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Network Exchange Theory: Recent Developments and New Directions*

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The new millennium opens the third decade of work on network exchange theory. During two decades of continuous growth, the program has been tested as intensively and extensively as any in sociology. This article summarizes existing research and describes new directions. First, we describe basic network connections and recently discovered structural power conditions that sharply affect exchange ratios. Then we show how game theory enhances understanding of collective action in exchange networks. Two new research programs link network exchange theory to status characteristics theory: the first demonstrates that power produces status, and the second shows how status value produces power. Finally, we discuss how questions about network dynamics, complexity, and legitimation define paths for future theory growth.

In this article we examine recent developments and new directions in network exchange theory (Markovsky, Willer, and Patton 1988; D. Willer 2000). Network exchange theory (NET) is an outgrowth of the elementary theory of social structures (Willer and Anderson 1981).[1] Elementary theory (ET) describes the mechanics of exchange, conflict, and coercive relations, and hybrid combinations of the three (D. Willer 1987; Willer and Anderson 1981). Over time, the program has concentrated increasingly on power in exchange networks.

ET's focus on exchange and power motivated the development of NET. Markovsky et al. (1988) introduced the graph-theoretic power index (GPI) and used it to identify strong and equal power structures. Subsequent formulations differentiated both of these from weak power structures (Markovsky et al. 1993).[2] The ET and NET programs have grown by developing a system-

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[1] Markovsky et al. (1988) called their formulation "network exchange theory." Contemporary researchers apply the label to several exchange-theoretic formulations (Yamagishi and Cook 1990), including some that predate NET (e.g., Coleman 1973; Emerson 1972a, 1972b). In this article we concentrate on work anchored in Willer and Anderson (1981) and Markovsky et al. (1988).

[2] Noah Friedkin (personal communication) showed that GPI does not make stable predictions for some networks. Lovaglia et al. (1995, 2000) and Simpson and Willer (2000) introduced alternative formulations that address Friedkin's critique.

atic classification of network connections, exploring relationships between network connections and structural power conditions, and identifying new combinations of network connections and power conditions.

In this article we describe the program's development. We begin with recent developments in NET's analysis of structural power conditions and network connections.

STRUCTURAL CONDITIONS, NETWORK CONNECTIONS, AND POWER

NET identifies and analyzes *structural conditions of power*: configurations of positions, resources, and network connections that determine the distribution of power in exchange networks. High-power positions gain more favorable exchange ratios, a primary measure of power exercise. David Willer (1999; Willer and Skvoretz 2000) uses patterns of *N, M,* and *Q* to develop a typology of network connections. For any node *i*, N_i is the number of connected exchange relations; M_i is the maximum number of relations from which the node can benefit; and Q_i is the minimum number of exchanges that must be completed if the node is to gain benefits. NET identifies five connection types (three "primary" and two compound).[3] We describe the distribution of power for each connection type and two "variant" structural power conditions using everyday examples for illustrations.

Exclusive Connection

Most exchange research focuses on exclusively connected networks.[4] The network A-B-C is exclusively connected at B if B can exchange with either A or C but not with both ($N > M \geq Q = 1$). Imagine that A and C are two universities that offer B a faculty position. A and C have no alternative candidates and will bid for B's services. B's eventual exchange partner (A or C) will benefit only minimally (one is excluded) because B gains the maximum salary from their competition. The exclusively connected A-B-C network is a *strong power structure* (Simpson and Willer 2000).

Changing the numbers of positions and relations in exclusively connected networks creates new power conditions. An A-B-C-D network, exclusively connected at B and C, is a *weak power structure.* Assume that B and D compete for a position at University C but that B also has received an offer from University A. B has an advantage in its negotiations with A but substantially less than B in the strong-power A-B-C network. Laboratory studies show that B and C gain only about 60 percent of resources in A-B-C-D, not the maximal amount, as does B in A-B-C (Lovaglia et al. 1995; Skvoretz and Willer 1993; Thye 2000b).

The A-B-C-D network can be converted easily to an *equal power structure.* Imagine that University A also makes an offer to D. Now the four positions are connected in a circle; all connections are exclusive, but all positions have equal power.

Network structures created in laboratories are short-lived, but exclusively connected networks are common in natural settings. As an example, subordinates cannot discharge managers in modern work organizations but managers can discharge subordinates. Potential employees are exclusively connected at the manager if employees can be replaced cheaply and easily. An oversupply of labor creates strong power structures that provide substantial advantage to employers.

Inclusive Connection

A network is inclusively connected when network positions must complete two or more exchanges to achieve benefits. The network A-B-C is inclusively connected at B if B must complete exchanges with both A and C to gain any benefit ($N = M = Q > 1$). Consider a network in which supplier A has all the ingredients for Toll House cookies, except chocolate chips. Supplier C has a monopoly on chocolate chips. B must exchange with both suppliers if he wishes to make Toll House cookies.

[3] A sixth type, singular connection, consists of a single exchange relation ($N = M = Q = 1$). For a full discussion of the typology, see D. Willer (1999; Willer and Skvoretz 2000).

[4] Cook, Molm, and Yamagishi (1993:313) discuss the correspondence between exclusive and inclusive connection and Emerson's (1972a, 1972b) typology of negative and positive connection.

The earliest formulation of ET offered the crucial insight that actors complete agreements at the point of *equal resistance.* We use NET's resistance equations (see Eq. (1)) to show that inclusive connection produces power differences which *disadvantage* the inclusively connected position (Willer and Skvoretz 2000). Let P represent an actor's payoff, Pmax its best payoff, and Pcon its payoff at disagreement (confrontation). Because B cannot benefit from a first exchange with A until it completes the second exchange with C, PBcon = PBa.[5]

$$R_B^I = \frac{P_B\text{max} - P_B}{P_B - (-P_{Ba})} = \frac{P_C\text{max} - P_C}{P_C - 0} = R_C \quad (1)$$

Consider an A-B-C structure created in the laboratory in which subjects divide 24 resource points in each relation. Resource points available to B from the A-B relationship have value only after B combines them with resources from the A-C relationship. The first division (A-B) is equipower at 12:12, but inclusive connection affects the second. For the A-C exchange, B's outcome at disagreement includes loss of the potential value of resources gained in the A-B trade, $-P_B = P_B\text{con} = -12$. When Eq. (1) is used, $P_B = 9.4$ and $P_C = 14.6$; the more central B is disadvantaged.

Null Connection

An A-B-C network is null connected at B if B can exchange with and benefit from either or both partners ($N = M > Q = 1$). Again, assume that A and C are faculty candidates but that University B has two positions and only A and C are qualified to fill them. The A-B and B-C relations are independent dyads in which there are no power differences (D. Willer 2000:55). Null connections are important for two reasons. First, like inclusive connection, centrality does not produce power advantage in null connected networks (Markovsky et al. 1988). Second, combining null connections with other network types has important consequences for the distribution of power.

[5] Our designation of the A-B exchange as the "first exchange" is arbitrary. NET predicts B's disadvantage no matter which exchange occurs "first."

Inclusive-Exclusive Connection

Natural settings that involve Toll House cookie bakers differ from laboratory networks. Normally, several stores sell chocolate chips. Under such circumstances, B is embedded in an *inclusive-exclusive* network. B must trade with one A from a set of As *and* one C from a set of Cs ($N > M \gg Q > 1$). NET predicts, and previous research shows, that B is not disadvantaged in inclusively-exclusively connected networks because exclusive connection eliminates the effect of inclusive connection (Szmatka and Willer 1995).

Inclusive-Null Connection

Our hypothetical cookie maker can convert its network to an *inclusive-null* connected network ($N = M > Q > 1$). To do so it locates new suppliers for chocolate chips and the other ingredients, and contracts with two or more for each specialized commodity. B can buy every ingredient from multiple suppliers—the hallmark of null connection. The network retains its inclusive character because no ingredient possesses value for B unless it is combined with every other ingredient. Yet suppliers are no longer advantaged because no single supplier can thwart B's cookie baking (Willer and Skvoretz 2000).

Subordinates' work is often so interdependent in organizations that the subordinates produce value only after all tasks are completed. In such cases, the boss is inclusively connected across the subordinates, a condition for power decentralization. As we have shown, employer-employee networks are exclusively connected when bosses can discharge subordinates. Combining high task interdependence with replaceability creates an inclusive-exclusive network, and power is centralized in management. Yet it is not always possible to discharge subordinates (e.g., in tight labor markets or in government bureaucracies). When subordinates' jobs are assured, power will decentralize unless another power condition is present, such as the structural variant, hierarchy/mobility.

Structural Variants

For future research, our claim that only five connection types are analytically neces-

sary does not inhibit discovery. There are other power conditions that do not depend on relations between N, M, and Q. These conditions are called *variants* because each (1) is similar to a connection type and (2) interacts with other connection types like the type it emulates. Although connection types are limited, we see no reason why the number of variants is limited. Therefore the search for new structural power conditions remains open.

NET researchers have identified two variants. The first, *hierarchy/mobility,* occurs in modern organizations with promotion systems and vertical mobility. It produces strong power effects (Bell, Walker, and Willer 2000). NET researchers describe hierarchy/mobility as a variant of exclusive connection because the two forms are similar. Role occupants in hierarchy/mobility systems are concerned about *exclusion from mobility* rather than exclusion from exchange. The effects of hierarchy/mobility are as strong as the strongest effects of exclusive connection (D. Willer 1987). Researchers must determine whether the combination of inclusive connection with hierarchy/mobility behaves like inclusive-exclusive connection and eliminates the effect of inclusive connections.

Ordered exchange is the second variant and the seventh power condition studied by NET. Ordered exchanges occur when an actor must complete two or more exchanges in serial order. Gatekeeping, in which B must gain A's consent to contact C, is an example of ordered exchange. As a gatekeeper, A exercises power over B and obtains benefits from B through its control of B's access to C.

Ordered exchange is a variant of inclusive connection. The two forms are similar, but ordered exchanges, unlike inclusive connection, produce power differences in earlier, not later exchanges. Furthermore, recent research shows that the effects of ordering, like those of inclusive connection, are eliminated when combined with exclusive and null connection. Alternative gatekeepers, whether exclusively connected or not, cannot gain fees for granting access (Corra 2000).

COALITIONS AND COOPERATION IN EXCHANGE NETWORKS

Network exchange theory explains how structure and network connections combine to create power inequalities. Its analysis also shows how actors and external factors can transform structures to reduce or nullify inequality (e.g., by finding alternative partners). Early exchange theories emphasized coalition formation as a strategy for countervailing power inequalities (e.g., Emerson 1972b; Thibaut and Kelley 1959). Coalitions countervail power by controlling the effects of exclusion. Despite its importance to the study of power, however, few contemporary exchange studies address coalition formation (Cook and Gillmore 1984; D. Willer 2000). Still fewer treat the collective action inherent in coalition formation as a social dilemma, even though social dilemmas are central to theories of collective action (see Heckathorn 1996).

We compare two recent applications of NET to the study of cooperation and coalitions in exchange networks (Simpson and Macy forthcoming; Willer and Skvoretz 1997). We suggest that they provide grounding for future research. Each considers how network structure, actors' strategies, and the *institutional rules* that govern exchange combine to create conditions more or less favorable to collective action. Because these applications activate different institutional rules, they generate distinct predictions concerning the likelihood that actors initiate collective action in a given network. We apply game-theoretic reasoning to the two systems and draw a paradoxical conclusion: when coalitions are possible, cooperation will be higher in the more competitive network situation. Our analysis suggests that studies of the institutional rules governing exchange will play a prominent role in the long-term development of NET.

Bringing Rules In

Consider two networks in which three actors, B_1, B_2, and B_3, are connected to a central actor A. Any number of institutional rules might govern interactions, but we limit our concerns to two types. First, we limit A in both networks to two exchanges involving 24

profit points each in a given round. The networks are exclusively connected (i.e., $N = 3 > M = 2 > Q = 1$; one actor must be excluded). The next type of rule governs the number of offers that potential partners can send to A. Let the first network (Br321-A) use a "single-offer" rule: no B can revoke an offer that it sends to A. In the second network (Br321-B), a "multi-offer" rule serves as an alternative: Bs can change their offers as often as they wish until A completes two exchanges.[6]

At equilibrium, NET predicts no differences in exchange ratios for the two networks if Bs must act independently. Game theory, however, predicts that the rules governing offers generate distinct social dilemmas when coalitions are allowed.[7] The two settings produce different social dilemmas because the multi-offer rule permits within-round "bidding wars." Bidding wars occur when low-power actors make increasingly favorable offers to high-power actors to avoid exclusion.[8] Previous research shows that bidding wars can be blocked through coalitions that achieve a "critical mass," which Willer and Skvoretz (1997) define structurally as $N - M + 1$ (see typology above.) For Br321 networks, the critical mass is 2 (3 – 2 + 1). Below we show that a critical mass (hereafter C_M) prevents bidding wars by transforming the Br321 networks from exclusive to null connected.

Permitting coalitions in Br321 networks defines four distinct possibilities: (1) all three Bs agree to form a coalition, (2) two Bs form a coalition and one "defects," (3) two Bs defect, and (4) all three defect. Consider condition 1, in which the coalition offers A the equipower rate (12:12). In both Br321 networks, A makes two equipower exchanges (12:12) with C_M whose members share earnings equally (C_M = 12 x 2/3 = 8).

Under condition 2, one B defects and offers 13:11 (by definition; see note 7). A accepts the defector's offer and completes a second exchange with CM. The expected payoffs advantage the defector in both networks (CM = 12/2 = 6 < defector = 11).

Predictions for Br321-A and for Br321-B diverge when C_M is not realized. Under condition 3, the defectors offer 13:11 and the "cooperator" offers 12:12. In Br321-A, the cooperator cannot submit a new offer to match the defectors' offers, and A completes successive exchanges with the defectors. The cooperator is excluded, and payoffs advantage defectors (cooperator = 0 < defectors = 11). In Br321-B, however, the defectors' initial offers lead the cooperator to offer 13:11, triggering a bidding war in which all actors bid down to 18:6 to avoid exclusion.[9] Because each has a two-thirds chance of acceptance for its bidding-war offer, the expected payoff to each is 4 (6 x 2/3).

All three actors defect under condition 4. In Br321-A, each defector offers 13:11 but one must be excluded. The expected defectors' payoff is 7.33 (11 x 2/3). The Br321-B network offers a sharp contrast: defectors' initial offers trigger bidding-war offers, and the expected payoff is 4 as in condition 3 (6 x 2/3).

Although structural conditions are identical, differences in institutional rules produce distinct social dilemmas. First, consider the Br321-A network. When two actors cooperate, the third actor's best response is defection (C_M = 8 < defector = 11). Further, if either one or two actors defect, the third actor's best response is also defection. In Br321-A, defection *dominates* cooperation.

Now consider the Br321-B network. As in Br321-A, if two Bs cooperate, the third B's best response is defection. In contrast to the Br321-A network, however, if one B defects and another cooperates, the third B's best response is *cooperation.* By cooperating, the actors help achieve critical mass. Although the payoffs to members of a critical mass (6) are lower than the defector's payoffs (11),

[6] These exchange rules correspond to experimental protocols used by NET researchers at the University of Iowa and the University of South Carolina respectively.

[7] We define a *coalition* as two or more actors who agree on a common offer to their target(s), and who share all earnings from exchanges with other group members. *Defectors* beat the cooperative offer by one point but do not share earnings from exchanges.

[8] In the single-offer setting, bidding occurs *across* rounds, as excluded actors make more favorable offers in subsequent rounds (see Willer and Skvoretz 1997).

[9] See Simpson and Macy (forthcoming) for the theoretical rationale and empirical support for the 18:6 ratio assumed here.

they are preferable to bidding wars (after which all can expect 4). There is no dominant strategy for the game implied by Br321-B; the best response for any actor depends on others' choices.

It follows from the analysis above that cooperation should be higher in the multi-offer system (Br321-B). The equilibrium solution for the game it implies is a two-person coalition (critical mass). In contrast, the equilibrium solution for the game implied by Br321-A is universal defection.[10] The implication seems paradoxical because cooperation is predicted to be greater when bidding wars are allowed. We offer a hypothesis for future tests: *Collective action will be more successful in institutional settings that allow bidding wars than in those which do not.*

We have shown here that two institutional rules applied to the same structure generate different social dilemmas. When actors negotiate independently, NET makes identical predictions for the two exchange settings. We suggest that, as the scope of NET expands, rules which govern exchange (institutional rules) will play an increasingly important role, as do network structure and strategy, in its analysis of power processes.

NETWORKS, POWER AND STATUS

Network exchange theory's insights and theoretic procedures for analyzing structural power facilitate exploration of related processes. In this section and the next, we explore connections between power and status.

Power and status are fundamental social relations (Kemper and Collins 1990). Furthermore, they are not independent: Weber (1968) identified power and status as two of three bases of stratification, and described connections between them. Among microsociologists, Homans (1974) considered power the ultimate source of social status: a person who wields power consistently over time gains prestige, honor, and influence. To date, social scientists have had only limited success at describing the mechanisms through which power creates status. A new branch of NET research combines ideas from NET and status characteristics theory to show how powerful actors gain status and combine status-based influence with their capacity to reward or punish.

USING POWER TO GAIN STATUS

Status characteristics theory (SCT) argues that performance expectations connect valued status characteristics to hierarchical, status-based structures of power and prestige (Berger, Cohen, and Zelditch 1972; Berger et al. 1977; Berger, Rosenholtz, and Zelditch 1980). Reward expectations theory, a branch of SCT, describes one avenue from power to status (Berger et al. 1985; Moore 1985). Power enhances actors' capacities to attain rewards: they can accumulate and use some of these (e.g., money), as resources to pursue their goals (Ridgeway 1991). Rewards also possess status value, and those who earn them reap status benefits (Stewart and Moore 1992). It follows that powerful actors who amass substantial resources will attain high status and status-based influence.

Lovaglia (1995) studied the idea experimentally. He used a network exchange setting to establish competition between laboratory subjects and a powerful partner. In the study's second phase, the partner—now powerless—suggested correct answers for problems facing the two. Lovaglia presumed that actors who amassed rewards in the network exchange setting would be influential in the second setting *if rewards possessed status value.*

Lovaglia (1995) reported mixed results: participants held higher expectations of competence for powerful partners, but the partners did not enjoy an influence advantage. He observed, however, that exchange with a powerful partner induced strong negative emotions in participants. He surmised that negative emotion may have blocked influence based in the status value of the partner's high rewards.[11]

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[10] The Br321-A game is analogous to an N-person prisoner's dilemma (PD); and the Br321-B game is similar to an N-person "chicken" game. Strategies, such as tit-for-tat, known to increase cooperation in iterated two-person PDs are less viable in N-person games because punishing defectors (via defection) also punishes cooperators (Dawes 1988). Therefore, iteration of the Br321-A game does not necessarily increase cooperation.

[11] SCT claims that *relative expectations* create influence effects. Lovaglia's observation of higher

Subsequently Lovaglia and Houser (1996) demonstrated that negative emotion can block a high-status partner's influence. In a gift exchange setting, participants either exchanged gifts with a partner or were confronted by a partner who refused to reciprocate a gift. Participants whose partners exchanged gifts reported positive emotional reactions to their partner; those whose partners refused to reciprocate reported negative emotional reactions. Next, participants and partners worked together to solve a series of problems. Participants who felt negative emotion after their partners failed to reciprocate were more resistant to influence. In addition, Lovaglia and Houser (1996) reported that the conditions which create different emotional reactions combine with other status characteristics as SCT predicts (Berger et al. 1992). Thus, negative emotion on the part of low-power actors seems to block status-based influence in exchange situations.

Willer, Lovaglia, and Markovsky (1997; also see Lovaglia 1997) conducted an experiment to show that power differences in exchange settings produce negative emotions in low-power actors. The investigators created a network with extreme power differences. Participants in low-power positions reported significant negative reactions and emotions like those reported by Lovaglia and Houser (1996); whereas high-power participants reported positive emotional reactions to their low-power partners. Because sources of positive and negative emotions combine with status characteristics, the three studies (Lovaglia 1995; Lovaglia and Houser 1996; Willer et al. 1997) imply that power differences can produce status differences and greater differences in influence when the exercise of power does not produce negative emotional reactions.

The research we describe here leaves a key question unanswered: If negative emotional reactions to the use of power frequently block status-based influence, why are powerful people so influential? The research of Samuel and Zelditch (1989) suggests that one key may lie in the hidden nature of much power use and in the limited amount of information that targets of power have about power structures.

Actors who hold low-power positions in exchange networks are often not connected directly to the most powerful actors. Because of their network positions, they may be unaware of how superordinate actors use power to acquire resources from others. Resource accumulation, however, may be visible to every member of the network. Powerful actors then may exercise status-based influence over those actors who have not had power used against them.[12]

Continuing theoretical work and research in progress promise to deepen our understanding of the issue. As an example, Robert Willer (1999) has begun to investigate whether persons who use power in an exchange network will gain status-based influence over bystanders who observe their power use. His work promises to further clarify issues raised by Samuel and Zelditch's analysis. In the next section we address the other side of the equation as we focus on the transformation of status differences into power differences.

USING STATUS TO GAIN POWER

Another emerging stream of NET research investigates the effects of culturally determined status characteristics (such as race and gender) on the exercise of power in exchange networks. Like the work described above, this research builds on theoretical developments in NET and SCT. The work has culminated in two theories that connect status processes to power: a theory of status value and a theory of status influence. Willer

performance expectations for high-reward actors than for low-reward actors implies high influence.

[12] Power relations in complex networks occasionally become transparent. Donald Trump amassed a great fortune through real estate transactions, but his positions in various exchange networks remain hidden from the general public. In turn, Trump's status permits him access to and influence over persons who have no direct experience of his exercise of power. Recently, when an elderly Atlantic City resident rejected Trump's offer to buy her home to make way for a new casino, Trump used economic and political power to have her home condemned. Television news crews recorded the woman's strong negative emotional reactions to Trump's use of power.

et al. (1997) hinted at both but did not distinguish them clearly.

The research we describe here establishes direct connections between SCT and NET through the values and beliefs of actors in exchange relations. The theory of status value describes processes through which status affects power via the value of actors' possessions. The theory of status influence connects variations in status to changes in actors' beliefs and expectations—changes that generate influence and power effects. Below we summarize formal statements and tests of these ideas.

The Status-Value Theory of Power

Thye's (1999, 2000b) status-value theory of power links the status value of actors' characteristics, and the things they possess, to power processes. The theory defines *status value* as feelings of worth, honor, or esteem based on the possession of a characteristic (e.g., race or sexual orientation) or an object (e.g., trophies or diplomas) (Berger et al. 1972; Thye 1997, 2000a; Veblen 1899). The theory claims that the status value of characteristics affects the status value of relevant exchangeable goods, independent of any monetary or use value they might possess. Subsequently the status value of goods affects their distribution in exchange. Actors who possess positive status characteristics have advantages in exchanges with lower status partners. The theory consists of three related propositions. (For a full statement, see Thye 2000b.)

The first assumption describes the spread of status value from characteristics to objects (Berger et al. 1972). It claims that *given relevance between states of valued characteristics and resources, actors assign higher status value to resources held by high-status actors than to those held by status inferiors.*[13]

The second assumption connects the possession of valued goods to power. It claims that the status value of goods will confer power beyond that generated by their monetary or use value.

According to the third assumption, the incremental effects of status-based power ensure that *powerful actors earn favorable profits from exchange.* Following existing NET conventions, status-value research uses variation in exchange ratios from equal power divisions as the primary indicator of status-value effects.

Thye (2000b) tested these ideas experimentally. Subjects in separate rooms bargained via networked personal computers. They were assigned randomly to distinct network positions and were given nominally different goods of equal monetary value. Next, experimenters told subjects that their potential exchange partners were of higher, equal, or lower status. After this status manipulation, subjects negotiated exchanges for 60 rounds, with a maximum of one deal per round.

The results provide clear and consistent support for the theory. First, concerning the spread of status value, responses to a series of Likert-scale items show that subjects perceive the goods possessed by higher-status partners to be more valuable, more important, and more worthy of acquisition than those held by lower-status partners. These data support the assumption that status value can spread from individuals to their possessions, and imply status-contingent shifts in the P values in NET's resistance equations (Thye 1999). Moreover, exchange ratios show that higher-status subjects exercised power over lower-status subjects in the negotiations. For example, when a total of 30 poker chips could be exchanged between positions, the higher-status member of a dyad earned 19.05 units on average, while the lower-status member earned only 10.95 (Thye 2000b). A second experiment showed that status-value effects could reduce, by more than 50 percent, the exercise of "weak power" in the four-line network (A-B-C-D).

In contrast to the status-value theory described above, analysis of the connection between status influence and exchange remains in its infancy. The fundamental assertion of status-influence theory is that high-status actors change the beliefs of low-status actors more strongly than low-status actors change the beliefs of high-status actors. Readers familiar with SCT will recall that

[13] An element e_i is relevant to an element e_j if and only if an actor who possesses e_i is expected to possess e_j (Freese and Cohen 1973:182).

this claim has been tested and supported in a wide array of collectively oriented groups (Ridgeway and Walker 1995). Yet influence is not restricted to task groups; exchange networks provide a well-understood venue in which to investigate influence processes. For example, assume that each actor in a four-line network like that described above can exchange only with connected partners, and that none has knowledge of more distal connections. Let B assert to A that the network structure is A-B-C, when in fact C is connected to D. If A believes B, A sees the network not as a weak-power four-line but as a strong power three-line. B's power over A is much greater in the three-line network. Under these conditions, status influence theory asserts that actors will more often believe communications from high-status Bs than from Bs of lower status. One measure of belief is the effect on exchange ratios: high-status Bs should profit much more than low-status Bs.

To summarize, network exchange theorists have made substantial progress over the last five years in connecting status to power. Even so, much work remains. Researchers should consider three important issues. First, theorists must connect NET's formal modeling procedures to those of SCT (see Thye 1999). Second, new models must systematically incorporate key concepts from SCT (e.g., "performance expectation") with those of NET. Finally, any new formulations must be tested in networks that are more varied and more diverse than networks studied previously. For example, neither status-value nor status-influence theory predicts how status characteristics affect exchange in strong power structures. With these issues to be resolved, efforts to integrate power with status will occupy the cutting edge of NET as the program develops in the new millennium.

COMPLEXITIES AND OPPORTUNITIES

For at least some NET researchers, dual motives have triggered key developments: they want to understand both dynamic processes and more complex networks. Current work stands at the threshold of substantial progress in both areas. These goals arise from a fundamental interest in applying network theories to natural settings. Invariably such networks are more dynamic and more complex than either the early theoretical models or networks created in research laboratories. Here we illustrate how theories of complexity may inform new directions for NET.

Network Dynamics

A dynamic approach to social networks must address network *processes*. We conceive network processes as a "series of events involving relationships that generate (specific) network structures" (Doreian and Stokman 1997:3). Usually NET applies to a set of network positions in which ties represent fixed exchange opportunities. There are a few exceptions, however. First, the GPI approach introduced by Markovsky et al. (1988) anticipated the attrition of certain unused ties. Second, Leik (1992) and Willer and Willer (1999) studied the conditions under which actors choose to open or close network ties, given opportunities to do so. Both approaches entail primitive dynamics involving change from an initial structure to a resultant structure.

Profit structures manifest dynamic patterns much like relational structures. Brennan (1981), for instance, applied a regression model to the time paths of profit differentiation across network positions. Marsden (1983) devised a highly sophisticated model of resource flows. This model has not been tested empirically, however, and its scope apparently does not intersect with that of NET. Since the time of Brennan's and Marsden's work, most research has concentrated on the stabilized, long-run pattern of exchange outcomes; virtually no significant developments pertain to profit dynamics.

The success of NET and other exchange-theoretic research may account in part for the lack of dynamic analyses. Researchers have achieved a thorough understanding of the networks that have been investigated. Most of these networks exhibit straightforward profit differentiations across time as they march toward their predicted equilibria. There are no anomalies suggesting the need for dynamic approaches. Computer simula-

tions built on very simple assumptions produce similar dynamics and nearly identical outcomes (Markovsky 1992, 1995). NET researchers generally acknowledge the importance of dynamics, but have not been forced to confront dynamic problematics. If intriguing questions about static and equilibrium phenomena have driven theoretical progress thus far, then what questions may demand more dynamic answers?

Network Complexity

NET researchers often allude to the goal of applying their theories to "more complex networks": more actors, more kinds of ties, and fewer scope restrictions on decision strategies, exchange rules, and structures. Today, researchers in other scientific disciplines associate "complexity" with a certain clearly defined set of empirical problems and theoretical solutions. In general complex systems have relatively large numbers of mutually influential objects or agents, and emergent (often surprising) higher-level patterns and structures arise from seemingly chaotic substrates. Thus *complexity* refers to conditions and processes that pose challenges which existing theories cannot meet: that is, many elements interacting over time with feedback from changing environments. In addition, complexity research describes a fairly clearly circumscribed class of phenomena that emerge when conditions and processes are complicated in certain ways. Many of these phenomena finally are becoming more comprehensible as the result of an integrative theoretical approach.[14]

A framework for dynamic extensions of NET can be found among concepts and theories of complexity if exchange networks and other complex systems can be shown to share certain properties. One such property is *self-organization*—the emergence of spontaneous macro order from seemingly random micro activity. Self-organization appears in surprisingly diverse phenomena including self-synchronizing chemical reactions, current formation in fluids, role differentiation in insect colonies, automobile traffic patterns, the growth of cities, and the evolution of celestial bodies (Prigogine and Stengers 1984).

The consistently observed macro orders of power differentials described by NET research qualify as emergent, self-organized phenomena. Subjects do not construct these patterns purposively; they arise from a combination of network structures and connections, exchange rules, and individual acts. To date, NET has investigated only the simplest combinations.

Adaptation is another property that typifies complex systems. System behaviors and properties react dynamically to external and internal perturbations or threats; NET experiments control such contingencies experimentally. Thus another research direction may involve the relaxation of such controls and the introduction of environmental variability. This could entail manipulation of resources available in different sectors of the exchange network, or perhaps the introduction of competition for exchanges from exogenous sources.

Feedback is another critical component of complex systems. As long as system components are coupled neither too loosely nor too tightly, their mutual responsiveness may have unintended, self-sustaining outcomes that reverberate throughout the system (e.g., nuclear fission or runaway economic inflation). In exchange networks, the most theoretically interesting phenomena might be found in networks of moderate density (i.e., moderate "coupling").

Complexity theory implies that NET researchers should begin to focus on network processes of self-organization, adaptation, and feedback. In addition, this theory suggests directions for solving otherwise intractable problems. It is probably safe to presume that networks only a little larger than those studied in the published literature will pose severe problems for current theoretical models, if only because of the explosion of possible structural forms that occurs with only small increments in the number of actors (Skvoretz 1996).

Already the old analytic models are working less well than in earlier work. For

[14] See Waldrop (1992) for examples in a broad range of disciplines; Eve, Horsfall, and Lee (1994) for sociological applications; and Read and Miller (1998) for a social psychological focus.

example, Lucas et al. (1998) investigated linear networks from two to seven positions in length. Prior research suggested that large profit differentiations would emerge across connected positions in odd-length lines, whereas even-length lines would produce only small advantages and disadvantages. The results were not nearly so clear-cut, however: with increasing length, the overall pattern of outcomes seems to become increasingly sensitive to the random idiosyncrasies of individual actors.

Our understanding of such findings may become clearer if we think in terms of larger exchange patterns self-organizing around interactions with random components. Subjects in laboratory networks have some leeway to explore their options; however experimental controls and smaller network structures constrain systematic profit differentials that might accrue from such explorations. As a result, subjects tend not to stray far from the predicted path. Yet slightly larger networks (e.g., seven-actor lines) provide more opportunity for the compounding effects of multiple subjects acting slightly "out of line." Consequently the process will depart from NET predictions in directions that make backtracking unlikely or impossible. Localized anomalies, such as those due to individual explorations, will crop up virtually at random; as a result, the subsequent course of events will be switched to a track that leads to stable but unpredicted macro patterns.

Thought experiments and computer simulations suggest further possibilities. For example, an actor in a disadvantaged position who takes an inordinately hard bargaining stance has an immediate and direct impact on neighboring positions. Even if the actor returns quickly to "normal" behavior, the local effect of the disruption may diffuse through the network like a wave. Depending on the peculiarities of a given network structure and on the state of the profit structure at a given moment, positions many steps removed from the deviant eventually may experience unexpected windfalls or losses of exchange opportunities. Conceptually it is only a short step from identifying this positive feedback or "network-wave" phenomenon to specifying the conditions that would amplify or dampen such effects.

Finally, another type of complexity may be inferred from our description of ongoing work. Explorations of dynamic exchange systems certainly will uncover legitimacy effects (Walker and Zelditch 1993). NET researchers have not explored this issue empirically, but Bell et al. (2000) discuss legitimacy effects on power processes in formal organizations. The legitimate exercise of power ought to ensure theoretically predicted resource flows, to *reduce* negative emotional reactions, and to reduce collective action (e.g., coalition formation) under institutional rules that permit such action. Similarly, we anticipate that the *illegitimate* exercise of power will introduce noise in studies of resource flows and will increase the likelihood of negative emotional reactions (Bell, et al. 2000; Walker and Zelditch 1993).

These and related "complexities" may presage the future of NET, especially if we take seriously our own talk of studying larger structures under relaxed scope conditions. Theories of complexity point to important aspects of exchange networks about which we may not have thought otherwise. Analysis of complexity moves us to the edges of known structures and processes, and directs us to understand how uncertainty, exploration, and innovation help us grasp phenomena that until now have seemed incomprehensible.

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