing is temporally limited (a film location or construction site) and site-specific: "Limitations are put on the length of time opportunism has to be suffered … And because jobs are performed on different sites … contract renewal for the next job is necessary since the relationship is automatically 'dissolved'" (R.G. Eccles, 1981, p. 342). More typical alliances, such as joint ventures and strategic alliances are established with an expectation of ongoing and open interactions (Jones and Lichtenstein, 2008). Traditional alliances facilitate access to unique resources and capabilities (Gulati, 1999) and having a portfolio of partners may provide a basis for competitive advantage (Dyer & Singh, 1998; Gulati, Nohria, & Zaheer, 2000; Hagedoorn & Duysters, 2002; Koka & Prescott, 2002; Zollo, Reuer, & Singh, 2002). However, due to the unspecified temporal dimensions of traditional alliance networks, empirical examination of temporal effects on organizational governance has received little attention (Anand & Khanna, 2000). While firms typically announce new alliances with great fanfare, reliable data on alliance dissolution is

rarely made available (Podolny & Page, 1998). Due to explicitly stated beginning and end dates, temporary networks provide a fruitful setting to examine both tie formation and dissolution among networks (Jones & Lichtenstein, 2008).

Jones and Lichtenstein (2008) suggest temporary alliance networks require special coordination techniques stemming from "temporal embeddedness." Temporal embeddedness captures "how the variance in the duration of projects influences what kinds of coordination techniques are used to manage uncertainty when multiple organizations collaborate to create a joint project or service" (Jones & Lichtenstein, 2008, p. 233). The concept of temporal embeddedness aligns nicely with Masten et al.'s (1991) exchange condition of temporal specificity. Temporal specificity suggests that "when timely execution by a partner is critical to success, delay becomes a potentially effective strategy for exacting price concessions" (Scott E. Masten, Meehan Jr., & Snyder, 1991, p. 9). Thus, in temporary projects, the exchange condition of temporal specificity is a key driver of organizational form. Jones and Lichtenstein (2008:240) define temporal embeddedness as "the expected duration of an interorganizational project," and I frame its impact on organizational forms as an exchange condition, consistent with Masten et al.'s (1991) temporal specificity.

Table 5 compares traditional alliance networks and temporary alliance networks in terms of the pre-conditions of network governance. As discussed in the previous chapter, by combining TCE with Powell (1990), Jones et al. (1997:918) identify four conditions necessary for network governance to emerge and thrive: "(1)

demand uncertainty with stable supply, (2) customized exchanges high in human asset specificity, (3) complex tasks under time pressure and (4) frequent exchanges among parties comprising the network."

Table 5: Comparing Traditional and Temporary Networks

Pre-Conditions for Network Governance	**Traditional Alliance Networks**	**Temporary Interorganizational Networks**
Demand Uncertainty	High	High
Stable Supply	Mixed to Low (Binding dyadic relations with unspecified time horizons)	High (Many lead firms/subcontractors to choose from with highly specified and short time horizons)
Customized Exchanges high in Human Asset Specificity	Yes	Yes
Frequent exchanges among partners	Yes	Yes
Task Complexity	High	High
High Time Pressure	Mixed to Low	High

Thus, temporary alliance networks represent a promising setting to study network governance as this setting meets each criteria for the emergence and persistence of network governance (Jones, Hesterly, & Borgatti, 1997). Next, I extend and amend previous conceptions of temporary project organizing (R.G. Eccles, 1981; Jones & Lichtenstein, 2008) by describing the process lead firms enact to design temporary networks and by defining a new term to capture variation across temporary networks – Aggregate Tie Strength.

<u>**Temporary Interorganizational Networks**</u>

Following Jones and Lichtenstein (2008), I use the term "temporary interorganizational network" (TIN) to refer to the network organizational form that a lead firm (ego) assembles in response to a temporary project. TINs are a network organizational form composed of two or more firms that is designed to complete a specific project over a known time duration. While Jones and Lichtenstein (2008) describe various "ideal types" of organizing for temporary projects, they do little to elucidate the mechanisms lead firms use in selecting partners. Next, I describe the iterative process of selecting partners to match project characteristics.

Figure 1 depicts the iterative process lead firms use to design a TIN around a project with known parameters. First, the lead firm receives a request for proposals (RFP) for a project with known characteristics. Then, this lead firm considers the population of available network partners, drawing on recent experience interacting with these partners (e.g. Gulati, 1995). The lead firm then designs a network architecture that represents the optimal match of network partner skills with project characteristics.

As depicted in Figure 1, when lead firms design TINs, they take into account the characteristics of a current project to determine "who does what" while simultaneously considering recent interactions with potential partners. Recall, relational embeddedness has been defined as "the degree to which exchange parties know of and consider one another's needs and goals (Granovetter, 1992)" – framed as "who does what" by Jones and Lichtenstein (2008).

Figure 1: The Iterative Design of a TIN According to Project Characteristics
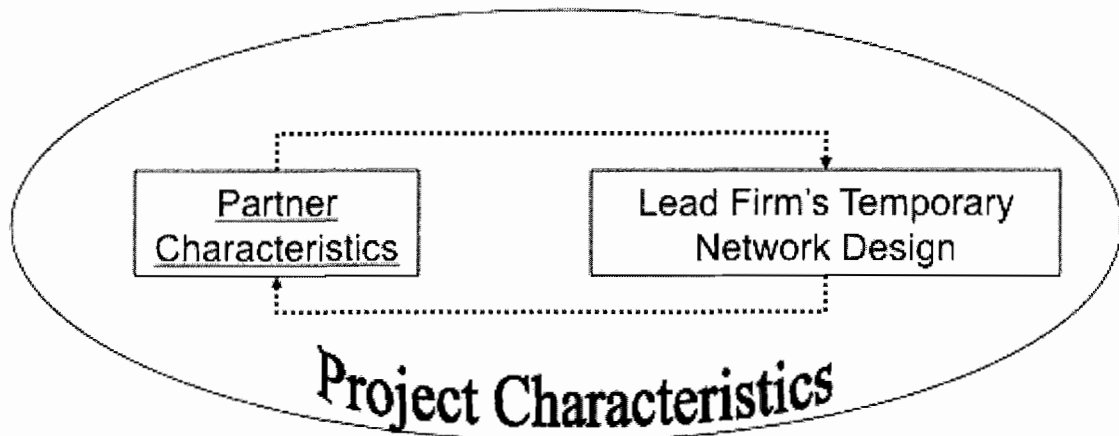
Second, the iterative design process accounts for the extent of repeated partnerships, a critical component of relational embeddedness (M. Granovetter, 1992; Jones, Hesterly, & Borgatti, 1997). Because TINs are transient organizational structures, lead firms will have worked with a large number of partners over several types of projects. Due to these experiences, they can assess how the quality of prior relationships with particular partners may affect the current project. Comparing the costs and benefits of these prior relationships enacts an iterative design process that ultimately results in a project specific TIN.

However, as reviewed in Chapter II, a limitation of past studies that examined the effects of repeated partnerships on organizational performance is that the value of prior partnerships is assumed to be durable over time. This suggests that the mere presence of a prior tie with a network partner brings value to a lead firm, but ignores the fact that the value of ties decays rapidly with time (Gulati, 1995). In order to

incorporate both the presence of previous ties and how their value may erode with time, I introduce a measure that captures relational embeddedness due to the presence of repeated ties, but also considers their value over time and any potential decay.

Aggregate Tie Strength: A Composite Measure of Network Structure

To capture these temporal aspects of how relational embeddedness affects the value of network ties, I introduce a composite measure of network structure, Aggregate Tie Strength. Aggregate Tie Strength (ATS) captures relational embeddedness in the context of TINs. However, my conceptualization of ATS extends previous treatments of repeated partnerships by limiting the temporal window through which a former tie adds value. Borrowing from Gulati's (1995) empirical finding that the value of repeated partnerships decays rapidly, my conceptualization of ATS only includes the sum of recent interactions between a lead firm and its network partners. Gulati (1995) empirically found that only the four most recent partnerships bring value to the current relationships, I use this finding and only account for the most recent partnerships to compute ATS. Thus ATS represents past relationships and future possibilities as interdependent, which more accurately reflects the decision processes in network partner selection (Poppo, Zhou, & Ryu, 2008).

Higher values of ATS indicate a TIN using fewer and better-known partners. Higher ATS values indicate a tight network with strong ties – high relational embeddedness, which can result from several scenarios. For example, high values

can result from either a large number of repeated partnerships that increase the value

of the numerator or from a lower value in the denominator (choosing only a select

few partners to do more of the work) or some combination of the two. Lower values

of ATS indicate lower tie strength, which is indicative of a wider network consisting

of more network partners, fewer repeated partners, and partners with more disparate

and more specialized skills. Having defined a measure to capture variation in

network organizational structure, next I revisit my research question: *How do*

exchange conditions and interfirm partnerships interact to affect the structure and

performance of temporary interorganizational networks?

Investigating the Relationship between Exchange Conditions, Network Governance Structure, and Performance

In this section, I develop an empirical model that allows testing how exchange

conditions affect the structure and performance of temporary interorganizational

networks (TINs). First, I present a general conceptual model (Figure 2) that reviews

the exchange conditions Jones et al. (1997) suggest are necessary for network

governance to persist. Figure 2 also extends their model into the context of TINs by

including temporal specificity as an exchange condition (Jones & Lichtenstein, 2008;

Scott E. Masten, Meehan Jr., & Snyder, 1991). TINs represent an exciting theoretical

setting to investigate how exchange conditions and network governance structure

affect network organizational performance. The remainder of this chapter develops

conceptual and empirical models specific to the context of temporary organizing, using TINs to test these relationships.

To extend the general model shown in Figure 2, I propose a relationship exists between exchange conditions, network governance structure, and performance. Performance is defined as the lowest total cost for structuring a TIN. Costs for structuring a TIN arise from exchange conditions (Jones, Hesterly, & Borgatti, 1997), but they also arise from the quality of the relationships a lead firm has with its partners (M. Granovetter, 1992; Gulati & Singh, 1998). Relational embeddedness captures the quality of relationships a lead firm has with its partners and is also a primary driver of organizational forms (M. Granovetter, 1992; Jones, Hesterly, & Borgatti, 1997; Jones & Lichtenstein, 2008). These factors give me reason to believe that both exchange conditions and relational embeddedness (ATS) affect performance. In the following paragraphs, I develop an empirical model to capture both the moderating and mediating effects that exchange conditions and ATS have on performance.

Figure 2: Exchange Conditions Common to TINs (Adapted from Jones at al., 1997)
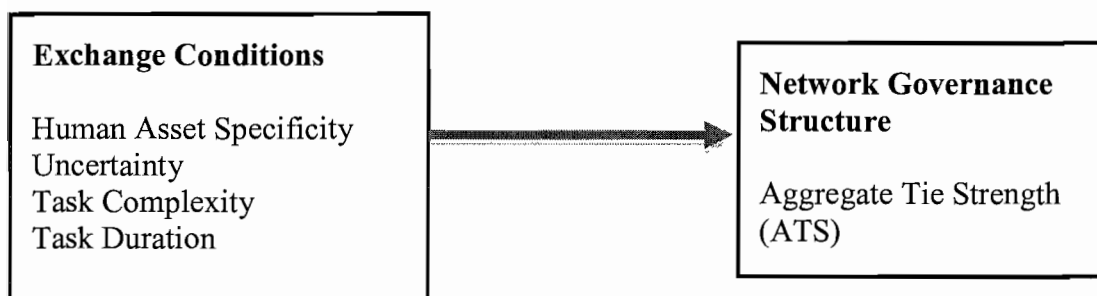
Figure 2 specifies the exchange conditions needed for network governance to emerge as shown in Jones et al., (1997) (human asset specificity, uncertainty, task complexity) and adds temporal specificity in the form of task duration (Jones & Lichtenstein, 2008; Scott E. Masten, Meehan Jr., & Snyder, 1991). It is worth noting that high human asset specificity is especially prevalent in networks and in TINs (Jones, Hesterly, & Borgatti, 1997; Jones & Lichtenstein, 2008). Additionally, customization of products and services is common among firms cooperating in networks (Miles & Snow, 1992). The interaction of high human asset specificity and high product customization increases the risks associated with human assets "quitting" an exchange or reducing their efforts (Jones, Hesterly, & Borgatti, 1997, p. 920), because in the more ephemeral relationships found in networks, these "assets" are more dependent upon one another's cooperation to complete an exchange (Coff, 1993). For this study, I do not measure human asset specificity directly; rather I follow Jones et al. (1997) and treat human asset specificity as a necessary component of all exchanges that occur within TINs. Thus, Figure 2 serves as a general conceptual model for how certain exchange conditions affect governance structure in the context of TINs.

While Jones, et al. (1997) proposed the interaction of these effects broadly promotes embeddedness among network partners, I am interested in extending Figure 2 to look at the joint effects of exchange conditions and network structure on performance. To model exchange conditions, I use project characteristics and to model governance structure, I follow other scholars who have used lead firm

networks to unpack how the these networks are designed and the implications of network design on performance (Lorenzoni & Lipparini, 1999; Provan, Fish, & Sydow, 2007).

As discussed previously, TINs represent a salient example of lead firm networks because they combine economic and sociological logics to explain network structure and performance. In economics, networks have been treated as a variant of the make-or-buy decision (Gulati & Singh, 1998; Lorenzoni & Lipparini, 1999). The same logic by which firms choose between the extremes of make-or-buy (Scott E. Masten, Meehan Jr., & Snyder, 1991; Monteverde & Teece, 1982; Walker & Weber, 1984) is expected to continue once firms elect to form an alliance (Gulati & Singh, 1998). Additionally, alliance networks exhibit relational embeddedness (Jones & Lichtenstein, 2008), a critical measure in sociology. Since lead firm networks are deliberately designed networks, these networks fit with Williamson's discriminating alignment hypotheses (Williamson, 1991). This suggests that lead firms select partners to reduce production and transaction costs according to factors that align exchange conditions with the cumulative capabilities found among a TIN's partners.

Research suggests the quality of relationships between partners drives the economic performance of these organizational forms (Robert G. Eccles, 1981; R.G. Eccles, 1981; Lorenzoni & Lipparini, 1999). For example, Eccles (1981a, b) found a select, persistent set of well-known and trusted subcontractors improves the efficiency of organizing in the construction industry. Lorenzoni and Lipparini (1999) found that as the quality of partners increases, the costs of organizing are reduced.

Lorenzoni and Lipparini (1999) link these cost efficiencies to gains from tight, repeated, and trust-based partnerships that bring both sustainable competitive advantage and cost economies to organizing. Collectively, these studies suggest that exchange conditions do not provide a complete explanation of the performance of networks; only when exchange conditions are linked with partner characteristics can performance be fully explained. This is a very strong statement, implying that repeated partnerships explain why or how exchange conditions cause performance. Analytically, this logic requires a test of mediation (Baron & Kenny, 1986). As described earlier, I operationalize repeated partnerships as *Aggregate Tie Strength* (ATS) and, following these scholars, propose that ATS mediates the relationship between exchange conditions and performance.

From Mediation to Moderation

Scholars have shown that exchange conditions and repeated partnerships can have synergistic effects on performance (Gulati, 1998; Poppo, Zhou, & Ryu, 2008). Exchange conditions and past partnerships are necessarily intertwined as origins of economic efficiency (M. Granovetter, 1985; Lorenzoni & Lipparini, 1999; Poppo, Zhou, & Ryu, 2008). Repeated partnerships act as a "social lubricant" to transactions that enhances task coordination between parties engaging in network partnerships (Gulati, 1998). Additionally, parties that choose to cooperate in repeated partnerships develop "credible assurances" that partnerships will continue into the future (Dyer & Singh, 1998). This expectation of continuity is an effective contractual safeguard

because repeated partnerships and long-term contractual relationships contain customized provisions that safeguard exchanges from opportunistic behaviors (Poppo & Zenger, 2002).

Poppo et al. (2008) suggested exchange conditions influence the expectation of continuity among network partners. This proposed interaction of exchange conditions and repeated partnerships in shaping network performance requires an analytic test of moderation. Figure 3 shows the complete empirical model for this study.

Figure 3 depicts the tests of mediation using solid lines and depicts the tests of moderation using dashed lines. For the mediation analysis, ATS mediates the relationship between project characteristics and performance. I begin with hypotheses to test the direct effect of project characteristics on ATS (Hypotheses 1a-c), followed by a hypothesis that tests the direct effect of ATS on performance (Hypothesis 2a). The relationships for these direct effects are depicted with solid arrows between variables. The dashed arrows shown below depict the interaction between exchange conditions and ATS. As described above, exchange conditions are expected to enhance or reduce the direct effect of ATS on performance (Poppo, Zhou, & Ryu, 2008).

Exchange Conditions and Governance Structure

In order to unpack the effects of exchange conditions on network structure, I begin by examining how project characteristics affect the structure of TIN's. Under a

discriminating alignment approach (Williamson, 1991), lead firms will design

networks to reduce the production and coordination costs on a project-by-project

basis.

Figure 3: General Empirical Model
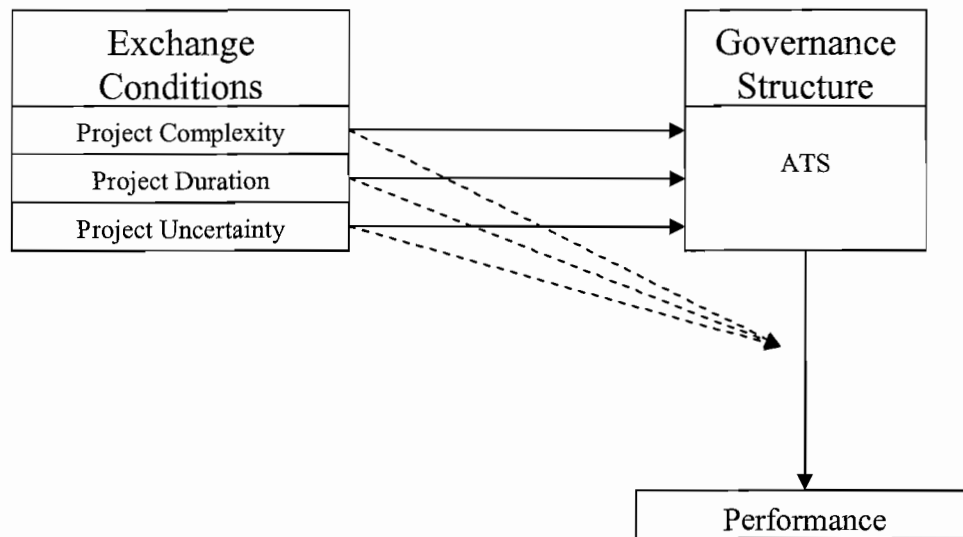
Since network governance relies on the interdependence of embeddedness and

exchange conditions, I develop a series of hypotheses according to literature from

TCE (Scott E. Masten, Meehan Jr., & Snyder, 1991; Poppo & Zenger, 1998; Walker

& Weber, 1984; Williamson, 1975, 1985b, 1991), capabilities (e.g. Eisenhardt &

Martin, 2000; David J. Teece, Pisano, & Shuen, 2000), and alliances (e.g. Dyer and

Singh, 1998; Dyer and Hatch, 2006; Gulati and Singh, 1998) on how these literatures

jointly inform network partner selection. From TCE and Capabilities, a firm should

internally produce goods that are close to its area of expertise, core to its business,

and related to items it already produces (J. B. Barney, 1986; Prahalad & Hamel, 1990;

Wernerfelt, 1984) . From alliance literatures, firms should seek to exert higher levels of hierarchical control when forming alliances with these same three properties (R.G. Eccles, 1981; Gulati & Singh, 1998). By combining insights from these two literatures, I offer hypotheses that link partner selection to project complexity, project duration and project uncertainty. Figure 4 outlines hypotheses 1a-c that unpack this relationship.

Figure 4: Hypothesis 1 – How Do Exchange Conditions Affect ATS?

Project Complexity	H1a (-)	ATS
Project Duration	H1b (+)	
Project Uncertainty	H1c (+)	
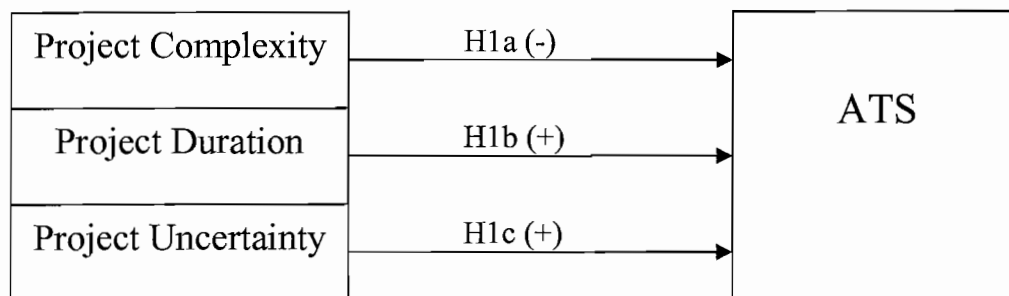
Project complexity is defined as the number of specialized inputs required to complete a project (Jones, Hesterly, & Borgatti, 1997). As project complexity increases, the number and specialization of tasks increases, which affects production by increasing the amount and types of equipment needed, increasing the diversity of materials used, and increasing the amount of subcontracting (Robert G. Eccles, 1981). Under these highly complex conditions, the network form of governance is particularly suited to integrating the actions of multiple autonomous firms (Jones, Hesterly, & Borgatti, 1997).

This discussion is similar to modularity (Sanchez & Mahoney, 1996). Modularity is founded on an expectation that "strategies, technologies, and transactions all change over time" (Baldwin, 2008, p. 156) which encourages firms to conduct transactions through loosely-coupled networks or "modular organizations" (Hoetker, 2006). Modular organizations are designed around loose-couplings between organizational units allowing the various units involved in production to operate autonomously and be easily reconfigured (Hoetker, 2006; Sanchez & Mahoney, 1996). Hoetker (2006:502) suggests that in modular organizational design, characteristics of the organization mirror the characteristics of the product:

> A new notebook computer model requires the design of the computer as a whole and of components including the hard drive, display and keyboard. The notebook manufacturer organizes the design process by choosing a supplier for each component and structuring the coordination between them. During the product design process ... the suppliers will develop their respective components, the firm will develop the end product, and they will work together so that the individual components integrate effectively into the end product.

In modular organizations, "a tightly integrated hierarchy is supplanted by a loosely – coupled network of organizational actors" (Schilling & Steensma, 2001, p. 1149). Within these loosely-coupled networks, transactions are not technologically determined, rather, they arise through the interplay of cooperating firms' knowledge and resources and in alignment with a specific opportunity (Baldwin, 2008). Collectively, this literature on modular organizations suggests that as project complexity increases, organizational characteristics will mirror those of the project and increase in complexity as well.

Another reason lead firms may reduce relational embeddedness when complexity is high is to take advantage of knowledge and skills found among their wider network of partners. Lead firms can benefit from external firms' expertise when pursuing complex projects (Argyres, 1996; Grant, 1996; Kogut & Zander, 1992; Rubin, 1973). Additionally, complex projects may benfit from leveraging the flexibility of the network form of governance to integrate multiple autonomous, diversely skilled parties to complete a project (Brusoni, Prencipe, & Pavitt, 2001). The use of more diverse partners that complete a greater portion of the work reduces relational embeddedness and results in a lower value of ATS.

Hypothesis 1a: *Higher levels of project complexity will be associated with lower levels of ATS within TINs*

Project duration is associated with the size of a project. Eccles (1981) suggested project duration is directly linked to project size because it is reasonable to assume larger projects require more labor, materials, and are more costly. Large, high budget projects are associated with longer time durations (Jones & Lichtenstein, 2008) and induce lead firms to form stable and continuous relations with their partners (R.G. Eccles, 1981). Longer interactions enhance incentives for greater cooperation, which increases the cost-effectiveness of trust as a contractual safeguard (Poppo, Zhou, & Ryu, 2008). For example, "when the expected payoffs from a finite series of cooperative exchanges are known and large compared to the gains of defecting in the present [and losing the stream of returns from future business],

parties choose to cooperate" (Poppo, Zhou, & Ryu, 2008, p. 41). Longer projects increase expectations of continuity, trust, and enhance the transfer of private or tacit knowledge (Dyer & Singh, 1998; Ring & Van de Ven, 1992; Tesler, 1980). Each of these conditions suggests projects of greater duration will encourage stronger networks with a dense cluster of strong ties so that firms can capitalize on these benefits.

Longer durations also allow firms to gain efficiencies from developing superior interorganizational routines (Nelson & Winter, 1982) and these longer relationships allow cooperating firms to derive benefits from dedicated resources (Kale, Dyer, & Singh, 2002). A select group of partners that interact over time derives benefits from information sharing (Dyer, 2000; Hayes, Wheelwright, & Clark, 1988), trust (Zaheer, McEvily, & Perrone, 1998) and greater cooperation (Carson, Madhok, & Wu, 2006; Heide & John, 1990). Using a smaller group of partners with long standing relationships increases relational embeddedness and results in a higher value of ATS, which provides the logic for hypothesis 1b:

Hypothesis 1b: *Higher levels of project duration will be associated with higher levels of ATS within TINs*

Uncertainty has been a central component of multiple theories of organizations (March & Simon, 1958; Jeffrey Pfeffer & Salancik, 1978; Thompson, 1967). Researchers in strategic management have also considered uncertainty as a major factor affecting strategic decisions (M. Porter, 1980). Within strategic

management, Williamson (1985) suggested two types of uncertainty most affect the transaction environment, *primary* and *secondary* uncertainty. Primary uncertainty refers to a lack of knowledge about exogenous states of nature, whereas secondary uncertainty refers to a lack of knowledge about other economic actors (Williamson, 1985b).

Project uncertainty, as used in this study, fits Williamson's definition of primary uncertainty. Project uncertainty arises from exogenous sources and is a characteristic of the task environment for a particular project. While the alliance literature suggests pure task uncertainty can be reduced only over time (Santoro & McGill, 2005), it also characterizes task uncertainty as a cause of more endogenous forms of uncertainty, which can be reduced by a firm's actions (Folta, 1998). Thus, task uncertainty and secondary uncertainties work in concert to explain the structure and performance of TINs.

An increase in the uncertainty within a firm's task environment also increases risks from behavioral (secondary) uncertainty arising from opportunism (Williamson, 1985b). Sutcliffe and Zaheer (1998) suggest that primary and behavioral uncertainty are interdependent and jointly inform network partner selection. Within TINs specifically, two types of secondary or "supplier uncertainty" (Sutcliffe & Zaheer, 1998) affect TIN organization the most. These types of secondary uncertainty arise from the volume of use for a transaction-specific technology and the potential for opportunistic behaviors by network partners.

Jones and Lichtenstein (2008) suggest volume uncertainty and behavioral uncertainty among partners affect temporary organizing the most. Volume uncertainty refers to the anticipated volume of use for a particular technology, asset or transaction component and the confidence placed upon estimates of its future demand (Walker & Weber, 1984). Due to its rigid role structure among subcontractors (Bechky, 2006; R.G. Eccles, 1981) temporary organizing reduces some concerns of volume uncertainty, but the positive effects of role coordination diminish as uncertainty increases. Role based coordination arises from repetitive, continuous and unchanging future opportunities, such as the workers that hold microphone booms for film projects (Bechky, 2006). However, when future opportunities are not as predictable, role-based coordination is dominated by relational mechanisms and trust (Jones & Lichtenstein, 2008). Eccles (1981) found an increasing reliance on trust in uncertain situations in the home building industry, an industry where quasi-firms and temporary networks are the dominant organizational form. Eccles (1981) found that general contractors preferred to use the same set of subcontractors whose work they knew they could rely upon.

Behavioral uncertainty increases risks associated with appropriability (Oxley, 1999) and favors engaging fewer partners and employing internal governance (Dyer, 1996a; Walker & Weber). Additionally, behavioral uncertainty coupled with task uncertainty makes comprehensive contracting with partners more difficult (Argyres & Mayer, 2007; Hart, 1995; Williamson, 1985b). Finally, "a lack of experience with a partner will increase concerns about the potential quality and quantity of that

partner's contributions, especially when task uncertainty is high … partner uncertainty will compound the risks from task uncertainty" (Santoro & McGill, 2005, p. 1263). Networks higher in shared experience and smaller in total number of partners will exhibit a higher value of ATS, which sets up hypothesis 1c:

Hypothesis 1c: *Higher levels of project uncertainty will be associated with higher levels of ATS within TINs*

Next, I examine the interaction of project characteristics and network structure on network organizational performance. Recall, for this study organizational performance increases as transaction and production costs decrease (Coase, 1937; Williamson, 1975). Network governance is expected to be observed in situations where the embeddedness of transactions within a wider social network enhances organizational effectiveness by safeguarding exchanges more effectively than markets, and adapting more effectively than hierarchies (Jones, Hesterly, & Borgatti, 1997).

Exchange Conditions, Governance Structure and Performance: Direct and Moderated Effects

To test the interaction between exchange conditions and governance structure on performance, a test of moderation is required. Within the specific context of TINs, exchange conditions are expected to moderate the direct relationship between governance structure (ATS) and performance. Figure 5 (below) models the direct

effect between ATS and performance (solid arrow) and the moderating effect that

exchange conditions have on ATS (dashed arrows). Depending on the type of

exchange condition, higher (lower) levels of ATS will enhance (reduce) the

performance of network governance. Through a series of hypotheses, I unpack how

exchange conditions moderate the direct effect of ATS on performance in temporary

interorganizational networks.

Figure 5: Testing the Moderating Effects of Exchange Conditions on Governance Structure and Their Joint Impact on Performance
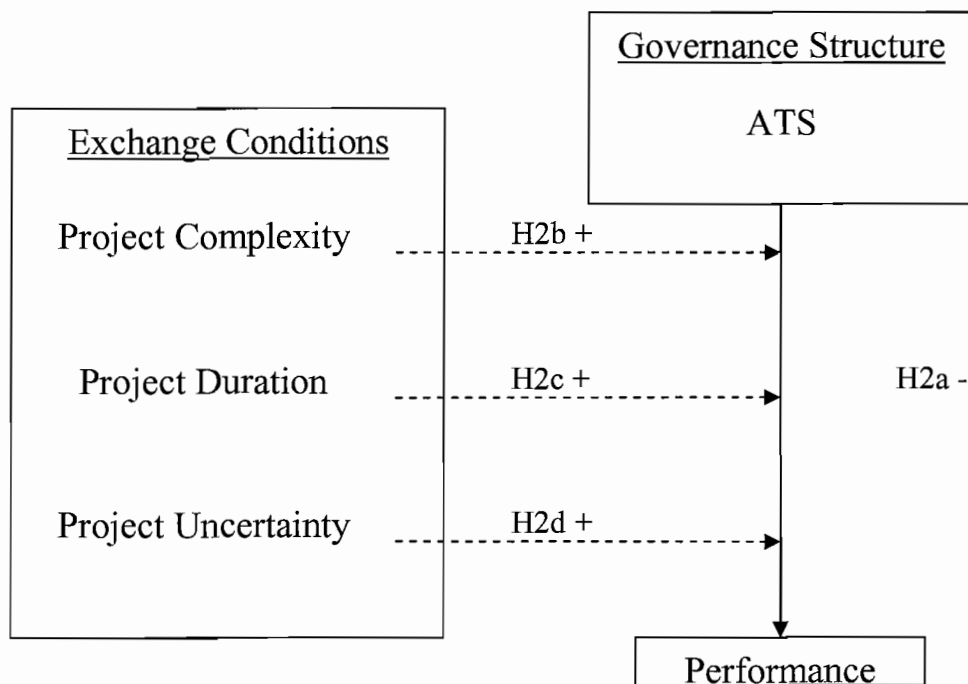
When considering the direct effect of governance structure on performance,

one needs to consider how TINs differ from other governance structures. As

described earlier, TINs are a specific variant of network organization that may or may

not derive benefits from relational embeddedness that are common in other

organizational forms. For example, relational embeddedness has been shown to increase performance in more hierarchical governance forms due to efficiencies gained from information sharing (Dyer, 2000; Hayes, Wheelwright, & Clark, 1988), trust (Zaheer, McEvily, & Perrone, 1998) and greater cooperation (Carson, Madhok, & Wu, 2006; Heide & John, 1990). However, these governance forms are more permanent than those formed for temporary projects and the benefits from repeated partnerships may not be as prevalent in TINs.

Within TINs, the pool of potential partners that a lead firm can select from is large, stable, and highly specialized. Due to the high degree of specialization, partner firms tend to work among and between lead firms performing similar functions, instead of working with a select few lead firms and developing complex functions (Bechky, 2006; R.G. Eccles, 1981; Jones & Lichtenstein, 2008). Kim, Oh and Swaminathan (2006) suggest network governance is particularly susceptible to adverse effects from relational embeddedness, because ties are formed and dissolved with increasing frequency. They argue that forming and dissolving ties are each associated with costs, and scholars cannot assume the same benefits found in hierarchies translate directly to networks.

Research on the formation and dissolution of network ties has largely assumed that changes in network structure result in beneficial or positive outcomes (Podolny & Page, 1998). This literature suggests changes in network partners are a critical strategic option for firms seeking to improve their capabilities (Hennart, Kim, & Zeng, 1998; Jones, Hesterly, Fladmoe-Lindquist, & Borgatti, 1998). Under this

framework, "if organizations are dissatisfied with partners that do not provide the desired resources, they attempt to change their partners to gain access to such resources from new partners" (Kim, Oh, & Swaminathan, 2006, p. 704). Because scholars treat tie formation and dissolution as discrete events and not as a sequence of events that unfold over time (Kim, Oh, & Swaminathan, 2006), their theories largely assume that tie formation and dissolution is easy and results in increasing strategic flexibility. However, when tie formation and dissolution are considered as sequences of events that unfold over time, the embedded nature of interorganizational ties reduces flexibility (Uzzi, 1996). This is particularly true in repeated partnerships where relationship-specific routines and co-developed assets further embed relationships between cooperating parties. In these cases of heightened constraint, Kim, Oh, and Swaminathan (2006) suggest "network inertia" may actually reduce beneficial outcomes that could be achieved by changes in network partners. I aim to investigate the effects of network inertia within the specific context of TINs.

According to structural inertia theory, inertia is an inevitable result of creating a well-tuned organizational architecture that exploits strategic advantage (Barnett & Carroll, 1995; Hannan & Freeman, 1984). Kim et al. (2006: 705) characterize network inertia in a similar fashion: "Network inertia can be regarded … as a by-product of the previously successful management of networks that generate synergies for the participating organizations." Thus, relationships with partners that resulted in past success are likely to be repeated. Over time, this behavior can result in "competency traps" that actually reduce performance. Competency traps occur when

a favorable performance is attributed to an inferior routine, which causes

organizations to continue building and refining that routine at the expense of other,

better routines (Levitt & March, 1988). In the TIN context, positive performance

outcomes from partnering with a select few partners will be repeated, but these

outcomes discourage the selection of potentially better TIN partners in the future.

Due to the nature of network inertia and its increasing embeddedness between TIN

partners over time, competency traps are likely to decrease performance. This

informs the direct effect between ATS and performance. Higher values of ATS are

associated with higher values of embeddedness, which suggests the following

hypothesis:

> *H2a:* *As ATS increases, temporary interorganizational network performance*
> *decreases*

In addition to the direct effect of embeddedness on performance, scholars

have shown that exchange conditions and embeddedness can have synergistic effects

on performance (Gulati, 1998; Poppo, Zhou, & Ryu, 2008). Exchange conditions and

past partnerships are necessarily intertwined as origins of economic efficiency (M.

Granovetter, 1985; Lorenzoni & Lipparini, 1999; Poppo, Zhou, & Ryu, 2008).

Poppo et al. (2008) suggest that when exchange conditions and embeddedness work

collectively, their joint effects have a stronger impact on organizational performance.

In the following hypotheses, I predict that the interactions between embeddedness and

exchange conditions will produce a synergistic effect on performance.

Exchange Conditions as Moderators of the Effect of Governance Structure on Performance

Project Complexity

Project complexity increases the number of specialized inputs necessary to complete a project (Jones et al., 1997), which increases the coordination costs in networks. Gulati and Singh (1998:782) define coordination costs in networks as "the anticipated organizational complexity of decomposing tasks among partners along with the coordination of activities to be completed jointly or individually across organizational boundaries and the related extent of communication and decisions that would be necessary." In situations where hierarchy is the preferred governance mode, high complexity is expected to lead to an increase in hierarchical controls, because such controls facilitate coordination, especially in situations of high interdependence (Barnard, 1938; Chandler, 1962; Thompson, 1967). The higher the anticipated interdependence between network partners, the higher the coordination costs (Gulati & Singh, 1998). Gulati and Singh (1998) conclude that in cases where coordination costs are high and complexity enacts higher interdependence between network partners, more hierarchical forms, such as alliances and equity joint ventures will result in better performance. Because joint ventures typically create shared equity between partners, they act more like a single entity and have their own hierarchical controls that allow managers to make on-the-fly adjustments more effectively than other alliance forms (Parkhe, 1993; Pisano, Russo, & Teece, 1988).

However, in cases where TINs are the preferred governance mode, project complexity has the opposite effect and causes more modular forms of organizations to emerge. Modular organizations address coordination demands by supplanting more hierarchical alliance forms with a loosely coupled network of cooperating partners (Hoetker, 2006). The central argument within modular systems is that while complex projects may contain multiple interdependent components, the firms that produce these components are interchangeable (Sanchez & Mahoney, 1996). Modular organizations actually derive benefits from complexity, because if decision makers are dissatisfied with a particular supply-chain firm, they can drop that firm while creating minimal disruption to the overall project (Schilling & Steensma, 2001). Because TIN's operate in industries where an adequate stock of role-based specialties exist (Bechky, 2006; R.G. Eccles, 1981) subcontracting firms can be swapped in and out with relative ease and at minimal cost (Hoetker, 2006).

To summarize, when project complexity is high, TINs that are designed more like modular organizations will have better performance. TINs designed like modular organizations will have lower values of ATS, reflecting a wider network, fewer repeated partnerships, and a network of specialized and interchangeable partners. Within the specific context of TINs, increasing project complexity will tend to decrease values of ATS. This suggests that increasing levels of project complexity will counteract the direct effect of ATS on performance.

H2b: *The negative influence of ATS on performance is moderated by project complexity such that at higher levels of project complexity, the impact of ATS on performance is lower*

Figure 6: Project Complexity Moderates the Direct Effect of ATS on Performance
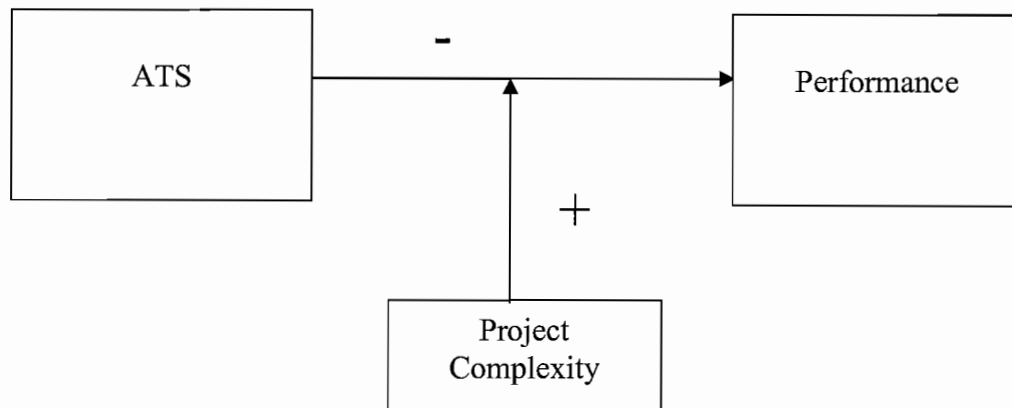
Project Duration

The second exchange condition expected to moderate the governance structure/performance relationship is project duration. Because TINs are a temporary governance structure, managing them over longer durations forces lead firms to balance between opposing forces: more flexible networks that facilitate adaptation versus more stable networks that facilitate coordination and increase efficiency. Provan and Kenis (2008) propose that longer project durations favor network structures with a strong central figure, such as lead firm networks. They suggest longer time horizons favor stability over flexibility, because efficiency gains arising from stable networks and known partners improve performance. Efficiency in networks primarily arises through trust, shared experience, and a mutual

understanding of each other's needs and goals (Gulati, 1998; Provan & Kenis, 2008); all of which depend upon the amount of repeated partnerships and relational embeddedness that partners bring to the TIN at its inception.

Efficiency gains from network stability are improved by partners' past history and by partners' shared expectation for the project's future (Ariño & Reuer, 2004). When projects have longer durations, the "shadow of the future" tends to make the partnership self-reinforcing and causes partners to think in win-win terms rather than in a zero-sum way (Ariño & Reuer, 2004; Poppo, Zhou, & Ryu, 2008). This suggests that when project duration increases, lead firms benefit more from strong and dense networks with deeply embedded partners.

Eccles (1981) noted that in industries where temporary organizing is present, relations between subcontractors and general contractors are generally stable and continuous over long periods of time because cooperating firms derive efficiency advantages from knowing each other's tendencies and routines and from sharing common expectations. Nelson and Winter (1982) echo these findings, noting how longer durations allow firms to gain efficiencies from developing superior interorganizational routines. Kale, Dyer and Singh (2002) agree, suggesting longer relationships allow cooperating firms to derive benefits from dedicated resources. A select group of partners that interact over time derive benefits from information sharing (Dyer, 2000; Hayes, Wheelwright, & Clark, 1988), trust (Zaheer, McEvily, & Perrone, 1998) and greater cooperation (Carson, Madhok, & Wu, 2006; Heide & John, 1990).

Select groups of partners who repeatedly work together form networks with high values of ATS. Repeated interactions increase relational embeddedness, which facilitates coordination as partners know and understand each other's preferences (Grabher, 2002; Levinthal & Fichman, 1988; Uzzi, 1996). Greater coordination attenuates transaction uncertainty, increases efficiency of exchanges, and improves performance. Collectively, these arguments suggest that projects with greater duration will lessen the negative direct effect of ATS on performance. For extremely long projects, such as those lasting several years, the efficiency gains found through strong and dense networks (high ATS) may overcome the negative performance from high ATS on shorter projects. This logic supports the following hypothesis:

H2c: *The negative influence of ATS on performance is moderated by project duration such that at higher levels of project duration, the impact of ATS on performance is lower*

Figure 7: Project Duration Moderates the Direct Effect of ATS on Performance
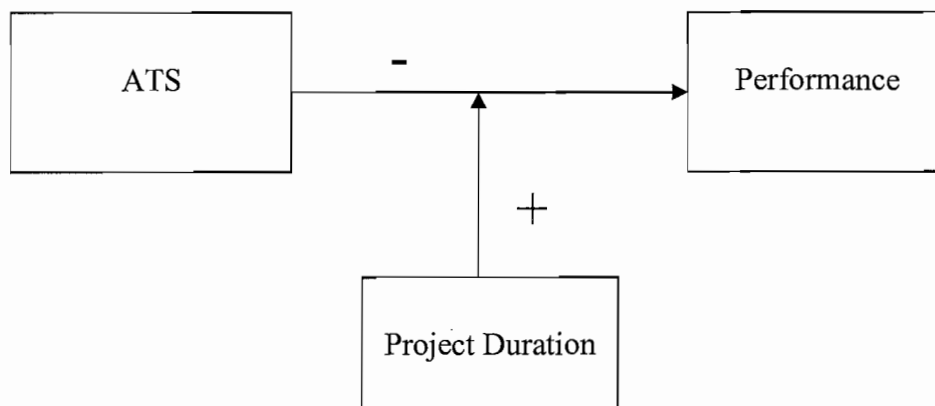
Project Uncertainty

Finally, ATS and project uncertainty are expected to have an interactive effect on performance. Project uncertainty is a characteristic of a TIN's task environment. When project uncertainty increases, risks associated with behavioral uncertainty and opportunism increase (Williamson, 1985b). When considered together, project uncertainty and behavioral uncertainty simultaneously inform network partner selection (Sutcliffe & Zaheer, 1998). When TINs are designed under higher levels of project uncertainty, lead firms must assess the resources a potential partner brings to the TIN and assess how the value derived from that partner's resources may change in the face of drastic changes in the external environment (Ariño & Reuer, 2004). Some unanticipated changes may increase the value of a partner's resources while others may decrease the value of that partner's resources (Zajac & Olsen, 1993). For example, Ariño and colleagues (Ariño, Torre, Doz, Ring, & Lorenzoni, 2002) showed how a seemingly straightforward alliance between Coca-Cola and Nestle, formed to distribute the iced coffee Nescafe, actually hurt Coca-Cola's sales in other areas. Neither Coca-Cola nor Nestle anticipated this prior to forming the alliance, thus contingencies for handling this development were not included in their initial contract (Ariño, Torre, Doz, Ring, & Lorenzoni, 2002). The inability of these partners to adapt to this new information ultimately led to the dissolution of the alliance between Coca-Cola and Nestle (Ariño & Reuer, 2004).

Because these future changes in value are unknown at the time an alliance is formed, Reuer, Zollo and Singh (2002) suggest the initial governance decision is only one component of a much broader series of challenges that cooperating firms must adjust to in the face of uncertainty. The increasing reliance on adaptation under high uncertainty favors TINs higher in relational embeddedness, because prior experience with a partner increases flexibility and allows for lower cost adaptations (Luo, 2002).

In addition to costs arising from unknown future adaptations, costs from uncertainty in networks also arise from concerns about future specifications, cost uncertainties, and problems associated with observing partners' contributions (Gulati & Singh, 1998). Each of these conditions increases the risks of moral hazard and encourages the incorporation of more hierarchical controls in networks (Oxley, 1997; Pisano, 1989; Pisano, Russo, & Teece, 1988). Within TINs, pressures that might encourage hierarchical controls are met instead by increasing relational embeddedness. Increasing relational embeddedness through repeated partnerships and by using fewer and better-known partners allows for greater cooperation and allows for adaptation at lower costs (Luo, 2002). These arguments imply that as project uncertainty increases, TINs will adapt better if they have higher values of ATS. To test this relationship, I hypothesize that increasing values of project complexity will lessen the negative direct effect of ATS on performance.

> *H2d:* *The negative influence of ATS on performance is moderated by project uncertainty such that at higher levels of project uncertainty, the impact of ATS on performance is lower*

Figure 8: Project Uncertainty Moderates the Direct Effect of ATS on Performance
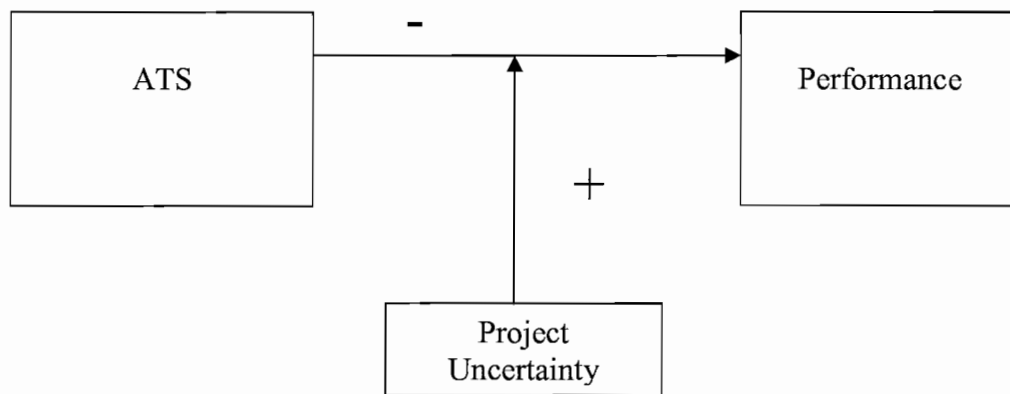
An Analysis of Learning Across a Population of TINs

A vast literature touts the learning benefits to firms from participating in networks. Network ties are conduits for rapid knowledge transfer between partners (Contractor & Lorange, 1988; Hamel & Prahalad, 1991; Kogut). Networks allow collaborating firms to internalize one another's skills (Hamel, 1991b). Finally, the dynamic capabilities literature suggests that learning is path dependent and "often a process of trial, feedback, and observation" (David J. Teece, Pisano, & Shuen, 1997, p. 523). I aim to investigate learning within the specific context of TINs.

Path dependent learning, due to its incorporation of feedback mechanisms, aligns with behavioral learning theories. Behavioral learning theories depict learning as a mechanistic and involuntary process where firms are assumed to repeat behaviors that lead to pleasant outcomes and discontinue behaviors that lead to unpleasant outcomes (Starbuck & Hedberg, 2001). One advantage of behavioral theories is they

can explain how learning can improve over time, even when information about individual manager perceptions is unavailable (Starbuck & Hedberg, 2001). I adopt a behavioral perspective to learning and develop hypotheses that measure the adoption of a network design based on past success or failure of this design across a population of network organizations, holding project characteristics constant across time.

Population level learning is defined as "a systematic change in the nature and mix of routines in a population of organizations arising from shared experience" (Miner & Haunschild, 1995). Thus, population level learning is largely a study of imitation – with the increasing adoption of successful routines drawing the majority of scholars' attention (Miner, Kim, Holzinger, & Haunschild, 1996). Like their counterparts in the network literature, scholars of population level learning largely ignore failure. When failure is examined, population ecology scholars (Hannan & Freeman, 1984) and a few studies of bankruptcy and disasters (Perrow, 1984; Sutton & Callahan, 1987) treat failure as an outcome, and their findings are limited to causal models of failure – what predicts it and how to avoid it (Miner, Kim, Holzinger, & Haunschild, 1996). By treating failure as an independent variable, scholars can ask a completely different series of questions. Specific to population level learning, treating success or failure as an independent variable allows scholars to investigate how success/failure at the organization level may affect a transformation at the population level (Miner, Kim, Holzinger, & Haunschild, 1996).

Miner, et al., (1996) suggest learning from success or failure at the population level is evidenced by the increasing adoption of successful routines and the removal

of routines that led to failure. They offer Volti's (1992) account of the removal of the Pony Express mail delivery routine once railroads rose to prominence. Following the rise of railroads, the nature and mix of routines for delivering transcontinental mail changed and the removal of the Pony Express represents learning from failure (Miner, Kim, Holzinger, & Haunschild, 1996, p. 240). I am interested in whether these same effects – the increasing adoption of beneficial routines and the removal of deleterious routines happens in the context of temporary interorganizational networks. Since the quasi-firm or temporary organization is characterized by a tight-knit culture of subcontractors intermingling with lead firms (Bechky, 2006; R.G. Eccles, 1981; Jones & Lichtenstein, 2008), these firms watch each other, communicate with each other, and learn each other's routines over time. To study learning from success and failure from these interactions, I offer the following hypotheses:

> *H3a:* *Populations of network organizations learn from success. When new projects have similar characteristics to past projects, organizations will exhibit learning by increasing the occurrence of TIN's that previously succeeded*

Figure 9: Learning From Success Across a Population of TINs
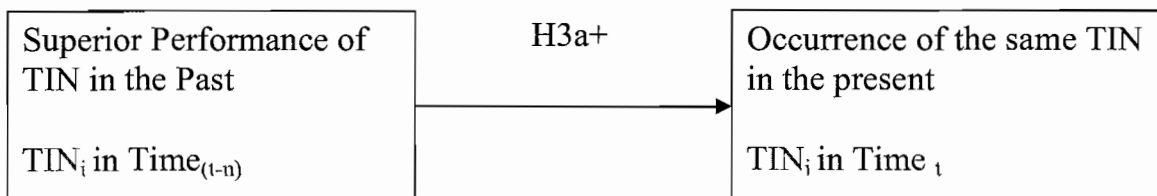
Superior Performance of TIN in the Past TIN_i in $Time_{(t-n)}$	H3a+ $\longrightarrow$	Occurrence of the same TIN in the present TIN_i in $Time_t$

H3b: *Populations of network organizations learn from failure. When new projects have similar characteristics to past projects, network organizations will exhibit learning by reducing the occurrence of TIN's that previously failed*

Figure 10: Learning From Failure Across a Population of TINs

Inferior Performance of TIN in the Past TIN_i in $Time_{(t-n)}$	H3b - $\longrightarrow$	Occurrence of the same TIN in the present TIN_i in $Time_t$
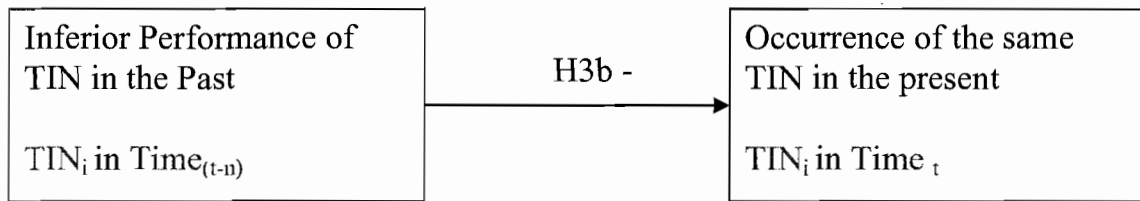
This concludes Chapter III. The goal of this chapter was to develop a series of hypotheses that examined how exchange conditions affect the structure and performance of network governance. The chapter began by reviewing gaps in the current literature associated with theoretical differences in level of analysis and with the decay in the value of network ties over time; and also an empirical gap associated the unavailability of network tie data that describes poor performance and failure. The construct of *Aggregate Tie Strength* addresses these issues in two important ways. First, ATS aggregates all of a lead firm's dyadic ties to the network level of analysis and allows studying performance of the whole network. Second, ATS incorporates Gulati's (1995) empirical finding that the value of ties is not durable and decays over time. Finally, by studying temporary interorganizational networks (TINs), this chapter addresses the third gap in understanding. Since TINs involve the

repeated formation and dissolution of ties over time, reliable data on how these network changes affect performance is available. In the next chapter, I describe the research setting, sample design, and method of analysis that allow me to test these hypotheses.

CHAPTER IV

RESEARCH METHODOLOGY

This chapter outlines the research design to test empirically the hypotheses presented in Chapter III. The first section explains the nature and rationale of the research method adopted for this study. The next section describes the empirical setting, arguing that it offers an ideal setting to examine the structure and performance of network governance. The sections that follow describe sources of data, data collection procedures, provide the operational definitions of variables, and describe statistical analysis techniques.

Description of the Research Method

Strategy research faces a difficult challenge because it studies a complex topic. "Strategy" is a difficult to measure construct (Hambrick, 1980) because in practice, strategies "can differ from competitor to competitor within the same industry" (Harrigan, 1983, p. 398). These challenges have led strategy scholars to follow a dichotomous research approach, choosing between fine-grained methods that capture the nuance and idiosyncrasies of individual organizations and more coarse-grained approaches that facilitate generalizeability (Hambrick, 1980; Harrigan, 1983). Much insight can be gained from fine-grained methodologies, such as ethnographies and cases studies, but

these findings often lack generalizeability and statistical rigor (Hambrick, 1980). Conversely, coarse-grained methodologies using data from sources such as PIMS and COMPUSTAT introduce statistical rigor that may be generalizeable to other populations, but they lose the nuance and insights about individual firm strategies that case studies can provide (Harrigan, 1983). Harrigan (1983) promotes a mixed-method or "hybrid methodology" for strategy research, which relies upon multiple data sources and intricate sample designs. Intricate sample designs are those that incorporate their hypotheses into decisions about data collection and sample stratification (Harrigan, 1983)

Research examining the effects of tie strength on network performance has followed the dichotomous approach (Harrigan, 1983) found in the larger strategy literature. At the fine-grained level, ethnographies and case studies have examined how strong ties provide organizations advantages from trust, mutual adjustment, reciprocity and from having a long-term perspective (Capaldo, 2007; Larson, 1992; Walter W. Powell, 1990; Uzzi, 1996). For example, in an ethnography of the New York City garment industry, Uzzi (1996) observed that firms participating in strong and dense networks derived advantages in information sharing that facilitated the fine-grained exchange of tacit knowledge. Similarly, Larson's (1992) ethnography of entrepreneurial firms across three industries found that firms become more dependent upon each other and rely more strongly on trust when strong ties are developed.

Capaldo (2007) examined the effect of tie strength on organizational performance in the Italian furniture industry. Using a comparative longitudinal case study methodology, Capaldo (2007) redefined tie-strength for use at the network level of

analysis (as discussed in Chapter 2). Capaldo suggests his definition of interorganizational tie-strength can facilitate empirical analyses at the coarse-grained level, due to its incorporation of interorganizational resource commitments, interorganizational social relationships, and a temporal dimension based on the frequency of interorganizational exchanges. Next, I review prominent coarse-grained studies on networks.

At the coarse-grained level, studies of network performance have relied on large datasets and described aggregate trends (Ahuja, 2000; Dyer, 1996c, 2000; Goerzen, 2007; Gulati, 1995). Furthermore, coarse-grained studies of network performance tend to focus on the largest companies within an industry, due to the availability of reliable data (Ahuja, 2000; Gulati, 1995; Gulati & Gargiulo, 1999). Ahuja (2000) studied the largest international chemical firms in Western Europe, Japan and the United States and found that larger numbers of strong ties increase innovation performance, but that this effect was moderated by the number of weak ties. A large number of weak ties enhanced the direct effect of strong ties on innovation output (Ahuja, 2000). This focus on the more prominent companies can introduce several biases, such as survivor bias resulting from studying only the most successful firms as well as issues with sampling on the dependent variable -- common in studies of patenting (Ahuja, 2000). Another methodological issue that is particularly prominent when studying only the largest firms in an industry is missing data. Over time, large firms tend to acquire other firms, creating unbalanced panels and missing data in studies seeking to study the pattern of tie formation and dissolution over time (Ahuja, 2000; Gulati, 1995).

Another issue that has plagued coarse-grained studies of network performance is the presence of confounding results from similar empirical settings. Despite theoretical support for the effects of strong and weak ties on network performance, several studies have found conflicting results despite examining similar phenomena. For example, Dyer (1996c) examined supplier networks among US and Japanese automakers. Using a survey instrument across a diverse array of Japanese supplier/*keiretsu* networks, including Toyota, Dyer (1996) found that tighter networks composed of more strong ties enhanced quality and reduced cycle times. While Dyer's coarse grained study facilitates generalizeability, his findings conflict with case study evidence that studied Toyota's supplier network directly (e.g. Lincoln, Ahmadjian, & Mason, 1998). Lincoln, Ahmadijan, and Mason (1998) found that strong ties to one supplier actually eroded ties across Toyota's wider *keiretsu* supplier network. Additional conflicting findings have emerged from multi-industry studies. For example, several multi-industry studies of tie formation and patterns of tie development have examined the effects of tie strength on economic performance (Goerzen, 2007; Gulati, 1995, 1998). These studies found mixed results for the impact of tie strength on economic performance, suggesting the limitations of coarse-grained methods to capturing how tie strength affects performance in networks.

To summarize, because dichotomous methodologies dominate the research on how the presence of network ties affect organizational performance, our understanding of this relationship is limited. Harrigan (1983) suggests several ways to reconcile this methodological shortcoming, including the design of mixed-method studies and use of intricate sample designs. Mixed-method studies offer advantages over purely fine-

grained methodologies, because they facilitate generalizeability and often add statistical rigor (Hambrick, 1980; Jick, 1979). Mixed-method studies also help scholars elucidate some of the idiosyncrasies and nuance that purely coarse-grained studies may lose in their error terms (Harrigan, 1983; Jick, 1979). In the absence of mixed methodologies, "intricate sample designs" are a means to unpack the idiosyncrasies of strategy (Harrigan, 1983). This dissertation represents a coarse-grained study coupled with an intricate sample design that capitalizes on the author's years of experience working within the bridge construction industry in Oregon.

In order to construct an intricate sample design, researchers must have detailed knowledge about their empirical setting and organize their sample to align data collection with the variables that their hypotheses test (Harrigan, 1983). Further, intricate sample designs must integrate coarse-grained data from multiple locations and triangulate data from multiple sources to increase the validity of the measures. When scholars use intricate sample designs, more potentially confounding variables are controlled, which helps ensure that interpretations of statistical coefficients are justifiable (Harrigan, 1983). In the Sample Design section of Chapter IV, I describe in detail how I organized these data to align with the hypotheses I tested. Prior to describing my intricate sample design, however, I will describe my experience in the industry and the empirical setting.

From 1996 - 2001, I worked in the bridge construction industry in Oregon (the empirical setting for this dissertation). As a manager in one of the more prominent firms, my primary responsibility was to choose partners and to design alliance networks. Of the roughly 40 lead firms in the research sample, I repeatedly competed against each of them

on sealed bid proposals. To compete successfully for low-cost sealed bid projects, I developed intimate knowledge of my competitors' equipment, capabilities, current project commitments, and bidding strategies. I gained this knowledge via conversations with multiple subcontractors, interacting with these firms at trade shows and training seminars put on by equipment manufacturers, and by reviewing their pricing strategy after each bid. Because these sealed bid proposals were for federally funded construction projects, all of the documents were publicly available. Over time, these conversations, trainings, and pricing reviews gave me intimate knowledge about each competitor's capabilities, their bidding tendencies, and the types of projects with which each firm was most successful. My experience provided me with detailed knowledge of this study's empirical setting, which allowed me to construct an intricate sample design as suggested by Harrigan (1983).

In the next section, I describe in further detail the empirical setting for which I designed this study, offering additional examples of why this setting and my industry experience represent a promising blend of fine-grained knowledge and coarse-grained archival data from which to study the performance of networks.

Empirical Setting

To empirically examine the governance structure and performance of temporary interorganizational networks (TINs), I adopt Jones, Hesterly, and Borgatti's (1997:916) definition of network governance: "a select, persistent, and structured set of autonomous firms engaged in creating products or services based on implicit and open ended contracts

to adapt to environmental contingencies and to coordinate and safeguard exchanges." The ideal setting to investigate TIN governance structure and performance, as defined for this study, would include a persistent and structured set of autonomous firms that join, disband and rejoin network organizations according to the characteristics of an opportunity (Jones, Hesterly, & Borgatti, 1997).

These settings are characterized by highly skilled human assets, demand uncertainty, complex tasks, and downstream adaptation needs that require more flexible organizational forms to facilitate network tie formation and dissolution (R.G. Eccles, 1981; Jones, Hesterly, & Borgatti, 1997). While Jones et al. (1997) choose the film industry as emblematic of these characteristics, I choose the bridge construction industry in Oregon. Much like the film industry, bridge construction firms and their subcontractors are autonomous units that regularly join, disband and rejoin networks; however, the bridge construction industry introduces an additional industry-wide control that facilitates testing the performance of these governance structures. Because bridge construction is largely funded by the federal government, federal regulations only permit a contract to be awarded to a general contractor with the lowest overall cost for completing a bridge. In effect, this low-cost requirement controls for firm-level strategy across all organizations, making this an excellent setting to examine the impact of network structure upon organizational performance.

Eccles (1981) suggests the construction industry is an ideal empirical setting to investigate how novel organizational forms respond to changes in market conditions. The construction industry is broken into three SIC codes, one each for general building

contractors, heavy and highway general contractors, and special trade contractors. General building contractors build residential buildings, industrial buildings and warehouses, and other types of nonresidential buildings such as schools, stores, restaurants, hospitals and churches. Heavy and highway general contractors perform all non-building construction, including bridges, tunnels, various pipelines, dams, harbor and port and military facilities. Special trade contactors offer plumbing, electrical, painting, masonry, plaster, roofing, and other specialties that serve the other two categories as subcontractors (Robert G. Eccles, 1981).

Eccles (1981) uses the term "subcontracting" to refer to the organizational form adopted by general contractors who construct buildings and highways. Eccles (1981, p. 451) suggests, "Subcontracting in the construction industry is a response to uncertainty arising from complexity, given the bounded rationality of the firm (Williamson, 1975)." Construction, particularly of highway bridges, demands specialized expertise in engineering, construction techniques, and project management (Robert G. Eccles, 1981). Coordinating these specialists is problematic due to demand uncertainty in the construction industry: "A general contractor cannot keep a large number of labor specialties, with constant capacity per specialty, productively occupied because of the great uncertainty about labor requirements by specialty" (Robert G. Eccles, 1981, p. 452). Thus, coordinating and retaining these diversely skilled workers within a single firm would increase transaction costs (Williamson, 1975) by placing a significant burden on the general contractor to administer and coordinate all the various labor specialties. Thus, subcontracting is the preferred option. Eccles concludes (1981, p. 451):

"Construction technology is intensive, requiring a project management form of organization to cope with the complexity and uncertainty of the technology and with the requirements for adaptability."

To summarize, due to highly skilled human assets, demand uncertainty, complex tasks, and the ongoing adaptation needed to construct a building or bridge, more flexible organizational forms like subcontracting are preferred. These exchange conditions are those said to elicit network governance (Jones, Hesterly, & Borgatti, 1997). Moreover, bridge construction introduces an additional industry-wide control that facilitates the testing of hypotheses about network governance. Bridge construction is largely funded by the federal government and federal regulations require the award of a contract to whichever general contractor submits the lowest bid for the project. This low-cost requirement enhances this empirical setting by controlling for strategy across all organizations.

In addition to the low cost requirement imposed on bridge construction organizations in Oregon, several other controls are present in this research setting. First, there is no product variation and each competing organization has near perfect information about product characteristics in the form of engineering blueprints and project specifications. Second, there is only one customer – the Oregon Department of Transportation. Third, technology does not vary widely within the industry – cranes and bulldozers are uniformly available and their functionality has remained consistent for decades. Thus, organizations within this industry do not vary widely due to product innovation, customer innovations, technology innovations, or strategy. The largest

source of variation among organizations in this industry is *how they organize their governance structure.*

In closing, I will reinforce one final and unique feature of this research setting – its data. These data include comprehensive financial, organizational, and performance information (down to the level of each individual network partner) on over 1600 detailed proposals that bridge construction firms submitted in response to requests for proposals to construct approximately 330 state highway bridges during the years 2000-2007. Each of the 1600 proposals in this dataset specifies a unique network governance structure for addressing a specific project, and these data cover both those proposals that succeeded in being selected, and those that failed to be selected. Thus, my research design finesses a conundrum that has plagued much prior research, the fact that only those organizations that succeeded and survived are usually available to be studied. In contrast, I observe the entire set of potential network designs – viable and nonviable alike. Next, I describe my sample design.

Sample Design

The goal of the sample design was to construct a representative sample for a larger population of Temporary Interorganizational Networks (TINs). As described above, the bridge construction industry in Oregon is an ideal setting to study TINs and network governance. The question remains, are TINs formed to construct bridges in Oregon representative of a larger population of TINs such that regression analyses provide useful information that can generalize to this wider population.

The ideal sampling method to test the hypotheses would be random sampling from the entire population of US bridge construction firms. Random sampling produces a probability sample, which allows the exact calculation of the extent to which a sample value can be expected to differ from a population value. This difference is referred to as sampling error (Hoyle, Harris, & Judd, 2002; McDaniel & Gates, 2008). When research constraints, such as time constraints and data availability, make random sampling prohibitive, nonrandom sampling methods are used. Since my empirical setting is constrained geographically to the state of Oregon and temporally to the years 2000 – 2007, my sample is nonrandom. Still, several key factors allow me to construct a representative sample using only information about bridge projects in Oregon. Furthermore, econometric techniques exist to control for sample selection bias and allows using regression analyses to generalize findings from a nonrandom sample to the wider population it represents (Kennedy, 2003). Next, I discuss how I constructed a representative sample of bridge construction firms and the analysis technique that allows me to generalize the findings.

Constructing a representative sample of the larger US bridge construction industry requires that the TINs building bridges in Oregon adequately represent TINs building bridges in any US state. McDaniel and Gates (2008) suggest that "judgment sampling" is an effective nonrandom sampling strategy for researchers with a high degree of experience in an industry. Judgment sampling is applied to any sample in which the selection criteria are based on a researcher's judgment about what constitutes a representative sample (McDaniel & Gates, 2008). As described above, my experience

building bridges according to federal guidelines makes me uniquely qualified to construct a representative sample. The Federal Highway Administration (FHWA) oversees all bridge construction projects in the US and their regulations apply to all 50 US states. Of course, adjustments to geographic conditions in Oregon are made, but these affect the engineering choices made in design, they do not alter the official rules of the FHWA. Thus, the rules that govern bridge construction in Oregon largely govern all bridge construction within the US, which facilitates generalizeability of regression results.

The next step in constructing a representative sample involves ensuring adequate representation of US construction firms among the TINs working in Oregon. Theory on construction firms suggests all strategic decisions (including bid proposal costs) are made at the firm headquarters, even though the actual construction processes may occur in entirely different locations (Robert G. Eccles, 1981; Seldin & Bloom, 1961). The lead firms in my sample have headquarters in ten different states. These states are Oregon, Minnesota, Utah, Washington, Pennsylvania, California, Ohio, Idaho, Nebraska, and Illinois. Some of these lead firms (~10% of the sample) construct bridges in all 50 states. Roughly 43% of the lead firms in the sample construct bridges in the states west of the Rocky Mountains. All of the lead firms in the sample construct bridges in Oregon, Washington, and Idaho. Thus, I am confident these data constitute a representative sample of the wider population of US bridge construction firms.

Finally, debates about the usefulness of significance testing on nonrandom samples continue within the literature (Schwab & Starbuck, 2009). Since my sample is indeed nonrandom, some scholars may characterize these data as a subpopulation.

Schwab and Starbuck (2009) suggest that since null hypothesis significance tests rely upon random sampling techniques, their use on nonrandom samples and subpopulations is misguided, because the means and variances of the nonrandom sample may bear no knowable relationship to means and variances of the population they aim to represent. To address these concerns, econometric models that incorporate sample selection equations are increasingly used (Hamilton & Nickerson, 2003; Kennedy, 2003; Shaver, 1998). Sample selection equations account for the sample selection phenomenon within subpopulations, which avoids bias during estimation (Kennedy, 2003). Sample selection techniques include two-stage techniques, such as the models prescribed by Heckman (1976), as well as simultaneous equation models where the selection equation operates simultaneously with the equation producing the parameter estimates. Kennedy (2003:284) suggests the Tobit regression model is particularly suited to analyzing nonrandom samples and subpopulations because of its simultaneous equation model that controls for sample selection bias during regression. Thus, while I agree that my sample of Oregon construction firms is indeed nonrandom, my use of the Tobit regression model (described later in this chapter) is an accepted technique to control for sample selection bias, which suggests findings from my regressions indeed represent the wider population. To increase the predictive power of regression results even further, Harrigan (1983) suggests intricate sample designs enhance researchers' ability to interpret findings from regression analyses.

Harrigan (1983) promotes the use of intricate sample designs to increase the usefulness of findings from coarse-grained studies. As described above, coarse-grained

studies and archival data increase the generalizeability of statistical analyses, but suffer because only limited distinctions between the strategies of competitors in the same industry can be made when solely using these types of data. In purely coarse-grained studies, these interesting and subtle differences get lumped into the error term of statistical analyses, which limits scholars' ability to tease out the important effects of the explanatory variables despite any statistical significance (Harrigan, 1983). However, by pursuing more intricate sample designs, scholars can unpack the idiosyncrasies between firms that strategy researchers so desperately desire.

Intricate sample designs are those that incorporate their hypotheses into decisions about data collection and sample stratification (Harrigan, 1983). Harrigan (1983) states: "if key variables hypothesized to affect strategic choices are used as criterion variables for segmenting the research sample, researchers ensure they can control for these variables when analyzing the effects of other factors" (Harrigan, 1983, p. 402). To restate Harrigan's (1983) point, careful planning of sample design that coaligns hypothesized variables with sample preparation and organization allows scholars to better assess the effects statistically significant (or insignificant) variables.

Following Harrigan (1983), my sample design is built specifically around the hypotheses I sought to test. Because my hypotheses concern the effects of project characteristics on network organizational performance, my data are organized by project, and stratified by network organizational performance. For each bridge project that met the empirical criteria, I include all of the proposals submitted and organize them according to their relative performance. Additionally, control variables were organized

on a project-to-project basis. Thus, the sample design reflects the hypotheses, which increases my ability to make judgments about the strategies I modeled and their affects on network organizational performance (Harrigan, 1983). Figure 11 represents the sample design and stratification.

Figure 11: Sample Design and Stratification
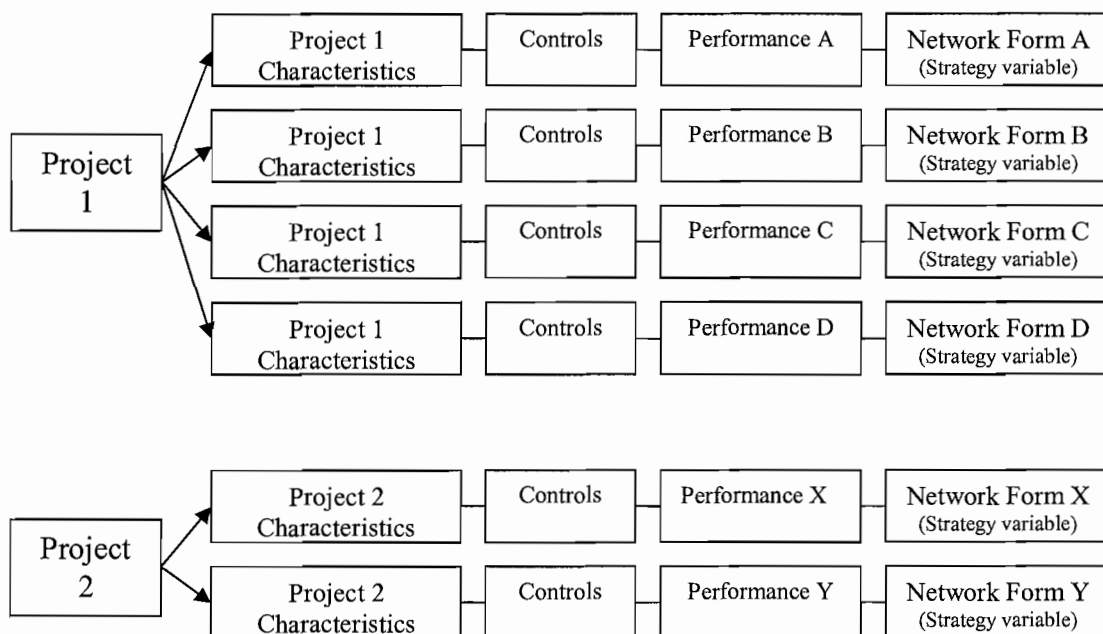
Sampling Frame

The sampling frame is a set defining which individuals, groups, organizations, or other units of analysis qualify for a research sample (Hoyle, Harris, & Judd, 2002). The selection process consisted of identifying all bridge projects constructed in the state of Oregon from 2000 – 2007. This period was chosen because prior to February 2000, the ODOT *Subcontractor Disclosure Form* (SDF) was not required. The SDF is a written list of all network participants that perform greater than 5% of the work on a particular

bridge project in Oregon. This list contains the name of each major subcontractor or supplier used in each lead firm's bid proposal and is thus the source of all network-partner data. SDF's from 2008 are not yet available, thus I stopped data collection in December of 2007.

In order for a project to be selected for the sample, it had to contain a bridge structure or other traffic control structure (retaining wall) that was constructed on-site and from raw materials. Some heavy highway construction projects, such as asphalt paving overlay projects, are so reliant on specialized equipment (asphalt paving machinery), that these proposals do not exhibit sufficient variation among network partners. In the paving project example, the limited scope of operations and specialized equipment rely on autonomous assets that limit strategic decisions because autonomous assets perform only one function and are not redeployable to other functions (David J. Teece, 1984).

Further, to continue with the large paving project example, many of these projects include bridge construction, but not all of them include on-site bridge construction from raw materials. Eccles (1981) suggests the increased complexity from on-site construction is inherently necessary to isolate the strategies behind subcontracting as an organizational form (Page 460 – 461). In projects without on-site construction processes, the bridge structures are so minor in size and so straightforward in scope that they are pre-manufactured off-site and installed as modular systems once they are hauled to the project location. The installation of these pre-fabricated modular structures requires no particular expertise in construction or management. These items include pre-cast

concrete box culverts, modular retaining wall systems, sign bridge supports, and even segmental bridge sections that are bolted together much like a child's erector set.

To summarize, non-bridge heavy highway construction projects, such as asphalt paving overlays, do not have sufficient complexity to cause lead firms to subcontract out much of the work – thus they are not TINs. Because the network structures formed for these non-bridge projects are not TINs, they are outside of the theoretical domain for this study. In these non-bridge projects, asset specialization drives the structure and performance of networks and often results in stand alone, single firm contractors completing the work (Hampson & Tatum, 1997). Since this study is interested in multiple firms organizing for construction projects, complex bridges that require complex networks are of interest.

Bridge projects that require on-site construction from raw materials are strategically different because they contain sufficient complexity in scope to require multiple autonomous firms to furnish and integrate specialized inputs in a coordinated fashion (Robert G. Eccles, 1981; Hampson & Tatum, 1997). To accurately select these projects, I reviewed every Request for Proposals (RFP) issued by ODOT from 2000 – 2007, and included all projects with bridge or traffic control (retaining wall) structures that were constructed on-site and from raw materials (no modular or pre-fabricated bridges). This initial screening process produced 335 bridge projects that elicited 1686 proposals. Figure 12 summarizes how I narrowed the sample after selecting these initial 1686 proposals.

The second screening process in sample preparation eliminated missing data. For the second screen, I looked over all 1686 proposals identified in the first stage and eliminated any proposal that did not have a viable subcontractor disclosure (SDF) form attached. The ODOT's archive department lost some SDF forms, sometimes lead firms forgot to include them with their proposals and some SDF's were missing for reasons I could not identify. This second screen reduced the sample size to 1380 proposals.

The third and final screening process removed projects that had no salient indicator of task uncertainty. Task uncertainty is a form of primary uncertainty that exists within an organization's external environment (Williamson, 1985b) and task uncertainty is a primary driver of subcontracting in the construction industry (Robert G. Eccles, 1981). Because my research design is limited to the domain of TINs, limiting the sample to projects with clearly identifiable sources of task uncertainty is necessary to ensure subcontracting occurs. To accomplish this, I limited the sample to only those projects that contained project-specific environmental regulations, environmental rules, or environmental performance stipulations. As described above, the Standard Specification for all ODOT projects outlines "the rules" for working on any bridge project in Oregon. These standard rules for environmental protection include some common sense items such as "only use grade 2 diesel fuels to power on-road equipment" and "only dispose of fuel in pre-approved containers." Since projects occur in different geographic locations, different climates, and adjacent to different wildlife, the Standard Specification is augmented by Project Special Provisions to account for these site-specific concerns. The presence or absence of Special Provision 00290 could affect a

lead firm's bidding strategy in many, unobservable ways, so I chose to eliminate all jobs that were missing section 00290 in the Project Special Provisions. This reduced the sample to 166 projects, which elicited 584 proposals. Figure 12 summarizes the sample selection process.

As described earlier, the owner-determined specifications reduce some of the uncertainty for lead firms in this competitive bidding process. However, section 00290 remains a salient source of task uncertainty, in spite of attempts to reduce uncertainty in other areas. Section 00290 involves rules and suggestions about older structures, about horticulture in the surrounding area, and about the "expected behavior" of wildlife in and around a project site. Trying to assess all of these potential uncertainties in a competitive bidding situation is nearly impossible ex ante of beginning work. Next are some examples of the type of information contained within section 00290 – Environmental Protection.

Section 00290 – Environmental Protection identifies potential sources of environmental spills, dictates how to handle disposal, and suggests *potential* behavior of wildlife that *might* be adjacent to a project site. For example, if a bridge project requires the removal of an old structure that contains lead-based paint, section 00290 will stipulate procedures for removal and disposal of lead-based paint to minimize any impact on the local environment. Similarly, if a bridge is to be constructed over a river, environmental regulations may stipulate that the surface of the river cannot be disturbed during fish spawning seasons or that in-water pile driving cannot occur when birds are nesting nearby. Section 00290 will also stipulate when these wildlife are expected to be in the

Figure 12: Process of Sample Selection

Stage 1:   Initial Identification of
            Bridge Projects

            ODOT Bid Tabulations
            (2000 – 2007)

            *335 Total Bridge
            Projects, eliciting 1686
            Proposals*

Project requirements include a
bridge structure for vehicles or
pedestrians, retaining walls, or
other major structures.

Sign bridges or minor structures
do not qualify

1686 Proposals

Stage 2:   Proposal Screening

            ODOT Subcontractor
            Disclosure Forms

            *330 Total Bridge
            Projects
            Eliciting 1380 Proposals*

Missing or incomplete
Subcontractor Disclosure
Forms result in these
proposals being
eliminated

1380 Proposals

Stage 3:   Special Provisions
            Screening

            ODOT Project Special
            Provisions

            *166 Total Bridge
            Projects, eliciting 584
            Proposals*

Special Provisions must contain
Section 00290 – Environmental
Regulations

All Projects missing Section
00290 of the Special Provisions
are eliminated

Final Sample   *584 Proposals*

area, but it does not give any concrete assurances of timing or suggested operational changes a contractor should make once these wildlife are spotted – other than "stop what you are doing." In contrast, if a bridge is constructed in a remote location, far from any river and any wildlife, the Project Special Provisions may not contain any Section 00290. This is because in these locations, the Standard Specifications cover all anticipated construction issues and these standard rules do not need to be augmented with any site-specific information. In the next section, I describe how I operationalized each variable used in this study.

Data Collection

The unit of analysis for this dissertation is the Temporary Interorganizational Network (TIN), whose structure and performance characteristics are contained within bridge construction proposals. All proposals submitted to the Oregon Department of Transportation (ODOT) for constructing a bridge contain the same types of data. Proposals are submitted by lead firms and include detailed information on subcontracting firms. Lead firms must be pre-qualified on an annual basis according to Oregon state provision OAR 734-010 sections 240 – 280. Subcontracting firms do not have to be pre-qualified by ODOT. The primary criterion for pre-qualification is a lead firm's ability to insure their work through bonds from surety companies. Surety companies will bond a particular lead firm to a maximum figure (in millions of dollars), and then ODOT will limit the projects upon which a lead firm can bid based on what the surety company is willing to insure.

Bonding capacities are adjusted on an annual basis. If a lead firm has poor safety record for a given year, their bonding capacity may be reduced. Alternatively, if a lead firm has a good safety record and completes projects according to plan and on budget, their bonding capacity may rise in the next year. This means that each year, a lead firm may increase or decrease the size of a project they can bid on based on past performance.

Once prequalified, a lead firm/general contractor engages in a competitive bidding process to win the right to construct a project. In general, highway construction involves submitting a competitive bid to the owner (ODOT in this setting) for a project whose specifications are determined by the owner, with the assistance of architects and engineers (Robert G. Eccles, 1981). These specifications (design, performance requirements, and even construction methods) "largely determine the types of labor skills needed and the amount and timing of their application" (Robert G. Eccles, 1981, p. 451). The combination of competitive bidding, owner-determined specifications, on-site production, and custom building techniques introduces a high amount of uncertainty for contractors and owners. To reduce this uncertainty as much as possible, general contractors must review and submit multiple supporting documents with each bid. For the owners, these comprehensive documents ensure prospective bidders understand the complexity and uncertainty involved within this particular project and account for this in their cost structures. For general contractors, these documents provide a means to assess risk. While not all components of a particular project can be identified and assigned stochastic weights reflecting their probability of occurrence (Knight, 1921), these specifications provide a means to assess the risk of some components, which mitigates

some of the uncertainty that is inherent to the larger process. Table 7 summarizes these documents and indicates where these publicly available documents are located.

The main goal of the data collection was to find or construct objective measures from these publicly available documents. Quantitative variables were extracted from archival documents maintained by the Oregon Department of Transportation (ODOT). Due to federal funding of bridge projects in Oregon, ODOT keeps a vast array of information on project characteristics, firm performance, and the network of subcontractors identified for each project. The variables were coded to align with theory. They represent continuous measures that capture variation across TINs according to exchange conditions, subcontractor network characteristics, performance ratios, and control variables. Information for control variables, such as lead firm size and age, were obtained from ODOT's General Prequalification Form, Dun and Bradstreet's *ReferenceUSA* database, and state business directories, published by American Directory Publishing and American Business Directories (1990- 2007). Table 6 summarizes the constructs, variable types, and data sources used to construct each variable.

Data Sources and Operationalization of Variables

Due to the voluminous records kept by the Oregon Department of Transportation, constructing variables to test my hypotheses was straightforward. Generally, I was able to construct a continuous measure for each variable directly from the bid tabulations.

Table 6: Data Sources Within Typical Bid Proposal Documents

Construct Name	Type of Variable	Data Source
Aggregate Tie Strength	Dependent Variable Continuous Ratio Variable	Subcontractor disclosure form – required by ODOT
Performance	Dependent Variable Continuous Ratio Variable	ODOT Bid Tabulations – Publicly available documents that offer cost information on a per project basis. Cost information includes the aggregate cost for a lead firm's network, plus costs for each sub-task needed to complete the project
Project Complexity	Independent Variable Continuous Ratio Variable	ODOT Bid Tabulations – One specific component of the Bid Tabulations is the Bid Schedule. The Bid Schedule provides a count and description of all the work that needs to be completed on a particular job.
Project Duration	Independent Variable Continuous	Bid Tabulations
Project Uncertainty	Independent Variable Continuous Ratio Variable	Project specifications for environmental regulations (e.g. fish windows) with specific penalties
Lead Firm-Size	Control Variable	*ReferenceUSA*, State Business Directory as published by the American Directory Publishing and American Business Directories
Lead Firm Age	Control Variable	*ReferenceUSA*, State Business Directory as published by the American Directory Publishing and American Business Directories
Project Frequency	Control Variable	Total sum of projects on annual basis, as noted in ODOT Bid Tabulations
Environmental Munificence	Control Variable	ODOT Bid Tabulations

Bid tabulations record detailed estimates of costs expected for completing a bridge project for every submitted proposal. For each of the 584 proposals that were retained from the 3-stage screening process, a complete bid tabulation was available.

The bid tabulation is composed of cost information for each proposal, as well as a schedule of work items that must be completed to satisfy the conditions of the RFP. This work schedule, called the "bid schedule" by ODOT, stipulates each component of the project that must be completed, including all bridge components, roadside improvements, landscaping, grading and excavation work, lighting and electrical work, painting, paving, and every other component needed to ensure the bridge is structurally sound and aesthetically pleasing. A complex project consisting of multiple bridges in a heavily populated area may require over 400 individual work items, while a similar project in the wilderness may have only 70 work items. To ease accounting for ODOT, all work items are assigned the same code, no matter the project type or location throughout Oregon. For example, digging the hole where a bridge foundation will ultimately be built is termed "Structure Excavation" and coded the same whether the structure is at a busy intersection in Portland, Oregon or across a remote ravine in the Cascade Mountains of Central Oregon. Thus, comparing the type of work and number of work items is consistent across projects. Table 7 describes each variable, its data source, and how the variables were operationalized. Next, I will describe these operationalization procedures in detail.

Dependent Variables

The dependent variables in my analyses measure the structure and the performance of temporary interorganizational networks (TINs). TIN structure is operationalized as the *Aggregate Tie Strength* for a lead firm's network of subcontractors.

Table 7: Data Sources, Variable Descriptions and Operationalization

Construct Name	Type of Variable	Data Source	Operationalization
Performance	Continuous Ratio Variable	ODOT Bid Tabulations – Publicly available documents that offer cost information on a per project basis. Cost information includes the aggregate cost for a lead firm's network, plus costs for each sub-task needed to complete the project	Ratio of costs of lead firm's network to lowest cost network on a per project basis (Truncated at 1.0 for lowest cost architecture, more expensive architectures will score > 1.0)
Aggregate Tie Strength	Continuous Ratio Variable	Subcontractor disclosure form – required by ODOT	$$\left(\frac{\sum\limits_{subcontractor_j=1}^{n} TR}{TC} \right)$$ As seen in Equation 4.0
Winning_Time1	Categorical	ODOT Bid Tabulations	All observations that had both a low proposal cost (Performance = 1.0) and occurred before 2005. All non-winning observations prior to January 1, 2005 were coded as zero.
Winning_Time2	Categorical	ODOT Bid Tabulations	All observations that had both a low proposal cost (Performance = 1.0) and occurred after January 1, 2005. All non-winning observations after January 1, 2005 were coded as zero.
Project Complexity	Continuous Ratio Variable	ODOT Bid Tabulations – One specific component of the Bid Tabulations is the Bid Schedule. The Bid Schedule provides a count and description of all the work that needs to be completed on a particular job.	Bid Schedule Complexity Normalized by project size. For a given job, the Bid Schedule will vary according to project characteristics. A simple count of the number of work items in a Bid Schedule, normalized by the project size, provides a measure of complexity
Project Duration	Continuous	Bid Tabulations	US dollars – Project size is a common proxy

			for duration with these data
Project Uncertainty	Continuous Ratio Variable	Project specifications for environmental regulations (e.g. fish windows) with specific penalties	Measured via number of pages in Section 00290 of Special Provisions. These pages delineate penalties for spills or other violations impacting natural environment
Lead Firm-Size	Controls	State Business Directory as published by American Directory Publishing and American Business Directories	Size measured by annual number of employees at the Lead Firm HQ
Lead Firm Age	Control	State Business Directory as published by American Directory Publishing and American Business Directories	Years
Project Frequency	Control	Total sum of projects on annual basis, as noted in ODOT Bid Tabulations	Count on annual basis
Environmental Munificence	Control	ODOT Bid Tabulations	Count variable of median proposal costs submitted for bid each year, Millions of dollars

Performance is operationalized by comparing a lead firm's proposed cost to the lowest-cost bid that was actually awarded the project.

Aggregate Tie Strength is constructed as a ratio variable and measures a TIN's relational embeddedness on a project-to-project basis. This ratio variable captures recent ties to subcontractors proposed for inclusion in an impending project, and adjusts this value by dividing it by the total number of subcontractors proposed for that project. This calculation is show in equation 4.0. The numerator contains the variable Ties Repeated (*TR*), which considers the identities of the subcontractors proposed for the current project, reviews recent projects for that lead firm, and sums all of the repeated ties during the

most recent projects. The denominator contains the variable Ties Current (*TC*), which counts the total number of ties for the current project.

$$\text{Aggregate Tie Strength} = \left(\frac{\sum_{subcontractor_j=1}^{n} TR}{TC} \right) \qquad (4.0)$$

Only the five most recent ties between a lead firm and a subcontractor were included in counting values of *TR*. Gulati (1995) found that only the four most recent interactions positively affected current alliance performance. I ran sensitivity analyses to determine the effects of repeated partnerships on the most recent partnership, the second most recent partnership and up to the five most recent partnerships. Sensitivity analyses did not show any statistical difference between the 3-5 most recent partnerships, thus I chose to include all five and use as much information as possible.

Values of Aggregate Tie Strength were truncated at zero, which reflects either a lead firm with no partners on the current project or a lead firm with no repeated partners in the current project. For projects where a lead firm chose no partners, equation 4.0 becomes undefined. In these instances, I overwrote the equation and entered zero to reflect no tie strength when a lead firm chooses to complete the work alone, despite the presence of ample subcontractors. The values for *Aggregate Tie Strength* ranged from 0 – 4.00 with a standard deviation of 0..55.

Performance is operationalized as a ratio of the lead firm's proposed cost for completing a project and the lowest cost of any proposal submitted for that project. Thus, the minimum value of this variable is 1.0, which indicates a lead firm submitted the

lowest cost and won the bid. For all other proposals submitted for that particular project, their cost ratio was some number greater than 1.0. Values of *Performance* ranged from 1.0 to 2.49, with a standard deviation of 0.17.

Population-level learning (Hypotheses 3a-b) is evidenced by the increasing use of successful routines or the removal of deleterious routines across a population of TINs. TIN structures act as a proxy for routines, and TIN structures that resulted in winning bids represent successful routines. Likewise, TIN structures that resulted in failing bids represent failing routines. In order to capture variation in routines over time, I had to construct a composite variable.

First, I divided the sample into two temporal periods. This was to ensure I had enough observations within each period to allow statistical analyses. The first period was from 2000 – 2004 (302 proposals) and the second period was from 2005 – 2007 (282 proposals). Next, I coded "winners" in each temporal period. Recall, in this competitive bidding case, only one proposal "wins" each bid and winning is determined by having the lowest total cost (Performance Ratio Variable = 1.0). Thus, two composite variables were constructed:

1)   *Winners_Time1* = Performance Ratio ==1.0 & Project Year <=2004

2)   *Winners_Time2* = Performance Ratio == 1.0 & Project Year >=2005

These dependent variables were coded 1 for winners in each period; all other results for that period were coded as zero.

Independent Variables

Project Complexity is a variable that measures the number of specialized inputs

needed to complete a project (Jones, Hesterly, & Borgatti, 1997) and is a key determinant

of organizational form in the construction industry (Robert G. Eccles, 1981). *Project*

Complexity is determined by the production requirements and the variety of individual

skills and specialized functions needed to construct a bridge or building: "The number of

uses, the amount and types of equipment used and installed, and the materials used … all

effect the number of specialties required" (Robert G. Eccles, 1981, p. 453). Previous

studies have used census data to model complexity (Stinchcombe, 1959), however this is

misleading because census data are too general and do not report indicators of complexity

specific to each type of construction (building, highway, and specialty trade). To more

accurately reflect complexity in highway bridges, Eccles (1981) suggests the number of

functions required to complete a given structure should operationalize complexity.

To model these processes, *Project Complexity* was calculated by counting the

number of work items listed in a project's bid schedule and dividing by the median

project cost of all proposed costs submitted for that project. As mentioned previously,

the number of items in a bid schedule can vary widely, depending on the work items that

make up a particular project. For example, in 2006 two projects had a median project

cost between $24-25 million. Project number one, with a median proposed cost of $25.1

million, had 211 work items in its bid schedule. Project number 2, with a median

proposed cost $24 million, had only 157 work items. Additionally, a project whose

median proposed cost in 2006 was $36.5 million contained only 66 work items. These differences provide a clean and valid way to operationalize complexity.

Project Duration is operationalized by a proxy – total project cost. Large projects are associated with longer time durations (Jones & Lichtenstein, 2008) and construction project duration is often measured by total project receipts in dollars (Robert G. Eccles, 1981). The reasons for using project cost as a proxy for duration are two-fold: (1) it is reasonable to assume that long duration projects require more labor and materials and are more costly. Also, (2) specific to the construction industry, coordination demands and project duration "are a resultant not a determinant of dollar volume"(Robert G. Eccles, 1981, p. 455).

Project Uncertainty is operationalized as the number of pages contained within Section 00290 of the Project Special Provisions. As mentioned previously, because section 00290 calls a prospective bidder's attention to potential behaviors by wildlife and potential issues with environmental hazards in existing structures, but does not give fine-grained estimates of their size or scope, section 00290 is a salient source of uncertainty for prospective bidders. Across the sample of projects, section 00290 ranges from one paragraph (1/4 page) to 25 pages. The mean number of pages is 6.85 with a standard deviation of 4.37 pages.

Control variables were operationalized as follows. *Lead Firm Size* was operationalized as the number of employees at the lead firm's headquarters. As shown in Eccles (1981), heavy highway construction firms are highly variable in their total number of employees due to the seasonal nature of the work and the technology differences

between heavy highway construction firms. Some firms specialize in earth-moving technology, which assigns one person to perform a large volume of work, such as a large bulldozer. Other firms specialize in paving or structures, where a team of carpenters and laborers must support the technologies (paving equipment, cranes) to complete even small volumes of work. The most valid measure of firm size, as it relates to strategic decision-making and the amount of subcontracting per project, is the total number of employees at the headquarters (Robert G. Eccles, 1981). Seldin and Bloom (1961) echoed this reasoning and gave evidence that in construction, planning, scheduling and control are performed by administrators at the home office, versus on site. *Lead Firm Age* is a count of the number of years since the lead firm was founded. *Project Frequency* is a count variable that counted the total number of projects in Oregon for a given year. *Project Frequency* is particularly important as a control variable in the construction industry. Eccles (1981) found that when controlling for "market variability," which he measured as the number of construction opportunities for a given year, previous findings by Stinchcombe (1959) about the structure and performance of the subcontracting organizational form were reversed. *Environmental Munificence* is a count of the total dollar volume of projects in Oregon for a given year. Eccles (1981) also suggests controlling for munificence allows scholars to more clearly describe the organizational role of subcontracting in construction projects.

One control variable that is not included is a variable for new entrants. As noted in Eccles (1981), entrance into the construction industry is relatively easy when compared to other industries such as manufacturing. However, the effect of new entrants

on existing firms in the construction industry is limited, particularly in heavy highway construction where the capital requirements for entry are much greater than other forms of construction (Robert G. Eccles, 1981). Still, despite the findings of Eccles (1981), I conducted a careful review of the sample to determine if any new entrants entered the population. To get a sense of the population of lead firms in Oregon prior to my sampling window of 2000 – 2007, I reviewed those lead firms prequalified to bid on bridge projects since 1995. Among the sample of firms, there were only two new entrants and one exit in the years 2000 – 2007. Both of the new entrants were spinouts from existing lead firms and the exit was through acquisition by another lead firm in the sample. These firms accounted for less than 2% of the 584 proposals that made the final sample. Including a dummy variable for new entrants did not affect the results, and therefore was removed from the analysis. In the next section, I provide a framework for the statistical analyses I used to test the hypotheses from Chapter III.

Framework for Statistical Analyses

The nature of the dependent variables within this study drove the selection of analytic method. I have three dependent variables in this study, and each of them is classified as either a qualitative "dichotomous" dependent variable or as a "limited dependent variable," which makes ordinary least squares (OLS) regression insufficient (Greene, 2003; Kennedy, 2003). In general, dichotomous and limited dependent variables are examined using Maximum Likelihood Estimation because OLS estimates of these dependent variables are biased (Greene, 2003; Kennedy, 2003). Maximum

Likelihood Estimates are based on the idea that the sample at hand is more likely to have come from "the real world," which can often have attributes that violate the assumptions underlying OLS (Kennedy, 2003).

Rather than assuming a distribution ex ante of regression as in OLS, Maximum Likelihood Estimation creates estimates based on the greatest probability of having obtained the sample in question, which introduces several desirable properties when investigating limited and dichotomous dependent variables. Maximum Likelihood Estimators have several desirable asymptotic properties: they are asymptotically unbiased, they are asymptotically efficient, they are distributed asymptotically normally, and their asymptotic variance can be calculated with the standard formula (Kennedy, 2003).

Two types of dependent variables call for Maximum Likelihood Estimation, qualitative (dichotomous) dependent variables and limited dependent variables. Qualitative dependent variables are often dichotomous values, such as values of 0 or 1, and are used to model how a series of independent variables affect the likelihood of discrete event occurring (Kennedy, 2003). As an example, Kennedy (2003) uses factors that affect a person's decision to buy a car. Buying a car is coded as a 1, and not buying a car is coded as 0, which assumes that the predicted value of this dichotomous dependent variable can be interpreted as the probability that the individual will buy a car, given the values of the explanatory variables for that individual. For Hypotheses 3a-b, where "winning" a bid is coded as a 1 and all other values of the dependent variable are coded as zero, the Logit regression model is preferred (Kennedy, 2003).

When dependent variables are continuous but limited to a range of values, the dichotomous approaches described above do not fit. Additionally, OLS is not the best regression technique. While OLS does assume continuous dependent variables, the assumption is that these variables range from negative infinity to positive infinity, or at least through a large range of values (Kennedy, 2003). In these cases of limited but continuous dependent variables, a hybrid between OLS and maximum likelihood offers the optimal solution. Next, I describe the characteristics of continuous limited dependent variables, followed by the hybrid estimation technique that allows regression, the Tobit model.

When dependent variables are continuous, but limited in their range of values, censored and truncated regression techniques are preferred (Kennedy, 2003). In the censored sample case, some values of the dependent variable, corresponding to known values of the independent variables, are not observable (Kennedy, 2003). For example, in a study of the determinants of wages, "you may have data on the explanatory variables for people who were not working, as well as for those who were working, but for the former there is no observed wage" (Kennedy, 2003: 282). In the truncated sample case, values of the independent variables are known only when the dependent variable is observed (Kennedy, 2003). James Tobin (1958) was the first to analyze these types of data in the regression context, and advocates regression in these cases employing the Tobit regression model (Kennedy, 2003).

The Tobit model is a hybrid model that incorporates components from OLS to handle continuous dependent variables and components from Maximum Likelihood

Estimation to handle the limited range of a dependent variable (Greene, 2003). The distinctive feature of Tobin's model is that all observations on the dependent variable that lie in a certain range are translated into a single variable (Kennedy, 2003). The logic behind the Tobit estimation procedure requires that values of the dependent variable must be able to take on values close to the limit or truncation point. Kennedy uses the demand for hockey game tickets as an example: "For demand for hockey game tickets … demand can be close to the arena capacity, so this is a legitimate use of Tobit model" (Kennedy, 2003: 283).

To summarize, the best use of the Tobit model involves limited and continuous dependent variables, a fixed range of values for the dependent variable that may be truncated on either an upper or lower limit, and an empirical setting where observations can take on values close to the limit. Both of my dependent variables satisfy these conditions, which suggests Tobit regression is the preferred model for this study.

An additional feature of the Tobit model is that it incorporates sample selection correction into the estimation technique (Kennedy, 2003). Sample selection bias is introduced when observations are drawn from a special subpopulation and generalizations to a wider population are made. This causes the sample to be non-random, which means any conclusions drawn about the wider population drawn from these samples can be biased, unless this bias is taken into account during estimation (Kennedy, 2003). "In the Tobit model, the sample selection equation is the same as the equation being estimated, with a fixed, known limit determining what observations get into the sample" (Kennedy, 2003: 284). However, scholars need to be careful employing

the Tobit model and its sample selection correction only in cases where both the observations on the dependent variable and those found in the real world are *actually* truncated – such as in the hockey arena example. An arena is a physical structure whose capacity is fixed, and whose sell-out crowds provide situations where the demand for tickets is capped at this limit. In other cases, where the fixed range of values is not as clear, two-stage selection corrections, such as those by Heckman (1974) are more appropriate.

The dependent variables in this study, *Performance* and *Aggregate Tie Strength*, each is truncated at a lower limit, and each has a limited range of values – suggesting Tobit regression is the preferred modeling technique. Furthermore, for each bridge proposal in the sample, observations take on values at the limit, which is another strong indicator that Tobit regression is the appropriate choice in this case (Kennedy, 2003). In the next chapter, I provide results from these Tobit regressions, interpret these results, and provide conclusions.

CHAPTER V

EMPIRICAL TESTING AND FINDINGS

This chapter is an empirical exploration of the structure and performance of network organizational forms, using descriptive summaries of the data and regression analyses. As described in the previous chapter, Maximum Likelihood Estimation is preferred in this empirical setting, due to the limited and dichotomous nature of the dependent variables. The first section reports descriptive statistics and inter-correlations, and goes on to investigate how project characteristics affect the governance structure of temporary interorganizational networks (TINs). The second section describes the empirical models and results that test how project characteristics and network structure affect the performance of TINs. The third section discusses the results and offers estimates of effect size, which facilitate interpreting the practical significance of the results from hypothesis testing (Ellis, 2009). The fourth section examines population level learning in the context of TINs. Chapter V concludes with a review of the empirical findings, a summary table, and a discussion of limitations to this study.

Investigating the Structure and Performance of TINs

Table 8 provides descriptive statistics and correlations for the variables used to study the structure and performance of TINs. None of the correlations are statistically significant at the 5% level and none of the correlations are extraordinarily high. Kennedy (2003) suggests correlations with an absolute value greater than 0.8 or 0.9 indicate high correlation. The highest correlation between variables exists between *Project Duration* and *Project Complexity* (-0.66) and between *Project Duration* and *Project Uncertainty* (-0.68). Higher values of correlation may introduce problems with collinearity, but the Tobit procedure does not yield collinearity test statistics. To ensure collinearity was not a problem, I ran OLS regression to estimate network governance structure (Model 5) and performance (Model 7) with the full range of variables in Table 8. Following regression I calculated the variable inflation factor (VIF), which is a salient indicator of collinearity if its value is greater that 10.0 (Meyers, 2006). The largest VIF value in Model 5 was 1.68 and the largest value in Model 7 was 1.70. Thus, I conclude that collinearity did not degrade the results from the Tobit regression procedures.

Analysis of Governance Structure

Recall that for each proposal included in the sample, I analyze how exchange conditions relate to governance structure. The three exchange conditions are project complexity, project duration and project uncertainty. Table 9 presents the results from the Tobit regression that tests the effects of exchange conditions on the governance

structure of TINs[1]. Model 1 includes only the control variables and provides baseline estimates. Models 2, 3, and 4 begin introducing the key independent variables, with Model 5 being the full or unrestricted model for Hypothesis 1.

To test the goodness-of-fit of the models, I used a chi-squared likelihood ratio (LR) test developed by Neyman and Pearson (Greene, 2003). The LR test is commonly used to assess two competing models, and provides evidence of the support of one model (usually a full or complete model) over another model that is restricted by having a reduced number of parameters (Greene, 2003). The Neyman-Pearson LR test statistic is:

$$\chi^2 = -2\left[LL(\beta_R) - LL(\beta_U)\right]$$

$LL(\beta_R)$ represents the log-likelihood at convergence of the restricted model and $LL(\beta_U)$ represents the log-likelihood at convergence of the unrestricted or full model. The LR test statistic is χ^2 distributed with degrees of freedom equal to the difference in the number of parameters between the restricted and unrestricted models. The results from LR testing indicate Model 5, the full model, is the best fit for these data (p < .05).

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[1] Environmental Munificence, captured on an annual basis, also serves as a control for contemporaneous correlation. Contemporaneous correlation exists when the error terms of observations in each time period are correlated (Certo and Semadeni, 2006). As an additional robustness check, I replaced munificence with year dummies and found no adverse effects from contemporaneous correlation.

Table 8: Descriptive Statistics and Correlations

		Mean	S.D.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	Performance	1.15	0.17	1.00	2.49	1.00								
(2)	ATS	0.37	0.55	0.00	4.00	-0.02	1.00							
(3)	Project Duration[a]	14.62	1.42	11.39	18.13	-0.22	-0.40	1.00						
(4)	Project Complexity	0.53	0.61	0.02	8.49	0.06	-0.04	-0.45	1.00					
(5)	Project Uncertainty	6.85	4.37	0.25	25.00	-0.12	0.08	0.46	-0.23	1.00				
(6)	Lead Firm Size[b]	64.76	107.92	1.00	750.00	0.02	-0.09	0.19	-0.06	0.04	1.00			
(7)	Lead Firm Age[c]	35.15	22.80	0.00	130.00	-0.11	-0.02	0.30	-0.10	0.08	0.36	1.00		
(8)	Env. Munificence[a]	19.21	0.29	18.62	19.74	-0.10	0.09	0.09	-0.13	0.09	0.08	0.04	1.00	
(9)	Project Frequency[d]	42.84	7.46	28.00	52.00	0.05	0.00	-0.17	0.10	-0.37	0.04	0.05	0.30	1.00

a Log, Millions of US Dollars
b Number of HQ Employees
c Years
d Projects Per Year

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Table 9: Tobit Regression of Exchange Conditions on Governance Structure
DV – Aggregate Tie Strength

	Model 1		Model 2		Model 3		Model 4		Model 5	
Constant	-14.914	***	-13.38	**	-14.86	***	-13.1	***	-11.29	*
	(4.86)		(4.94)		(4.88)		(4.94)		(4.99)	
Lead Firm Size[a]	-0.001	**	-0.001	**	-0.001	**	-0.001	**	-0.001	**
	(.000)		(.000)		(.000)		(.000)		(.000)	
Lead Firm Age[b]	0.001		0.001		0.001		0.001		0.001	
	(.002)		(.002)		(.002)		(.002)		(.002)	
Log Munificence[c]	0.790	***	0.711	***	0.778	***	.678	***	0.636	***
	(.255)		(.258)		(.258)		(.260)		(.261)	
Project Frequency	-0.009	*	-0.007		-0.008	*	-0.003		-0.003	
	(.006)		(.006)		(.006)		(.006)		(.006)	
Project Complexity			-0.144	*					-0.186	*
H1a			(.089)						(.118)	
Project Duration[d]					0.011				-0.06	*
H1b					(.037)				(.047)	
Project Uncertainty							0.022	**	0.025	**
H1c							(.011)		(.012)	
Observations	584		584		584		584		584	
Log Likelihood	-612.35		-610.71		-612.30		-610.35		-608.34	
χ^2 LR Test Statistic			3.28*		0.10		4.00**		8.02**	

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
a Number of Employees
b Years
c Millions USD, annually
d Log Duration

Hypothesis 1a predicted that as project complexity increases, TINs will be designed with a more diverse set of network partners. The logic offered was that greater project complexity will be associated with greater and more diverse project components, which will require a lead firm to contract with more specialty subcontractors. A greater number of diverse specialists were expected to reduce the relational embeddedness within TINs, as reflected by a lower value of the dependent variable, *Aggregate Tie Strength*. The negative and significant coefficients obtained for project complexity in Models 2 and

5 indicate that as project complexity increases, *Aggregate Tie Strength* decreases. This supports Hypothesis 1a.

Hypothesis 1b predicted that as project duration increases, TINs will be designed to include a set of more familiar network partners, which increases relational embeddedness. Increasing relational embeddedness can occur by increasing the number of repeated partnerships within a TIN and by using fewer partners to do a larger share of the work. Either of these behaviors – more repeated partnerships or fewer partners each performing a greater portion of the work – increases relational embeddedness, corresponding to a larger value of the dependent variable, *Aggregate Ties Strength*. The negative and significant coefficient obtained for project duration in Model 5 indicates that longer projects are associated with lower values of *Aggregate Tie Strength*, which contradicts the hypothesized relationship. Therefore, H1b is not supported.

Hypothesis 1c predicted that as project uncertainty increases, TINs will be designed with a tighter set of network partners, which increases relational embeddedness. As described above, increasing relational embeddedness may result from a greater use of repeated partnerships or from collaborating with a select few firms with each firm completing a larger portion of the work. The coefficient on the *Project Uncertainty* variable is positive and significant in Models 4 and 5. This means that project uncertainty is associated with increased relational embeddedness among TIN partners, which supports Hypothesis 1c.

To summarize, the results in Model 5 (the full model) are consistent with the interpretation that exchange conditions significantly affect the structure of TINs. The

negative and significant coefficients for *Project Complexity* and *Project Duration* indicate that TINs under these exchange conditions have lower values of relational embeddedness. The positive and significant coefficient for *Project Uncertainty* in Model 5 indicates that TINs exhibit higher relational embeddedness under the exchange condition of project uncertainty. Turning to the control variables, I see that large firms tend to experiment with a more diverse array of subcontractors and that environmental munificence, which measures the total volume of work for a given year, is related to higher values of *Aggregate Tie Strength*. Next, I present the results from Models 6 – 11, which test how exchange conditions and relational embeddedness interact to affect network organizational performance.

Analysis of Performance

Table 10 presents the results from the Tobit analyses that relate the structure of TINs to their performance. To facilitate exposition and interpretation of the results, the raw data for the dependent variable, *Performance* needed to be "reversed." Because *Performance* is a ratio of a particular TIN's cost against the lowest overall cost for a TIN on that project, values of 1.0 signal the best performance, and values greater than 1.0 signal poorer performance. Thus, performance increases by having the actual values get smaller, while values of the independent variables increase by getting larger. To address this problem, I regressed the independent variables against -1.0 times the values of *Performance*, which effectively reversed their signs and eases interpretation of the results.

Models 6 and 7 present the results for the main effects and Models 8 – 11 add in the interaction terms. Likelihood ratio tests for goodness of fit show that as interaction terms are added, the predictive power of the models increases. However, the LR test statistic for Model 11 is not significant at the 10% level (p = 0.1119), which raises concerns that one or more of the models is misspecified. Several authors suggest that misspecifications are common in Tobit regressions due to the limited nature of the dependent variable (Kennedy, 2003; Vuong, 1989). In cases where LR tests provide inconclusive results for goodness of fit, Sribney (1997) suggests LR statistics and p-values for the individual models (similar to the R^2 in OLS) are an additional option. Each of the LR test statistics for models 6 – 11 is significant at the 1% level, and all of the p-values are less than 0.001. While these statistics are not as powerful as the traditional Neyman-Pearson LR test, the do reduce concerns of misspecification in Models 6 - 11. As in the previous regression analyses, *Environmental Munificence* effectively controls for contemporaneous correlation (Certo & Semadeni, 2006). Thus, I am confident that contemporaneous correlation does not degrade the results from the Tobit regression.

Due to the specification issues described above, I ran Models 6 – 11 using a Logit regression to see whether this type of analysis improved the results. Logit regression requires the dependent variable to be set up as a 0-1 dummy variable (Kennedy, 2003), where observations producing the desired outcome are coded as 1 and all other outcomes are coded as zero. Since these data are drawn from federally funded highway bridge projects, only the lowest cost proposal is awarded a contract, and all of the other proposals (of greater cost) are rejected. Perhaps winning TIN proposals are substantively

different than proposals that do not win, while the costs reflected in the losing TIN proposals are not a systematic measure of their relative performance. Were this so, it follows that an alternative analysis to the Tobit model is to code "winning" proposals (*Performance* values =1) with a dummy variable of 1 and all other proposals with zero. However, the results from the Logit regression did not explain more variance than those reported in Table 10. In fact, the results from the Logit analysis explained less variance. This is likely due to the categorical nature of the dependent variable in the Logit analysis, which uses less information to generate the parameter estimates than the continuous dependent variable in the Tobit regression (Kennedy, 2003). Since the results from the Logit regression have shed no additional light on the findings shown in Table 10, these results can be interpreted as offering only partial support for Hypotheses 2a-d.

Overall, Hypotheses 2a-d predict that *Aggregate Tie Strength* will have a direct effect on the performance of TINs as a governance structure, and that this direct effect will be moderated by exchange conditions. In general terms, this is expressed as equation 5.0:

$$\text{Performance} = \alpha(\text{ATS}) + \beta(\text{ATS} * \text{Exchange Condition}) + \gamma(\text{Controls}) + \varepsilon \qquad (5.0)$$

Alpha (α) represents the parameter estimates for ATS, beta (β) reports the parameter estimates for the interaction variables, gamma (γ) reports the parameter estimates for the control variables, and epsilon (ϵ) is the error term. Models 7 through 11 test these relationships, with Model 7 testing the direct effect of *ATS* on *Performance,* and with

each successive model introducing an interaction term. As described above, the predictive power of each model increases with the introduction of each successive interaction term.

Hypothesis 2a predicts that the direct effect of increasing relational embeddedness decreases performance, due to deleterious effects from network inertia. Relational embeddedness is captured by *Aggregate Tie Strength* and TINs exhibiting network inertia will have higher values of *Aggregate Tie Strength*. Model 7 indicated that the direct effect of ATS on performance is positive an not significant. However, when considered with the interaction terms (Models 8 and 9) the coefficient becomes negative, which suggests the direct effect of ATS may only be negative in the presence of the interaction terms. This is further confirmed in the full model, Model 11. The negative and significant coefficient for *Aggregate Tie Strength* in Model 11 (p = .0418) indicates that network inertia, when simultaneously considered with the interaction terms, is associated with lower levels of performance. Thus, Hypothesis 2a is partially supported.

Hypothesis 2b predicts there will be an interaction between *Project Complexity* and *ATS*, and that higher values of *Project Complexity* will lessen the direct effect of *ATS* on *Performance*. Model 11 shows a positive and significant coefficient for the interaction variable, *ATS*Complexity* (p = .0392), which partially supports Hypothesis 2b. To facilitate interpretation of the positive and significant coefficient for *ATS*Complexity*, the following series of equations provides insight as to how the interaction term can lessen the direct effect of *ATS* on *Performance*.

Table 10: Tobit Regression of Exchange Conditions and Governance Structure on Performance
DV – Performance

	Model 6		Model 7		Model 8		Model 9		Model 10		Model 11	
Constant	-3.375	***	-3.336	***	-3.340	***	-3.332	***	-3.298	***	-3.380	***
	(.802)		(.805)		(.806)		(.805)		(.806)		(.807)	
Lead Firm Size[ad]	-0.018	***	-0.018	***	-0.018	***	-0.018	***	-0.018	***	-0.018	***
	(.006)		(.006)		(.006)		(.006)		(.006)		(.006)	
Lead Firm Age[bd]	0.020	**	0.019	**	0.019	**	0.019	**	0.019	**	0.019	**
	(.010)		(.010)		(.010)		(.010)		(.010)		(.010)	
Env. Munificence[c]	0.093	**	0.091	**	0.092	**	0.091	**	0.088	**	0.096	**
	(.042)		(.042)		(.042)		(.042)		(.042)		(.042)	
Project Frequency	0.001	*	0.001	*	0.001	*	0.001	*	0.001	*	0.001	*
	(.001)		(.001)		(.001)		(.001)		(.001)		(.001)	
Project Complexity	0.012		0.013		0.012		0.013		0.013		0.010	*
	(.011)		(.011)		(.011)		(.011)		(.011)		(.011)	
Project Duration[d]	0.027	***	0.028	***	0.030	***	0.027	***	0.028	***	0.023	***
	(.007)		(.007)		(.007)		(.008)		(.007)		(.008)	
Project Uncertainty	0.001		0.001		0.001		0.001		0.002		0.002	
	(.002)		(.002)		(.002)		(.002)		(.002)		(.003)	
ATS **H2a**			0.008		-0.008		-0.016		0.023		-0.451	**
			(.013)		(.020)		(.150)		(.022)		(.260)	
ATS*Complexity **H2b**					0.033						0.090	**
					(.033)						(.051)	
ATS*Duration **H2c**							0.002				0.030	**
							(.010)				(.017)	
ATS*Uncertainty **H2d**									-0.002		-0.003	
									(.002)		(.003)	
Observations	584		584		584		584		584		584	
Log Likelihood	35.97		36.15		36.66		36.17		36.51		38.34	
χ^2 LR Test Statistic			0.36		1.38		0.4		1.08		4.38	

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1% (One-tailed tests)

a   Number of Employees

b   Years

c   Millions USD, annually

d   Log (Variable)

$$\text{Performance} = \alpha(\text{ATS}) + \beta(\text{ATS*Exchange Condition}) + \gamma(\text{Controls}) + \varepsilon \quad (5.0)$$

Equation (5.0) represents the general format for the regression analyses. To test hypothesis 2b, the specific exchange condition of *Project Complexity* is evaluated, which is shown in equation 5.1.

$$\text{Performance} = \alpha(\text{ATS}) + \beta(\text{ATS*Project Complexity}) + \gamma(\text{Controls}) + \varepsilon \quad (5.1)$$

Taking the partial derivative of equation 5.1 with respect to *ATS* yields equation 5.2:

$$\frac{\partial_{Performance}}{\partial_{ATS}} = \alpha + \beta(\text{Project Complexity}) \quad (5.2)$$

Equation 5.2 provides the mathematical basis for interpreting the coefficients provided in Model 11, which is necessary to determine whether H2b is supported. Model 11 provides the coefficient for ATS ($\alpha = -0.451$) and the coefficient for the interaction term, *ATS*Project Complexity* ($\beta = .090$). Inserting this information into equation 5.2 yields:

$$\frac{\partial_{Performance}}{\partial_{ATS}} = -.451 + 0.090(\text{ProjectComplexity}) \quad (5.3)$$

Setting equation 5.3 equal to zero and solving for *Project Complexity*, shows that for any project with a *Project Complexity* score greater than 5.011, the moderating effect of *Project Complexity* on *ATS* is able to overcome the negative direct effect of *ATS* on *Performance*. Since values of *Project Complexity* range up to 8.49 (as seen in Table 8), there are observations within the sample that exhibit this value, which confirms both the partial statistical support for Hypothesis 2b and its practical significance.

Hypothesis 2c predicts there will be an interaction between *Project Duration* and *ATS*, and that higher values of *Project Duration* will lessen the direct effect of *ATS* on *Performance*. The coefficient for *ATS*Duration* in Model 11 is positive and statistically significant (p = .0383), thus H2c is partially supported. By performing the same calculations shown above (Equations 5.0 – 5.3), we can confirm the statistical support for Hypothesis 2c. The coefficients from Model 11, inserted into equation 5.3, indicate that values for *Project Duration* greater than 15.03 will overcome the negative direct effect of *ATS* on *Performance*. Checking Table 8, values for *Project Duration* range up to 18.13, which not only confirms the statistical support Hypothesis 2c, but also the plausibility of the findings given the data range.

Hypothesis 2d predicts there will be an interaction between *Project Uncertainty* and *ATS*, and that higher values of *Project Uncertainty* will lessen the direct effect of *ATS* on *Performance*. The coefficient for the interaction variable *ATS*Uncertainty* in Model 11 is not statistically significant at the 10% level (p = 0.1271). Thus, H2d is not supported.

Discussion of Results for the Structure and Performance of TINs

In this dissertation, I have proposed and tested a theory that integrates ideas from transaction cost economics and sociology to explain the structure and performance of temporary interorganizational networks (TINs). I also argued that TINs represent a unique variant of network organizational forms. Because TINs are composed of much more transient relationships than traditional network organizations, they require integrative theoretical frameworks to test their structure and performance. I argued that TIN structures are designed according to exchange conditions. I argued that the design of TINs directly affects their performance as a governance structure. I also argued that the direct affect of a TIN's governance structure on performance is moderated by exchange conditions. Next, I summarize the findings and discuss the implications of the study for theory.

Studying TINs seems a logical extension of existing theories of organizational governance. The notion that governance structures are designed according to exchange conditions is not new and has been empirically supported across a wide range of industries. However, these theories were largely formulated to study organizations that last for a long time. Even when applied to less permanent organizations, such as strategic alliances or equity joint ventures, theories of organizational governance consistently held when studying these less permanent governance structures. However, dramatic changes in the last twenty years have shortened the temporal duration of many governance structures. Whereas strategic alliances and joint ventures may shorten the time window from several decades to

several years, these emerging governance structures may last only a few days (music video production), weeks (film and housing construction), or months (highway construction). New terminology arose to describe these more ephemeral governance structures, such as virtual organizations (Davidow & Malone, 1992), temporary project originations (Bechky, 2006; Jones & Lichtenstein, 2008), quasifirms (R.G. Eccles, 1981), and modular organizations (Hoetker, 2006; Schilling & Steensma, 2001). The question remains, do the older theories still apply despite a dramatic reduction in the lifespan of more temporary organizational forms. This study represents an initial attempt at solving this puzzle and the results for Hypothesis 1a-c provide evidence that a new system of rules for governance design may be needed.

The results for both hypotheses 1a and 1b, suggest TINs behave like modular systems. The literature on modular systems suggests that subcontractor firms are highly interchangeable, and that lead firms can effectively reduce costs by having a loosely-coupled network of specialists that can be plugged in and out of a network with little impact on its performance (Hoetker, 2006; Sanchez & Mahoney, 1996; Schilling & Steensma, 2001). For *Project Complexity*, TCE and capabilities arguments also support the increased use of subcontractors as project complexity increases (S. W. Anderson, Glenn, & Sedatole, 2000; Argyres, 1996; Balakrishnan & Wernerfelt, 1986; R.G. Eccles, 1981; Grant, 1996; Kogut & Zander, 1992; Perry, 1982; Rubin, 1973; Williamson, 1975, 1985b). What is interesting is that the benefits that follow from TCE and Capabilities logics do not hold for TIN designs on projects

of longer duration. In fact, the findings for how *Project Duration* affects *Aggregate Tie Strength* are directly opposite to the hypothesized relationship.

One explanation of this surprising result could be the empirical setting. Because these data come from an industry where competitive bidding is the rule, firms may elect to use market forces to drive down the prices via competition between subcontractors (M. E. Porter, 1985; David J. Teece, 1984), in spite of the acknowledged benefits from choosing repetitive partnerships as duration increases (R.G. Eccles, 1981). Eccles (1981) suggests that competitive bidding situations may cause a "reverse effect" in subcontractor selection in the construction industry, due to the high availability of specialty subcontractors and the tendency for these subcontractors to perform similar functions for multiple lead firms (page 399). Still, while Eccles (1981, pp. 399-400) did find increased use of subcontractors for contractors in the residential and industrial building space (38% and 54% subcontracted out, respectively), he did not find as large a percentage for highway and bridge contractors (18% and 22%, respectively). Thus, despite highway and bridge contractors competing in a competitive bidding scenario, Eccles (1981) found these trades exhibited higher amounts of repeated partnerships and using fewer subcontractors overall. Thus, the empirical setting and its competitive bidding requirement only partially explains the negative relationship between *Project Duration* and *ATS*. Despite competitive bidding being a logically persuasive explanation for the negative and significant coefficient on *Project Duration*, it

appears modularity is a better foundation to explain the unexpected result that *ATS* decreases as *Project Duration* increases.

Project Uncertainty, however, does follow logics from TCE and Capabilities, suggesting that when uncertainty is high , TINs are designed with more highly embedded networks and more repeated partnerships. Project uncertainty arises from exogenous sources and is a characteristic of a TIN's task environment. TCE and Capabilities literatures suggest that as task uncertainty increases, more hierarchical governance forms will dominate (Robert G. Eccles, 1981; R.G. Eccles, 1981; Santoro & McGill, 2005; Walker & Weber, 1984). This finding also supports the conceptual claims of Jones and Lichtenstein (2008) and the empirical findings of Eccles (1981), suggesting *Project Uncertainty* is indeed a salient driver of organizational form in TINs. Eccles (1981) found an increasing reliance on trust in uncertain situations in the home building industry, where general contractors preferred to use the same set of subcontractors whose work they knew they could rely upon. Next, I interpret the results from hypotheses 2a-d that investigate how the structure of TINs affects their performance.

Despite only partial support for Hypothesis 2a, the result for H2a may be the most intriguing finding of this study. As described earlier in this dissertation, the primary motivation for this study was to construct a more balanced measure of the performance of networks to allow investigation of negative performance outcomes associated with network organizational forms. A primary criticism of the network literature is that scholars continue to tout the flexibility and economic benefits to

network organizational forms, without obtaining empirical evidence of network constraint, poor performance, or failure (Kim, Oh, & Swaminathan, 2006; Podolny & Page, 1998). The negative and significant coefficient for H2a suggests that network inertia may be a salient source of failure for the network organizational form and represents one of the first empirical tests of failure among network organizations. Additionally, the size of the coefficient on H2a relative to those for the other hypotheses suggests that network inertia might have an adverse effect upon organizational performance (see Table 12 for an estimate of effect size) are particularly large. Despite this finding for the negative main effect of *ATS* on *Performance*, results from the interaction variables suggest these adverse effects can be overcome when TINs adjust their structure in a contingent fashion. Perhaps aligning exchange conditions and TIN structures does improve performance.

Because H2a receives statistically significant support only in Model 11, concerns about multicollinearity surface. Multicollinearity arises when the variances of some correlated independent variables are quite large (Kennedy, 2003). When these variances are large, it is difficult to determine which independent variable should be "given credit" for explaining the variation on the dependent variable. When multicollinearity is present, it is likely that two highly correlated variables may jointly explain the variation on the dependent variable, causing the parameter estimates to be imprecise and reducing the power of hypothesis testing (Kennedy, 2003). However, since the largest inter-correlation value is only 0.46 (Between *Project Duration* and *Project Uncertainty*) and the results from the variable inflation

factor (VIF) analysis were so low, issues with multicollinearity are likely not the only reason Model 11 obtains statistical significance for H2a. However, the dramatic changes in parameter estimates in Model 11 cannot be ignored, which means the most I can say about these Hypothesis 2a is that it is partially supported. Further, interpretations of the interaction terms must also be tempered as their statistical significance could be partially explained by effects from multicollinearity.

Hypotheses H2b-d investigated how the negative direct effect of *ATS* on performance may lessen due to the interaction between exchange conditions and *ATS*. The results provide mixed support for the hypothesized relationships. H2b is partially supported and suggests that in the presence of sufficient project complexity, the negative direct effect of *ATS* on performance may be overcome. This finding enhances the earlier findings from Hypothesis 1a-b, which suggests that TINs behave as modular systems. By evaluating the effects of more modular organizational forms on performance, this finding confirms Jones, Hesterly and Borgatti's (1997) conceptual argument that more flexible governance structures increase performance as complexity increases.

Hypothesis 2c is partially supported and suggests that in the presence of sufficiently high *Project Duration*, the negative direct effect of *ATS* on *Performance* may be overcome. This finding supports arguments from TCE and Capabilities scholars that suggest repeated interactions reduce the costs of organizing due to efficiencies gained from trust (R.G. Eccles, 1981; Zaheer, McEvily, & Perrone, 1998), from developing superior interorganizational routines with a select group of

partners (Nelson & Winter, 1982), and from developing dedicated resources (Kale, Dyer, & Singh, 2002). Further, these findings align with prior investigations of more traditional networks, such as supplier networks and traditional alliances, which suggest a select group of partners that interact over time derive benefits from information sharing (Dyer, 2000; Hayes, Wheelwright, & Clark, 1988) and greater cooperation (Carson, Madhok, & Wu, 2006; Heide & John, 1990).

The results obtained for Hypothesis 2c become even more interesting when considered in parallel with the findings for Hypothesis 1b. Recall that H1b is a test of behaviors among TINs, but H2c is a test of how these behaviors affect performance. Findings for H1b support that TINs behave more like modular systems that are composed of a greater number of partners, repeat fewer partnerships, and exhibit decreasing relational embeddedness when *Project Duration* is higher. However, despite the frequent occurrence of this behavior among the sample of TINs within this study, H2c suggests that the opposite behavior can lead to better performance. Among the 584 observations that comprise the final sample frame, 384 projects exhibited sufficient project duration (score >= 15.01 in Model 10) to benefit from higher values of relational embeddedness. Thus, modularization largely explains *how* TINs organize in response to project duration, but transaction efficiency arguments and arguments for the coordination benefits gained through relational embeddedness suggest this is the wrong behavior for TINs seeking to reduce the costs of organizing.

Hypothesis 2d is not supported. The coefficient on the interaction of *ATS* and *Project Uncertainty* is negative and is not significant at the 10% level. Given the

small size of the coefficient and lack of statistical significance, it is difficult to make any meaningful conjectures.

Calculating Effect Sizes

Increasingly, scholars are using effect sizes to estimate the "actual" impact of strategy research on the performance of "real" firms. Ellis (2009) presents their argument in his book: *The Essential Guide to Effect Sizes: An Introduction to Statistical Power, Meta-Analysis and the Interpretation of Research Results*. Ellis (2009) essentially argues that statistical models may be high in rigor and high in their ability to explain nuances of theory, but scholars often fail to translate statistical findings into valuable insights that influence businesses in the real world. Moreover, researchers have reported statistically significant findings that support theorizing about the impact of a particular strategy on performance, even when the actual effect of following this strategy does little to benefit firms (i.e. increase profits). Only by assessing effect size and statistical significance in tandem can we ensure our interpretations translate into valuable insights in the real world (Ellis, 2009).

Table 11 offers estimates of effect sizes for Hypotheses H1a-c and these effects represent the percent change in ATS associated with each exchange condition. Calculating percent change as an effect size is more complex than other calculations of effect size, because one needs to isolate the *change* in the expected value of the dependent variable, rather than simply considering the magnitude of the expected value of the dependent variable that is associated with a particular regression

coefficient (McDonald & Moffit, 1980). Isolating the *change* in expected value

requires decomposing the Tobit regression coefficient (Boschung, Sharpe, & Abdel-

Ghany, 1998; McDonald & Moffit, 1980). Following McDonald and Moffit (1980), I

offer a series of equations that decompose Tobit coefficients and allow the calculation

of percent change. Equation (5.4) offers the general Tobit model for regression

where the dependent variable has a lower limit of zero.

$$
\begin{aligned}
Y_I &= \alpha + X_i B_i + \mu_i \quad \text{if } \alpha + XB_i + \mu_i > 0 \\
Y_i &= 0 \quad \text{if } \alpha + XB_i + \mu_i \leq 0 \\
&= 1,...n
\end{aligned}
\tag{5.4}
$$

In Equation (5.4), Y_i is the dependent variable, alpha (α) is a constant term, X_i is a

vector of independent variables, B_i is a vector of unknown coefficients, μ_i is a

normally distributed error term, and n is the number of observations. The expected

value of the dependent variable, EY_i, is presented by the following formula:

$$
EY_i = X_i B_i F(z) + \sigma f(z)
\tag{5.5}
$$

where $F(z)$ is the cumulative normal distribution function associated with the

proportion of cases above the threshold value (zero in this example), $f(z)$ is the unit

normal density, z is the z score for an area under the normal curve, sigma (σ) is the

standard deviation of the error term, and B_i is the Tobit coefficient for the specific

independent variable X_i.

The first order partial derivative of Equation (5.5) $\dfrac{\partial EY_i}{\partial X_i}$ signifies the effect of

an independent variable on the expected value of the dependent variable for all

observations and can be presented as follows:

$$\frac{\partial EY_i}{\partial X_i} = F(z)\frac{\left(\partial EY_i^*\right)}{\partial X_i} + EY_i^* \frac{\left(\partial F(z)\right)}{\partial X_i} \tag{5.6}$$

Where EY_i^* is the expected value of the dependent variable for observations above

the threshold, $\dfrac{\partial EY_i^*}{\partial X_i}$ is the change in the expected value of the dependent variable,

and $\dfrac{\partial F(z)}{\partial X_i}$ is the change in the cumulative probability of being above the threshold

value associated with an independent variable. For calculating percent change as an

effect, $\dfrac{\partial EY_i^*}{\partial X_i}$ is the term of interest (McDonald & Moffit, 1980). The formula for

deriving this value is presented in equation 5.7:

$$\frac{\partial EY_i^*}{\partial X_i} = B_i\left[1 - \frac{zf(z)}{F(z)} - \frac{f(z)^2}{F(z)^2}\right] \tag{5.7}$$

Finally, the value derived from Equation (5.7) is then divided by the mean value for

ATS (0.4047) to obtain the percent change. Table 11 presents these results.

Table 11: Effect Sizes
Hypotheses 1a-1c

Independent Variable	Tobit Coefficient	Change in the Expected Value of the Dependent Variable (Equation 5.7)	Mean Value for ATS	Percent Change in ATS
Project Complexity H1a	-0.1856	-0.1473	0.4047	-36.4%
Project Duration H1b	-0.06489	-0.0480	0.4047	-11.9%
Project Uncertainty H1c	0.25	0.2247	0.4047	55.3%

To summarize the information in Table 11, it appears that exchange conditions produce significant effects on ATS. The variable *Project Complexity* produces a 36.4% reduction in values of ATS. The variable *Project Duration* produces an 11.9% reduction in values of ATS. Finally, *Project Uncertainty* increases relational embeddedness (ATS) by 55.3 %. These percent changes in the governance structure of TINs are dramatic and support the regression analyses with actual effects.

Table 12 offers several estimates of the effect sizes for Hypotheses H2a-d. For these calculations, I calculate effect sizes based on the expected value of the dependent variable associated with the regression coefficient of an independent variable (i.e. not the percent change as in Table 11). Since my dependent variable, *Performance*, is a ratio of the lowest cost for a TIN on a particular project, calculating the effects on profits of following a strategy is difficult. Further, nearly all of the lead firms in this sample are privately held, and compete in an industry where low cost is

the only path to contract award. Thus, firms are very reluctant to disclose any information about profit margins for fear of a competitor gaining an advantage. However, in 2007, the *Construction Financial Managers Association* (CFMA) solicited anonymous accounting records from heavy and highway construction firms and published a report that shows average profit margins per dollar of bid costs for heavy and highway construction firms. While certainly not a comprehensive review of all highway construction firms (n = 15), this report does allow calculating effect sizes.

Since this empirical setting only awards contracts to the lowest bidding TIN, I began by selecting the winning projects for the years 2006 and 2007 – the only years where profit information was available (CFMA, 2007). Next, I calculated a median winning bid cost for each year, and then multiplied this number by the coefficients in Model 10 (full model) for each strategy (H2a-d). Profit margins as a percentage of bid cost, gained from the CFMA 2007 annual report, were then multiplied by that number. The resulting estimate of effect size is reported in US Dollars and represents a potential increase (or decrease) in profits for those firms that follow the strategies my hypotheses test. These initial calculations represent the direct effects of each strategy on profit (Table 12).

The interaction effects are presented in Table 13. Since I hypothesized that the interaction effects may overcome the negative direct effect of ATS on performance, Table 13 presents effect sizes for projects where this occurs. In 2006 and 2007, the only observations I had that were above the threshold value for the

interaction effects were for the *Project Duration* variable (threshold = 15.01). The median winning bid cost for projects above the *Project Duration* threshold was $13,500,000 for 2006 and $13,800,000 for 2007. Table 13 shows estimates of these interaction effects.

Despite my options for calculating effect sizes being constrained, the estimates in Table 12 and Table 13 do provide an indication of how the statistical findings may transfer to the real world. Since the magnitude of the coefficient on H2a, for example, is so much larger (-0.451 versus 0.090) it appears that the effect of network inertia is much more potent than that of any of the other variables examined in the study. For example, in 2007, my calculations indicate that, for a firm whose maximum annual revenue did not exceed $10 million (CFMA, 2007), a rigid and inflexible network conforming to the assumptions of H2a could result in losing over $667,000 dollars. In contrast, the coefficients for H2b and H2c were positive and significantly related to performance, but their positive effect was more than ten times smaller than the negative effect from *ATS* alone (H2a).

Table 13 provides more encouraging results. Table 13 presents calculations from projects of sufficient duration as to potentially allow TINs to overcome the negative effects of ATS. In 2006, where the median winning bid cost for projects above the threshold was $13,500,000, TINs exhibiting the strategy for H2c were able to overcome the main effect of ATS on performance and be profitable. In 2007, however, TINs were unable to completely overcome the negative direct effect of ATS, though this effect was dramatically reduced.

Table 12: Effect Sizes
Direct Effects
Potential Effects of Hypothesized Strategies on Profit
(Profit Percentages Calculated From Highway Construction Firms with Average Annual Revenues of $10 Million or less)

Strategy	Coefficient (T-stat)	Median Winning Bid Cost (US Dollars)		% Profit for Winning Bids[1]		Potential Increase (Decrease) in Profit from Following Direct Strategy (US Dollars)	
Direct Effect		2006	2007	2006	2007	2006	2007
Aggregate Tie Strength **H2a**	-.451 (1.73)**	$2,760,250	$6,848,662	15.6	21.6	($194,200.14)	($667,1 69.24)
Project Complexity*ATS **H2b**	0.090 (1.76)**	$2,760,250	$6,848,662	15.6	21.6	$38,753.91	$133,13 7.98
Project Duration*ATS **H2c**	0.030 (1.77)**	$2,760,250	$6,848,662	15.6	21.6	$12,917.97	$44,379 .33
Project Uncertainty*ATS **H2d**	-0.003 (1.14)	$2,760,250	$6,848,662	15.6	21.6	($1,291.76)	($4,437 .93)

1   Average % Profit Per Dollar of Proposed Cost for Heavy Highway Construction.   As reported in *Construction Financial Managers Association Annual Report(2007)*
*   significant at 10%; ** significant at 5%; *** significant at 1% (One-tailed test)

Table 13: Effect Sizes
Interaction Effects
Potential Effects of Hypothesized Strategies on Profit
(Profit Percentages Calculated From Highway Construction Firms with Average Annual Revenues of $10 Million or less)

Direct Effect	Coefficient (T-stat)	2006	2007	2006	2007	2006	2007
Aggregate Tie Strength **H2a**	-.451 (1.73)**	$2,760,250	$6,848,662	15.6	21.6	($194,200.14)	($667169.24)
		Median Winning Cost of Projects Greater than Threshold Value: Above Threshold, Interaction May Overcome Direct Effect				Potential Increase (Decrease) in Profit from Following Interaction Strategy (USD) Profit = Direct Effect + Interaction Effect	
Interaction Effects	Coefficient (T-stat)	2006	2007	2006	2007	2006	2007
Project Complexity*ATS **H2b**	0.090 (1.76)**	No Projects	No Projects				
Project Duration*ATS **H2c**	0.030 (1.77)**	$13,500,000	$13,800,000	15.6	21.6	$210799.86	($253,169.24)
Project Uncertainty*ATS **H2d**	-0.003 (1.14)	No Projects	No Projects				

1 Average % Profit Per Dollar of Proposed Cost for Heavy Highway Construction. As reported in *Construction Financial Managers Association Annual Report(2007)*

* significant at 10%; ** significant at 5%; *** significant at 1% (One-tailed test)

Thus, firms interpreting my results should be more concerned about the negative effects of *ATS* on performance. However, if the actual duration of a project is sufficiently large as to allow the influence from that project's duration to overcome the large and negative direct effect of ATS, my results support that this strategy dramatically improves performance.

Population Level Learning in the Context of TINs

Another interesting but distinct performance outcome for network organizations is learning. As reviewed in Chapter III, the benefits of learning from network organizing have received ample attention from scholars. Network ties are conduits for rapid knowledge transfer between partners (Contractor & Lorange, 1988; Hamel & Prahalad, 1991; Kogut). Networks allow collaborating firms to internalize one another's skills (Hamel, 1991b). Finally, the dynamic capabilities literature suggests that learning is path dependent and "often a process of trial, feedback, and observation" (David J. Teece, Pisano, & Shuen, 1997, p. 523). This study investigated learning within the context of TINs, and I focus on path dependent learning and feedback mechanisms.

Path dependent learning, due to its incorporation of feedback mechanisms, aligns with behavioral learning theories. Behavioral learning theories depict learning as a mechanistic and involuntary process where firms are assumed to repeat behaviors that lead to pleasant outcomes and discontinue behaviors that lead to unpleasant outcomes (Starbuck & Hedberg, 2001). One advantage of behavioral theories is they can explain

how learning can improve over time, even when information about individual manager perceptions is unavailable (Starbuck & Hedberg, 2001). In Chapter III, I adopted a behavioral perspective to learning and developed hypotheses that measure the adoption of a network design based on past success or failure of this design across a population of network organizations, holding project characteristics constant across time.

Population level learning is defined as "a systematic change in the nature and mix of routines in a population of organizations arising from shared experience" (Miner & Haunschild, 1995). Thus, population level learning is largely a study of imitation – with the increasing adoption of successful routines drawing the most attention among scholars (Miner, Kim, Holzinger, & Haunschild, 1996). Like their counterparts in the network literature, scholars of population level learning have largely ignored failure. When failure is examined, population ecology scholars (Hannan & Freeman, 1984) and a few studies of bankruptcy and disasters (Perrow, 1984; Sutton & Callahan, 1987) have treated failure as an outcome, and their analyses usually are limited to causal models of failure – what predicts failure and how to avoid it (Miner, Kim, Holzinger, & Haunschild, 1996). However, by treating failure as an independent variable, scholars can ask a completely different series of questions. For example, what effect does failure by one or more organizations have on the larger groups for which they are a member (Miner, Kim, Holzinger, & Haunschild, 1996)? Further, how does success or failure affect the rate of learning within and between collaborating organizations? Specific to the context of TINs, how does success/failure of TIN structures/behaviors at the organization level affect a transformation of behaviors at the population level.

Empirical Testing and Findings for Population Level Learning

To study how success or failure among TIN routines at the organization level affect behaviors at the population level, I began by segmenting the population of TINs according to their structure and across time. I divided the sample into two temporal periods, from 2000 – 2004 and from 2005 – 2007. The two periods were chosen to split the sample in half, thus ensuring an adequate number of observations in each period to allow statistical analyses. The first period contained 302 observations and the second period contained 282 observations.

Within each period, I used the statistical software STATA to group all TINs according to *ATS*. Using STATA's "group" command, I segmented the population of TINs into three groups of equal size. Next, I regressed two of the groups (dropping one group to avoid issues with multicollinearity) against "winning" (and losing) to see whether a particular TIN structure was significantly related to winning (or losing) a bid during the first period. Using a Logit model, I found that TINs exhibiting lower values of ATS were significantly more likely to "lose" and that firms in the mid-range of ATS were significantly more likely to "win." These behaviors (reflected in TIN structures) represent organization-level routines during the period between 2000 - 2004.

In order to test population level learning, I had to examine the second period, from 2005 – 2007, to see whether winning routines were increasingly adopted and whether losing routines were removed (Miner & Haunschild, 1995). Using t-tests to see whether the occurrence of winning (and losing) routines significantly increased (or decreased) during the second period, my findings suggest that the extent of learning

reflected in the incidence of routines encoded in TIN structures depended on whether the routines had resulted in successes or in failures. Table 14 shows the results from this study of population level learning.

Table 14: Learning from Success and Failure at the Population Level
Reporting Percent Change in Occurrence of Successful/Unsuccessful Routines

	Percentage of Sample Exhibiting the best/worst routines		Population Level Learning	Test	Comment
	2000 - 2004	2005 – 2007	% Change in Routine	T-test Statistic	
Best Routines (Lowest Cost = Success)	33.64%	33.07%	(.57%)	0.17	H3a Not Supported
Worst Routines (Highest Cost = Failure)	40.55%	31.25%	(9.3%)	2.296	H3b Supported

As shown in Table 14, the lead firms appear to have learned more from failure than from success. The percent change in the occurrence of successful routines was small and statistically insignificant (H3a not supported), while the percent change in the occurrence of deleterious routines was large and statistically significant (H3b supported).

Discussion of Results for Population Level Learning

The context of temporary organizing provides new insight to previous studies about learning from success and failure at the population level of analysis. Previous

studies suggest drastic failure is the main mechanism for learning at the population level: "Organizations disappear if they act inappropriately or ineffectively, so the surviving organizations act appropriately and effectively" (Starbuck & Hedberg, 2001, p. 450). However, population level learning is defined as an increase or decrease in the use of *routines*, which may fail multiple times for a variety of reasons without causing organizational failure. Miner et al. (1996) attempted to uncover the more subtle effects of failure, but also used the failure of an entire organization (or a few of them) as an indicator of change at the population level. This study measures the failure of routines directly, indeed, no lead firm failed during the years 2000 – 2007. Thus, my findings offer more fine-grained evidence bearing upon how the removal of deleterious routines affect behaviors across a population of TINs.

Another interesting finding has to do with the Red Queen effect, or in this case, the lack thereof. In a population of competing organizations, learning often creates a Red Queen effect (Barnett & Hansen, 1996, p. 139):

> An organization facing competition is likely to engage in a search for ways to improve performance. When successful, this search results in learning that is likely to increase the organization's competitive strength, which in turn triggers learning by its rivals – consequently making them stronger competitors and so again triggering learning in the first organization.

Barnett and Hanson (1996) inferred that some learning behaviors in banks are consistent with the Red Queen effect. Ingram and Baum (1997) found similar learning among hotel chains, which grew less likely to fail by observing more other hotel chains and more failures by other hotels. In this population of TINs, at least for the most successful routines from 2000 – 2004, firms did not exhibit learning from observing the past

successes of their competitors (H3a not supported). This suggests the context of temporary organizations may enact different mechanisms for learning than more traditional organizational forms.

Summary of Empirical Findings and Limitations

This chapter has reported and interpreted the outcomes of hypothesis tests and other empirical findings as summarized in Table 15. In the first series of analyses, hypotheses aiming to unpack how project characteristics affect TIN structure were tested. A second series of analyses tested hypotheses about the performance of TINs, and a third offered estimates of effect sizes for the strategies modeled in the hypotheses. A fourth set of analyses examined population level learning within TINs. The results suggest that TIN structures are designed as modular systems, but that this structural design does not necessarily lead to better performance. Additionally, strong support was found for negative performance associated with particular network structures, with structures exhibiting network inertia negatively related to performance and also producing the largest potential effect size from the relationships tested. The analyses of population level learning suggest that designers of TINs are more likely to learn from failure than from success, which echoes previous findings at the individual and organizational levels of analysis (Starbuck & Hedberg, 2001).

In the next section, I discuss several limitations to this research design that may affect this study's contribution to theory and also the ability to generalize these findings to other populations.

Table 15: Summary of Statistical Findings

Legend	
Hypothesis Supported	+
Hypothesis Not Supported	Ø
Significant Contrary Relationship Found	−

I. Investigating Network Organizational Structure		
H1a	*Higher levels of project complexity will be associated with lower levels of ATS among TINs*	+
H1b	*Higher levels of project duration will be associated with higher levels of ATS among TINs*	−
H1c	*Higher levels of project uncertainty will be associated with higher levels of ATS among TINs*	+
II. Investigating Network Organizational Performance		
H2a	*As ATS increases, temporary interorganizational network performance decreases*	+
H2b	*The negative influence of ATS on Performance is moderated by project complexity such that as Project Complexity rises, the impact of ATS on Performance lessens*	+
H2c	*The negative influence of ATS on Performance is moderated by Project Duration such that as Project Duration rises, the impact of ATS on Performance lessens*	+
H2d	*The negative influence of ATS on Performance is moderated by Project Uncertainty such that as Project Uncertainty rises, the impact of ATS on Performance lessens*	Ø
III. Investigating Population Level Learning		
H3a	*Populations of network organizations learn from success. When new projects have similar characteristics to past projects, organizations will exhibit learning by increasing the occurrence of TINs that previously succeeded*	Ø
H3b	*Populations of network organizations learn from failure. When new projects have similar characteristics to past projects, network organizations will exhibit learning by reducing the occurrence of TINs that previously failed*	+

Limitations of the Study

In designing the research to investigate the structure and performance of network

organizational forms, I faced several challenges. While this study represents an

important step toward our understanding of the full range of performance for network forms of organization (including poor performance and failure), a series of decisions about research methods, operationalization of variables, and supporting theory was made, and these decisions introduce limitations to this study. It is important to address possible limitations arising from these decisions prior to considering any normative and research implications of my findings.

One limitation arises from the decision to investigate temporary network organizations instead of more permanent networks. This choice was made for three reasons. First, TINs are a form of network organization that has received comparatively little scholarly attention, despite its growing prevalence and economic importance. Second, temporary network organizations highlight the role of temporal variation into the design of governance structures (Jones, Hesterly, & Borgatti, 1997; Jones & Lichtenstein, 2008; Scott E. Masten, Meehan Jr., & Snyder, 1991). Transient networks increase firms' awareness of time pressure, a critical antecedent to network governance (Jones, Hesterly, & Borgatti, 1997). Third, studying temporary networks increases the availability of reliable data on network tie dissolution – without which one cannot reliably examine poor performance and failure. While firms tend to announce tie formation with great fanfare (Podolny & Page, 1998), reliable data on tie dissolution and the performance outcomes from dissolution are much more difficult to obtain. However, despite the advantages of studying temporary network organizations, many other types of network organizations do not exhibit these characteristics. Examples of networks that exhibit a lower degree of time pressure include R&D alliances, where the outcome of interest is often innovation

output and patenting (e.g. Ahuja, 2000), rather than reducing the costs of the organizational form itself.

Limitations of the Research Design

The research design also introduces limitations. First, choosing bridge construction firms in Oregon reduces the generalizeability of the findings to other geographic areas, other industries, and to other cultures. During my career in bridge construction, I completed RFPs to construct bridges whose physical locations spanned six western states (Oregon, Washington, California, Idaho, Nevada, and Alaska). Each of these projects was funded with federal dollars, which meant they required many of the same types of information to be submitted with each bid (total cost, bonding capacities, etc.). However, Oregon is the only state to require the subcontractor disclosure form (SDF), which provides information about the network of subcontractors each lead firm intends to use. Thus, I was constrained to only collecting data within Oregon and only during those years when the Oregon Department of Transportation began requiring the SDF with each bid (2000 – 2007). Still, I am confident that my findings will directly generalize to bridge construction within the United States, and may also generalize to other industries where temporary networks are the preferred organizational form (film industry, music video production, etc.) and where minimizing the costs of organizing is critical.

Second, the screening process used to select the final sample aimed to reduce the "noise" inherent in the archival data, but doing this may have introduced sample selection

bias. Sometimes lead firms forget to turn in a subcontractor disclosure form, which removes that observation from consideration. Since the subcontractor disclosure form is required for contract award, it is unlikely that a "winning" bidder will "forget" to turn in this required form. Similarly, if a proposal finished dead last, that lead firm's motivation to turn in all required paperwork is likely to be less than for a bid that is very close to winning or that of the actual winner. This raises some concerns of a success bias being present in these data, but my concerns are reduced by the simultaneous equation modeling present in Tobit regression, which controls for this form of bias (Kennedy, 2003).

In addition to concerns from missing data, the research design relied on proposed costs for completing a bridge and did not measure actual costs. I tried to obtain actual project costs from the Oregon Department of Transportation, but many of these documents were sealed and not publicly available. Since my sampling window was very recent, many of the projects I included are currently underway and some are in litigation, which precludes acquiring actual cost data. Despite this limitation, using proposed costs increased the availability of data on tie dissolution and its associated costs. Consider a project with ten bidders wherein only one of them wins a contract, while the nine other proposals "fail," the ties they propose to dissolve immediately. Even if two of these lead firms do not turn in a list of ties for that project (via the SDF), data are still available to describe the winning bidder's network as well as seven examples of "failing" networks. Due to the presence of so much reliable data on failure, the inability to obtain actual costs seemed a suitable compromise.

Despite the limitations described above, there are several normative and research implications that this study provides. In Chapter VI, I review the contributions of this study and delineate normative implications for managers and research implications for scholars interested in the performance of temporary interorganizational networks. I conclude with areas of future research, including studies I plan to conduct using these data.

CHAPTER VI

CONCLUSION

This concluding chapter reviews the study, summarizes the study's empirical findings, and posits some research and managerial implications that extend current perspectives on network organizational forms. The first section is an overview and summary of the research issues and the theoretical framework constructed to investigate the structure and performance of network organizational forms. Major empirical findings are also summarized in this section. The final sections are devoted to some research implications that recast current theorizing on governance structure and performance and managerial implications suggested by the empirical findings. I also suggest future research that may further extend our understanding of the structure and performance of network organizational forms.

<u>Overview and Summary</u>

In this study, I have proposed and tested an integrative theory explaining the structure and performance of temporary interorganizational networks (TINs). Prior to about 1980, the notion that firms could improve performance by cooperating with competitors and by designing temporary governance structures would have been

viewed with extreme skepticism. The prevailing organizational structures had long time horizons and explicit contracts and governance structures of that period facilitated resource accumulation and control (Snow, Miles, & Coleman, 1992). This began to change with advances in information technology, deregulation, and privatization that allowed companies access to new forms of capital, technology and skills that simply were not available previously (Prahalad & Oosterveld, 1999). These rapid changes led to an increasing occurrence of network organizational forms and the inability of contemporary theories to fully explain the structure and performance of network forms motivated this dissertation.

Prior Theory and Research

In past research, two main theories informed the design and performance of governance structures – transaction cost economics (TCE) and social embeddedness. Economic and sociological explanations of governance represent independent approaches to explain a common phenomenon. Each theory presents a compelling, yet polarizing argument for the emergence and persistence of network governance.

Transaction cost economics (TCE) has been the dominant theoretical perspective to examine the structure and performance of governance forms. TCE "is grounded upon a legal understanding of organizations as governance mechanisms distinct from markets" (Santos & Eisenhardt, 2005, p. 492). Under TCE, the firm boundary is determined by asking whether conducting a transaction inside the firm or externally in the market most reduces the sum of production and governance costs.

Governance costs include monitoring operations, allocating requirements for production, initial contractual agreements, and setting up initial procedures for exchange (Mayer & Salomon, 2006).

However, TCE has come under fire from sociologists, who argue that transaction efficiency arguments are "under socialized" (M. Granovetter, 1985). Sociologists argue that all economic transactions are embedded within a wider network of social relationships and that governance structures arise from these embedded relationships in addition to economic considerations (M. Granovetter, 1985). This is particularly the case in networked economies, where the shorter temporal duration of economic exchanges increases the influence of social relationships (Jones, Hesterly, & Borgatti, 1997; Walter W. Powell, 1990). Sociologists define the quality of relationships between firms according to the level of relational embeddedness between partners. Relational embeddedness refers to the degree to which exchange parties know of and consider one another's needs and goals (M. Granovetter, 1992). From a sociological perspective, relational embeddedness drives organizational form at least as much as economic concerns. Reconciling these competing theories is necessary to explain the structure and performance of network governance.

Gaps in Understanding

My analysis of the literature highlighted three critical shortcomings that block a fuller understanding of network governance. First, theorizing about network-level

performance, which requires conceptualization of webs of multiple simultaneous relationships (Provan, Fish, & Sydow, 2007), is combined with data collection and analysis of individual and discrete dyadic relationships. Second, because scholars largely study networks using cross-sectional analyses, their findings imply that ties are durable and that all observed network ties add value (Gulati, 1995; Kim, Oh, & Swaminathan, 2006). Attending to benefits realized from successful networks, while ignoring the costs associated with failing networks limits our understanding of network performance. Third, reliable performance data for a population of network organizations are often unavailable.

The first gap in understanding arises from a mismatch between levels of analysis. Scholars continue to explain network level performance using dyad level relationships. This is likely due to the availability of reliable data at the dyad level, but in order to advance a more robust theory of networks, we must move the level of analysis up to the network level (Gulati & Gargiulo, 1999; Walter W. Powell, White, Koput, & Jason, 2005; Rosenkopf & Schilling, 2007). The network level of analysis involves the aggregation of multiple dyads interacting simultaneously (Provan, Fish, & Sydow, 2007). This dissertation introduced a new construct, *Aggregate Tie Strength (ATS)*, that resolved the inconsistency between levels of analysis.

The second gap in understanding arises from theorizing that implies network relationships are durable and that all observed network ties add value (Gulati, 1995; Kim, Oh, & Swaminathan, 2006). As mentioned by Kim et al. (2006), a selection bias exists among scholars studying these ties due to their comparing returns to

organizational performance with the presence of current and new partners. Because these comparisons treat tie formation and dissolution as discrete events, rather than as a series of unfolding events that occur over time, changes in network ties always seem to result in positive outcomes (Kim, Oh, & Swaminathan, 2006). This is in sharp contrast to empirical findings about the durability of network ties. Gulati's (1995) findings show network ties are unstable, short-lived, and that the transformation of network ties is associated with costs. This dissertation treats network ties as temporary, and offers new theorizing about both the costs and benefits that network ties have on performance.

The third gap in understanding stems from a lack of data. Without reliable data on tie dissolution and network failure, we cannot fully understand the performance implications of network organizing (Podolny & Page, 1998). While firms tend to announce tie formation with great fanfare (Podolny & Page, 1998), reliable data on tie dissolution and the performance outcomes from dissolution are much more difficult to obtain. This lack of data on poor performance and failure results in a preoccupation with the benefits of successful networks and little attention to the costs of unsuccessful networks. This has introduced a survivor bias into empirical studies that link the presence of network ties to performance (Kim, Oh, & Swaminathan, 2006; Podolny & Page, 1998).

Closing these gaps in understanding requires a new theoretical model that addresses each of the issues described above. By treating economic and sociological theories as interdependent, the theoretical model developed in this study effectively

addresses temporary governance and provides insight into how organizational structures can adapt to the networked economy.

Theoretical Model

This study represents an important step in our understanding of the relationship between network ties and performance. By focusing on TINs, this study developed a model that integrates core arguments from TCE and social embeddedness perspectives, conceptualizes and measures ties at the network level of analysis, and incorporates performance data across the full range of performance.

TINs represent a salient example of lead-firm networks. They offer an unparalleled setting to test the ability of economic and sociological logics to explain network structure and performance. In economics, networks have been treated as a variant of the make-or-buy decision (Gulati & Singh, 1998; Lorenzoni & Lipparini, 1999). The same logic by which firms choose between the extremes of make-or-buy (Scott E. Masten, Meehan Jr., & Snyder, 1991; Monteverde & Teece, 1982; Walker & Weber, 1984) is expected to continue once firms elect to form an alliance (Gulati & Singh, 1998). Additionally, alliance networks exhibit relational embeddedness (Jones & Lichtenstein, 2008), a critical theoretical perspective in sociology. Since lead-firm networks are deliberately designed networks, these networks fit with Williamson's discriminating alignment hypotheses (Williamson, 1991). This suggests that lead firms select partners to reduce production and transaction costs according to factors

that align exchange conditions with the cumulative capabilities found among a TIN's partners.
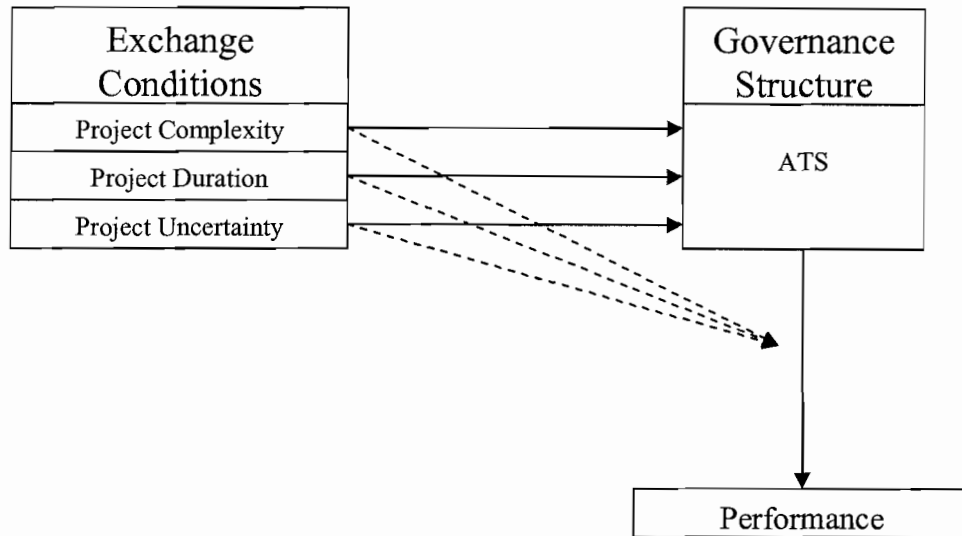
Research suggests the quality of relationships between partners drives the economic performance of these organizational forms (Robert G. Eccles, 1981; R.G. Eccles, 1981; Lorenzoni & Lipparini, 1999). For example, Eccles (1981a, b) found that partnering with a select, persistent set of well-known and trusted subcontractors improves the efficiency of organizing in the construction industry. Lorenzoni and Lipparini (1999) found that as the quality of partners increases, the costs of organizing are reduced. Lorenzoni and Lipparini (1999) link these cost efficiencies to gains from tight, repeated, and trust-based partnerships that bring both sustainable competitive advantage and cost economies to organizing. Collectively, these studies suggest that exchange conditions do not provide a complete explanation of the performance of networks; only when exchange conditions are linked with partner characteristics can performance be fully explained. This is a very strong statement, implying that repeated partnerships explain why or how exchange conditions cause performance. Analytically, this logic requires a test of mediation (Baron & Kenny, 1986). As described earlier, I operationalize repeated partnerships as *Aggregate Tie Strength* (ATS) and, following these scholars, propose that ATS mediates the relationship between exchange conditions and performance.

Scholars have shown that exchange conditions and repeated partnerships can have synergistic effects on performance (Gulati, 1998; Poppo, Zhou, & Ryu, 2008). Exchange conditions and past partnerships are necessarily intertwined as origins of

economic efficiency (M. Granovetter, 1985; Lorenzoni & Lipparini, 1999; Poppo,

Zhou, & Ryu, 2008). Repeated partnerships act as a "social lubricant" to transactions

that enhances task coordination between parties engaging in network partnerships

(Gulati, 1998). Additionally, parties that choose to cooperate in repeated partnerships

develop "credible assurances" that partnerships will continue into the future (Dyer &

Singh, 1998). This expectation of continuity is an effective contractual safeguard

because repeated partnerships and long-term contractual relationships contain

customized provisions that safeguard exchanges from opportunistic behaviors (Poppo

& Zenger, 2002).

Poppo et al. (2008) suggested exchange conditions influence the expectation

of continuity among network partners. This proposed interaction of exchange

conditions and repeated partnerships in shaping network performance requires an

analytic test of moderation. Figure 13 shows the conceptual model for this study.

Figure 13 depicts the mediating relationships with solid lines and depicts the

moderating relationships using dashed lines. For the mediation analysis, governance

structure (ATS) mediates the relationship between exchange conditions (project

characteristics) and performance. The dashed arrows shown below depict the

interaction between exchange conditions and governance structure. As described

above, exchange conditions are expected to enhance or reduce the direct effect of

governance structure on performance (Poppo, Zhou, & Ryu, 2008).

Figure 13: Conceptual Model

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┌─────────────────────┐                    ┌─────────────────────┐
│      Exchange       │                    │     Governance      │
│     Conditions      │                    │     Structure       │
├─────────────────────┤                    │                     │
│  Project Complexity │ ─────────────────▶ │        ATS          │
├─────────────────────┤                    │                     │
│  Project Duration   │ ─────────────────▶ │                     │
├─────────────────────┤                    │                     │
│ Project Uncertainty │ ─────────────────▶ │                     │
└─────────────────────┘                    └─────────────────────┘
                                                      │
                                                      ▼
                                           ┌─────────────────────┐
                                           │     Performance     │
                                           └─────────────────────┘
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TIN Design and Behavioral Learning at the Population Level

Behavioral learning theories depict learning as a mechanistic and involuntary process where firms are assumed to repeat behaviors that lead to pleasant outcomes and discontinue behaviors that lead to unpleasant outcomes (Starbuck & Hedberg, 2001). One advantage of behavioral theories is they can explain how learning can improve over time, even when information about individual manager perceptions is unavailable (Starbuck & Hedberg, 2001). I adopted a behavioral perspective to learning and developed hypotheses that tested how the performance outcomes from adopting a network design in one temporal period affect the subsequent adoption of that design.

Population level learning is defined as "a systematic change in the nature and mix of routines in a population of organizations arising from shared experience"

(Miner & Haunschild, 1995). Thus, population level learning examines how outcomes from past behaviors among a group of organizations (shared experience) affect the behaviors these same firms exhibit in later periods. If previously successful behaviors are increasingly adopted, the population has learned from shared positive experience. Likewise, if prior shared experience that resulted in poor outcomes enacts decreasing adoption of those prior behaviors, the population has learned from shared negative experience. This study represents one of the first examinations of population level learning in a temporary network context.

Analysis and Findings

In this dissertation, I have proposed and tested a theory that integrates ideas from transaction cost economics and sociology to explain the structure and performance of temporary interorganizational networks (TINs). I also argued that TINs represent a unique variant of network organizational forms. I argued that TIN structures are designed according to exchange conditions. I argued that the design of TINs directly affects their performance as a governance structure. Finally, I argued that the direct effect of a TIN's governance structure on performance is moderated by exchange conditions.

The results from hypothesis testing suggest TINs are designed to fit exchange conditions. Project Complexity and Project Duration were significantly related to lower values of relational embeddedness, which suggests these exchange conditions promote more modular organizational structures. Modular organizational structures

tend to mirror the organizational structure of the product being produced (Hoetker, 2006). In the case of TINs, the greater the number of production requirements and specialized tasks, the greater the number of partners and the greater diversity among partner skills that composed the TIN. Project Uncertainty was significantly related to higher values of relational embeddedness, which suggests this exchange condition promotes more repeated partnerships and a greater amount of strong ties within TINs.

The relationship between TIN structures and performance suggests there are contingent benefits to relational embeddedness for temporary interorganizational networks. The direct effect of high relational embeddedness on performance was negative and produced the largest effect size on performance. Despite the negative main effect of relational embeddedness on governance performance, results from the interaction variables indicate these adverse effects disappear when TINs adjust their structure in a contingent fashion; aligning exchange conditions and TIN structures does improve performance.

The context of temporary organizing provides new insight to previous studies about learning from success and failure at the population level of analysis. Previous studies suggest drastic failure is the main mechanism for learning at the population level: "Organizations disappear if they act inappropriately or ineffectively, so the surviving organizations act appropriately and effectively" (Starbuck & Hedberg, 2001, p. 450). However, population level learning is defined as an increase or decrease in the use of *routines*, which may fail multiple times for a variety of reasons without causing organizational failure. Miner et al. (1996) attempted to uncover the

more subtle effects of failure, but also used the failure of an entire organization (or a few of them) as an indicator of change at the population level. This study measures the failure of routines directly, indeed, no lead firm failed during the years 2000 – 2007. Thus, my findings offer more fine-grained evidence bearing upon how the removal of deleterious routines affects behaviors across a population of TINs.

Research Implications

The conceptual and empirical findings of this dissertation provide several new directions for current and future studies of network organizations. In this section, I first explain how the dissertation extends the existing literature on network organizational forms. Next, I explain implications for existing theories in economics and sociology, focusing on implications for the design of governance structures specifically. The third part of this section emphasizes the extensions of research methodology for studying performance within network organizations.

Extensions of Existing Theory

This dissertation overcomes many of prior limitations by proposing a new theoretical framework based on temporary interorganizational networks (TINs). TINs raise the level of analysis to the network level. TINs also highlight the transient nature of relationships between network partners, which is conspicuously missing from previous studies. Finally, TINs persist in industries where network tie formation and tie dissolution is common and expected by cooperating partners. Within these

industries, information on tie formation and dissolution is more available, as are data that link network ties with fine-grained performance information (construction costs, film revenues and awards, Playbills and gate receipts).

Before discussing how this dissertation extends current theory, it is important to note the boundary conditions of this study's applicability in other industries. The findings from this study apply to temporary governance structures. Even within industries that exhibit temporary governance (film production, music, banking syndicates, etc.) the results from this study must be used with caution. The outcome variable I was most interested in was reducing the costs of organizing, which may not be the most important or interesting outcome within other industries (e.g. Ray, Barney, & Muhanna, 2004). For example, researchers studying temporary organizing in the film industry generally use box office sales or industry awards received as outcome measures (Faulkner & Anderson, 1987; Jones & DeFillippi, 1996) and not the actual costs of forming and dissolving the temporary networks that produced the films. However, since the costs of organizing do affect the overall profitability of the TINs producing films, this study could provide information to film studios about how to lower the costs of organizing and, potentially extract more profits from box office sales. At the very least, this study may provide a starting point for studying other industries that exhibit temporary governance.

Another boundary condition of this study is that I chose a very stable industry. The bridge construction industry in the US has changed very little over the years and the engineering standards to which bridges are built have been around since at least

1927, with the introduction of the Steel Construction Manual (AISC, 1927).

Choosing a stable industry allowed me to distinguish the costs of organizing networks

from many other potential sources of cost, but one must be cautious about translating

the findings from this study to more dynamic industries that use temporary

governance. In these more dynamic industries, perhaps some of the constraints

present in bridge construction are relaxed, and the questions asked in this study could

be adapted to temporary governance in more dynamic settings.

By thinking differently about strategy research and incorporating knowledge

from multiple fields, scholars of network governance can recognize new sources of

value from old contexts. For example, while my study leaned heavily on Uzzi's

(1996) ethnography of the New York City garment industry for theoretical

inspiration, it was Uzzi and Spiro's (2005) study of Broadway musicals that inspired

my research design. Their realization that Broadway Playbills serve as artifacts that

track the movement of social actors within a closed network was highly innovative.

Further, cross-referencing these movements with gate receipts and other artifacts

from this industry produced important insight about networks from an empirical

setting that is quite different from the more common settings used to study

governance (equity joint ventures, strategic alliances, supplier networks, etc.). While

Uzzi and Spiro (2005) did not address governance costs directly in their study of

small world networks, their research design transferred directly to my study of TINs.

Although questions about network constraint, poor performance, and failure

rose to prominence in the late 1990s (Podolny & Page, 1998), many questions

remained unanswered ten years later (Kim, Oh, & Swaminathan, 2006). This dissertation has addressed some of these questions and I hope this study inspires other scholars to follow Uzzi and Spiro (2005) and ask old questions in new and exciting ways.

Future research on network governance may examine structure and performance in more permanent settings, such as R&D alliances, banking syndicates, and traditional outsourcing. As in the case of this dissertation, findings from coarse-grained analyses should be supplemented by case studies and ethnographies in these more permanent contexts, to uncover the impacts of network governance in settings that are more permanent.

Implications for Transaction Cost Economics

Research suggests that organizations are becoming more temporary and are requiring more flexibility to adapt to rapid changes in the environment (Achrol & Kotler, 1999; Snow, Miles, & Coleman, 1992). This trend calls for transforming internal governance (Prahalad & Oosterveld, 1999) and results in more temporary governance structures. Temporary governance structures pose challenges to the traditional make-or-buy decision because of their shorter temporal duration. Like more traditional alliance networks, TINs are deliberately designed networks, whose design follows Williamson's discriminating alignment hypothesis (Williamson, 1991). TINs aim to create competitive advantage through cooperative advantage (Ring, 1996), through idiosyncratic combinations of complementary resources

(Kogut, 1991; Kogut & Zander, 1992), and through relational advantages (Dyer & Singh, 1998). However, the window of time cooperating parties have to extract value from these relationships is much shorter in TINs than in traditional alliances and alliance networks. This suggests strategies for efficient organization may shift toward modularization when time horizons are dramatically shorter.

As firms reduce the temporal length of sourcing arrangements and become modular in their structures, the complexity inherent in modular organizations will increase the knowledge burdens on the focal firm. For example, when the number of firms collaborating to produce a product increases, firms need to have deeper knowledge about their partner firms' skills and processes to overcome imbalances in knowledge that may slow production (Brusoni, Prencipe, & Pavitt, 2001). Additionally, increased modularity raises the number of labor specialties, which increases coordination costs between firms (Brusoni & Prencipe, 2001). Modularity and shorter durations change the dynamics in the traditional "make-or-buy" decision, causing firms to both make and buy the same function and adopt contingencies that were previously viewed as extraneous and unnecessary (Parmigiani, 2007; Parmigiani & Mitchell, 2007).

Brusoni and Prencipe (2001) suggest focal firms that behave as "systems integrators" will increase performance when designing modular sourcing arrangements. Systems integrators rely on accumulated knowledge about product components as well as knowledge about component linkages that drive the overall organizational system. Because systems integrators have an abundance of knowledge

that spans organizational boundaries, they can isolate capabilities (like knowledge capabilities) that require fewer resources, produce these in-house, and outsource the more expensive components (like manufacturing) to suppliers. By splitting risks and revenues among a wider population of suppliers, systems integrators reduce their own stake in production, while simultaneously increasing the potential revenues from operations (Brusoni & Prencipe, 2001).

Brusoni and Prencipe (2001) developed their theory of systems integrators by studying aircraft engines and chemical plants, industries with much longer time horizons than are typical within TINs. However, in terms of the organizational design processes, their setting shares many similarities with the research setting of this dissertation. Lead firms designing TINs must have boundary spanning knowledge to design their network structure according the project characteristics. Lead firms must have precise knowledge about their own capabilities as well as those for each specialty contractor. However, TINs generally have much shorter lives than sourcing networks formed for aircraft engine manufacturers and chemical plants. This suggests TINs are a logical next step in understanding for scholars interested in more temporary sourcing arrangements.

Another promising setting for investigating TINs are networks formed in the public sector. Provan and Kenis (2008, p. 230) contrast public sector and private sector governance, suggesting that in public management, "governance refers not to the activities of boards, but mainly, to the funding and oversight roles of government agencies." Hill and Lynn (2005) suggest the use of network governance is increasing

in the public sector, particularly in the public oversight of private companies contracted to provide public services. Since the employment contracts for public officials are temporally limited, but the projects undertaken may actually bridge between multiple political terms and multiple government regimes, researching TINs in the public sector could provide an interesting extension of this study's analysis and findings. For example, it would be interesting to consider how the costs of organizing differ when the projects stay the same, but the lead organization and political regimes change. Answering questions of this sort could add important nuance to the findings from bridge construction TINs, and they may generalize to a wider population of temporary networks.

Implications for Sociology

This study focused on relational embeddedness as its primary sociological indicator of network structure. Because TIN design is framed as an endogenous and strategic decision by lead firms, the quality of relationships between a lead firm and its potential partners, defined as relational embeddedness by Granovetter (1992), is a key driver of network organizational structure. Further, as confirmed in this study, relational embeddedness has a direct effect on network organizational performance.

Still, the other half of embeddedness – structural embeddedness – deserves further attention within the context of TINs. Structural embeddedness is a measure of the mutual contacts between parties within a network. Operationally, structural embeddedness refers to the amount of indirect communication between third parties

and how this communication affects the overall network structure. A greater amount of communication between third parties enhances structural embeddedness because organizational actors "will not only have direct relations, but also are linked indirectly to third parties, who are likely to have future interactions and talk about their interactions with one another" (Jones & Lichtenstein, 2008, p. 239). Measuring structural embeddedness directly calls for social network theory and its measures of how network position may affect the performance of actors in those positions.

Measuring the degree of structural embeddedness within TINs requires shifting the focus away from lead firms and toward subcontractors. While this study focused on relational embeddedness, the quality of relationships between a lead firm and its subcontractors, shifting the focus to subcontractors and how they move among and between lead firms would directly measure structural embeddedness. TINs represent a much more ephemeral network structure, which may require different strategies than more permanent network structures. For example, within TINs is it more advantageous for a subcontractor to occupy structural holes as has been shown in more permanent networks (Burt, 1992)? Alternatively, since TINs form and dissolve ties more frequently than permanent networks, perhaps the benefits from brokering positions within structural holes are diminished. Since the economy is moving more toward temporary governance, it seems scholars should reexamine the performance benefits to network position within the context of TINs moving forward.

TINs also offer a setting to examine the interaction of relational and structural embeddedness. Rowley, Behrens and Krackhardt (2000) examined the interaction of

relational and structural embeddedness in the steel and semiconductor manufacturing industries. They argued that the roles that relational and structural embeddedness play in firm performance could only be understood in reference to each other. Rowley et al. (2000) found that benefits from relational embeddedness were contingent upon the industry as well as upon the level of structural embeddedness for the lead firm. However, like most studies of network ties and performance, these authors count any previous tie as bringing value to a firm and ignore how the value of previous relationships may decay over time. It seems asking questions about the interaction of relational and structural embeddedness within the context of TINs would offer findings that are more robust because TINs allow scholars to track both positive and negative effects of network ties on performance.

Implications for Research Methodology

Current research methodologies that aim to examine network organizational failure suffer because they look for data in settings that only model success. Traditional sources of network data come from industrial settings like traditional alliances (Gulati, 1995; Gulati & Singh, 1998) and patenting (Ahuja, 2000), where reliable data on failure is either not recorded or not published (Podolny & Page, 1998). While I certainly had to make some concession in this study (e.g. measuring proposed costs instead of actual costs), researching TINs within the bridge construction industry provided a valid way to model and test failure for network organizational forms. Another benefit of the bridge construction empirical setting is

its low cost requirement for project award. Because I was interested in studying the governance costs of network forms, choosing an industry where each firm aims to achieve low cost with every TIN design controlled for many unobserved effects. As scholars move forward and test other industrial settings, it seems advantageous to look for data in new places, to see if the same findings from bridge construction can inform other empirical settings.

This study also looked at networks from an unusual methodological perspective, that of the lead firm. In general, social network scholars show greater interest in the structural characteristics of the larger network, and less interest in how specific chunks of a network are strategically transformed over time. Social network theory and its analytical methods have come under fire as atheoretical (Salancik, 1995) and cast as merely a collection of tools which can inform other, more traditional theories of strategy. However, by thinking differently about networks, this dissertation offers a direct link to more traditional theories of organization (M. Granovetter, 1985; Williamson, 1975), but does so in a context that is more aligned with a networked economy.

Future studies that take older theories and adapt them to network theories may be better at explaining strategy in the new economy (Evans & Wurster, 2000; Tapscott, 1997). I hope this initial attempt to move old conversations into new places generates interest in TINs and network governance moving forward.

Managerial Implications

Managerial implications from the empirical findings of this study lie in choosing network partners, structuring network organizations, and transforming network organizations over time. These implications inform the decisions made by lead firms when they design network organizations according to exchange conditions. These implications also inform lead firms in terms of how repeated partnerships and relational embeddedness affect performance in a contingent fashion. In some cases, repeated partnerships and relational embeddedness improve performance, while in others these characteristics of network structure can decrease performance. Next, I address the managerial implications for lead firms.

Implications for Lead Firms

The empirical findings of this dissertation suggest that exchange conditions and relational embeddedness interact to affect the costs of organizing in temporary networks. Managers should consider exchange conditions to inform their initial make-or-buy decision, which determines the portion of the work they should conduct themselves and the portion they should outsource to subcontractors. By carefully reviewing the exchange conditions for a particular project, considering their current capabilities, and determining which portion of the project they can complete for themselves, lead firms can design an initial TIN prior to evaluating the specific characteristics of available partners. However, once an estimate of the in-house work

is determined, choosing the right partners will enhance or reduce the efficiency of the ultimate network design.

Managers designing networks high in complexity should consider more modular organizational forms. Complex projects increased the likelihood of downstream adaptations; and forms that are more flexible can adapt better and at lower cost than less flexible forms. This is particularly true in industrial settings where a stable supply of specialty subcontractors exists. In these industrial settings, like construction and film production, networks with loosely coupled and interchangeable partners perform better because they adapt more easily and at lower cost.

For managers designing TINs around projects of greater duration and with greater uncertainty, the strategies tested in this dissertation are less clear in their path to good performance. The empirical findings support that higher relational embeddedness improves performance for longer projects, but the effect size for this strategy is small. Further, for uncertain projects, I cannot make any strong claims other than some adaptation in network partners is needed to reduce the direct and negative effects of rigid networks on performance.

Finally, another contribution of this study for managers arises from the skeptical perspective this dissertation takes on the effectiveness of network organizations. The previously mentioned bias emphasizing the positive benefits from informal contracting and the increased flexibility found in networks has transferred from the pages of scholarly journals into the minds of managers (e.g. Johnson,

Christensen, & Kagermann, 2008). Contrary to the rosy perspective on networks that

dominates the literature (Kim, Oh, & Swaminathan, 2006; Podolny & Page, 1998),

my perspective is that of a "cranky professor" that says we must temper our

excitement moving forward and seek a middle ground between hierarchy, arms-

length contracts, and purely socially governed transactions. Moving forward,

managers must also be skeptics and perhaps this dissertation provides support for how

a mix of contractual and relational governance can improve performance.

Managers in other industrial settings can derive value from this study. Due to

advances in information technology, deregulation, and privatization, managers in

more traditional industrial settings are being asked to design radically different

business models (Evans & Wurster, 2000) that access new forms of capital,

technology and skills that simply were not available previously (Prahalad &

Oosterveld, 1999). Current evidence suggests firms are ill-equipped to make these

changes, requiring federal bailouts, bankruptcies, and other stays of execution just to

survive long enough to begin thinking about how to reorganize the hierarchical

behemoths that so dominated the 20th century. Faced with this daunting challenge,

perhaps these managers can look at the performance outcomes if TINs as a place to

start.

As shown in this dissertation, managers designing TINs form, dissolve, and

reform their business model with each project; and over many years and hundreds of

projects, these managers develop "organizing capabilities" by necessity. With the

emergence of a networked economy, perhaps organizing capabilities will become

increasingly important to organizational performance and survival. Lessons learned from the expert organizers within TINs can translate to other settings and, potentially, serve as a basis to reorganize existing firms in a strategic and contingent fashion.

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