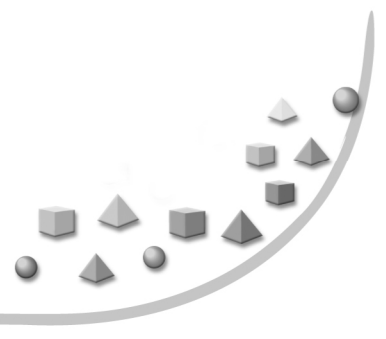
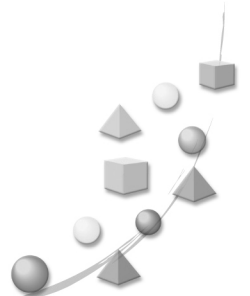


Parallel Applications Session II —

# **Social Policy and Computational Knowledge**





## BEYOND MARKETS AND COMMUNITIES: A COMPARATIVE APPROACH TO KNOWLEDGE EXCHANGE IN ORGANIZATIONS

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### ABSTRACT

While knowledge transfer has been shown to affect organizational performance, little is known about the processes of knowledge exchange between organizational agents. We propose that combinations of various modes of exchange and degrees of tie strength produce at least five different configurations: neo-classical exchange, local search, embeddedness, community exchange, and performative ties. By using an agent-based simulation of problem solving with knowledge exchange in an organizational setting, we find that embeddedness and community exchange provide results that are superior to neo-classical exchange. Performative ties, however, outperform both, even if just a minority of the organizational agents are able to extend such ties. In addition, we find that the marginal returns on performative ties are greatest when such ties are relatively rare, suggesting that the cost associated with encouraging them can be minimized with few adverse effects. We conclude by discussing managerial implications for team setup and facilitation of knowledge transfer.

**Keywords:** Knowledge, social network, exchange, reciprocity, performance

### INTRODUCTION

Knowledge has grown to occupy a major role in the discussion on firm performance and survival (Winter 1987). In the management literature, knowledge has been recognized as a valuable resource (Kogut and Zander 1995), a source of lasting competitive advantage (Teece et al. 1997), and even the very foundation for the existence of a firm (Grant 1996). But unlike other economic resources such as capital or land, knowledge is a social entity. In the last two decades, much ink has been spilled to argue and show that organizational knowledge — the kind that is necessary to create a competitive advantage — does not reside in manuals or training books but in individuals and the regularities by which they cooperate (i.e., routines) (Cohen and Bacdayan 1994; Kogut and Zander 1992; Nelson and Winter 1982).

Consequently, the organizational literature has been devoting much attention to the transfer of knowledge between agents, either between individuals within the same organization (intraorganizational knowledge transfer) or between organizations (interorganizational), and much has been achieved. We now have established an understanding of the flows of knowledge between agents, the consequences for various phenomena of managerial interest (e.g., innovation), and the obstacles to knowledge flows.

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Valuable knowledge is knowledge that is unique and protected from easy imitation. As such, it is likely to be intangible (Teece 1998; Winter 1987) and to reside in people and the patterns of interactions among them (i.e., routines) rather than in manuals or textbooks (Winter 1995). However, it is difficult to observe or directly identify the presence of knowledge or measure its quality (Arrow 1962, 1969). For instance, it is difficult to judge whether a person does indeed carry the knowledge that she claims to possess without requiring her to reveal that knowledge. Because knowledge resides in people and routines, it cannot be easily taken from one location and transferred to another. Knowledge cannot be extracted against one's will, nor can it be force-fed to others. A recent front-page story in the *Wall Street Journal* described how experienced employees in a manufacturing facility refused to share their knowledge with newcomers or managers, because this knowledge made the veterans irreplaceable (Aeppel 2002).

If we agree that knowledge is contained in routines (Winter 1995), then it naturally follows that knowledge is a social entity and requires social interaction for transfer. Our primary interest here is modeling processes of knowledge interactions between individuals (i.e., intraorganizational agents). Specifically, we are interested in linking individual choices to organizational performance. When performing their professional tasks, agents decide who to turn to in their search for knowledge and how to negotiate the transfer. These micro choices — mode of exchange and the characteristics of the exchange partner — can eventually affect organizational performance, a macro variable. We are thus interested in linking individual choices to organizational performance. In our model, we examine the gamut of modes of exchange and the nature of relationships between the agents. Our model allows an agent to interact purely in one mode of exchange or, more realistically, in a combination of them, depending on the characteristics of the partner.

## CHOICE OF PARTNERS AND MODES OF EXCHANGE

### Tie Strength

From empirical research on knowledge processes, we know that individuals often search for knowledge that is necessary to perform their professional tasks, whether they are service technicians (Orr 1990, 1996), high-technology engineers (Bechky 2003), or white-shoe professionals (Haas and Hansen forthcoming; Hansen 1999).

In a study of a global professional service firm, Levine (2004) found some use of codified sources, such as textbooks and internal publications. These sources were typically used when an employee was completely unfamiliar with the industry or the problem at hand and was interested in an introductory overview. More commonly, professionals in the firm turned to their social network for knowledge. They approached *strong ties* — office mates, close friends, and family members — making a variety of requests, from asking quick questions about statistical functions in Microsoft Excel to spending several hours sourcing an insider view on an industry. Individuals also called on *weak ties* — acquaintances in their office and in other offices — when seeking references and advice (cf. Granovetter 1973). However, strong and weak ties were not the only sources for knowledge. Employees often sought knowledge from strangers — others they had neither met nor been referred to by a mutual contact. A *performative tie* involved two or more individuals that became linked following a process of wide search. While the individuals had no transaction history, nor did they expect to develop one, the transaction was carried out in a mode

of generalized exchange, without expectations of reciprocity from the beneficiary to the benefactor. Table 1 summarizes the various sources of knowledge and provides examples and theoretical and empirical referents.

A knowledge transaction involved several steps: identification of the potential knowledge carrier, initiation of contact with that individual and negotiation of terms, and transfer of content. An important feature is the choice of the mode of exchange, which determines the expectations of both partners for arrangements of reciprocity.

## Partner Identification: Local and Global Search

A common way to identify an exchange partner is to examine proximate individuals. Empirically, we know that people are more likely to choose as exchange partners those that belong to the same cluster (Levine and Kurzban forthcoming). The search criteria can be geographic propinquity (Marsden and Campbell 1984; Newcomb 1961; 1966), similar characteristics such as ethnicity or age (Ibarra 1992; Marsden 1988; McPherson et al. 2001), or membership in a focal group (Burt 2004; Feld 1981). In a great number of search situations, individuals (and organizations) exercise *local search*, turning to a neighbor or an acquaintance, and neglect searching distant prospective exchange partners (Levinthal and March 1993).

### Global Search

Normative approaches for search call for a comprehensive search of the gamut before deciding on an exchange partner, thus achieving optimality. This approach is the hallmark of

**TABLE 1** Knowledge sources, examples, and theoretical referents

Source	Contribution	Example	Theoretical and Empirical Referents
Codified sources	Provide an overview of industry, typical problems, and frameworks	Internal manuals, textbooks, proceedings of professional conferences	cf. Arrow 1969; Kogut and Zander 1995; Teece 1977
Strong ties	Vary, from help in using computer software to getting an insider view on industry	An associate consulted her knowledgeable spouse about a professional problem	Bian 1997; Coleman 1988; Nelson 1989; Straits 1991; Wellman and Wortley 1990
Weak ties	Provide an account of previous projects in the same or a similar industry	A senior analyst helped an associate sitting nearby to program a statistical routine for data analysis	Granovetter 1973; Hansen 1999, 2002; Levin and Cross 2004
Performative ties	Recall specific similar cases, suggest ways to think about issues, provide proprietary data	A manager called an unacquainted partner in Australia	Constant et al. 1996; Levine 2005; Saxenian 1996; von Hippel 1987

neo-classical economics (Wilson 1987) and the early decision-making literature (cf. Simon 1957).

While an optimal search may not be possible, organizations have created organizational indexes, which list members and their experience, to be used when searching for knowledge. Students of knowledge transfer in organizations have documented knowledge management systems (KMSs) — organizational indices that contain summaries of projects and contact information on those involved (Hansen 1999; McDermott 1999). In the case described by Levine (2004), the KMS did not attempt to capture much knowledge, but it did contain short descriptions of many of the projects performed in the firm worldwide. In addition to a sketch of the problem and the solution, it also contained contact information for all of the project team members, even if they were no longer employed at the firm, allowing direct contact. Rather than a library of codified knowledge, the KMS served more as a collection of pointers — an organizational index that identified individuals who possibly possessed relevant knowledge. Knowledge seekers used the information contained in the KMS to filter through the list of potential knowledge carriers and decide which ones to contact.

If the KMS did not provide a lead, employees sometimes sent out a mass electronic mail message to the whole office, to employees in a certain geographical region, or to all of the associates worldwide, for instance. The message detailed the knowledge needed and asked for assistance. A similar pattern of sending out mass electronic messages (with considerable success) was documented among sales personnel in a large computer hardware manufacturer (Constant et al. 1996).

Whether through the use of a central KMS or by sending a mass message to colleagues, knowledge seekers attempted to perform a global search (under constraints) for prospective exchange partners.

## Typology of Exchange Modes and Tie Strengths

Once a prospective exchange partner is identified, the seeker makes contact, either directly or through a broker — a third party who can introduce both individuals to each other (for more on the role of brokers, see Burt 1992, 2005; Hargadon and Sutton 1997). Then, the sides must agree on the terms of the exchange. As detailed below, the transfer can be arranged as a spot barter (neo-classical exchange), as a favor that must be returned in the future (social exchange), or as a nonreciprocated donation (generalized exchange).<sup>1</sup> These modes of exchange have different meanings when used on ties of varying strength, leading to five types of ties.

Table 2 categorizes patterns of exchange according to two criteria: tie strength (strong, weak, no prior) and mode of exchange (spot, social, generalized).

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<sup>1</sup> We do not discuss altruism as a mode of exchange because there is no substantial empirical evidence that shows it to serve as a sustainable mode of exchange within organizations.

**TABLE 2** Typology of exchange

Tie Strength	Mode of Exchange		
	Spot Exchange Autonomous economic agents repeatedly search for best price and quality combination (Wilson 1987)	Social Exchange Repeated exchange with stable partners: goods, gifts, favors (Blau 1964; Bourdieu 1977; Emerson 1981; Homans 1958)	Generalized Exchange Direct reciprocity is not expected (Ekeh 1974; Lévi-Strauss 1969 [1949]; Malinowski 1920)
Strong tie (frequent, close, and intensive)	2. Local search Limited scope of search and the need for simultaneous availability of exchange items mean that transactions are executed at a suboptimal level.	3. Embeddedness Allows access to benefits that are not available in the marketplace, but limited scope of search can lead to suboptimal results. Requires pre-existing personal trust in the exchange partner.	4. Community/clan Allows access to benefits that are not available in the marketplace, and allows resource-poor agents to participate. But relationships tend to be primary and oriented for the long term, and the breadth of the search is limited.
Weak tie (not frequent, close, or intensive)	1. Neo-classical market Wide search for global optimum, but hinders customization, increases risk, and negotiation costs. Requires simultaneity in exchange.	(Weak emergence) <sup>a</sup>	5. Performative ties Allow wide search for potential exchange partners. Generalized exchange allows for transactions that are unbalanced in the dyadic level, and does not require simultaneity.
No prior tie (no history of dyadic interaction)			

<sup>a</sup> Social exchange requires repeated exchange with stable partners, and it is unlikely to take place with strangers. Closest to social exchange with strangers would be generalized exchange (or pure altruism, where reciprocity is not expected at all).

## *Tie Strength*

As discussed earlier, tie strength measures the degree of frequency of interaction, closeness, and intensiveness of the relationship between the agents. The definition is based on the empirical work of Marsden and Campbell (1984), who concluded that a measure of closeness or intensity is the best indicator of strength. It also includes frequency, which has been commonly used to measure tie strength (e.g., Granovetter 1973).

Tie strength is a continuum here, running from strong ties, as those between close friends or family, to “no prior ties,” which indicates interaction between people who are completely unacquainted directly and indirectly.<sup>2</sup> The label “weak tie” is added for convenience, to show the drop in tie strength, but its location along the continuum is arbitrary.

## *Mode of Exchange: Spot, Social, and Generalized*

Mode of exchange refers to the principle underlying the transaction — what is transferred from each agent to the other. The three categories along the mode of exchange axis begin with a spot market exchange, where, in a neo-classical sense, autonomous economic agents repeatedly search for the best price-quality combination and where exchange is price-based and simultaneous, as both sides agree on a price and proceed to give and receive at the same time.<sup>3</sup>

Social exchange can be used for tangible goods as well as for some desirable social goods that are not easily tradable in neo-classical markets because of the difficulty in evaluating them or their unavailability for simultaneous transaction (such as exchange of prestige and friendship). The problem could be, for instance, due to the difficulty in evaluating them or their unavailability for simultaneous transaction. In the classical work of Homans (1958) and Blau (1964), individuals attain their personal or group goals by exchanging with others. Bourdieu (1977, 1997) employs this logic to analyze the practice of gift giving as a system of direct exchange, which differs from lending or swapping because of the requirements that the exchanged items be different from each other and the exchange be serial rather than simultaneous.

An important distinction of social exchange is that the transactions are repeated, or expected to be repeated; thus, the need for simultaneity is reduced, as in the case of a gift. Unlike the case of the neo-classical economic model, repeated transactions between agents are expected here. For instance, relations of power and dependency are created between two agents when one repeatedly needs a resource that the other controls but has no way of paying back. Thus the needy one “must subordinate himself to the other and comply with his wishes, thereby rewarding the other with power over himself as an inducement for furnishing the needed help” (Blau 1964, page 21). Naturally, subordination is not a behavior that lends itself to an instantaneous market transaction. The exchange is also not price-based but is governed by other rules pertaining to aspects such as value, similarity, and timing (Bourdieu 1977, 1997).

<sup>2</sup> Indirect ties are those between ego and those that are tied to the people whom the focal individual already knows, such as a friend of a friend. Such ties can be important in attaining certain resources, as Boissevain (1974) showed, and therefore are quite different from the complete absence of ties.

<sup>3</sup> If payment (or supply) does not happen immediately, the seller (buyer) expects formal assurance, such as a guarantee from the third side (e.g. credit card company).



An important commonality of neo-classical and social exchange is that both are cases of direct exchange. In the either case, exchange is a transaction between two agents, where both give and receive from each other, either identical or different goods, either immediately or sequentially. Generally, direct exchange “includes any system which effectively or functionally divides the group into a certain number of pair of exchange units so that, for any one pair X-Y there is a reciprocal relationship” (Lévi-Strauss 1969 [1949], page 146).

Generalized exchange, in contrast, occurs when a beneficiary is not obliged to reciprocate directly to her benefactor, but is to any other agent: “An individual feels obliged to reciprocate another’s action, not by directly rewarding his benefactor, but by benefiting another agent implicated in a social exchange situation with his benefactor and himself” (Ekeh 1974, page 48). Generalized exchange is quite different from direct exchange: it neither requires immediate reciprocity nor creates a direct obligation to a specific benefactor.<sup>4</sup> Several subcategories of generalized exchange have been identified (Bearman 1997; Ekeh 1974; Lévi-Strauss 1963; Malinowski 1920; Sahlins 1965), and they differ from each other in the way the goods exchanged are transferred (for a recent review, see Takahashi 2005).

While generalized exchange often takes place in communities, where the agents eligible to participate are known and boundaries are drawn, it can also guide transactions among strangers (Befu 1977, 1980; Emerson 1981; Molm and Cook 1995). Helping a stranded driver on a remote mountain road, for example, is such an instance, because the benefactor does not expect the beneficiary to return the favor in the future.

It is important to note that generalized exchange is a term that describes a mode of exchange. It is neutral, however, as to the underlying motivation leading to the adoption of this mode. Scholars have attributed the emergence of generalized exchange to altruism (Sahlins 1972; Takagi 1996) and social norms (Ekeh 1974; Lévi-Strauss 1969 [1949]). However, it has been recently shown that generalized exchange can develop without general norms but just with individual notions of fairness (Takahashi 2000).

### *Cell 1: Neo-classical Market*

The interaction of the axis produces several terms of exchange, some of which are more familiar than others. One very familiar case is cell 1, which combines spot exchange and the absence of social ties, which is essentially the case of neo-classical markets, where autonomous economic agents repeatedly search for the best price-quality combination and then engage in a transaction with whoever happens to offer that combination (Wilson 1987). The agents have no preference as to the identity of their exchange partners. The strength of a neo-classical market is that it vastly expands the choice of exchange partners: one goes to an (efficient) open-air vegetable market, searches for the best-priced (or highest-quality) tomatoes, bargains a deal with the seller, purchases a pound or two, and then goes home to make soup (Rombauer and Rombauer-Becker 1985). The following day, one can choose to search again for the best price or the highest quality, return to the same merchant, or go elsewhere if a better deal is known. The search is wide, and the gains are potentially greater. Drawbacks lie in the arms-length nature of

<sup>4</sup> The sociological literature uses “generalized exchange” (Takahashi 2000) side by side with “generalized reciprocity” (Mauss 1954). After a close reading, it seems that the two terms refer to the same phenomenon. For simplicity, we use “generalized exchange” throughout this paper.

the transaction, which hinders customization, increases risk, and increases costs in haggling and negotiations. It also requires that the goods be available for simultaneous exchange; that is, both agents must have something desirable for the counterpart for the transaction to take place.<sup>5</sup>

### *Cell 2: Local Search*

In cell 2, the search is narrower, as one searches only along her direct and immediate indirect ties; that is, among her acquaintances and her acquaintances' acquaintances.<sup>6</sup> Such a local search is a common deviation from the ideal, and it can occur as a result of the cost of a search, unavailability of information, or cognitive limitations (Levinthal and March 1993). Local search is inefficient, for it settles on the local maximum (best combination of quality and price), which is not likely to also be the global maximum (Levinthal 1997). In other words, one may find a better deal by extending the search. Local search suffers from the drawbacks mentioned above, and it does not benefit from the possibility of conducting a wide search, for which markets are especially conducive.

### *Cell 3: Embeddedness*

Embedded exchange takes place when social and economic relations are intertwined (Granovetter 1992; Portes and Sensenberger 1993; Zukin and DiMaggio 1990). It is a combination of repeated exchange partner and social exchange logic, which allows for non-price-based transactions under less-specified terms, in comparison to the contract-based transactions in markets. Some of the transfers may be done as favors. Others do not carry a specific price tag but have to be repaid. Others may be market-like transactions but are performed in a more trusting environment, under less formal conditions. In embedded exchange, the need for simultaneity in exchange is reduced. These conditions allow the exchange partners to reap benefits that are not possible in a market exchange (Baker et al. 1998; Granovetter 1985; Gulati and Gargiulo 1999; Uzzi 1999; Uzzi and Gillespie 2002). In one of the first empirical accounts, Uzzi (1997) described some of the benefits: fine-grained information transfer, joint problem-solving arrangements, economies of time, integrative agreements, and greater willingness to invest and take associated risks. In a separate article (1996), Uzzi provided evidence on the financial benefits of embedded exchange vis-à-vis market-based exchange. Embeddedness, however, can result in several risks, primarily because the search for exchange partners is “deep rather than wide” (page 51). Agents repeatedly turned to the same exchange partners rather than searching widely for the best price-quality combination. Access to nonembedded agents may be limited, and an unforeseeable exit of a major network partner can be disastrous, as it may be difficult to replace. By interfering with the propagation of information from diverse sources, embeddedness can also disguise changes in the environment (Sorenson et al. 2002). For instance, a phase of “creative destruction” (Schumpeter 1942) can go unnoticed and be realized only when it is too late to adjust. Such contextual disruptions can be detrimental

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<sup>5</sup> In modern societies, one of these things is commonly money.

<sup>6</sup> As a result of rapid attrition, the search is unlikely to succeed beyond direct and immediately indirect ties. Some research has shown that the completion rate is less than 12% even for a second-degree tie. Beyond that, more than 95% of attempts to extend a tie fail (Watts et al. 2002).

to the trust needed for embedded exchange (Axelrod 1984) and therefore lead to the collapse of the system rather than promote a successful adjustment.

#### *Cell 4: Community/Clan*

Many, if not most, of the documented cases of generalized exchange take place among specific exchange partners through direct and indirect ties (Bearman 1997; Lazega 2001). For generalized exchange along direct ties, Uehara (1990) discusses the relations between generalized exchange, solidarity, and social support, using data on a small network of low-income black women who support each other directly as they go through job loss. Here support flows to the needy — the ones who are unemployed — from their circle of supporting friends and relatives. The goods offered do not necessitate direct reciprocity, so the need for simultaneity is gone.

Communal exchange can also be lineal. A case of generalized exchange through indirect ties is intergenerational altruism: the transfer of assets from parents to their children without a direct return. Instead, the children are expected to make a transfer, in turn, to their children, the original parents' grandchildren, who are indirectly connected to the original giver. Intergenerational altruism has been used in sociobiology to explain the seemingly unreciprocated investment of parents in their children (Boorman and Levitt 1980). In the field of public policy, it was argued that intergenerational altruism can cause the family to behave financially as if it was a single, infinite-lived individual (Barro 1974). The potentially significant implications for governmental debt, retirement programs, and social security has been debated in detail (Abel and Bernheim 1991; Bernheim and Bagwell 1988).

A community that establishes generalized exchange as its mode of exchange benefits from the reduced need for simultaneity and direct reciprocity. It enjoys many of the benefits of embeddedness, plus the added ability to transact with agents who have little to offer in the short run, as calculations for direct reciprocity are eliminated.

However, it is important to distinguish between the environment where performative ties appear and the environment of communities and clans. In brief, "The Firm" is a collective that is quite different from a community or a clan, but this difference does not seem to interfere with the appearance of performative ties. A more detailed discussion follows.

#### *Cell 5: Performative Ties*

When resources are heterogeneous, such as knowledge in the cases presented here, a wide search becomes uniquely more efficient in facilitating transaction. Compared to embeddedness or community, performative ties allow a much wider search — wider than that achieved through direct and indirect ties. Even if indirect ties are used to extend the search beyond immediate locality, extension of such ties requires mediation of at least one other individual. As Burt (1992) showed, mediators of network ties gain from their control over transactions in the network. While this can be beneficial for an individual, it may interfere with organizational tasks. Even if only benevolent individuals are involved, the message can still become jumbled as it passes from one to another (cf. Winter and Szulanski 2001). Indirect ties are also likely to consume more time and resources because they require a seeker to contact not

only the carrier but also everyone in between them. There is also a rapidly decreasing likelihood of reaching the carrier because of very strong cumulative attrition (Watts et al. 2002). Finally, indirect ties are still limited in reach — ego can reach only other individuals with whom she has indirect ties but not others who are not tied to ego's ties. Thus, performative ties greatly extend the scope of a search and decrease its cost, compared to the alternative of indirect ties.

Performative ties may feature the search benefits of a market transaction, but a wide search is insufficient to assure transaction, because once a potential carrier is found, the terms have to be negotiated. The data indicate that transfer between employees of unequal status was quite common in The Firm. Thus, the mode of generalized exchange provides benefits that are comparable to embeddedness and community, absent from markets, and especially beneficial in a knowledge-intensive organizational setting, such as the one studied here. First, knowledge in The Firm was typically amassed through work experience and in-house tenure. As noted above, most promotions came from within The Firm and were based on tenure, so those who were knowledge-rich tended to be rich in other resources, such as power and prestige. It was difficult for an analyst to return a favor to a manager, simply because analysts, as junior employees in The Firm, commanded few valuable resources. Second, even if an employee had the resources to pay back a favor, the structure of project work made it difficult to enforce direct reciprocity, even through subordination or deference (cf. Blau 1964). If the benefactor and the beneficiary worked in a team together, they both knew that the team would be disbanded at the end of the project, and they could never work together again. Furthermore, transfers were observed to come from knowledgeable individuals who were not members of the same team. To be sustainable, a system of favors requires sufficient trust in future reciprocation, but in the fluid environment of project work, such favors had to be returned quickly, as one never knew whether he would meet the beneficiary again. Not only did project-based work made it difficult to create a favor system, but The Firm, as do many professional service firms (Lorsch and Tierney 2002; Maister 1993), has a high turnover rate among employees, which makes future interaction even less certain. Third, the data also show that nonroutine projects, such as work in a new industry, tended to be concentrated in main offices, so that employees in main offices accumulated knowledge that was not available in smaller offices. This led to repeated cases of employees in smaller offices calling others in main offices, asking for help. Such a pattern exacerbated the nonreciprocity risk in helping a resource-poor or transient team member. Not only were main office employees approached by others they were not likely to meet again, but also there was little that a beneficiary in a peripheral office could offer in return. Indeed, knowledge transactions often benefited individuals who were unlikely to be able to reciprocate, such as in transactions between senior and junior employees, between employees located in faraway locations, and between individuals who were unlikely to meet again or who even had never met.

## THE MODEL

We investigate the effect of choice of mode of exchange and partner on the efficacy of organizational problem solving. In addition, we investigate the robustness of a hybrid mode, combining performative ties with community relations, and examine the returns on firm-level investment in nurturing performative ties.

The model simulates agents that are embedded in local groups of direct ties, such as project teams, who work to solve a large overall problem. A problem is decomposed into assignable tasks for the agents. Each agent has a set of skills suitable for a set of tasks, which

may or may not be the tasks assigned to it. For each of those skills, the agent has an attained competence level. Tasks are completed through the application of these task-relevant skills by the agent. Knowledge (as skill development) is attained either through self-learning, acquisition through exchange with another agent, or both. Acquisition from other agents is driven by the nature of the network exchange environment within which the agent resides and the ties it can exploit. By simulating the various types and parameters of network exchange environments and ties, as in the table above, we explore their impact on the dynamics of knowledge growth, distribution, and decline within an organization.

## Agent Behavior

At the beginning of the simulation, each agent is randomly assigned tasks for solution. When an agent receives a task, it first checks to see whether it has any knowledge of the task. If so, it applies the knowledge. If the knowledge is insufficient to solve the task, the agent will endeavor to acquire the remaining knowledge through self-learning. However, if the agent possesses no knowledge about the task, it must acquire that knowledge through a process of search among the other agents present. The nature of that search process and the mechanisms of acquisition are largely determined by the pattern or patterns of exchange set by the simulation operator.

For the model, we represent the horizontal line of Table 2 (i.e., Mode of Exchange) in the following way:

1. *Spot exchange.* Agents will search to maximize the knowledge gained through the exchange. For knowledge acquisition to ensue, it is necessary that both agents agree and exchange knowledge under a strict requirement of simultaneity and direct reciprocity without incurring debt. As all exchanges are immediate (either agreed or declined), no social memory of agents or events is required.
2. *Social exchange.* Agents will engage in a knowledge exchange, but one agent can endure a debt of exchange to another agent if it is in good standing (i.e., without current debt to that agent). Therefore, agents must possess a social memory capable of distinguishing individual agents and their obligations. Again, direct reciprocity is expected, but social debt is permitted, and thus simultaneity in exchange is not required.
3. *Generalized exchange.* Agents will engage in a knowledge exchange, and, as in social exchange, one agent can endure a debt. However, the debt is one of indirect reciprocity, where the debt is obligated to a group and not to a specific individual. As such, there must be a mechanism to identify the extent to which an agent has or has not completed an obligation to the group.

The second axis of this typology (i.e., Interaction History) specifies the extent to which there is an existing social link, as a degree of familiarity, between the transaction partners. Both of these require social memory of specific agents.

1. *Extant social ties*. Extant social ties exist between transaction partners who have an existing (direct tie) relationship, are neighbors, or can be referred to each other by a common acquaintance (indirect tie).
2. *No social ties*. The agents in the transaction have no direct or indirect social ties, nor do they have a prior history of transactions.

### *Searching Existing Social Ties*

The following three contexts are based on existing social ties, which are defined as direct ties as members of the immediate group, or indirect ties as agents who have direct ties with the immediate group. In local search, agents search only their local ties for knowledge. Knowledge will be acquired by any given agent only if the two agents can agree on an exchange, that is, if one agent has task-knowledge that is immediately useful for the other agent's task. Agents will attempt to maximize the exchange, but it is restricted to the local/group "market-like" environment. In embeddedness, agents search only their local ties in an attempt to maximize the acquisition, but unlike pure local search, this context sets the agent within a relatively stable social group that tolerates debt. Thus, opportunities for exchange revealed by this local group search are expanded by the acceptance of obligation as determined by its individual members. Here agents do not seek the optimal, but sacrifice by engaging in the first acceptable exchange condition. In community, although agents are again restricted in their search to local group ties, the nature of the social environment now transcends direct reciprocity requirements for individual transactions and affords opportunities for asymmetric exchanges without direct debt to specific individuals. Rather, agents are in the debt of the group, and that obligation can be managed by using a variety of social mechanisms, such as R-scores, standing, image scores, and altruism.

### *Searching Unacquainted Others*

The remaining three contexts are based on agents who seek out others with whom they have no previous social ties when the examination of existing ties fails. As discussed earlier, the search is facilitated by KMS, which links task descriptions, solution descriptions, and contact information for all of the agents. In neo-classical markets, similar to the agents engaged in local search, these agents seek to maximize their exchange opportunities. However, these agents elect to search beyond the group and engage the KMS to spot potential opportunities on a firm-wide basis, and they attempt an exchange with the source who provides the most value. Similarly, an exchange requires simultaneous direct reciprocity without debt. An agent needs to have knowledge of value to the other agent. A performative tie is enabled by finding agents in the KMS who may have knowledge of potential value and have agreed to participate in this type of use of the KMS. As discussed earlier, direct reciprocity is not expected.

### **Agent, Group, Organizational, and Problem Structures**

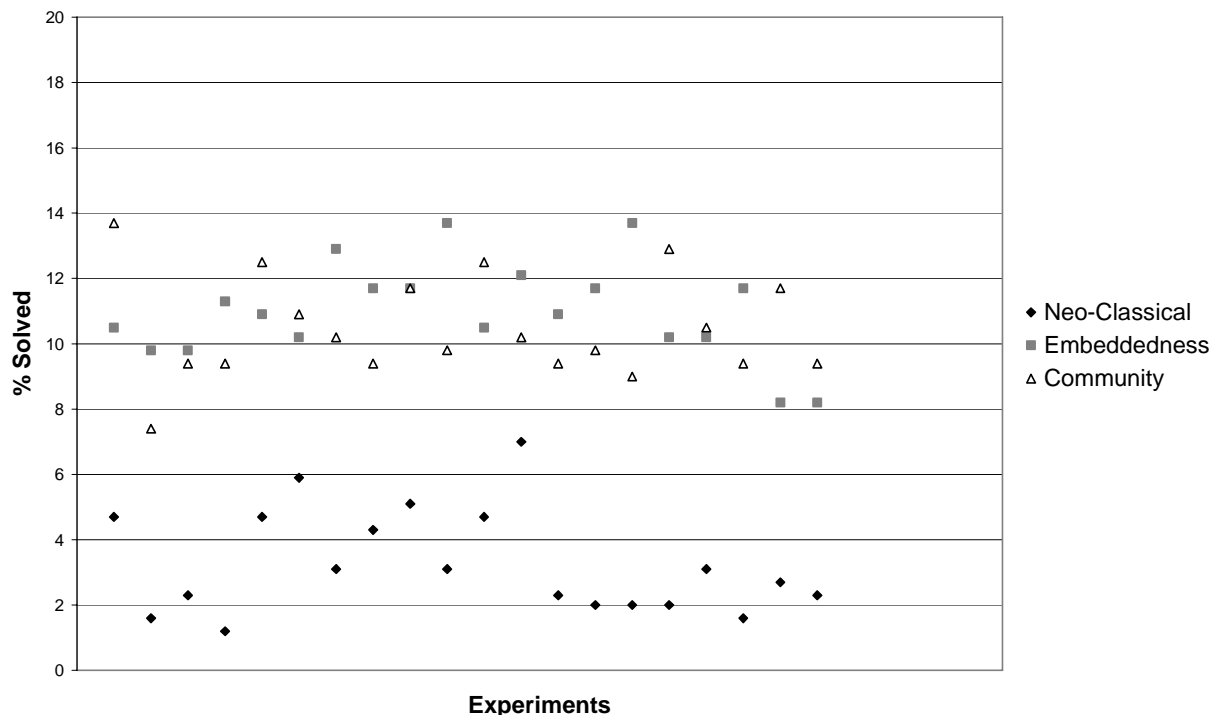
The agent structure includes the size (i.e., number of slots) in its knowledge memory, the decay rate of skill loss, learning rate parameters, and its strategy for skill replacement, where newly acquired skills must replace existing memory slots. The group structure is simple. One can

vary the size of the teams, number of teams, turnover rate, bias in the knowledge for replacement agents, and attrition rate for direct, indirect, and performative ties. The organizational structure is a simple hierarchy with dispersed teams. The organizational problem structure,  $P$ , is represented as a vector of integers. Each element,  $P_i$ , is an assignable task to an agent, and the value of the element indicates the task difficulty in terms of required competence level. The problem structure can be manipulated as follows: difficulty (increasing or decreasing the competence level for each task); complexity (where there is a strict precedence order for implementing [i.e., posting] a solution such that the solution to  $P_i$  must be completed and posted before  $P_{i+1}$  can be implemented); problem size (where the number of task elements in a problem can be changed); precision (which describes the precision required to achieve competency [i.e., slack in the competence level]); number of problems to be solved; and the redundancy each new problem has with the prior problems.

## RESULTS AND DISCUSSION

### Performance and Neo-classical Exchange, Embeddedness, and Community/Clan

We begin by comparing the efficacy of the modes of exchange against each other. To obtain variance, we let the agents handle difficult problems that contain a large number of subtasks (Figure 1 and Table 3).



**FIGURE 1** Effect of neo-classical exchange, embeddedness, and community/clan configurations on performance

**TABLE 3** Effect of neo-classical exchange, embeddedness, and community/clan modes on performance

Configuration	Performance		
	Average	Median	Standard Deviation
Neo-classical exchange	3.29***	2.90	1.61
Embeddedness	11.00	10.90	1.49
Community/clan	10.46	10.00	1.58

<sup>†</sup>  $p \leq 0.1$ , \*  $p \leq 0.05$ , \*\*  $p \leq 0.01$ , \*\*\*  $p \leq 0.001$ , in a two-tailed paired t-test,  $n = 20$ .

The first experiment shows that neo-classical exchange performs poorly in comparison to either embeddedness or community/clan configurations. The difference are statistically significant between the first and the latter two, but not between embeddedness and community/clan. This finding serves to validate the model, because it confirms predictions and empirical findings. For instance, embeddedness was found to provide fine-grained information transfer, joint problem-solving arrangements, economies of time, integrative agreements, and greater willingness to invest and take associated risks (Uzzi 1996), all of which are shown to result in financial benefits of embedded exchange vis-à-vis market-based exchange (Uzzi 1997). In the context of bank loans, embedded bank/firm ties provide special governance arrangements that facilitated the firm's access to bank-centered informational and capital resources, which uniquely enhanced the firm's ability to manage trade credit and resulted in better financial performance (Uzzi and Gillespie 2002).

Community/clan configuration differs from embeddedness in that it employs generalized exchange as the mode of exchange rather than social exchange. Research on communities as sources of support has expanded in the last decade, examining their role in providing economic, social, and emotional benefits, which are difficult to contract in a neo-classical economic market. For instance, informal community ties are essential for survival in the impoverished barrios of Santiago, Chile. They provide food and shelter and job leads and help in dealing with bureaucracies and even short-term loans (Espinoza 1999). In Hungary, members rely on their neighborhood community for large projects, such as erecting houses (Sik and Wellman 1999). Similarly, informal ethnic associations fulfill an important mediating function between new immigrants, their societies of origin, and their new homelands. Their expected support plays a role in the decision to immigrate, and recent immigrants help new immigrants find their way in a new country once they arrive, as exemplified in work on immigrants from Hong Kong to North America (Fong et al. 1995; Salaff et al. 1999). Community institutions provide revolving credit arrangements and allow immigrants to start their own businesses, even when their commercial credit worthiness is low (Portes 1995). For the unemployed, communities can provide referrals to jobs and material and emotional support (Uehara 1990).

Similarly, clan organizations have been hailed as distinctly different from traditional hierarchical organizations, with many benefits. In Theory Z, Ouchi (1980) proposed that



Japanese firms are based on a clan logic, which is different from bureaucracies (and certainly markets), and it called for American managers to follow in changing their organizations to be more clan-like. Clan organizations are supposed to provide superior performance through stable membership of life-time employment, high interpersonal contact that facilitated nonspecialized careers and collective decision making, and organizational myths and ceremonies (Ouchi 1980; Sullivan 1983; Wilkins and Ouchi 1983).

## Robustness of Performative Ties

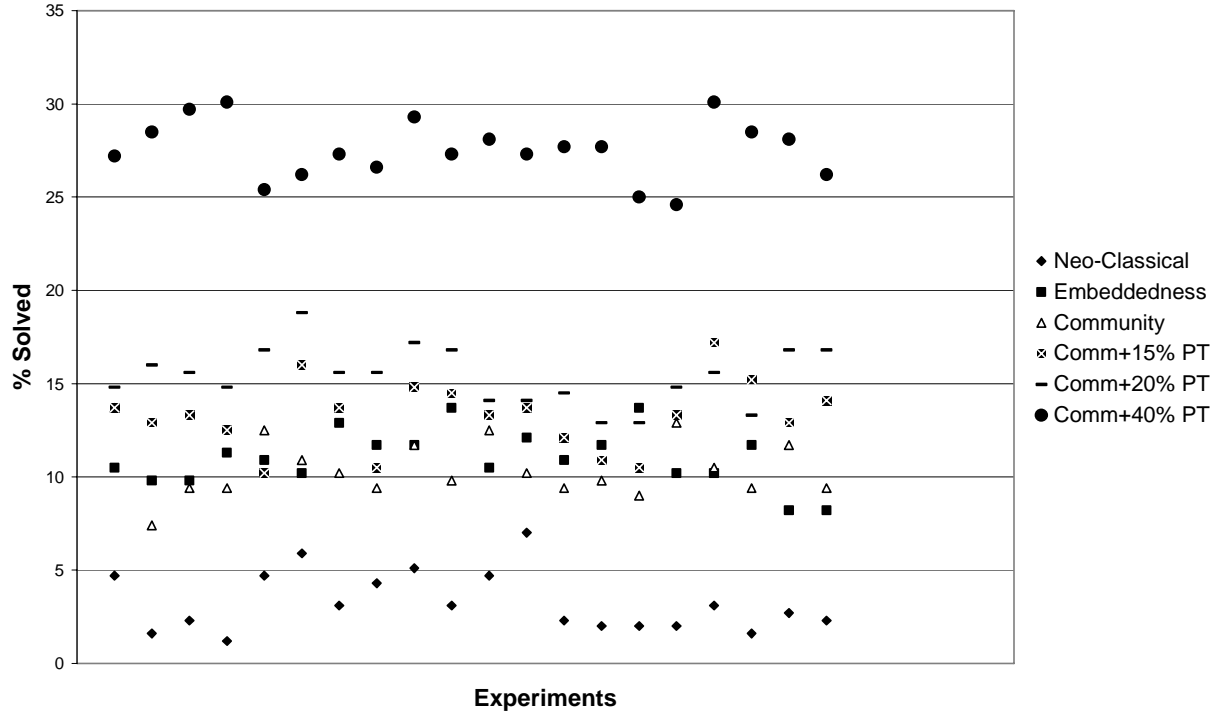
Levine (2004) argued that performative ties are superior to other modes of exchange, because such ties combine the wide-search of neo-classical exchange with the low transaction costs of community exchange. Performative ties also allow resource-poor agents to remain productive, because dyadic reciprocity is not required. Preliminary runs of the simulations have adhered to this logic; the performance of organizations composed of performative ties agent were vastly superior to any combination.

However, it may not be realistic to assume that an organization would be entirely composed of agents that are always willing to benefit strangers. In real-life organizations, employees may be absent, busy, uncooperative, or straight-out “free riders.” Hence, it is valuable to explore whether performative ties can still affect organizational performance. In this experiment, we allowed a blend of agents, the majority of which followed the community mode (i.e., within-group generalized exchange). A certain percentage of the agents were hybrid; when seeking a piece of knowledge, they began by a local search, following the logic of the community mode. However, when the knowledge was not available locally, the agents employed performative ties: they turned to the KMS, and searched for another *hybrid* agent that would be willing to exchange knowledge. It is important to note that hybrid agents could extend a performative tie only to other hybrid agents and not to the majority, which used community as the sole mode.

As evident in the results above (Figure 2 and Table 4), the hybrid configurations performed significantly better than the community configuration. In addition, an increase in the percentage of agents that were able to extend performative ties led to significantly increased performance. The results were unchanged when we included the 10% and 30% levels, as well as the levels above 50%. These results lead to a potentially important theoretical proposition: the benefits from performative ties are significant, even if the majority of the agent population adhere to another mode (in this case, community). Organizationally, the results suggests that organizations will begin to see benefits from performative ties even with low levels of individuals that are able to extend and willing to receive such ties.

## Marginal Returns from Performative Ties

While performative ties can boost organizational performance above other modes of exchange, the organizational setting that is necessary to enable them may be prohibitively expensive. In this experiment, we investigate the marginal returns, in terms of organizational performance, to additional levels of agents who practice performative ties in the organizational population, under different problem structures (Figure 3).

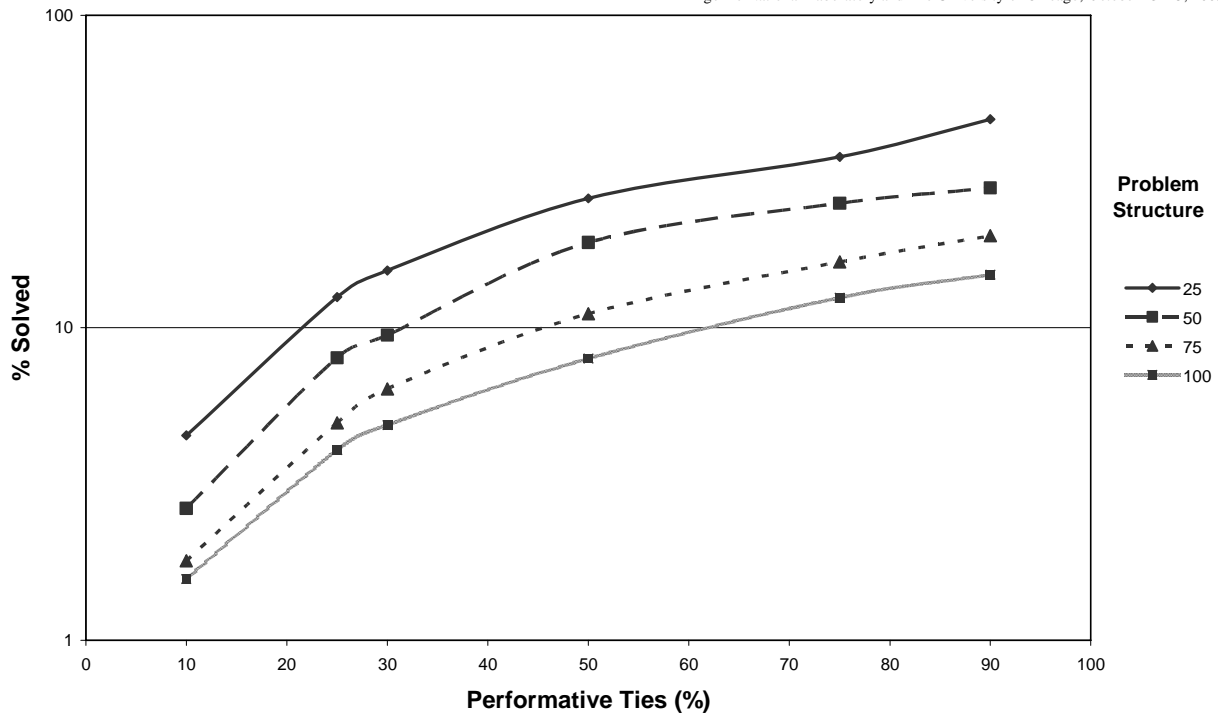


**FIGURE 2** Effect of community hybrid mode on performance

**TABLE 4** Effect of community hybrid mode on performance (prior tests included for comparison)

Configuration	Performance		
	Average	Median	Standard Deviation
Community + 15% hybrid	13.27**	13.30	1.84
Community + 20% hybrid	15.39***	15.60	1.54
Community + 40% hybrid	27.55***	27.50	1.59

<sup>†</sup>  $p \leq 0.1$ , \*  $p \leq 0.05$ , \*\*  $p \leq 0.01$ , \*\*\*  $p \leq 0.001$ , in a two-tailed paired t-test,  $n = 20$ .



**FIGURE 3** Effect of performative ties on performance under different problem structures

Performative ties are thought to be associated with a variety of organizational practices, some of which are fairly costly to implement. Most elementary, the creation and maintenance of a KMS is necessary for a wide search. A practice that may contribute to the appearance of performative ties is embeddedness of workers in multiple networks, so that the network appears dense (cf. Levine and Kurzban forthcoming). This can be achieved, for instance, by employing teams that are transient and composed of nonspecialized employees, so as to increase the perceived chances that each one of them could eventually be in the same team with any other member of the firm. Mentoring of junior employees by senior ones and cross-hierarchical teams may increase the chance of ties across levels, and multiple simultaneous team assignments immediately increase one's organizational social network.

Spatial arrangements can also increase interaction and the perception of a dense network: the rotation of employees allocated space and the generous provision of public spaces may be two ways to achieve that, but both require the expenditure of capital on extra moving and space.

Also associated with performative ties are cross-site occasions, where employees from multiple offices meet together for training or retreat, or they move to another office for a while. As Levine (2004) notes, flying even junior employees across the continent to attend a routine training session may allow them to meet more peers, but the associated cost can be borne only by wealthy firms.

Our results show that firms see the great return on their investment in such practices early on, because the marginal returns from performative ties tend to be higher at lower levels, with the steepest improvement occurring in the range of 10% to 30%. The marginal returns taper off

as the percentage of hybrid agents increases, although they always remain significantly higher than zero. Similar behavior was observed along problem structures of increasing difficulty.

## CONCLUSION

With the understanding that knowledge is crucial for organizational performance comes the desire to facilitate intraorganizational and interorganizational processes of knowledge exchange. We began by explicating the approaches to knowledge exchange and showing how they interact with agent characteristics. While the first study replicated prior empirical findings and theoretical propositions, the second study showed that performative ties provide superior returns, even when those who practice them are a tiny minority in the organization. We noted that this finding suggests that management will see benefits from performative ties even if only a small number adopt them.

The ability of performative ties to generate significantly higher organizational performance even at low levels may suggest that they contribute to the appearance of an organizational “small world” (Milgram 1967; Travers and Milgram 1969). Recent research on small-world networks has generated interest and interpretations of how global and local structural properties interact in dynamical systems. For example, it has been demonstrated that connecting disparate, clustered worlds by shifting a local edge in a cluster to link to a distant node has little impact on the clustering (a local property) but has a distinctly nonlinear effect on the characteristic path length (a global property) (Watts and Strogatz 1998). Because individuals are likely to communicate easily with their immediate neighbors, it is sufficient if just one of these neighbors is able to extend performative ties to enable the entire team (local cluster) to enjoy the benefit of performative ties.

Furthermore, it has interesting applications with regard to organizational diversity. It has long been argued that diversity (e.g., in gender and race) can increase organizational performance because it allows the organization to choose from a greater variety of approaches to a given problem. However, it has been recently questioned whether creating truly diverse teams is likely, or even possible (Reagans et al. 2004). At the same time, we know that individuals have social networks that are largely homogenous (i.e., composed of people that are similar to self) (McPherson et al. 2001). Our results lead us to think that creating diverse teams may not be entirely necessary. It is sufficient to have a small number of agents who can extend and receive performative ties. These may be individuals who belong to a distinct group, such as alumni of the same university. As noted earlier, their ability to extend performative ties will cascade to their neighbors. Thus, creating teams that are homogenous but include at least one agent with performative ties capability may be a sufficient substitute for the Holy Grail of full diversity in teams.

While knowledge transfer has been hailed as a means for improved organizational performance, the question of the cost of the transfer has rarely been addressed (Haas and Hansen forthcoming). This is not a moot question by any means; as is the case with any other organizational resource, the benefit from knowledge transfer should exceed the cost of facilitating the process. Our last experiment, which examines the marginal returns to performative ties, suggests that these returns are higher when performative ties are scarcer. If one bears in mind the cost of facilitating performative ties, and adds to that the fact that they immediately show a greater jump in performance early on, management may choose to keep

performative ties at levels that are lower than maximum, thus economizing on costs without sacrificing a great deal of organizational performance. Future research is likely to dwell longer on the question of benefits and costs associated with knowledge.

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