DOES COMPETENCY-BASED TRUST BENEFIT ORGANIZATIONAL PERFORMANCE—A MESO EXPLORATION USING COMPUTER MODELING

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From a competency-based perspective of trust and an open system's view of organizations, this study explores the micro-macro linkage between interpersonal trust and organizational performance in work organizations where internal and external contexts can matter. With the help of a formal computer model for meso theorizing, this study shows that competency-based trust generally does not benefit organizational performance in a distributed decision-making setting, except under incorrect information conditions or when no formal procedure is available. The study further demonstrates that external environments, organizational structures, and internal operating conditions can all moderate such trust-performance relationships. Findings from this study suggest the need for new thinking relating to trust in organizations and the possibility to integrate psychological, economic, and sociological perspectives on trust.

Keywords: Competency-based trust, Open system's perspective, Organizational performance, Organizational context, Meso approach, Agent-based computer modeling

INTRODUCTION

With the increased attention to the role of interpersonal trust in management, researchers have begun to theorize how trust functions in work organizations. Such efforts include work from the fields of psychology (Lewicki & Bunker, 1995; McAllister, 1995), economics (Williamson, 1985), and sociology (Barber, 1983; Butler & Cantrell, 1984; Zucker, 1986). A recent special issue on trust by the Academy of Management Review has

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further alerted attentions to trust (Sitkin et al., 1998). While there is a
general recognition of the importance of trust, the overemphasis on indi-
vidual-level lateral relationships in trust research has resulted in its lack of
linkage with organizational-level outcomes as well as the neglect of or-
ganizational and environmental settings (Rousseau et al., 1998). As a result,
two major questions remain: Does individual-level trust lead to higher
organizational performance? If so, what is the role of organizational context
in such a relationship?

To address these questions, this study adopts a meso approach by
exploring the micro-macro processes in work organizations (House,
Rousseau, & Thomas-Hunt, 1995), which is one of the most challenging and
least understood areas in organizational management (Klein, Tosi, &
Cannella, 1999; Schelling, 1978). We treat trust as a competency-based
individual-level construct that can develop based on one party’s cognitive
perception of the other party’s behavioral outcomes (Barber, 1983;
Nooteboom, Berger, & Noorderhaven, 1997) and view organizations as
open systems that can interact with both internal and external contexts
(Thompson, 1967). From these bases, this study examines how such a
dynamic trust mechanism embedded in interpersonal dyadic relationships
in work organizations may affect organizational performance, in particular
in decision-making tasks, and explores how different organizational struc-
tures and environmental settings may moderate such processes. This study
relies on a computer-simulation model using an agent-based artificial
intelligence technique, which enables the formal modeling of not only
cognitively capable individual members and their adaptive interpersonal
relationships but also organizational-level outcomes in a dynamic and
controlled setting (Axelrod, 1997; Carley & Lin, 1997; Weiss, 1999).

In this paper, we first conduct a review of prior trust research before
developing a conceptual framework from the literature. The theoretical
development will serve as the springboard for the formal computer model.
Following that, a detailed description of the formal computer model is pro-
vided, and results from the model are analyzed. Finally, we end this article
with a discussion of the implications and limitations of the current study.

STATE OF PRIOR TRUST RESEARCH

Research on trust started with the psychological perspective that views
trust as an individual attribute (e.g., Erickson, 1963). From that perspec-
tive, interpersonal trust consists of two aspects: cognition and affect (Lewis
& Wiegert, 1985). The cognition-based trust refers to the rational trust
encompassing competence, ability, responsibility, integrity, credibility,
reliability, and dependability, while the affect-based trust refers to the
social trust originated with an emotional connotation (McAllister, 1995). More recently, social psychologists have begun to focus on the behavioral or competency aspect of trust and consider trust to be a psychological state comprising the intention to accept vulnerability based upon positive expectations of intentions or behavior of another party (Kramer, 1996; Lewicki, McAllister, & Bies 1998). This psychological perspective, as the predominant force that drives the current trust research, focuses on dyadic interpersonal relationships. Their basic belief is that such interpersonal trust is necessary and beneficial to work relationships; whether such trust relationships will further extend their benefits to the organizational-level outcome such as performance is only assumed but not explored.

Economists and game theorists have viewed trust as based on the calculation of cost and benefit of one party regarding the actions of another party (Sheppard & Tuchinsky, 1996; Williamson, 1993). From this perspective, trust is more calculus based in that it can be considered as the rational choice by the actor in the form of economic transactions. Trust is again an individual-based construct that is set in specific situations and limited to some narrowly defined relationship, with frequent short-term feedback (Barber, 1983; Doney, Cannon, & Mullen, 1998). The economic and game theory perspective tends to discount such informal aspects as emotion and considers actors to be maximization oriented with full alternatives. Although this perspective also assumes that trust is important to exchange relations, whether interpersonal or inter-organizational, it is not interested in extending the quest to organizational performance.

On the other hand, sociologists have generally not emphasized interpersonal trust in the function of organizations or simply regarded trust as a result of institutional arrangements (Gambetta, 1988; Zucker, 1986). Institutional factors are considered to act as "broad supports for the critical mass of trust that sustains further risk taking and trust behavior" (Rousseau et al., 1998) and can exist at the organizational level or social-cultural level such as legal systems (Fukuyama, 1995; Gabarro, 1990; Miles & Creed, 1995). From this sociological perspective, once set up, organizations can resort to structures and procedures to regulate their members' behaviors and so the opportunities for creating interpersonal trust will be minimized (Zucker, 1986). With this perspective, individual-level trust only occurs as an unimportant mechanism due to some imperfect structural controls (Child, 1974). The causal link between trust as an independent factor and organizational performance, however, is again not fully addressed.

In sum, the focus on the individual-level lateral relationship has left trust research mainly a subject of micro psychology with little organizational relevance. Treating trust relationships as symmetrical and lateral, research on trust has become more interested in knowing how interpersonal trust
contributes to more reliable or cooperative relationships at the individual level (Jones & George, 1998) than in exploring the effect of such trust on work organizations, where relationships are often hierarchical and asymmetrical (Kramer, 1996). The overemphasis on trust at the individual level also has resulted in a lack of understanding of the causal effect of such trust on organizational performance. Some scholars have called for more attention to the linkage between the individual-level construct and organizational-level outcome (Rousseau et al., 1998). The effort, however, has generally been scarce or only stayed at the conceptual stage with the organizational-level outcome often being such constructs as cooperative relationships instead of organizational performance (Creed & Miles, 1996; Zaheer, McEvily, & Perrone 1998). As a result, the potential of trust remains unexplored, with the question of whether it can contribute to the overall organizational effectiveness unanswered.

In addition, as echoed by some leading scholars (e.g., Rousseau et al., 1998), research on trust has given relatively little attention to the role of organizational context such as structures, rules, and task environments. While some researchers have began to realize that context is critical for understanding trust (Chan, 1997; Rousseau et al., 1998; Whitener et al., 1998), little concrete work has been carried out, nor is such exploration extended to the causal relationships between individual-level trust and organizational performance. The lack of organizational context in trust research is further typified by the fact that most trust researchers have either ignored the nature of the task faced by the organization or only assumed a simple or homogeneous task (Golembiewski & McConkie, 1975; Zand, 1972).

A CONCEPTUAL FRAMEWORK OF TRUST IN WORK ORGANIZATIONS

To extend trust research, this study takes a meso approach and explores the linkage between individual-level trust and organizational performance while considering the role of organizational context.

A Meso Approach Towards Organizations

According to House et al. (1995), “Meso theory and research concerns the simultaneous study of at least two levels of analysis wherein (a) one or more levels concern individual or group behavioral processes or variables, (b) one or more levels concern organizational processes or variables, and (c) the processes by which the levels of analysis are related are articulated in the form of bridging, or linking, propositions” (p. 73). A meso approach
allows researchers to investigate the relationships among the fundamental building blocks of organizations, provides richer and more diverse interpretations of the meanings and functioning of organizations, and demonstrates deeper understanding of researchers' assumptions (Rousseau and House, 1994). The meso research requires nonconventional thinking. From a meso perspective, the causal relationship between the micro-level behavior and the macro-level organizational outcome can go both ways. In addition, the interactions among different factors no longer follow statistical analogy (House et al., 1995). Therefore, it is believed that such an approach is capable of presenting the best alternative to understanding how trust functions in work organizations.

A Competency-Based View of Trust

Trust in work organizations is fundamentally about cognitive information processing of expectations of other's behavior and actions associated with such expectations (Doney et al., 1998; Kramer, 1996). Trust in a work organization is embedded in interpersonal dyadic relationships that can often be asymmetrical (Kramer, 1996). Given the high correlation between cognitive and affective trusts (McAllister, 1995), we focus on the cognition/competency (as versus the affect/intention) aspect of trust as we are more interested in work organizations where sustained trust relationships are ultimately determined by performance. Specifically, we adopt the essence of the definition by Kramer (1996) and create the following working definition for our study:

Interpersonal trust in a work organization is the degree of confidence that one places based on the positive expectations of the other's behavior and the subsequent experience that supports or discredits these expectations.

Similar to the basic premise of game theory, trust is about interdependent choices (Zagare, 1984). Unlike classical game theory, however, trust in this study does not assume full rationality by the parties nor a symmetrical and competitive relationship between the parties. We are more interested in hierarchical cooperation that can be affected with various contextual factors, as such relationships are "among the most important and prevalent form of intra-organizational relation" (Kramer, 1996; p. 217). While hierarchical relationships may involve either downward trust (Rosen & Jerdee, 1977; Whitener et al., 1998) or upward trust (Deci, Connell, & Ryan 1989), we are more concerned with the downward trust from supervisory positions, while subordinates can also indirectly learn about such trust through the feedback received from the organization (Kramer, 1996).
In a hierarchical relationship, trust also involves risks. The trust by a manager may bear more risks as his/her decisions have a more influential impact on the organization's final decision. In turn, errors made by a manager through the reliance of subordinates will have more severe consequences not only to the organization but also to the manager's credibility (trustworthiness) in other members’ eyes (Kramer, 1996; Nooteboom, et al., 1997).

Finally, we consider trust to be relative. Specifically in multiple relationships, how one party can trust another party (e.g., A to B) depends on the availability of other simultaneous relationships (e.g., A to C and A to D). This is particularly important in a work setting where a manager can have several subordinates and thus multiple hierarchical relationships.

**Other Mechanisms as Comparison Groups**

To study the effect of trust on organizational performance, we need comparison groups. In this study we compare organizations of the above-defined trust mechanism with those employing either a procedure mechanism or a random mechanism. An organization is said to have a trust mechanism or is trust-mechanism based (TMB) if at the individual level each member relies on the interpersonal trust described above for adjusting the weight of information sources and making decisions. An organization is said to have a procedure mechanism or is procedure-mechanism based (PMB) if at the individual level each member relies on a standard operating procedure that emphasizes unbiased treatment of information sources and discounts individual source's past behaviors. This is in fact a special case of the trust mechanism where a member treats each source of information with equal amount of trust, which in effect makes trust not relevant in the supervisor's decision-making process. If an organization uses neither the trust mechanism nor the procedure mechanism and its individual member bases his or her decision mainly on hunches, the organization is said to have a random mechanism or is random-mechanism based (RMB).

**Organizational Performance from a Decision-Making Aspect**

Organizational performance has been represented by a wide range of indicators. Research has shown that it is impossible to obtain the best or sufficient indicator of organizational performance (Molnar & Rogers, 1976; Kahn, 1977) and that whether an organization is said to be effective depends on “the purposes and constraints placed on the organizational effectiveness investigation” (Cameron, 1986). In this study we examine one aspect of organizational performance—accuracy of decision outcomes.
(Cohen, March, & Olsen 1972; Hollenbeck et al., 1998; Lin & Carley, 1997a). While we understand that organizations may have different performance criteria depending on the nature of their existence, it is our belief that to achieve any kind of success, organizations must make good decisions.

**The Effect of Interpersonal Trust on Organizational Performance**

Research on trust has long assumed that interpersonal dyadic trust is beneficial or even necessary to organizations (Blau, 1964; Deutsch, 1958; Lewicki et al., 1998). The argument of these authors is that trust in organizations can serve as a social mechanism that can regulate members' behaviors through the reinforcement of positive actions. Interpersonal trust in organizations can direct members' behaviors toward desired goals and potentially increase individual performance (Lewis & Weigert, 1985). Trust is also argued for being essential to accurate communication (Mellinger, 1956) and decision making (O'Reilly & Roberts, 1974). As a result, the organization as a whole may benefit from such a trust mechanism (Creed & Miles, 1996).

Institutional theorists, on the other hand, have focused on a different approach that does not emphasize interpersonal trust (Cohen, 1991; Lin & Carley, 1997a). They believe in institutionalized and sometimes even rigid rules. For this type of procedure mechanism, individual members' past experience is not of concern (Powell & DiMaggio, 1991). Each member is required to strictly follow the rulebook, which is usually the programmed organizational knowledge (Levitt & March, 1990; Lin, 2000). The important expectation from this procedure is for organizational members to be "objective and unbiased" in processing received information.

Researchers, however, have also noticed the limits of a trust mechanism when compared with the procedure mechanism (Barber 1983). While the pro-trust argument suggests that interpersonal trust can serve to regulate members' behavior at all organizational levels toward the organizational goal, it tends to assume that all subunit level goals should match the organizational-level goals for the organization to achieve high performance (Hollman, 1976; Mellinger, 1956). Although this may be true for an organization dealing with simple or homogeneous tasks, this trust mechanism may in effect discount functional expertise when organizations are dealing with distributed and complex tasks that require specialized and sometimes different expertise (Hackman, 1990; Levis, 1988).

Some scholars have also argued against relying too much on interpersonal trust and over-adapting to the local relationships (Ganster, Poppler, & Williams, 1991; Nystrom & Starbuck, 1984). They suggest that while the procedure mechanism is more rigid, it may actually help organizations avoid
unnecessary mistakes by limiting the transmission of individual members’ discretionary judgment (Jablin, Putnam, Roberts, & Porter, 1986). As a result, compared with a trust mechanism, a procedure mechanism that relies on indiscriminant personal relationships may serve better in a distributed decision task because of its more institutionalized and supposedly more objective approach (Powell, & DiMaggio, 1991; Zucker, 1986).

There is another extreme case in which neither interpersonal trust nor procedure trust exists, thus forcing organizations to behave more like random guessing (Lin & Carley, 1997b). Such a random mechanism situation can happen when organizations are newly formed, when necessary information is not available, or when time pressure is too severe for organizations to respond accordingly. Compared with such a random mechanism, a trust mechanism or a procedure mechanism should help organizations because these mechanism at least provide a direction and rational approach (Axelrod, 1984; Deutsch, 1958). To summarize the above arguments from the literature, we may have the following general claim.

Cl: A trust mechanism based (TMB) organization has a higher performance than a random mechanism based (RMB) organization, but a lower performance than a procedure mechanism based (PMB) organization.

THE MODERATING ROLES OF ORGANIZATIONAL CONTEXT

While trust affects the interactions among organizational members and thus their work relationships, organizations are open systems and are subject to the environmental influences (Thompson, 1967). Organizations can have different structures to coordinate members’ behaviors, which may moderate the effect of trust on organizational performance (Galbraith, 1973; Joyce and McGee, 1997). Furthermore, organizations operate in a larger setting and thus face the challenge of the environment (Hannan & Freeman, 1977). Finally, various intra-organizational conditions such as information ambiguity and member turnover can also impact how members in work organizations treat their colleagues, thus affecting their relationships (March & Olsen, 1976). Therefore, to fully understand how trust functions in the organization, we need to examine the moderating roles of organizational structures, task environment, and internal operating conditions.

Organizational Structure

Organizational structure refers to the way that an organization coordinates members’ activities and transforms external resources into products (Coleman, 1990; Mintzberg, 1983). Organizational structure is about the
collection of vertical and horizontal differentiation within an organization for the coordination of divided work (Pugh et al., 1963). It also serves as a control system constraining members’ behavior and determining, in significant part, the information to which organizational members attend (Hopwood, 1978). Organizational structure affects information flow and consequently the premises of decision-makers (Cohen, March, & Olsen, 1972). Organizations can have different forms of structures. For this study, we focus on two of them: a hierarchy structure, with multiple layers of management and narrowly defined roles for members; and a team structure (flat hierarchy), with only one layer of management (a team leader) and more widely defined roles for members (Lin & Hui, 1999). This is not only because hierarchy and team structures are the most common and natural ones in the world, but also because there is a long research history on such structures in organization studies (Mackenzie, 1978; Simon, 1962).

Studies of organizations have generally regarded the hierarchy structure as one that is based on the premise of distrust and serves the purpose of limiting members’ responsibility to a narrowly defined set (Creed & Miles, 1996; Weber, 1964). As a result, trust research has extensively favored the so-called team approach, in which a flat or team structure that allows more broadly defined roles and less strict control is suggested (Whitener et al., 1998). As trust researchers argue, for organizations with a team structure, members have more responsibilities, are more interdependent, and play a larger role in organizational decision-making processes (Creed & Miles, 1996; Whitener et al., 1998). Therefore, a team structure may foster a better environment for trust to develop than a hierarchy structure, which may ultimately affect organizational performance in a positive way (Chan, 1997; Creed & Miles, 1996). Some scholars have also pointed to the Japanese organizations as an example of the effect of trust in a team-like environment (Ouchi, 1981; McCauley & Kuhnert, 1992).

Other scholars, however, have favored a hierarchy structure (Janis, 1982). They argue that a hierarchy structure can help reduce individual members’ information processing loads as well as managers’ reliance on subordinates, thus limiting the impact of misplaced trust through cross checking via multiple organizational layers (Jaibin et al., 1986; Pfeffer, 1982). A hierarchy is considered even more important when organizations are dealing with a task for which having distributed expertise may be more important than emphasizing common goals and minimal differences, which a team structure supports (Hackman, 1990). As a result, a hierarchy structure may play a more positive role in the performance of a trust-mechanism based organization in a distributed decision situation (Kramer, 1996). We can summarize this view from the literature as follows.
C2: In a distributed decision-making setting, the trust mechanism will have a more positive impact on the organizational performance if the organization has a hierarchy structure instead of a team structure.

Task Environment

Task environments are forces outside the organization's control that affect the organization's performance (Aldrich, 1979). In much of current organizational theory, task is treated exogenously as the problem to be solved (Mackenzie, 1978; Perrow, 1967, 1979) or "the sources of inputs" (Dill, 1958). Research has repeatedly demonstrated that features of the task environment serve as constraints on what organizations are most effective (Carroll, 1984; Demael & Levis, 1991; Levis, 1988). In our research, task environment is viewed as a collection of classification problems (tasks) to be solved, with the nature of each problem externally predefined and uncontrolled by the organization.

While there are multiple characteristics of the environment that can affect how organizations respond, one of the most fundamental dimensions has always been whether a task environment is predictable or unpredictable (Aldrich, 1979). Predictability/unpredictability refers to such things as variation of customer demands, market fluctuation, or change in technology, and can affect organization's survival (Koberg, 1987). A predictable environment features stable conditions and less volatile customer demands and thus puts less pressure on an organization's information processing capability (Galbraith, 1973; Lawrence & Lorsch, 1967). When organizations face this type of environment, members' trust is believed to be much more accurate and reliable, thus leading to higher overall organizational performance. In contrast, an unpredictable environment features diverse problems or customer demands and is more unstable. It thus puts more pressure on the organization to respond more timely and effectively (Aldrich, 1979; Lawrence & Lorsch, 1967). Thus, the disadvantage of a trust mechanism rises as the insufficient information processing capability, while a procedure mechanism benefits from capturing more information resources in the unpredictable environment. That is to say, when compared with a procedure mechanism, a trust mechanism in this type of the environment may suffer more effectiveness loss due to the more frequent fluctuations in the environment and the more diverse nature of the problems, which can cause highly unreliable relationships (Hammond, 1973; Moorman, Deshpande, & Zaltman 1993; Nystrom & Starbuck, 1984). Therefore, we expect the following claim.

C3: A TMB organization will have more performance disadvantage over a PMB organization in an unpredictable task environment than in a predictable task environment.
As organizational research has suggested, however, organizations can also design different structures to counter environmental challenges (Courtright, Fairhurst, & Rogers, 1989; Thompson, 1967). In particular, a team structure is suggested to be generally better off in an unpredictable environment as members have better information processing capability and each member can help others in their responses (Lin & Hui, 1999; Scott, 1987). On the other hand, for a hierarchy organization, the members' information processing capabilities is limited by the design and so may be generally more suitable for dealing with a predictable task environment (Lin & Hui, 1999; Mackenzie, 1978; Scott, 1987). Such arguments, however, may not hold true with the consideration of the trust mechanism, which emphasizes relationship adjustment at individual levels (Hammond, 1973; Nystrom & Starbuck, 1984). For a team structure in an unpredictable task environment, for example, organizations with a trust mechanism may become too vulnerable to constant changes without sufficient buffers, even though a team structure has the wider role design for its members. As a result, in an unpredictable environment, a team structure may not be as helpful to the organization as a hierarchy structure, which features more layers and may sustain more external impact (Jablin et al., 1986). In contrast, a team structure may be helpful only in a predictable task environment, given its susceptibility to environmental and relational fluctuations (Mackenzie, 1978). We can summarize the interaction effects of the environment and organizational structure as suggested in the literature as follows:

C4: In a predictable task environment, a TMB organization will have a higher performance with a team structure than with a hierarchy structure; in an unpredictable task environment, the opposite will be true.

Internal Operating Conditions

Organizations also face additional uncertainties due to the disruptions to internal operating conditions. From time to time, turnover may occur or information systems may malfunction. These so-called sub-normal conditions stress the organization because they cause ambiguities (March & Olsen 1976) and force individuals in the organization to make decisions under sub-optimal conditions, thus affecting trust relations and potentially organizational performance (Driskell & Salas, 1991). In contrast to the external task environment, these internal operating conditions are more or less under an organization's influence (Aldrich, 1979; Pfeffer & Salancik, 1978). Research on trust has generally been silent on the effect of such internal operating conditions on trust-mechanism-based organizations. We believe these operating conditions are important to consider because they
can cause ambiguities and uncertainties that may disrupt the fundamental components of trust process and potentially degrade organizational performance (March & Olsen, 1976). In this study, we examine three internal operating conditions: normal condition, member turnover (some experienced members are replaced by new inexperienced members), and incorrect information condition (some external sources provide incorrect information) because they are the most common and also the most damaging conditions to an organization (Perrow, 1984; Price & Mueller, 1981; Shrivastava, 1987). A normal operating condition is a baseline condition in which an organization operates with no interruptions or information ambiguity.

Member turnover is known to have serious implications for an organization. When turnover occurs, knowledge is lost and an organization's cognitive capabilities are reduced (Lin, 2000). As a result, uncertainty increases, which can shake the existing trust relationships. The severity of the consequence of turnover has been mentioned in many management studies, though often not with a trust focus (McEvoy & Cascio, 1987; Mobley, 1982). While member turnover can have severe effect on organizations with a trust mechanism, its effect on organizations with a procedure mechanism should be minimal because of the procedure mechanism's role-based design and impersonal process of information (Carley & Lin, 1997). Therefore, we can have the following claim from the literature:

**C5: The member turnover condition will have more negative effects on the performance of a TMB organization than on that of a PMB one.**

While it is commonly agreed that turnover affects trust relationships and organizational performance, there is the belief that organizations can also design proper structures to fend off such sub-normal conditions (Carley & Lin, 1997). One view is that when organizations are organized in a hierarchy structure, because of members' narrowly-defined responsibilities, there should be less effect if a few members leave the organization, even if some inexperienced members' information is incorporated in the decision-making processes (Lin & Hui, 1999). A hierarchy structure thus may help organizations to reduce the impact of misplaced trust due to turnover and new membership through multiple layers (Jaiblin et al., 1986; Simon, 1962). A different view, however, suggests that with a team structure, the impact of member turnover can be reduced due to the wider roles of individual members ensuring the overlapping of information (Chan, 1997). According to this belief, when interpersonal trust is employed, organizations may have the mechanism to regulate the behaviors of all members and be able to discount the newness of inexperienced members (Creed & Miles, 1996). As a result, a team structure may be more effective in mitigating the turnover
effect, in particular for trust-mechanism-based organizations (McCauley & Kuhnert, 1992; Ouchi, 1981).

**C6: The negative impact of the member turnover condition will be smaller on the performance of a TMB organization with a team structure than with a hierarchy structure.**

Incorrect information conditions can occur when organizations deal with unreliable information sources or use malfunctioned information systems, which transmit wrong information into the organization. Such sub-normal conditions cause organizations to make judgments based on erroneous information and therefore the erosion of trust without members' intention or knowledge. As a result, organizational performance may also suffer (Carley & Lin, 1997). In a trust-mechanism-based organization, the impact of incorrect information may be limited by the active adjustment of trustworthiness of information sources at different levels within the organization. On the other hand, a procedure mechanism lacks such adjustment processes and passively transmits incorrect information through the whole decision-making process. Therefore, a procedure-mechanism-based organization may be more severely affected by such a sub-normal condition (Carley & Lin, 1997; O'Reilly & Roberts, 1974). The following can reflect the views from the literature:

**C7: The incorrect information condition will have more negative effects on the performance of a PMB organization than on that of a TMB one.**

Organization scholars have recommended designs for offsetting the potential damage of incorrect information conditions (Jablin et al., 1986). A hierarchy structure is recommended by some for providing more layers to filter the information, thus reducing the impact of uncertainties of communication (Roberts, 1990; Simon, 1962). Other scholars, however, have challenged this view by arguing that more layers in the organization may actually become a liability as smaller errors can have more chances to be amplified along the chain of command (Vyhmeister & Ouksel, 1999). Instead, a team structure may be just as effective to counter the impact of incorrect information in a trust-mechanism-based organization due to its wider member roles and information sharing (Creed & Miles, 1996; Hackman, 1990). The following may summarize the diverse views from the literature:

**C8: The negative effect of the incorrect information condition will be smaller on the performance of a trust-mechanism-based organization with a team structure than with a hierarchy structure.**
Summary

The conceptual framework is summarized in Figure 1, with key claims from the literature listed. In reviewing and summarizing the claims, different and sometimes even contradictory views have been considered. This approach, while reflecting the segmented state of trust research, is useful in that it shows that there is a limit to pure conceptual thinking on this meso issue (House et al., 1995; Simon, 1962). It also creates a springboard leading to the more formal and systematic explorations of the research issues using computer modeling.

A FORMAL COMPUTER SIMULATION MODEL

Organizations are dynamic and complex systems (Thompson, 1967). To study the multi-level problem of how individual-level trust impacts organizational performance, we must understand the internal dynamic processes and sort out various complex relationships across different levels in organizations. To achieve these objectives we use the computer simulation technique in particular agent-based modeling for formal modeling. The decision to use this methodology is based not only on the necessity given the nature of this study but also on the fact that computer modeling has its unique advantages over other methods such as qualitative case studies,

![Diagram](image_url)

FIGURE 1 A conceptual framework of trust in work organizations.
quantitative data analyses, and mathematical modeling (Axelrod 1997; Taber & Timpone, 1996).

First, we are dealing with a multi-level problem that involves complex and adaptive relations that are often mathematically and statistically inexpressible (Axelrod, 1997). One of the most critical barriers to multi-level (meso) theory is the lack of understanding of the internal processes that link different levels in organizations (Klein et al., 1999). Computer modeling is strong in representing complex and adaptive processes as well as predictive outcomes with the high control of contextual settings (Lant, 1994; Taber & Timpone, 1996). It is much more efficient while much less influenced by subjective interpretations of the researchers once the assumptions are laid out (Axelrod, 1997).

Second, computer modeling can be used to express theory, that is, to build models embedded in programs (Axelrod, 1997; Gasser, 1991; Taber & Timpone, 1996). In fact, computer modeling is a more strict form of theorizing (Axelrod, 1997). In computer modeling, organizations no longer have to be treated as black boxes, thus providing more insights into the dynamic processes of organizations. While computer simulation models are designed to reflect reality, they are not constrained by it. Computer models allow the explicit examination of counterfactual data and situations, even when the underlying theory is complex (Baligh, Burton, & Obel 1996; Carley & Prietula, 1994).

Finally, literature on organization studies has contained numerous claims that are not always consistent with one another. A lack of a comprehensive and systematic method may be one of the contributing reasons for the current fragmented state of trust research, as we reviewed earlier. Using computational theorizing to enhance our cognitive capability, we can have a better chance of integrating different perspectives and finding more systematic insight (Harrison, 1998; Lant, 1994).

The current model is built upon Carley and Lin's (1997) model and was tested in their comparison studies. It has been proven to be both empirically valid and methodologically reliable. Our model, however, extends their agent-based models in that it is interested in the long-term relationships as well as the final outcomes at multiple levels. It also takes a meso perspective and explores the micro-macro linkage that bridges an important micro phenomenon with the macro organization theory.

The following sections contain a brief description for the main components of the computer simulation model used in this study. Due to page limitation, not all details can be included here. Additional technical information can be obtained upon request or from some similar studies using agent-based modeling methods (Carley & Lin, 1997; Glance et al., 1997; Lin & Carley, 1995; Lounamaa & March, 1987; Weiss, 1999).
Overview of the Model

The agent-based computer model used in this study allows the modeling of not only cognitively capable individual members (nodes) and their adaptive interpersonal relationships but also organizational-level outcomes in a dynamic and controlled setting (Weiss, 1999). In the model the fundamental units are individual members in organizations. Each member is modeled with its own memory that allows him/her to communicate information, process information, make decisions, and update past experiences. How members interact depends on decision-making mechanisms (trust, procedure, or random) through prescribed communication structures.

The computer model is composed of several major modules (Figure 2). They are:

- **the task environment module**, which predefines all possible problems, some of which can be randomly fed to the organization once the program starts and can also be used to compare against the organization's decision for accuracy;
- **the organizational structure module**, which allows the organization to receive information of the problems from the external task environment and determines how members in the organizations should communicate;

![Diagram](image_url)

**FIGURE 2** An overview of the computer model.
A Meso Exploration Using Computer Modeling

- *the decision mechanism module*, which assigns each member of the organization with either the trust mechanism, the procedure mechanism, or the random mechanism for evaluating received information and making decisions; and

- *the internal operating condition module*, which specifies whether the organization's internal operating condition is normal, or subnormal featured by turnover or incorrect information.

To run the computer model in the simulation experiment, the researcher can input relevant parameters specifying the choice of each module. The model will then run through specified modules to get the results. The source code is written in C in a UNIX environment and can be obtained from the authors upon request.

**Task Problems**

In the computer simulation model a ternary task is built for which organizations have to make decisions regarding a series of quasi-repetitive problems, based on multiple indicators that can only be partly accessed by different organizational members in a distributed environment (Carley & Lin, 1997; Hollenbeck et al., 1998). This task can find resemblance in real world settings that involve distributed decision making. A few settings can include military radar operation (Rochlin, 1991), civilian air-traffic control (Kornecki, Cieplak, & Schneider 1991), and manufacturing planning (Bhaskaran, 1998). For example, in a manufacturing planning setting, the task can be considered as consisting of a series of production proposals that require the organization to decide whether to produce, hold, or reject the production of certain products based on information from nine indicators such as financial status of the company, human resources, technology, customer preference, etc.

Because of bounded rationality, each member of the organization naturally can only process a limited number of pieces of information while each one or two single indicators may not provide a complete picture of the situation. Thus, an organization's decision requires coordination among various people who work with different indicators. For each problem period, based on their positions, members of the organization can receive information from either subordinates or outside sources, evaluate the trustworthiness of such information based on prior experiences (if using a trust mechanism), make a decision, and pass the decision to higher level managers. The decision made at the top level becomes the organization's decision for that problem. Due to limited information access by each member of the organization and the rationally bounded communication, the organization's decision may not always reflect the true nature of the
problem so that mistakes can happen. After each problem, the feedback with regard to the true decision of the problem is provided to the whole organization. Based on the feedback, each individual member's memory is updated and relationships adjusted. A new problem then occurs (Figure 3).

**Task Environment**

Organizations operate under task environments that can exhibit different characteristics categorized as predictability/unpredictability (Aldrich, 1979). The nature of the task environment and how organizations respond to it may impact organizations' outcomes. In the real world, the correctness of the decision can be judged by the reality, if there is one. This paper employs the advantage of computer modeling and builds the true state of each problem in an independent formula, thus we can know the correct decision for each problem situation. Thus, we can have the baseline against which an organizational system's decision outcomes can be compared. In this paper, we limit ourselves to modeling the predictability/unpredictability dimension of a task environment as proposed by Aldrich (1979) and focus on whether the distributions of problems of different natures are concentrated or dispersed. Two types of environment can be predefined based on a simple formula, which has also been used in other
studies (Carley & Lin, 1997; Lin & Hui, 1999):

\[
\Sigma = T1 + T2 + T3 + T4 + T5 + T6 + T7 + T8 + T9
\]  

(1)

In the formula, each \( T_i \) refers to one specific indicator that can take an integer value ranging from 1 to 3, with a bigger number representing a more positive indication toward the decision to produce. By varying all possible values of nine indicators, the computer model can create a task environment that has a total of 19,683 (=3^9) problems of different combinations. For the predictable task environment we define the true state of the problem in such a way that (a) if \( \Sigma \leq 13 \), the true decision should be to “reject”; (b) if \( \Sigma \geq 18 \), the correct decision should be to “produce”; and (c) if other values, the true decision should be to “hold.” Following this formula, the task environment contains 625 problems whose true decision should be to “reject” (meaning not pursue), 7,647 problems whose true decisions should be to “hold” (wait before pursuing), and 11,441 problems whose true decisions should be to “produce.” With the domination of one type of problems whose true state is to “produce,” the organization is facing a more certain environment and may have a less chance of making a mistake if it decides to produce.

For the unpredictable task environment, we use the same formula, but we define the true decision as “reject” if \( \Sigma < 16 \), as “produce” if \( \Sigma > 20 \), and as “hold” if otherwise. With this manipulation, we have a task environment that regards one third (6561) of decisions of “reject” as correct, one-third (6561) of decisions of “hold” as correct, and one third (6561) of decisions of “produce” as correct. In this case, the organization may have a tougher time to make the correct decisions when faced with a particular problem because of increased uncertainty.

With the above definitions, each problem can have a “true” decision depending on whether the task environment is set to be predictable or unpredictable. For example, for a problem of nine indicators (1-2-3-2-1-2-1-1-3), if the task environment is predictable, the true decision of the problem (\( \Sigma = 16 \)) will be considered as “hold” and if the task environment is unpredictable, the true decision of the problem will be considered as “reject.” Since the organization has no knowledge of the task environment and the organization’s final decision is through coordination of individual members’ judgments based on their partial knowledge of each problem, It is possible that a decision made by the organization be incorrect with regard to the true state of the problem.

**Competency-based Trust Mechanism Operationalized**

Based on the definition outlined in the conceptual framework, a member’s trust toward his or her subordinate (for a base-level analyst that would be
the external information source) in a work organization is based on how well the subordinate has provided decision information, which in turn determines how much weight the subordinate's current information has in the superior's decision making. We operationalize trust in two steps. First, in each member's memory, his or her subordinate's absolute credibility is adjusted based on the outcome of the decision after each problem period:

$$C_{ij}(t) = C_{ij}(t-1) + 1 - \text{abs}[CD(t) - D_j(t)]$$  \hspace{1cm} (2)

where $C_{ij}(t)$ is the cumulative credit that member $i$ has given to $j$ (a subordinate) at the end of problem period $t$; $CD(t)$ is the correct decision for the problem at period $t$; and $D_j(t)$ is the decision information provided by $j$ for problem period $t$.

In the above formula, a correct decision information by the subordinate will result in one increased credit and a totally incorrect decision information (two away from the truth) will result in one decreased credit. If the decision is incorrect but is of smaller negative consequences, such as only one away from the truth, no credit is earned or subtracted. This formula takes into account different individual behavior outcomes and is a starting point for the exploration of competency-based trust. Though such an operationalization is in no way perfect or exhaustive, it reflects to some degree the findings that organizations, in particular those in the United States, tend to take such a reward and punishment approach toward trust in work organizations (Adler, 1994; Casse, 1982; Punnett, 1989).

Trust from a member to each of his or her subordinates (or information sources) is then calculated with consideration of other simultaneous relationships to the member:

$$T_{ij}(t) = C_{ij}(t)/\Sigma C_{ik}(t) \hspace{1cm} k = 1..n$$  \hspace{1cm} (3)

where $T_{ij}(t)$ is the trust that member $i$ has for $j$ at the end of problem period $t$; and $n$ is the total number of dyadic relations from member $i$ to the lower level members $k$, which can be $1, \ldots, j, \ldots, n$.

If $C_{ij}(t)$ is negative, mistrust occurs. In this case, $T_{ij}(t)$ is set to zero, while the absolute value of $C_{ij}(t)$ is distributed evenly to other members for the calculation of all trust relationships. For example, if a manager $A$ has three subordinates $B_1$, $B_2$, and $B_3$. At the end of period $T$, the credits for the three subordinates are -2, 4, 6, respectively. They are then reset to 0, 5, 7. To illustrate, the trust from manager $A$ to subordinate $B_1$ at the end of period $T$ becomes zero. On the other hand, the trust from manager $A$ to subordinate $B_2$ becomes $(5)/(0+5+7) = 5/12 = 0.417$, while the trust from manager $A$ to subordinate $B_3$ increases to $(7)/(0+5+7) = 7/12 = 0.583$. By doing so, we turn mistrust for a certain member into more positive trust to other members, thus avoiding the unnecessary division by zero.
Given this operationalization of trust, at any time if a member needs to make a decision, he or she will first check the expected behavior of the source of the information. The member then makes a decision based on the weighted average of all the sources of information associated with the relative degree of trust:

$$DT_i(t) = \sum (C_{ij}(t-1)^*V_{ij}(t)) \quad J = 1..n$$ (4)

where $DT_i(t)$ is the sum of information weighted according to the relative trust of each incoming source $j$ to member $i$ at period $t$; $C_{ij}(t-1)$ is the cumulative credit member $i$ given to $j$ at the end of problem period $t-1$; and $V_{ij}(t)$ is the value of information, either 1, 2, or 3, supplied by source $j$ to member $i$ at period $t$.

Finally, the decision by member $i$ is calculated by dividing the distributions evenly into three categories:

$$D_i(t) = \begin{cases} 1 & \text{if } DT_i(t) \text{ in } [1, 1.7); \\ 2 & \text{if } DT_i(t) \text{ in } [1.7, 2.3); \\ 3 & \text{if } DT_i(t) \text{ in } (2.3, 3] \end{cases}$$ (5)

where $D_i(t)$ is the decision made by member $i$ at the end of problem period $t$.

For instance, if the member's decision happens to be a 3 while the correct decision should be 1, the member will lose one credit at the end of the problem period, which affects the member's trustworthiness to his or her superior in the next round. If at a problem period there is no trust (e.g., at the very beginning of the first organizational problem) or only negative trust for all trust relationships to a member, the member will have no credible sources to rely on and will have to make a random decision. At the end of the problem period, the member can learn from the feedback and adjust the trust relationships for each of his or her information sources. These trust relationships are not restricted to only intra-organizational relationships, but can also be extended to include relationships between the boundary spanning members such as the base-level analysts and the external sources.

**Procedure Mechanism and Random Mechanism Operationalized**

To study the effect of the trust mechanism, we also consider organizations that do not rely on trust mechanisms. In these organizations, interpersonal relationships do not change and are not determined by prior transactions. The procedure mechanism features each member relying on a standard
operating procedure that emphasizes unbiased treatment of information sources and discounts individual source’s past behaviors (Cohen, 1991; Lin & Carley, 1997b). Each member will treat all incoming information with equal weight regardless of the past behaviors of the information providers. As a result, past behavior has no effect on interpersonal relationships. This is similar to the case when each member’s credibility in Equation (2) always remains the same and equal to other group members’. With this standard operating procedure, a member will simply take the mean of the three pieces of information and round it to the nearest integer number.

We recognize that in world organizations, organizations may contain a mixture of trust and procedure mechanisms. The purpose of the current study is to explore a more stylized case in which the impact of highly contrasted mechanisms within organizations can be compared. This is similar to the approach used by scholars such as Courtright et al., (1989).

Finally, the random mechanism features the individual members making random decisions regardless of the information received, which serves as a baseline for the study.

Organizational Structure

Most organizations in the real world are formed in some hierarchical structure, although they are recognized with vertical and horizontal differentiation (Hall, 1991; Mackenzie, 1978). In this study we model two forms of organizational structure as shown in Figure 2—hierarchy and team structures, which differ in complexity, formalization, and centralization (Scott 1987).

Multi-Level Hierarchy

In this structure, there are nine base-level analysts, three middle-level managers, and one top-level manager. Each analyst examines only one piece of information from the external task environment and makes a recommendation to his/her immediate supervisor. No two analysts share the same information. Each middle-level manager examines the recommendations from his or her subordinates and makes a recommendation to the top-level manager. The top-level manager examines the middle-level managers’ recommendations and makes the organizational decision. There are two levels of management.

Team or Flat Hierarchy

In this structure, there are nine base-level analysts and one top-level manager. Each analyst examines two pieces of information from the external task environment and makes a recommendation to his or her immediate middle-level manager. Because each problem comprises nine
individual characteristics, the information an analyst has access to is thus partially shared by another analyst. All analysts report to the top-level manager. The manager examines these recommendations and makes the organizational decision. There is only one level of management.

**Internal Operating Conditions**

Another organizational context in the model is the internal operating conditions that can potentially affect organizational performance because of additional uncertainty and ambiguity (March & Olsen, 1976). We model three operating conditions within the organization: normal condition, member turnover condition, and incorrect information condition. Under the normal operating condition, there is nothing wrong within the organization. All information is available and correct, all communication channels are functioning, and all members are doing what they are supposed to do. This condition serves as a baseline to examine the impacts of sub-normal conditions.

The member turnover condition occurs when three base-level analysts leave the organization and are replaced by new base-level analysts. New analysts are assumed to be untrained and having blank memories.

Under the incorrect information condition, three selected external sources yield incorrect information to the base-level analysts, without the knowledge of those members. As a result, these three base-level analysts will make decisions based on such erroneous sources and report their findings to their managers.

**Organizational Outcome**

In the model, all members' as well as the organization's decision choices for problem solving tasks are recorded, which can then be compared with the predefined nature of the problems. Accuracy of the decision indicates how well each member and the organization can classify problems into the right category as specified by the task environment. Organizational performance in terms of decision-making accuracy is then measured as the percentage of total correct decisions made by the organization given the total number of problems encountered under the specific condition (Lin & Carley, 1997b).

**Simulation Experiment**

To explore the dynamic relationships between trust and organizational performance and the impact of various factors, two series of 24 experiments are conducted. The first series of 12 experiments is conducted where three types of organizations (using trust, procedure, or random
mechanism) are presented with 30 runs of 100 problems (each or in total) under normal operating conditions. Through these experiments, the overall performance for organizations as well as individual level trust for trust-mechanism organizations can be derived. A second series of 12 experiments is then conducted where internal operating conditions can change from normal to subnormal and back to normal. Each of the three types of organizations is again presented with 30 runs of 100 problems. For the first 30 problems, each organization is under the normal condition. From problems 31 to 35 the member turnover condition occurs. After that the operating condition returns to normal. From problems 66 to 70 the incorrect information condition occurs, and then the internal operating condition returns to normal again and remains that till the end. To examine the effect of a particular sub-normal condition, for example, member turnover condition, we can compare the mean value of organizational performance under the five problem periods of member turnover condition with the mean value of organizational performance in the five problem periods immediately preceding the member turnover condition. Such a comparison helps controlling the effect from being contaminated by the beginning stage and the post-event building stage.

All organizations are given feedback after each problem period and members keep updating their memories of trust relations based on their information sources' prior decision accuracy. Through these experiments we can then see how trust may affect organizational performance and further examine the claims listed in the conceptual framework. Appendix A has also listed a simplified algorithm on which the computer program is based.

RESULTS

Through the simulation experiments, we have recorded decision-making outcomes at both the individual level and the organizational level for each type of organization. The results are analyzed focusing on the performance patterns at the organizational level across different type of organizations employing different mechanisms (trust, procedure, and random). Following that, the moderating impact of different organizational contextual variables such as structure, environment, and internal operating conditions are examined.

The Effect of Competency-Based Trust on Organizational Performance

To examine Claim 1, we look at how organizations with different mechanisms perform when the internal operating condition is normal. We
do not treat trust as an isolated construct that can be aggregated at the individual level to reflect the organizational level performance. Rather, we treat trust as a dynamic and integrated mechanism that is embedded in the organizational system (Klein et al., 1999). Such a meso approach is supported by a correlation analysis between isolated individual level interpersonal trust and organizational level performance. The results show that none of the interpersonal trust, individually, has a higher correlation than 0.13 with the organizational performance. In other words, interpersonal trust does not directly predict organizational performance. This is true regardless of what the context the organization is in.

Based on the overall comparison results, organizations with the trust mechanism (mean = 0.73, std = 0.27, n = 12,000) have a much higher performance (p < 0.01) than those with the random mechanism (mean = 0.33, std = 0.00, n = 12,000) but a lower performance (p < 0.01) than those with the procedure mechanism (mean = 0.81, std = 0.24, n = 12,000). This result shows that the effect of interpersonal trust lies between a random mechanism that lacks basic rational rules and a procedure mechanism that relies on institutionalized impersonal judgment. It suggests that interpersonal trust may be an intermediate mechanism in the development of an organization from initial anarchy to final institutionalization. The fact that a trust mechanism based organization can have very different performance patterns when compared with a procedure mechanism based organization, may also suggest that new explorations are needed before traditional organizational research findings can be applied to trust mechanism based organizations. This supports Claim 1 and suggests that there is a limit to which organizations can benefit from a competency-based trust mechanism.

The Moderating Role of Organizational Context

While the above result informs us of the limited effect of the trust mechanism, we go further to explore whether such a pattern changes under different internal and external conditions.

The Role of Organizational Structure

To examine Claim 2, we compare how organizations of different mechanisms perform with different structures, again under the normal operating condition (i.e., no member turnover or incorrect information). We can see that when holding other factors constant, the same performance pattern exists across both hierarchy and team structures. Specifically, for organizations with a hierarchy structure, the procedure mechanism (mean = 0.80, std = 0.24, n = 6,000) provides the best help to organizations, with the trust mechanism (mean = 0.75, std = 0.28,
n = 6,000) and the random mechanism (mean = 0.33, std = 0.00, n = 6,000) following. The differences across these three mechanisms are again significant (p < 0.01). For organizations with a team structure, the same significant pattern remains (p < 0.01), with the highest performer being those with the procedure mechanism (mean = 0.81, std = 0.23, n = 6,000), the next being those with the trust mechanism (mean = 0.72, std = 0.25, n = 6,000) and the last being those with the random mechanism (mean = 0.33, std = 0.00, n = 6,000). The results, however, also show that having a hierarchy structure can provide significant help to trust mechanism based organizations when compared with having a team structure (p < 0.01). This suggests that organizational structure does affect organizational performance, but its effect may be limited by the decision-making mechanism used by the organization. Organizations with a hierarchy structure may provide some stronger role coordination that can help complement the trust mechanism. This supports Claim 2.

The Role of Task Environment

To examine Claim 3, we compare the performance of organization with different mechanisms in different task environments, again under the normal operating condition. We can see that when holding other factors constant, the same performance pattern exists across both predictable and unpredictable task environments. In the predictable task environment, the procedure mechanism (mean = 0.72, std = 0.27, n = 6,000) provides the best help to organizations, with the trust mechanism (mean = 0.70, std = 0.27, n = 6,000) and the random mechanism (mean = 0.33, std = 0.00, n = 6,000) following. The differences across these three mechanisms are again significant (p < 0.01). In the unpredictable task environment, the same significant pattern remains (p < 0.01), with the highest performer being those with the procedure mechanism (mean = 0.89, std = 0.21, n = 6,000), the next being those with the trust mechanism (mean = 0.76, std = 0.26, n = 6,000) and the last being those with the random mechanism (mean = 0.33, std = 0.00, n = 6,000). The results, however, also show that the performance gap between trust mechanism based organizations and procedure mechanism based organizations grows much bigger in the unpredictable task environment. Specifically, an unpredictable task environment seems to provide more positive push to organizations with the procedure mechanism than to organizations with the trust mechanism. This suggests that task environment does impact how the trust mechanism and other decision-making mechanisms function in work organizations. When the task environment is unpredictable it may be more important for organizations to implement impersonal procedures than try to incorporate all the minor fluctuations of the environment with personal attachments. This supports Claim 3.
**The Role of Organizational Structure and Task Environment**

To examine Claim 4 and explore whether organizational structure and task environment combined would have some different impact, Table 1 has listed the results of the performance of organizations with different mechanisms under different organizational structures and task environments when the internal operating condition is normal. We can see that with any combination of structure and task environment, the order of organizational performance (random < trust < procedure) remains throughout, thus further confirming Claim 1. On the other hand, the table also shows that while Claim 3 on the effect of task environment still holds regardless of organizational structure, Claim 2 no longer is true under different task environments. Specifically, a hierarchy structure only becomes helpful to organizations with a trust mechanism in an unpredictable task environment. A team structure, on the other hand, helps organizations with a trust mechanism in a predictable task environment. This suggests that the structural effect on how trust affects organizations can be further moderated by the nature of the task environment. These results again suggest that findings from the conventional organizational research may not be readily transferable if we do not take a contingency approach in our trust research. The advantage of a hierarchy or a team structure may disappear in certain task environment. These results support Claim 4.

**The Role of Sub-Normal Condition and Organizational Structure**

Figures 4 and 5 show the dynamic processes of trust-mechanism-based and procedure-mechanism-based organizations under different external

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**TABLE 1** The Role of Organizational Structure and Task Environment in Moderating the Effect of Different Mechanisms on Organizational Performance Under Normal Conditions*

<table>
<thead>
<tr>
<th>Decision making mechanism</th>
<th>Organizational structure</th>
<th>Predictable</th>
<th>Unpredictable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trust mechanism</td>
<td>Hierarchy</td>
<td>0.69 (0.29)**</td>
<td>0.80 (0.27)d</td>
</tr>
<tr>
<td>Procedure mechanism</td>
<td>Hierarchy</td>
<td>0.72 (0.27)c</td>
<td>0.88 (0.22)c</td>
</tr>
<tr>
<td>Random mechanism</td>
<td>Team</td>
<td>0.33 (0.00)a</td>
<td>0.33 (0.00)b</td>
</tr>
<tr>
<td>Trust mechanism</td>
<td>Team</td>
<td>0.71 (0.26)c</td>
<td>0.72 (0.25)c</td>
</tr>
<tr>
<td>Procedure mechanism</td>
<td>Team</td>
<td>0.72 (0.27)c</td>
<td>0.90 (0.20)f</td>
</tr>
<tr>
<td>Random mechanism</td>
<td>Team</td>
<td>0.33 (0.00)a</td>
<td>0.33 (0.00)a</td>
</tr>
</tbody>
</table>

*Mean values are based on 30 runs of 100 period experiments. N=3,000. Standard deviations are in parentheses.

**Means having different superscripts are significantly different at p < 0.01.
FIGURE 4 Processes of dynamic organizational performance under predictable task environments.

and internal conditions. First, we can examine Claim 5 by looking at how member turnover may affect the performance of trust-mechanism-based organizations. To fully understand the impact of sub-normal conditions, we compare the mean values of organizational performance in the five periods immediately prior to the sub-normal condition and the five periods under the sub-normal condition. We first look at the impact of the member turnover condition. We can see that the member turnover condition does

FIGURE 5 Process of dynamic organizational performance under unpredictable task environments.
not impact the performance of the organizations with either the trust mechanism (Prior to Member Turnover: mean = 0.74, std = 0.26, n = 600; During Member Turnover: mean = 0.74, std = 0.26, n = 600), or the procedure mechanism (Prior to Member Turnover: mean = 0.81, std = 0.24, n = 600; During Member Turnover: mean = 0.80, std = 0.24, n = 600), or the random mechanism (Prior to Member Turnover: mean = 0.33, std = 0.00, n = 600; During Member Turnover: mean = 0.33, std = 0.00, n = 600). This is different from many prior research results and needs further explorations. This suggests that both a trust mechanism and a procedure mechanism may serve as strong deterrence to the negative effect of member turnover through either a trust mechanism that relies on dynamic personal adaptation at every level of the organization or a procedure mechanism that relies on impersonal assessment of information. This is an interesting finding as it shows new signs of equifinality in decision-making mechanisms for mitigating the impact of member turnover (Gresov & Drizin 1997). This does not support Claim 5.

We then examine Claim 6 by looking at the how such member turnover condition may impact organizational performance under different organizational structures (Table 2). We can see that in a predictable task environment, both hierarchy and team organizations' performance stays virtually the same regardless of the member turnover condition. In an unpredictable task environment, however, there is a significant effect of the member turnover condition but only on the organization with a hierarchy structure. The team organization again shows a strong resistance to

<table>
<thead>
<tr>
<th>Decision making mechanism</th>
<th>Organizational structure</th>
<th>Predictable task environment</th>
<th>Unpredictable task environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Prior to turnover*</td>
<td>During turnover</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prior to turnover</td>
<td>During turnover</td>
</tr>
<tr>
<td>Trust</td>
<td>Hierarchy</td>
<td>0.68 (0.29)**</td>
<td>0.71 (0.28)</td>
</tr>
<tr>
<td>Procedure</td>
<td>Hierarchy</td>
<td>0.75 (0.26)**</td>
<td>0.73 (0.28)</td>
</tr>
<tr>
<td>Random</td>
<td>Team</td>
<td>0.33 (0.00)*</td>
<td>0.33 (0.00)</td>
</tr>
<tr>
<td>Trust</td>
<td>Team</td>
<td>0.71 (0.25)**</td>
<td>0.73 (0.25)</td>
</tr>
<tr>
<td>Procedure</td>
<td>Team</td>
<td>0.73 (0.28)**</td>
<td>0.71 (0.26)</td>
</tr>
<tr>
<td>Random</td>
<td></td>
<td>0.33 (0.00)*</td>
<td>0.33 (0.00)</td>
</tr>
</tbody>
</table>

* Mean values for Prior to Turnover Condition is based on the five periods immediately preceding the During Turnover Condition. N = 30 × 5 = 150 for each cell. Standard deviations are in parentheses.

** Means having different superscripts are significantly different at p < 0.10.

TABLE 2 The Role of Member Turnover Condition in Moderating the Effect of Different Mechanisms on Organizational Performance Under Different Organizational Structures and Task Environments
member turnovers. This suggests that a team organization may be better protected from sub-normal conditions by having a trust mechanism, in particular when compared with having a procedure mechanism, though its performance also stays lower than the hierarchy organization. This result extends prior research on teams and trust as it shows the conditions under which a trust mechanism based organization may or may not be effective. These results support Claim 6.

To examine Claim 7 and explore the effect of the incorrect information condition, we look at the mean values of organizational performance in the five periods immediately prior to the incorrect information condition and the five periods during the incorrect information condition. We can see that organizations with either a trust mechanism (Prior to Incorrect Information: mean = 0.74, std = 0.26, n = 600; During Incorrect Information: mean = 0.69, std = 0.27, n = 600), or a procedure mechanism (Prior to Incorrect Information: mean = 0.82, std = 0.23, n = 600; During Incorrect Information: mean = 0.66, std = 0.36, n = 600) can be severely affected by such a sub-normal condition (p < 0.01), with the exception of a random mechanism (Prior to Incorrect Information: mean = 0.33, std = 0.00, n = 600; During Incorrect Information: mean = 0.33, std = 0.00, n = 600). The result has also shown that the performance of the organization with the procedure mechanism has had a much bigger drop, indicating a stronger impact of the incorrect information on procedure mechanism based organizations. Such an effect also illustrates the consequence of a rigid procedure in an adverse condition when information is no longer reliable. This suggests that incorrect information, not member turnover, may pose the biggest challenge to organizations, whose main tasks involve decision making. These results thus support Claim 7.

We finally examine Claim 8 by looking at how such incorrect information condition may impact organizational performance under different organizational structures (Table 3). We can see that in a predictable task environment, a trust-mechanism-based organization with the team structure is not affected by the sub-normal condition, unlike the one with the hierarchy structure. In an unpredictable task environment, the impact of the incorrect information becomes severe for trust-mechanism-based organizations with either the hierarchy or the team structure. Organizations with the procedure mechanism are consistently found to be negatively affected by incorrect information. The above results show that the hierarchy organization, while having a higher performance under normal conditions, tends to be more susceptible to the incorrect information condition. This is an interesting finding as it shows that the principle of a hierarchy design may not serve its original purpose in a purely competency based trust environment, as individuals are given more flexible control of the information, thus causing the spread of interpersonal mistrust to the multi-layers of the
TABLE 3 The Role of Incorrect Information Condition in Moderating the Effect of Different Mechanisms on Organizational Performance Under Different Organizational Structures and Task Environments

<table>
<thead>
<tr>
<th>Decision making mechanism</th>
<th>Organizational structure</th>
<th>Predictable task environment</th>
<th>Unpredictable task environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Prior to incorrect information*</td>
<td>During incorrect information</td>
</tr>
<tr>
<td>Trust</td>
<td>Hierarchy</td>
<td>0.74 (0.29)**</td>
<td>0.62 (0.31)b</td>
</tr>
<tr>
<td>Procedure</td>
<td></td>
<td>0.70 (0.29)d</td>
<td>0.65 (0.36)c</td>
</tr>
<tr>
<td>Random</td>
<td>Hierarchy</td>
<td>0.33 (0.00)a</td>
<td>0.33 (0.00)a</td>
</tr>
<tr>
<td>Trust</td>
<td>Team</td>
<td>0.70 (0.25)d</td>
<td>0.71 (0.26)d</td>
</tr>
<tr>
<td>Procedure</td>
<td></td>
<td>0.77 (0.25)f</td>
<td>0.60 (0.35)b</td>
</tr>
<tr>
<td>Random</td>
<td></td>
<td>0.33 (0.00)a</td>
<td>0.33 (0.00)a</td>
</tr>
</tbody>
</table>

*Mean values for Prior to Incorrect Information condition is based on the five periods immediately preceding the During Incorrect Information condition. N = 30 x 5 = 150 for each cell. Standard deviations are in parentheses.

**Means having different superscripts are significantly different at p < 0.10.

organization. We also see that a procedure organization is more susceptible to incorrect information, regardless of organizational structures. This is the one place we see that having a trust mechanism can actually help organizations in particular in a predictable task environment. These results partially support Claim 8.

**DISCUSSION**

**Conclusion and Implications**

This study, viewing trust as a competency-based construct and organizations as open systems, has explored the micro-macro process linkage between interpersonal trust and organizational-level performance where organizational context matters. Through the use of an agent-based computer model, the study demonstrates that it is both necessary and feasible to extend our understanding of trust in work organizations from a meso perspective. We have not only examined trust in a highly systematic manner but also moved trust into settings that resemble the key function of real world work organization. Specifically, our study has shown that while a competency-based trust mechanism helps organizational performance when compared with a random mechanism, organizations can actually be better off with a simple procedure mechanism. Organizations, however, can benefit from such a trust mechanism under incorrect information conditions, especially when assisted by a team structure.
This study has shed light into some interesting issues in the research of trust. It no longer treats trust as symmetrical and lateral as in most prior research. Rather, it allows trust to be hierarchical as this is the most common case in work organizations (Kramer, 1996). In addition, we have treated trust as relative, in particular when there are multiple pairs of simultaneous relationships, which is consistent with the fact that human beings have only bounded rationality (March & Simon, 1958).

The findings that interpersonal trust may not be as beneficial to organizational performance as most trust researchers would speculate and that individual interpersonal trust does not correlate with organizational performance, have profound implications. It suggests that trust, with the purpose of aligning subordinates' behaviors toward the manager's expectations, may actually cause the group-think phenomenon and harm the organizational performance due to strong local rationality and goal alignment tendency (Hackman, 1990; Lewis & Weigert, 1985). In addition, the belief that trust should be beneficial to organizational performance has built its assumption on a simple, homogeneous, and stable task for which past experience may have a much stronger and long lasting effect. Such trust, however, becomes detrimental when organizations are dealing with distributed, complex, and dynamic tasks. It suggests to organizations that they should be aware of the limit of trust because trust does not automatically translate into organizational performance. Some scholars have rightly pointed out the false assumptions commonly existed in micro research that the aggregation of individual-level constructs can automatically translate into unit-level outcomes and that within-unit agreement is a necessary and perhaps even sufficient condition for unit-level performance (Argote, Devadas, & Melone 1990; Klein et al., 1999). This study has shown that such assumptions indeed do not necessarily hold in multi-level (or meso) theorizing.

This study treats organizations as adaptive open systems that can be affected by both the internal and external settings. From the external setting, two types of task environments are considered: predictable and unpredictable, as predictability has been considered one of the most important dimensions in task environment (Aldrich, 1979). Our results have shown the great impact of task environment on how trust affects organizational performance and the importance of understanding the nature of different task environments. From the internal structural settings, we have considered a hierarchy structure and a team structure. These are the two most compared forms (Weick, 1995) and, though stylized, can provide rich insight into the effect of structures on moderating the linkage between trust and organizational performance. This study also calls for organizations to be aware of internal operating conditions before stressing trust relationships. Trust can be affected by internal operating conditions
and such conditions can pose different challenges to organizations. To better minimize the impact of a sub-normal condition, it is vital for organizations to both consider the nature of the task environment and design proper structures.

While this study has focused on trust, its results may also be useful for the study of reputations. Reputation has been studied in research, in particular from a game theory or an economic perspective (Clark & Montgomery, 1998) often as a precondition of trust (Axelrod, 1984; Raub & Weesie, 1990; Williamson, 1991) and as a social capital (Fombrun & Shanley, 1990; Granovetter, 1992). The construct of trust, while to some degree similar to the construct of reputation in the contemporary game theory, does not take the classical game theory’s assumption of full rationality and competition for participants. Instead, it treats participants as in organizational settings, who are adaptive and cooperative but also rationally bounded (Axelrod, 1997).

This paper regards individuals in structurally equivalent roles as having similar capabilities and functions, though their relationships can change (Burt, 1978; Lorrain & White, 1971). This view is different from some of the micro psychological perspectives, which consider trust to be a result of individual differences such as personality. By taking the structural equivalence approach, we are able to derive the effect of trust as a result of behaviors in well-controlled organizational contexts.

This study has demonstrated that computer modeling can be a natural and effective method for studying multi-level issues in dynamic and complex organizations (Carley & Prietula 1994; Lant 1994; Weiss 1999). Scholars like Axelrod (1997) have also emphasized the usefulness of computer modeling, in particular agent-based technique, dealing with adaptive behaviors of multiple interacting agents, even though his work is mainly concerned with societal level phenomena. In fact, Axelrod even claimed that “simulation is necessary because the interactions of adaptive agents typically lead to nonlinear effects that are not amenable to the deductive tools of formal mathematics.” He further argues that “the simulation of an agent-based model is often the only viable way to study populations of agents who are adaptive rather than fully rational” (p. 4).

**Limitations**

While we believe this study has important contributions to the development of organization science in general and trust research in specific, we also recognize the fact that we have only focused on distributed decision-making tasks, which though are commonly faced by today’s organizations, may not be the only form of tasks. There are situations where organizations can face more homogeneous tasks or simpler tasks that do not require the
distributed expertise and so consensus decision making may be more desirable. Also, although our paper has attempted to integrate different perspectives and consider various important organizational factors in the same model, we have not considered the case where there can be a mixture of the procedure mechanism and the trust mechanism in organizations, as these mechanisms may not be so clear cut in real world organizations. For example, the study by Zaheer et al. (1998) suggested that, besides interpersonal trust, there are other organizational factors that can affect organizational performance, although the organizational performance they focused on is only cooperative relationships between the focal firm and its partner firms. Other scholars in the organization theory literature have also pointed out that oftentimes, formal and informal processes within the organization can interact to influence how organizations perform (Lin & Hui, 1999; Zucker, 1986). As a result of these limitations, whether the conclusions of our model will stand or whether the traditional trust research findings can be applied will require further explorations.

Consistent with other trust research, this study considers behavior as the most basic foundation for building trust. Such a trust mechanism naturally regards some of the commonly studied trust relationships such as loyalty as also behavioral based as we believe without the desired behavior, organizations will not be able to survive and so loyalty will not last long either. While such a belief may serve as a starting point for our exploration of trust in work organizations, we realize that it has inevitably narrowed the bandwidth of trust. We hope in our future research some informal and less rational aspects of trust may be incorporated in the model, if new theoretical and technical developments have made the quest feasible.

While agent-based modeling has the great advantage of examining dynamic, complex, and even mathematically inexpressible relations, we must be aware that such a modeling approach may also create a different type of gray, if not black, box for readers or even other researchers to fully grasp the internal programming mechanisms without going over the detailed computer codes, which can easily be over thousands of lines. Thus, it puts a much higher demand on us to provide clearer descriptions for future model replications. In addition, as a special form of laboratory study, the computer model has to confront the question of generalizability from a specifically defined setting given the need for researcher to operationalize various constructs into computer executable objects. Our purpose in this study is not to present a model that is generalizable to all organizations, but to organizations with certain characteristics as stylized in this paper. We believe the results from this study will at least help us expand our thinking and advance the field of organization science. The benefit of using computer modeling thus far outweighs the potential opportunity loss.
There are several other areas for potential improvement. For example, with the further development of the field of trust research and the advancement of the modeling technology, a future model may incorporate broader aspects of trust relations of different cultural implications and consider wider ranges of organizational context, which may yield further insights. Future research should also incorporate the literature on top management teams into that of formal organizations to provide theoretical background for modeling the mixture of various mechanisms. For example, as some scholars have suggested, top management executives rely more on interpersonal relationships as they often face no-routine problems, while lower level employees tend to follow organizational procedures as they face more routine problems (Hambrick & Mason, 1984; Lin & Li, forthcoming). Finally, it will also be beneficial to learn from available cases of real world organizations, which though may not be as systematic and controlled, may help provide new empirical information for further theoretical development. Despite these areas for potential improvement, we believe findings from this study can shed light into the field of trust research and provide new directions and methods that can be further pursued both theoretically and empirically.

REFERENCES


APPENDIX A

A GENERAL ALGORITHM FOR DECISION-MAKING PROCESSES IN THE MODEL

/*declare external variables;*/
external integer , ; /*agents' memories*/
external integer , ; /*flags and indicators*/
external double , , ; /*decision storages*/
...

/*main function starts*/
main()
{
input_experimental_parameters();
loop begins;
task_problem_generation();
base_level_decision_process();
middle_level_decision_process();
top_level_decision_process();
feedback_and_update_process();
loop ends;
}

/*define functions called in the main function*/
input_experimental_parameters()
{
show on screen the "experiment type" choice menu;
read the choice from the screen with 1 for no change of experimental
  conditions throughout the experiment or 2 for changing conditions in the
  experimental process, such as the for certain problem periods, the
  internal operating conditions can automatically change to sub-normal
  ones as described in the simulation experiment section of the paper;
show on screen the "task environment" choice menu;
read the choice from the screen with 1 for predictable or 2 for unpre-
dictable task environment;
show on screen the "organization structure" choice menu;
read the choice from the screen with 1 for multi-level hierarchy or 2 for
  team/flat hierarchy;
show on screen the "decision mechanism" choice menu;
read the choice from the screen with 1 for trust based, 2 for procedure-
based, or 3 for random mechanism;

show on screen the "internal operating condition" choice menu;
read the choice from the screen with 1 for normal, 2 for member turnover,
or 3 for incorrect information conditions.

use flags to record all the choices;
}

task_problem_generation()
{
    /* select a random problem with nine components from the task
    environment chosen earlier; */
    component_1 = ;
    component_2 = ;
    ...
    component_9 = ;
    use flags to record the problem components;
}

base_level_decision_process()
{
    each base-level analyst accesses a subset of the nine problem components as
    specified by the organization structure;
    each base-level analyst makes a decision recommendation on his/her
    subset of the problem information using the specified decision
    mechanism;
    each base-level analyst passes up the decision recommendation to his/her
    designated manager as specified by the organization structure;
}

middle_level_decision_process()
{
    if the organization structure is a team/flat hierarchy structure, skip this
    function;
    each middle-level manager reads recommendations from his/her
    subordinates as specified by the organization structure;
    each middle-level manager makes a decision recommendation on his/her
    collected information using the specified decision mechanism;
each middle-level manager passes up the decision recommendation to the
top-level manager as specified by the organization structure;
"

```c

top_level_decision_process()
{
the top-level manager reads recommendations from his/her subordinates
as specified by the organization structure: if the structure is a team/
flat hierarchy, the top_level manager reads information from the nine
base-level analysts, if the structure is a multi-level hierarchy, the
top_level manager reads information from the three middle-level
managers;
the top-level manager makes a decision on his/her collected information
using the specified decision mechanism;
the top_level manager registers the decision as the organizational decision;
}
```

```c

feedback_and_update_process()
{
calculate true nature of the problem based on the formula for the specified
task environment;
compare the organization decision with the true decision and record the
comparison results;
provide feedback of the true nature of the problem to the organization;
if the decision mechanism is a trust-based one, each organizational member
updates his/her memory and interpersonal trust relationships;
}
```