
Power-at-a-Distance
Author(s): David Willer
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Power-at-a-Distance*

DAVID WILLER, *University of South Carolina*

Abstract

How power is extended vertically through hierarchies and horizontally through industrial networks and markets is a classic issue in sociology that was once extensively studied by Weber. Yet it is little studied today. Definitions of power exclude power exercise beyond the single relation, as does research in exchange networks. In contrast, research in organizations recognizes the extension of power, but offers no theory to explain how it is produced or to identify the conditions which might further or impede it. Here the extension of power beyond the single relationship is called power-at-a-distance. New theory offering metric predictions is applied to power-at-a-distance in exchange networks. That theory identifies the conditions that extend power beyond the dyad and the conditions that tend to block that extension. Five experiments on contrasting structures broadly support those predictions. Relations between power-at-a-distance and power centralization are theorized. Practical problems of extending power are addressed and further research is proposed.

Unlike earlier, simpler societies where the exercise of power was always direct and face-to-face, in the large power structures of contemporary society, power also operates indirectly. When the U.S. president signs a new law, normally it will be enforced by officials who are separated from the president by a long chain of command. Voters recognize that policies advocated by winning candidates, if implemented, will be carried out by public officials many levels below the elected.[1] Generals expect their armies and admirals expect their squadrons to maneuver upon commands communicated to subordinates many steps away. Nor is the exercise of power across many levels restricted to the

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Direct all correspondence to David Willer, Department of Sociology, University of South Carolina, Columbia, SC 29208. E-mail: dwiller@sc.edu.

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public sphere. Implementation of policy set by the top officials of large corporations can and does occur many levels below.

Power can also extend horizontally through industrial networks in the following way. Assume that the monopolist, *A*, is selling to a large number of buyers, the *B*s. In turn, the *B*s sell to *C*s in a perfectly competitive market. That is to say, all *B*s buy from *A* and each *B* sells to one or more of the *C*s. Beginning with the theory of the firm, economic theory asserts that, if demand is relatively inelastic, *A* has market power such that the price to the *B*s will be substantially higher than it would have been in a perfectly competitive market (Robinson [1933] 1969: 51). Since the *B*s and *C*s are in a competitive market, the *B*s do not absorb all of *A*'s inflated price. Just as *B*'s price is inflated by *A*'s market power, the price paid by the *C*s is also inflated (Clower & Due 1972:161-62). As defined below, *A* is exercising power over the Bs *and* through the *B*s also over the *C*s. Theory introduced below makes predictions for networks where *A*s, *B*s and *C*s are linked by resource flows and offers an alternative for industrial networks to these market-economic formulations.

How does power operate indirectly and how is that operation to be predicted? For example, do organizations vary in their effectiveness in sending directives through their hierarchies and if so why? These questions are as old as the study of sociology. Weber's classical studies of bureaucracy, patrimonial domination and feudalism found conditions which facilitated and conditions which impeded the extension of power beyond the immediate relations of the "master" ([1918] 1968: 956-1110). The conditions he most frequently cited — the separation of officials from the means of administration versus the official's appropriation of office — foreshadow parts of this research and I will return to them below.

Contemporary research also recognizes the significance of indirect power. For Krackhardt (1990), "If power is the ability to influence a target, then meta-power is an indirect power derived from knowing and using the power others have to influence the target" (359). In seeking to apply "power-dependence notions" to networks, Salancik (1986) recognized that "indirect dependencies become a problem when network relationships are treated as if only direct transactions matter when indirect ones also determine outcomes" (194). Unlike Weber, neither Krackhardt nor Salancik attempted to explain how power is extended beyond direct face-to-face relations.

Organizational theorists have long recognized that power exercise extends through hierarchies. In discussing that extension, Simon ([1947] 1976) uses the terms "unity of command" and "determinate hierarchy" (22) while Thompson (1961) asserts that the "hierarchical institution is monocratic" (104). Pfiffner and Sherwood (1960) assert that "The channels of administrative authority would follow the hierarchical pattern, making everyone in the pyramid administratively answerable to the President, governor, or mayor" (65), while Barnard (1956) suggests that "everyone must be subordinate to someone" (176).[2] These and the more recent works just referenced, while recognizing that power is extended through hierarchies, do not explain that extension, how it is to be measured, and why the effectiveness of that extension might vary across organizations.

Because this article offers the first formal theory and experiments investigating power beyond the dyad, it is important to emphasize its modest goals. In contemporary society it is quite impossible not to encounter the extension of power every day, and, due to that familiarity, it may seem reasonable to expect this study to offer definitive answers to a wide array of practical issues including how best to extend power exercise and how to block it. To the contrary, this study is the first attempt to theorize power exercise beyond the dyad since Weber's almost a century ago (see just below). Definitive answers to practical questions will need to await further study. Instead, the goal is to put forward and test a theory that extends the scope of network exchange theory beyond the study of local power exercise. More will be said about that scope extension below.

I offer three kinds of evidence supporting the contention that power beyond the dyad has long been ignored. First, the definitions that social scientists offer for power have been implicitly dyadic or, in contrast to organizational theorists just quoted, have explicitly restricted power to local exercise. For example, Dahl and Lukes leave power beyond the dyad undefined:

> *A* has power over *B* to the extent that he can get *B* to do something that *B* would not otherwise do (Dahl 1957:202-3).

> *A* exercises power over *B* when *A* affects *B* in a manner contrary to *B*'s interests. (Lukes 1974:34).

Other formulations explicitly restrict the phenomenon to the dyad. According to Zelditch (1992), "'Power over' always implies a relation between two actors" (994). Nagel (1968:132) notes for Dahl (1968) that "a 'connection' between *A* and *B* is a 'necessary condition' for a power relation." Similarly, for French (1956), the basis of interpersonal power is "the more or less enduring relationship between *A* and *B* which gives rise to the power" (183).

Second, not now nor in the past has a technical term been developed to designate power beyond adjacencies. A possible exception is *meta-power*, mentioned in passing by Krackhardt and not in general use. The term offered here for that extension is *power-at-a-distance*. Whereas power exercise between adjacent positions is called local power, power-at-a-distance refers to power exercise beyond adjacencies.

Third, whereas exchange theories have substantially advanced the understanding of structurally induced power, as shown below, those theories have studied only local power exercise. Nevertheless, formulations for power drawn from exchange theories are easily extended beyond the dyad. According to Cook and colleagues (1983), "the power of *A* over *B* (P_{AB}) is the potential of *A* to obtain favorable outcomes at *B*'s expense" (284). According to Willer, an outcome "indicates a power difference when it is more favorable to one actor and less favorable to another than an equipower baseline" (1992:191). Taken together, *A* exercises power over *B* when *A*'s payoff is greater than equipower *because B*'s payoff is smaller than equipower. For power exercise it is necessary that two payoffs be linked — as one increases the other decreases — but nothing is asserted about the placement of *A* and *B* in a larger structure. For *A*'s favorable outcome to be at *B*'s expense, it is not necessary that the two be adjacent. Developed further below, this understanding allows local power exercise to be distinguished from power-at-a-distance.

For any exchange network where power-at-a-distance can occur, there are interdependent resource flows across the structure. This interdependence poses new problems for theory. All contemporary theories of exchange (Bienenstock & Bonacich 1992, 1993; Bonacich & Bienenstock 1995; Cook & Yamagishi 1992; Friedkin 1992, 1993a, 1993b; Lovaglia et al. 1995; Markovsky 1992; Simpson & Willer 1999) predict from structural conditions to power *only within* relations. They do not predict interdependent flows *across* relations.[3] *A* new theoretic procedure introduced here applies simultaneous equations to predict those interdependencies.[4] With this procedure in hand, the well-developed experimental procedures used in network exchange research will be applied to investigate power-at-a-distance.

The goal of this investigation is to advance and test a theory that extends the scope of network exchange theory beyond the study of local power exercise. Nevertheless, its significance will be enhanced if it also contributes to the general theory of social power and if its results uncover issues that are relevant to structures in the field. In fact, this study will find that the exercise of power-at-a-distance is enhanced or diminished by structural power conditions not previously noticed in the context of networks where resources flow through positions. To link to larger issues, in the discussion section I will relate results found here back to Weber and to resource dependence theory.

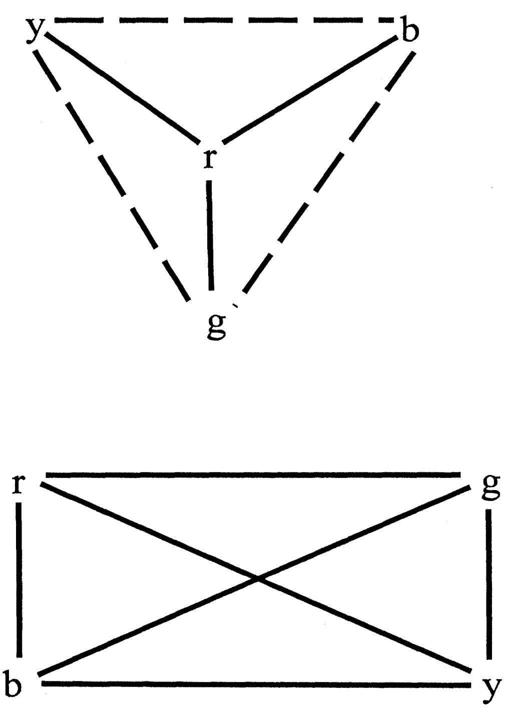
Network Exchange Research and Local Power

Power-at-a-distance was not previously investigated in exchange networks because new theory is needed to predict interdependencies across structures, but also because of a longstanding and almost exclusive reliance upon a single experimental paradigm introduced by Stolte and Emerson (1977).[5] In this section, I will (1) explain why that paradigm precludes power-at-a-distance, (2) distinguish power-at-a-distance from distal effects and (3) consider briefly

FIGURE 1A: Two Stolte and Emerson (1977) Networks

A.

B.



Note: Solid lines contain 13 point pools. Dashed lines contain 3 point pools.

the only previous network exchange study where resources flowed through positions.

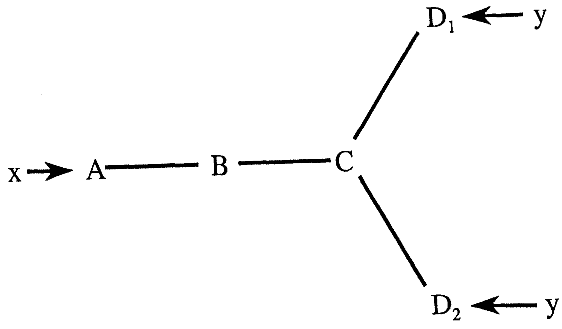
Figure 1a gives two networks studied in 1977 by Stolte and Emerson. Though called *exchange* networks, subjects in positions *b*, *g*, *r*, and *y* (for blue, green, red, and yellow, respectively) did *not* exchange by sending and receiving resources. *A resource pool* was placed between members of each pair of positions. As indicated in the figure, some resource pools totaled 13 points while others totaled 3. Positions which gain more than half of the pool exercise power over adjacent positions which gain less than half. In the experiment, subjects negotiate over divisions of these pools and, when any pair agree, they acquire resources from the pool between them. More specifically, any subject can gain resources *only* by dividing a pool with a subject in an adjacent position. No resources can be sent to or received from positions distant in the network. For example, *g* can receive resources by dividing a resource pool with *r*, but *r* cannot send resources through b to g. Therefore, power exercise can occur only between adjacencies and power-at-a-distance is precluded.[6]

How the conditions specific to the Stolte and Emerson paradigm limit power to local exercise is seen in longer networks like the $A_1 - B_1 - C - B_2 - A_2$ 5-actor line studied by Cook and colleagues (1983). They found that power was decentralized; the *B*s were high in power while *C* and the two *A*s were low. That power was decentralized is a result which then commanded substantial interest. Importantly, centralized power is precluded by the experimental paradigm for the following reason. Later in the article I define power centralization — a term not previously given formal meaning in network exchange — as the concentration at the central position of resources gained from exchange. To centralize power in the 5-actor line, resources from exchange must flow from the *A*s through the *B*s to the central *C*. For those flows *C* is exercising power locally at the expense of the *B*s *and* at a distance at the expense of the *A*s. In Cook and colleagues' 5-actor line, however, it is quite impossible for *C* to gain any resouces from either *A*. Resource pools link *C* to the Bs, but no resource pool links *C* to the As. Therefore, *C* cannot benefit at the expense of the *A*s, and power cannot be centralized.

For the 5-actor line, power can be centralized if and only if resources flow from the As through the Bs to the C. In fact, flows like that occur in this research where power in a different kind of 5-actor line, here called NET122, is highly centralized. (See Figure 4 and Discussion section below.)

It is now imperative to distinguish power-at-a-distance from the very different phenomenon, distal effects with which it might be confused. Discovered more than a decade ago by Markovsky, Willer and Patton (1988), resource pool networks have distal effects in that the power of positions is determined, not just locally, but by the configuration of the network as a whole — including positions many steps distant. Consider a series of networks in which each position can divide maximally one resource pool. For the $A - B$ dyad, power is equal, but for the $A - B - C$ triad, either *A* or *C* is excluded and *B* gains maximally. Adding *C* to the dyad has distal effects: *A*'s power is reduced and *B*'s power is increased. Now add B_2 to give the $A - B_1 - C - B_2$ 4-actor line in which B_1 gains only slightly more than *A*: now *C* and B_1 are power equals (Lovaglia et al. 1995). Adding B_2 has distal effects on the $A - B$ relation for it reduces power differences. Now add another *A* to give the $A_1 - B_1 - C - B_2 - A_2$ 5-actor line as studied by Cook and colleagues. Because that addition increases *B*'s power and reduces *A*'s, again there is a distal effect — and similarly for further additions. For all these distal effects, however, power is always exercised only locally — between adjacent positions like *A* and *B* who divide a resource pool — while determined globally by the configuration of the network as a whole.

FIGURE 1B: Yamagishi, Gillmore, and Cook's and Associates' Experiment 2 Network



Importantly, distal effects and power-at-a-distance, when they occur together, are *orthogonal* phenomena. Looking ahead, Figure 3b, which shows one of the experimental networks, gives the flow of resources from *A* through *B* to *C* and the reverse. That network has modest distal effects *across the line of resource flows*. For example, because B_2 is a second exchange partner for *A*, B_1 is low power to *A* — and similarly for each *B* and its two *C*s. By contrast, both local power and power-at-a-distance occur *in line with resource flows*. Theory offered below will predict that *A* gains resources at the expense of the *B*s and the *C*s, a prediction that will be supported experimentally. In fact, distal effects and power-at-a-distance occur orthogonally here and for all of the networks studied.

Only Yamagishi, Gillmore, and Cook (1988) previously studied networks, including that of Figure 1b, where resources flow through positions. Whereas power-at-a-distance might well have been possible in their networks, it was not explicitly theorized or investigated. That study was done in the power-dependence tradition and, as quoted earlier for that theory, "the power of *A* over *B* (P_{AB}) is the potential of *A* to obtain favorable outcomes at *B*'s expense." Whereas Yamagishi, Gillmore, and Cook (1988) designate the positions with favorable (highest) earnings as the ones highest in power, they did not locate the positions from which these earnings stemmed and at whose expense they were gained.[7] Since no formalism was offered, there was no equipower baseline from which the payoffs to high and low power positions could be seen to depart. Thus it cannot be determined whether observed power exercise was local or not. Yamagishi and colleagues assert that "the relative scarcity of the resources controlled by the partners determines relative power" (838), but Bonacich

(1992) asserts that "The rarer good is not more valuable in Yamagishi's experiment. It merely serves to limit the magnitude of mutually profitable exchanges" (33). To initiate the investigation of power-at-a-distance, this research will now design flow networks, but with parameters which are not like those of Yamagishi and colleagues (1988).

Designing Resource Flow Networks

Since power can occur only between positions which contend for resources, to extend power beyond local exercise, exchanges need to move resources across structures. These exchanges will occur if and only if all positions profit (Newman 1965:7-8). Resource flows and payoffs for the first three networks to be investigated are introduced using NET124 as the running example. NET124 is a network where *one A* has *two Bs* as exchange partners while *four Cs* give each *B* two exchange alternatives. To highlight connections across positions, NET124 is drawn in Figure 3a as an organization chart. In Figure 3b the same structure is given with details of resource flows and payoffs.

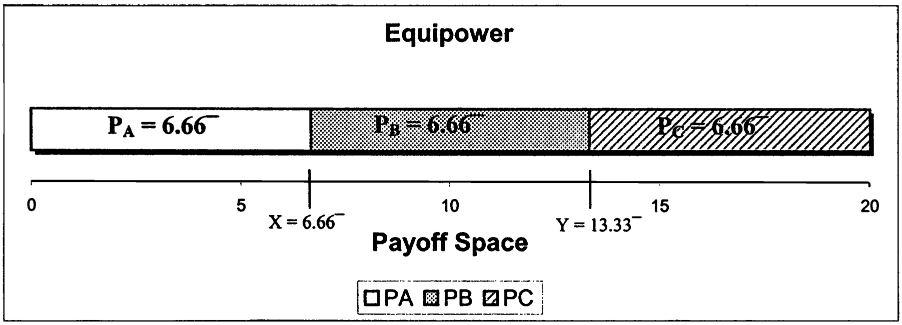
Two types of resources that are valued differently by position are input into the two ends of the structure. At the *A* end of the network a single generalized commodity called a widget is introduced. The widget will move from *A* to *B* and from *B* to C. Both *B* and *C* are initially allocated 20 resources that serve as a medium of exchange. They are labeled "$" and are called money. Money moves from *B* to *A* when *B* buys the widget and from *C* to *B* when *C* buys the widget.

Each negotiation round is divided into two parts. During the first part, *A* and the two *B*s negotiate for the purchase of the single widget. During the second part, the *B* who bought the widget negotiates with two *C*s for its sale. As shown in Figure 3b, the price paid by *B* is *X*, the number of units of money flowing from *B* to *A*. The price paid by *C* is *Y*, the number of units of money flowing from *C* to *B*.[8]

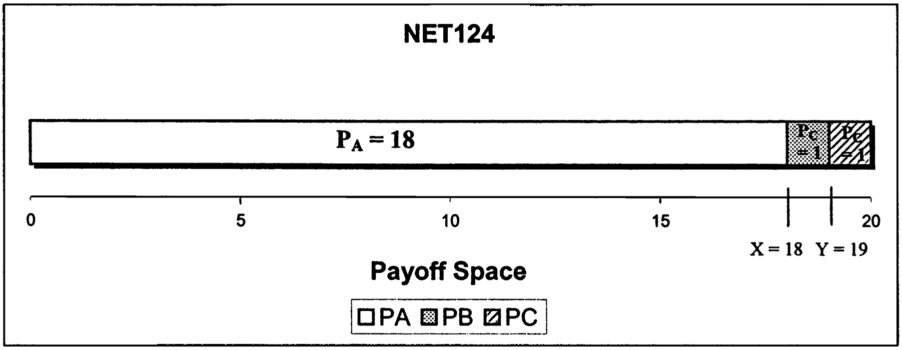
Payoffs by position are determined by the value of resources to the position and the numbers of resources flowing to and from that position. The widget is worth 20 to the *C*. For *A* and *B*, the widget has no inherent value; they cannot gain points by retaining it. Since the widget has only exchange value for *A* and *B*, no signs are adjacent to its flows for those positions. Each unit of money is worth one point to each position. For example, the –1 next to the *Y* flow from *C* indicates that *C* loses one point for each unit of money paid to *B* for the widget. The +1 of the *Y* flow at *B* indicates that *B* gains one point for each unit of money received. The signs of the *X* flow are interpreted similarly.

FIGURE 2: Payoff Space for Three Flow Networks

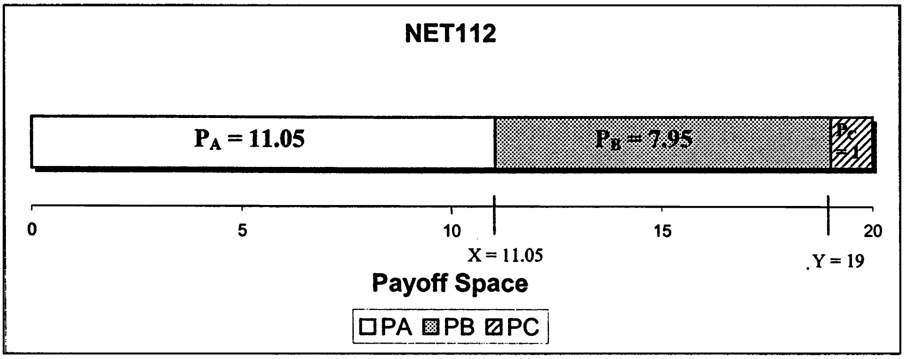
a:



b:



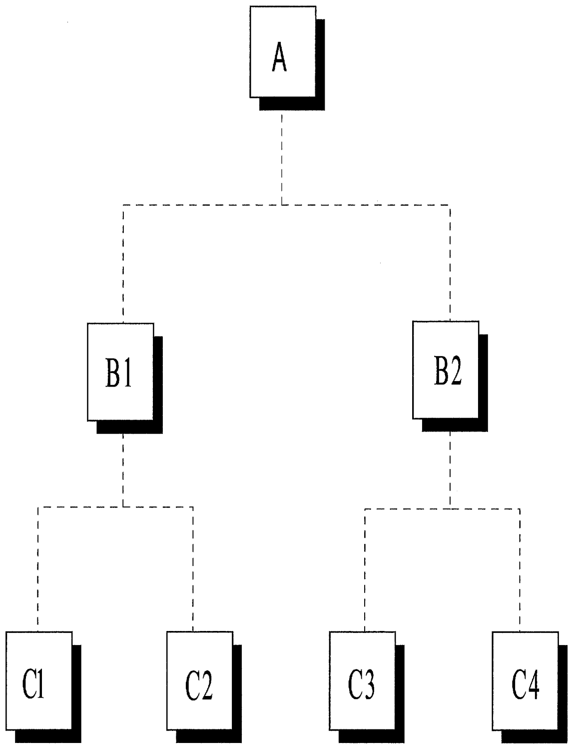
c:



Let P_i be the payoff from exchanging to any actor *i*. Then the exchange conditions given above and repeated in Figure 3b allow functions to be written for the payoffs of *A*, *B* and *C* positions:

$$P_A = X \qquad P_B = Y - X \qquad P_C = 20 - Y$$

FIGURE 3a: NET124: An Organizational Network with Power between All Three Levels

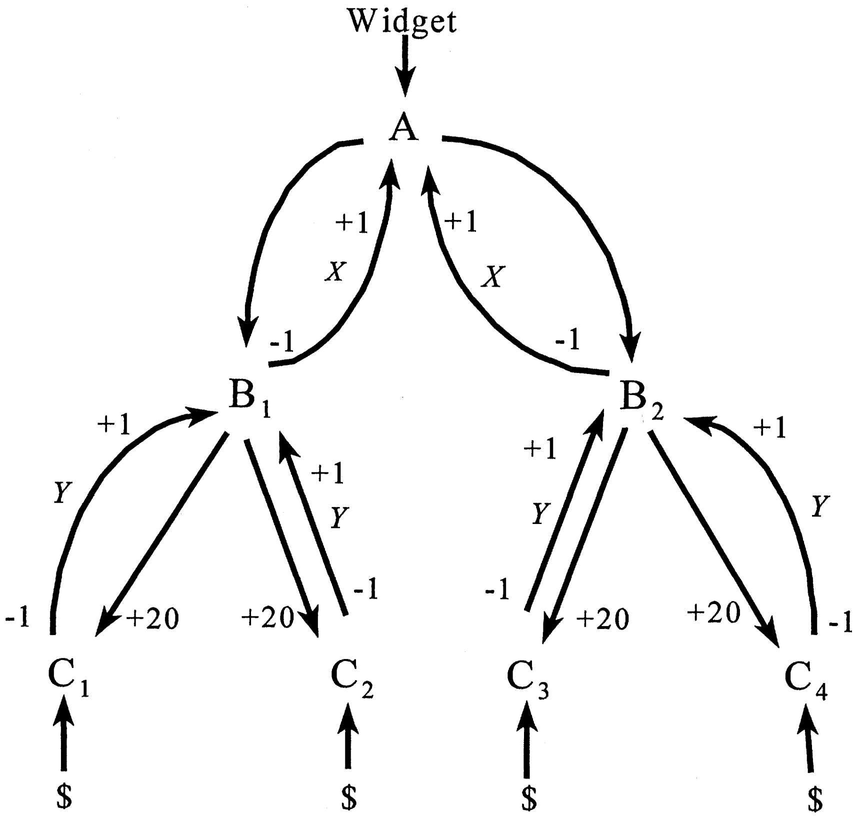


A's payoff is *X*, the price received from *B* for the widget. *B*'s payoff is *Y* – *X*, the difference between the price received from *C* and the price paid to *A*. The payoff to *C* is 20 – *Y*, the value of the widget minus its cost paid to *B*. The payoff to any position which fails to exchange is zero.

To predict payoffs to each position, Pmax, the maximum payoff possible for each position, must be determined. Pmax for any position occurs when other positions receive the minimum payoff when exchanging. Rational actors will not exchange unless they receive at least minimal gain and money will be divisible to units of one and no smaller. Then, if the structure maximally favors the middle *B*, *A* and *C* gain minimally: $P_A = 1$, and $P_C = 1$. Therefore $X = 1$ and $Y = 19$. Then $P_B$max = 19 – 1 = 18. By the same reasoning, when $X = 18$ and $Y = 19$, $P_A$max = 18, while $P_B = 1$, and $P_C = 1$, and when $X = 1$ and $Y = 2$, $P_C$max = 18 while $P_A = 1$, and $P_B = 1$.

With resources which flow through the network specified, the payoffs to all positions are interdependent. Now power exercise can be local, at-a-distance,

FIGURE 3B: Resource Flows and Values for the Three-Level Network



or both. The next section uses the network exchange definitions of power which were given in the introduction to distinguish the kinds of exercise.[9]

How to Distinguish Local Power from Power-at-a-Distance

This section answers the question: "How is power exercised at a distance to be distinguished from power exercised locally?" As seen in the introduction, network exchange theory asserts that *i* exercises power over *j* when *i* benefits at *j*'s expense. When *i* is exercising power, its payoff, P_i will be *greater* than at equipower. To determine whether *i*'s power exercise is local, is power-at-a-distance, or both, find the position(s) *j*, *k*, . . . *z* which are the source of *i*'s payoff increment and determine their location; their payoffs will be *less* than equipower. Since equipower is the baseline from which power exercise is inferred, the baseline condition will be considered first.

The equipower payoffs for *A*, *B*, and *C* are displayed in Figure 2a. For this structure, the value of the widget *V* is 20 to *C*; therefore the sum of the payoffs to A, *B* and *C* must be 20.[10] Three payoff blocks are labeled P_A, P_B, and P_C and each is proportional in size to the position's payoff. Here $P_A = 6.\overline{66}$, $P_B = 6.\overline{66}$ and $P_C = 6.\overline{66}$, and the blocks are equal in size. Later, when resistance equations are introduced and applied, it will be shown that values displayed in Figure 2a are at equipower.[11] With the sum of payoffs to *A*, *B*, and *C* fixed, were any payoff block to expand, at least one other block must contract.

Predicted payoff blocks for NET124 are shown in Figure 2b. The sizes of the three blocks follow from predictions developed below. Comparing the payoffs of NET124 to the equipower baseline shown in 2a, it is seen that *A*'s payoff block has expanded to almost three times its size at equipower: $P_A = 18 >> 6.\overline{66}$. *B*'s and *C*'s payoffs are much smaller than equipower being minimal at P = 1. *A* is benefiting at *B*'s expense *and* at *C*'s expense. Therefore, *A* is exercising power locally over *B* and exercising power-at-a-distance over *C*.

The NET112 structure is displayed in Figure 5, and its predicted payoff blocks are shown in Figure 2c. Compared to the equipower baseline, the *A* and *B* payoff blocks have expanded while the *C* payoff block has contracted. Since P_A and P_B are larger than equipower while P_C is substantially smaller, both *A* and *B* are exercising power over *C*. More precisely *A* is exercising power-at-a-distance over *C*, while *B* is exercising power locally over *C*. The payoff blocks show how this dual exercise occurs. Since $P_A = 11.05 > 6.\overline{66}$, the payoff block for *A* has expanded relative to equipower, but since $P_B = 7.95 > 6.\overline{66}$, *B*'s payoff block has also expanded. Only *C*'s payoff block is small, being minimal at $P_C = 1$. Because *B* is gaining more than at equipower, *A*'s increased payoff is not at *B*'s expense; therefore, *A* is not exercising power locally over *B*.

Considering NET112 and NET124 together, *A*'s exercise of power-at-a-distance is indicated by two conditions only, the increase in P_A and decrease in P_C. In NET112, the increment of *A*'s payoff above equipower cannot be from *B* because *B*'s payoff is also larger than equipower. By default the increment of *A*'s payoff *must be* at *C*'s expense. In NET124, *B*'s payoff is smaller than equipower as is *C*'s payoff. Since only *A* and not *B* is benefiting from *C*'s loss, *A* is exercising power-at-a-distance over *C*. Thus the exercise of power-at-a-distance is defined only by $P_A > 6.\overline{66}$ and $P_C < 6.\overline{66}$ and is independent from the size of P_B.[12] One-step-longer networks are studied later, and again, for finding power-at-a-greater-distance, the payoffs to the intermediate positions is irrelevant. The Appendix explains these points and gives axioms for power exercise in two step flow networks that are easily generalizable to networks, three steps and longer.

Whereas this investigation follows previous research in designating power exercise by the deviation of payoffs from equipower, there is a necessary departure from previous practice here. In previous studies payoffs at the equipower baseline were theoretically derived *and* could be produced experimentally in simple dyads or other equipower structures. For this research, however, equipower payoffs are only theoretically derived. For equipower payoffs to be produced experimentally, no conditions which produce power differences can be present. As will now be seen, however, it may well be impossible to eliminate all power conditions from flow networks.

An Overview of Structural Power Conditions in Flow Networks

In exchange networks, the exercise of power is produced by structural conditions like exclusion, inclusion, and ordering. These power conditions are found where two or more exchange relations are connected. Sometimes more than one condition is present at a connection. For example, in some of the networks to be investigated, inclusion and exclusion occur together while in others ordering is found together with exclusion. The joint effect when two power conditions are present is discussed immediately below.

Strong power structures where power is due to exclusive connection are defined in the following way:

> Strong power structures are networks that contain two and only two types of positions: one or more high power positions which are never excluded and two or more low power positions, at least one of which must be excluded; low power positions are only connected to high power positions. (Simpson & Willer 1999:271)

Ignoring the low profit relations, the first of the Stolte and Emerson networks shown in Figure 1a is a strong power structure. Since each position is limited to one exchange, *r* is exclusively connected to the other nodes such that *r* is never excluded, but two of *y*, *b*, and *g* must be excluded. Seeking to avoid exclusion, low power positions like *y*, *b*, and *g* make better and better offers until exchange ratios come to maximally favor *r*, the high power position (Willer & Skvoretz 1997a).

Exclusive connections occur in NET124 because *A* – *B* and *B* – *C* strong power substructures are linked in series. As shown in Figure 3b, *A* has a single widget and two *B*s as exchange partners. *A* is exclusively connected and, with one *B* always excluded, the *A* – *B* substructure is strong power. *A* is a high power position while the *B*s are low power positions relative to *A*. For the *B* – *C* exchange, the *B* holding the widget is exclusively connected having two *C* exchange partners, one of which will be excluded. Thus the *B* – *C* substructure is strong power with *B* the high power position relative to the *C*s which are low power positions. Unlike the positions in the Stotle and Emerson networks, the *B*s occupy two very different statuses; relative to *A* they are low power positions, but relative to *C* they are high power positions. In this regard *B*s are like middle managers who are low power relative to CEOs and high in power relative to their subordinates.

Exclusive connection also occurs in other of the networks studied here. Looking at Figures 4 and 5 shows that each has only one strong power substructure. In NET122 of Figure 4, *A* is exclusively connected to the two *B*s. Thus *A* is a high power position and excludes one of two *B*s, which are low power relative to *A*. In NET112 of Figure 5, *B* is exclusively connected to the *C*s. Thus *B* is a high power position relative to the *C*s and excludes one of two low power *C*s.

Because *A, B* and *C* are connected in series in all of the networks, two other power conditions are present, inclusion and ordering. Any position is inclusively connected when it must exchange with two or more others to benefit from any one (Patton & Willer 1990; Szmatka & Willer 1995; Willer & Skvoretz 1997a). Inclusion affects the second of two exchanges. For example, in NET122, *B* must complete the *A* – *B* exchange *and* the *B* – *C* exchange to gain a payoff.[13] Being inclusively connected, resistance will predict that *B* is lower in power than *C* (see below). That *B* is lower in power should have two effects. First *B* will receive smaller payoffs than *C*. Second, because *B* is weaker than *C*, *A*'s power exercise in NET122 is less than the maximal predicted for NET124.

The power condition ordering occurs when *i* must deal with *j* to gain access to *k* (Corra 2000; Corra & Willer 2002). In NET112, *B* must exchange first with the *A* before exchanging with either *C*. The effect of ordering is seen in the first exchange, where *B* is weaker than *A*. It was already seen that *B* exercises power from exclusion over the *C*s. But resistance predicts that, as a result of ordering, *A* benefits more from *B*'s power exercise than does *B* (see below).

More generally, inclusion and ordering occur at all connections of all resource flow networks, but their effects are masked when exclusion is also present. Previous work has shown that the effects of inclusion and ordering are eliminated by exclusion (Corra & Willer 2002; Szmatka & Willer 1995; Willer & Skvoretz 1997a). More precisely, exclusion eliminates the effects of ordering and inclusion when the two work in opposite directions. For example, in the *B* – *C* substructure of NET124, *B* is weakened by its inclusive connection to *A* and C, but in *B* – *C* the *B* is very strong because of its exclusive connection to two *C*s. Here exclusion is predicted to eliminate the effect of inclusion. In the *A* – *B* substructure of NET124, ordering and exclusion work in the same direction; both favor A. While exclusion does not eliminate the effect of ordering here, exclusion alone is predicted to be powerful enough to produce payoffs at the extreme favoring A, masking the smaller ordering effect.

Both inclusion and ordering are present in NET112 and NET122, but only one of the two power conditions is detectable in each. In NET112, exclusion masks the effect of inclusion, but not ordering. In NET122, exclusion masks the effect of ordering, but not inclusion. The effects of inclusion and ordering and how they are masked by exclusion are not particular to the three networks just discussed. That they are quite general will be seen in the two longer networks, NET1122 and NET1248 which are also studied. As displayed in Figures 6 and 7, NET1248 is like NET124 but adds one further step, while NET1122 combines structural qualities of NET112 and NET122. Thus their investigation offers an important further test for theory offered here and, in addition, finds whether power-at-a-distance is attenuated as it is extended.

Applying Resistance Equations to Predict Power Exer

Resistance equations have successfully predicted exchange ratios and power in a large body of previous research.[14] Van Assen (2001) shows that resistance is mathematically equivalent to the RKS solution (Kalai & Smorodinsky 1975; Raiffa 1953) of cooperative game theory.[15] The application of resistance here is new. To capture the interdependence of power events across the flows of the network, two resistance equations are formed — one for each of the exchanges in the structure — and solved simultaneously.

Resistance uses each actor's mixed motives in exchange to predict exchange ratios and thus power exercise. Let P_i be *i*'s payoff, $P_i$max is *i*'s best payoff and $P_i$con is *i*'s payoff at confrontation — when agreement does not occur. Then resistance is the ratio of $P_i\text{max} - P_i$, which is *i*'s interest in gaining a better payoff, to $P_i - P_i$con, which is *i*'s interest in avoiding confrontation:

$$R_i = \frac{P_i \max - P_i}{P_i - P_i \, con} \tag{1}$$

Principle 2 of Network Exchange Theory asserts that agreements occur at equal resistance (Willer 1981, 1999). For an *A* – *B* equal power dyad where *A* and *B* divide 24 resources,

$$R_A = \frac{P_A \max - P_A}{P_A - P_A \, con} = \frac{P_B \max - P_B}{P_B - P_B \, con} = R_B \tag{2}$$

$$R_A = \frac{23 - P_A}{P_A - 0} = \frac{23 - P_B}{P_B - 0} = R_B \tag{3}$$

and, by symmetry, $P_A = 12$ and $P_B = 12$.

Earlier it was shown for NET124 that $P_A = X$, $P_B = Y - X$ and $P_C = 20 - Y$ and that Pmax for all positions = 18.[16] Substituting those payoffs into equation 2, for an equipower network with *A* – *B* and *B* – *C* exchanges, there are two resistance equations. Here R_{Ab} is the resistance of *A* relative to *B* and similarly for the other expressions.

$$R_{Ab} = \frac{18 - X}{X - 0} = \frac{18 - (Y - X)}{(Y - X) - 0} = R_{Ba} \tag{4}$$

$$R_{Bc} = \frac{18 - (Y - X)}{(Y - X) - 0} = \frac{18 - (20 - Y)}{(20 - Y) - 0} = R_{Cb} \tag{5}$$

Solving, $X = 6.\overline{66}$ and $Y = 13.\overline{33}$ and all payoffs are numerically equal at $P_A = 6.\overline{66}$, $P_B = 6.\overline{66}$, and $P_C = 6.\overline{66}$. These are the equipower payoffs discussed earlier.

Because there are two equations (4 and 5) and two unknowns (*X* and *Y*), the equations are solved simultaneously — as are other pairs of equations encountered later. For longer networks, three resource flows (*X*, *Y*, and *Z*) are found by simultaneously solving three equations. By extension, for future studies where networks are *n* steps long, there will be *n* unknowns and *n* resistance equations.

That equations are solved simultaneously does not assume that the exchanges are simultaneous; as already explained they are not. Instead, a simultaneous solution assumes that the exchanges across the network are interdependent. But are they? Since the first exchange occurs in the *A* – *B* subnetwork and the second in the *B* – *C* subnetwork, it is obvious that agreements in *A* – *B* affect *B* – C. Nevertheless, these networks are studied as repeated games. Therefore, agreements in *B* – *C* at $t - 1$ react back and affect *A* – *B* agreements at *t* — and similarly to equilibrium. By capturing both effects, the simultaneous solution predicts *X* and *Y* at equilibrium. Ultimately, the measure of the interdependence of *X* and *Y* flows rests in the agreement between predictions, which assume that interdependence, and the empirical evidence to be offered below.

Predicting Power-at-a-Distance in NET124

For any strong power structure (or substructure), high power positions have offers which are exclusive alternatives. Let *A* be the high power position and P_A^{t-1} be the payoff to *A* at $t - 1$ from one of *A*'s exclusive alternatives. Then $P_A con = P_A^{t-1}$: the cost of confrontation for *A* at *t* is the alternative payoff already offered at $t - 1$. Let *B* be a low power position. Because *B* cannot hope to gain more than her rival gains in *A*'s alternative offer, that offer places an upper bound on $P_B max$. The upper bound is P_B^{t-1}, which is the payoff to *B* of an offer just better for *A* than *A*'s alternative payoff. Thus, $P_B max = P_B^{t-1}$ and

TABLE 1: Resource Flows for Power-at-a-Distance in Two-Step Networks: Resistance Predictions and Observed Means

Structure	Flow	Prediction	Observed Mean	t	p
NET 124	X	18.0	17.78	1.43	NS
$n = 45$[a]	(B→A)		(1.02)		
	Y	19.0	18.89	1.16	NS
	(C→B)		(.630)		
NET 122	X	17.1	14.96	5.15	< .001
$n = 28$[b]	(B→A)		(2.16)		
	Y	18.1	16.21	4.72	< .001
	(C→B)		(2.08)		
NET 112	X	11.05	12.76	5.14	< .001
$n = 36$[c]	(B→A)		(1.97)		
	Y	19.0	18.62	2.15	< .01
	(C→B)		(1.06)		

Note: Numbers in parentheses are standard deviations.

[a] The 45 periods were obtained from nine groups of five periods each. Subjects were rotated through positions at the conclusion of each period.

[b] The 28 periods were obtained from seven groups. Each group participated in four periods, each consisting of ten negotiation rounds. Subjects were rotated through positions at the conclusion of each period.

[c] The 36 periods were obtained from nine groups. Each group participated in four periods, each consisting of ten negotiation rounds. Subjects were rotated through positions at the conclusion of each period.

the resistance expression for a strong power structure where $R^H{}_A$ is the resistance of the high power *A* and $R^L{}_B$ is the resistance of the low power *B* is:

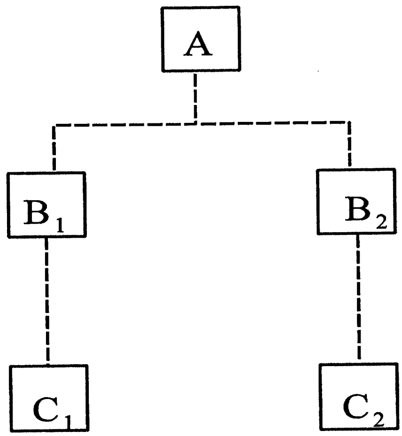
$$R_A^H = \frac{P_A \max - P_A}{P_A - P_A^{t-1}} = \frac{P_B^{t-1} - P_B}{P_B - P_B\, con} = R_B^L \qquad (6)$$

To illustrate how equation 6 works, let *A* have *B* and *C* as exchange partners and divide 24 resources with only one. Equation 3 suggests that *A*'s negotiations will begin at $t - 1$ with a 12 – 12 split. When that split is with *B*'s rival *C*, at *t*:

$$R_A = \frac{23 - P_A}{P_A - 12} = \frac{11 - P_B}{P_B - 0} = R_B$$

$P_A = 18$ and $P_B = 6$. These values signal the beginning of the power process. Now for $t + 1$ there are new negotiations and plugging in the new $P_A con = 18$

FIGURE 4: Net122: A Network with Exclusive Power between Levels One and Two



and $P_C max = 5$ gives $P_A = 21$ and $P_C = 3$. This is an iterative process which approaches the endpoint $P_A = P_A max = 23$ with $P = 1$ for either *B* or *C* while the other is excluded.[17]

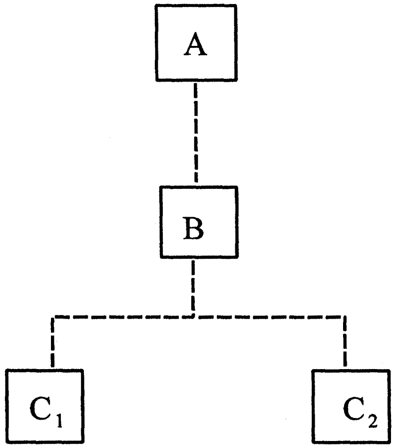
Predictions for NET124 of Figures 3a and 3b are generated in the same way, but with two equations and two unknowns, *X* and *Y*. Some *X* and *Y* values are time superscripted. For example, since *A* is high power, $P_A con = X^{t-1}$ and, since *B* is low power, $P_B max = Y^{t-1} - X^{t-1}$. R^H_{Ab} is the resistance of the high power *A* relative to *B* and similarly for the other expressions. Equation 7 is for the *A* – *B* strong power substructure where *A* is high power and *B* is low. Equation 8 is for *B* – *C* strong power substructure where *B* is a high power position and *C* is low.

$$R^H_{Ab} = \frac{18 - X}{X - X^{t-1}} = \frac{(Y^{t-1} - X^{t-1}) - (Y - X)}{Y - X} = R^L_{Ba} \qquad (7)$$

$$R^H_{Bc} = \frac{18 - (Y - X)}{(Y - X) - (Y^{t-1} - X^{t-1})} = \frac{(18 - Y^{t-1}) - (20 - Y)}{20 - Y} = R^L_{Cb} \qquad (8)$$

Let payoffs at $t - 1$ be equipower; then, as shown above, $X^{t-1} = 6.66$ and $Y^{t-1} = 13.33$ and, for $t = 1$, $X = 14.38$ and $Y = 18.90$. Therefore, at *t*, $P_A = 14.38$, $P_B = 4.52$ and $P_C = 1.10$. P_A has already substantially increased while P_B and P_C have substantially declined.[18] *A* is already exercising substantial power-at-

FIGURE 5: Net112: A Network with Exclusive Power between Levels Two and Three



a-distance over *C* and locally over *B*. *Y* is already very near its upper bound of 19 and, as *t* increases, *X* will increase such that P_{Ab} will approach $P_{Ab}max = 18$. Therefore, for NET124 resistance predicts $P_A = 18$ while $P_B = 1.0$ and $P_C = 1.0$: $X = 18$ and $Y = 19$. *A* exercises power maximally over both the Bs and Cs. This prediction is displayed in Table 1.

An alternative prediction for NET124 asserts that power is localized such that *A* and *B* divide half the value of the widget and *B* and *C* divide the remaining half. If so, $P_A = 9$ and $P_{Ba} = 1$ for the first exchange while $P_{Bc} = 9$ and $P_C = 1$ for the second. Overall, $P_B = P_{Ba} + P_{Bc} = 9 + 1 = 10$. These predictions will be compared to experimental results below.

Predicting Local Power and Power-at-a-Distance in NET122

Given in Figure 4 is NET122. Since the *A* – *B* substructure of NET122, like the *A* – *B* substructure of NET124, is strong power, equation 7 applies. *A* is high power and excludes one of two *B*s. *B* – *C* is not an exclusionary strong power substructure, however. Having only one exchange partner, *B* is not high in power relative to C. Resistance finds that *B* is inclusively connected and lower in power than C. *B*'s payoff is *Y* – *X*, and, since *B* will lose *Y* – *X* if the exchange with *C* is not completed, $P_{Bc}con = -(Y - X)$. Again the widget is worth 20 to *C*. $R_{Bc}{}^{I}$ is the resistance of the inclusively connected B.

$$R^I_{Bc} = \frac{18 - (Y - X)}{(Y - X) - [-(Y - X)]} = \frac{18 - (20 - Y)}{20 - Y} = R_{Cb}$$

and simplifying

$$R^I_{Bc} = \frac{18 - (Y - X)}{2(Y - X)} = \frac{18 - (20 - Y)}{20 - Y} = R_{Cb} \qquad (9)$$

B is squeezed between two structurally advantaged positions allowing a straightforward solution for NET122. *A* is the most powerful position and, as equation 7 asserts, *A* will gain better and better deals, such that *X* increases. But equation 9 asserts that, for similar payoffs, *C* will be more resistant than B. Therefore, P_C will decline, but P_B will decline even more rapidly. Eventually $P_B = 1$ and, because one is the least which *B* will accept, equilibrium payoffs will occur at that value. Substituting $Y - X = 1$ in equation 9 leaves only *Y* unknown. Solving, $Y = 18.1$ and $X = 17.1$.

Two alternative predictions are now proposed for NET122. The first alternative appeals to parsimony and asserts that only power due to exclusion is present. If so, *B* and *C* are not inclusively connected; they are power equals and *A* is the only advantaged position. As *A*'s power exercise increases, P_B and P_C both approach one together (P_B —> 1 and P_C —> 1). Then $P_A = P_A$ max = 18 and the prediction for NET122 is exactly the same as for NET124. A second alternative, suggested by an anonymous economist, holds that, for the *B* – *C* exchange, $P_B$con = – *X*, because *X* is *B*'s sunk costs. If so, *B* is again lowest power and, modifying equation 9, $X = 11.4$ and $Y = 12.4$. All three predictions will be compared to experimental results for NET122.

Predicting Power in NET112

In NET112 of Figure 5, *A* has a single *B* and *B* has two *C*s as exclusive alternatives. Because *B* is high power relative to the *C*s, equation 8 applies and $Y = 19$ is the equilibrium value predicted. Thus $P_C = 1$. If *A* and *B* are power equals, their payoffs will be the same; $P_A = 9.5$ and $P_B = 9.5$. Therefore, $X = 9.5$.

But resistance does not see *A* and *B* as power equals. *A* acts as a gatekeeper controlling *B*'s access to *C* and, because of the effect of ordering on B, *A* will benefit more than *B* from *B*'s power over *C*. Since failure to exchange with *A* deprives *B* of the opportunity to profit when exchanging with C, $P_B$con = –(*Y* – *X*). Therefore, $R_{Ba}{}^O$, the resistance factor for *B* as affected by ordering, takes the same form as $R_{Ba}{}^I$, B's resistance factor as affected by inclusion in equation 9.

$$R_{Ab} = \frac{18 - X}{X} = \frac{18 - (Y - X)}{2(Y - X)} = R^O_{Ba} \qquad (10)$$

Plugging $Y = 19$ into equation 10 gives $X = 11.05$. (These values were seen earlier in the discussion of Figure 2c.) *A* exercises power-at-a-distance benefiting at *C*'s expense while *B* exercises modest power locally over *C*: $P_A = 11.05$, $P_B = 7.95$, $P_C = 1$. These predictions and the alternative predictions, that *A* and *B* are power equals, will both be compared to experimental outcomes.

Experimental Design and Results

The Experimental Design

All experiments were conducted using ExNet II, a Windows-based electronic laboratory system for the investigation of exchange networks. Using mouse control, subjects seated at PCs in separate rooms send and receive offers and make exchanges. The design of ExNet II follows the rule, "Show don't tell." The network being investigated is an active display on each subject's screen; subjects click icons to make offers and complete exchanges. For example, to make an offer to one of the *B*s, the subject *A* clicks a counter to set the desired price and clicks an arrow aimed at that *B*. The arrow changes color to indicate that the offer is sent. On *B*'s screen, *A*'s offer is seen as a cartoon balloon over *A*. With experimental conditions actively displayed, interaction is intuitive and subjects' errors are substantially reduced.

Subjects were not misdirected. Instead, they were connected in exchange relations as shown in the figure for that structure. For example, in NET124, the *A* subject had two *B* subjects to whom a single widget could be sold. The *B* who purchased the widget had two *C*s as (exclusive) alternative exchange partners. Actually, only five subjects are needed for NET124's seven positions. Since only one *B* has a widget to sell, ExNet II automatically connects the subjects in the two *C* positions to the *B* holding the widget. Therefore, two *C*s perform the roles of the four pictured for NET124 for a total of five subjects for each session. In NET122, only four subjects were needed, an *A*, two *B*s, and a single *C* who was automatically connected to the *B* holding the widget. In NET112 the number of subjects per session corresponded to the number of positions in the network (see Figures 4 and 5).

For each structure, the first negotiation round opened with the subject at the *A* position initially holding the widget while subjects at *B* and *C* positions were each allocated 20 money ($) resources.[19] For NET124, during the first part of the round, the subject at *A* negotiates with subjects at the two *B* positions. Negotiations were lively. Offers and counteroffers flew back and forth and, in nearly all cases, agreements were reached relatively quickly. Since resistance assumes rational actors, this is a full information design. All offers and agreements are displayed on the screens of *A* and both of the *B* subjects. In fact, *A* – *B* offers and agreements are displayed on the *C*s' screens as well.

With the $A - B$ exchange completed, the second part of the round begins. Now the B subject who purchased the widget negotiates its sale with its two Cs. Again negotiations were lively; offers, counteroffers, and agreements are again displayed for all subjects. At the conclusion of the experiment, subjects were paid by points earned; they averaged about $20 for the experiment. Because subjects were rotated between advantaged and disadvantaged positions (see below) few earned as little as $15 or more than $25.

Experiments were organized in sessions, periods and negotiation rounds. Table 1 gives the number of sessions per structure.[20] For each session, there were as many periods as subjects, five for NET124, four for NET112 and similarly for the other structures. Within each period there were a number of rounds of negotiation. At the conclusion of each period, subjects were rotated to new positions, altering subject pairings.[21] The experiment concluded when each subject had occupied each position. For analysis, data were averaged within each period. For each session of NET124 there was one datum point for X and one for Y for each of five periods while each session of NET112 gave one X and one Y datum point for each of its four periods. The number of data points per structure is exchanges × periods × sessions. Since each structure had two exchanges, for NET124 there are $2 \times 5 \times 9 = 90$ data points while for NET112 there are $2 \times 4 \times 9 = 72$ data points. The observed means reported in Table 1 are averaged across periods and sessions.

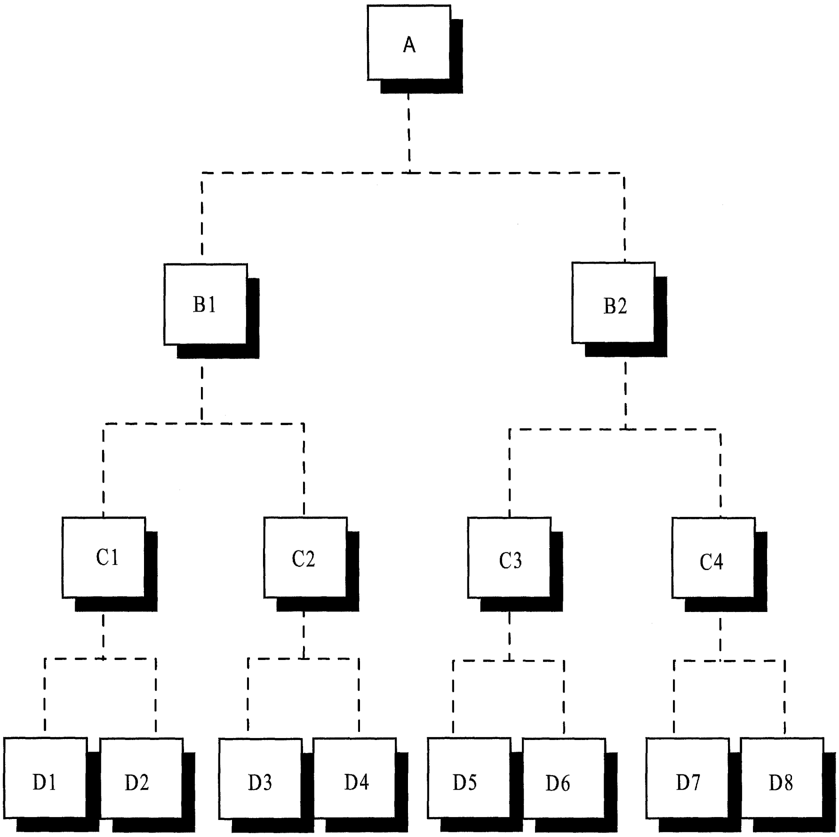
Experimental Results by Structure

Experimental results for the structures are given in Table 1. The structures are taken up in the order given in the table. Results are discussed in light of predictions from resistance equations and alternative predictions.

For NET124, experimental results are an excellent fit to resistance predictions and clearly show that A exercises power-at-a-distance. The results also show that A exercises power locally. The observed means $X = 17.78$ and $Y = 18.89$ indicate that A is benefiting ($P_A = 17.78$) at B's expense ($P_B = 1.11 << 6.\overline{66}$), *and* at C's expense ($P_C = 1.11 << 6.\overline{66}$). In fact, observed means fit resistance predictions well; $X = 17.78$ and $Y = 18.89$ are not significantly different from predicted $X = 18$ and $Y = 19$. The alternative prediction, that power is only local, predicts $P_A = 9$, $P_B = 10$ and $P_C = 1$. Because observed $P_A = 7.78$ and $P_B = 1.11$, the alternative prediction is not supported.

Observed X and Y values for NET122 are significantly different from resistance predictions. Resistance predictions are substantially closer to observed means than are alternative predictions, however. One alternative hypothesis holds that inclusion is not present: B and C are equal in power. If so, observed $X = 14.96$ and $Y = 16.21$ should be very like $X = 17.78$ and $Y = 18.89$ observed for NET124, but they are not. If B and C had been power equals, P_B

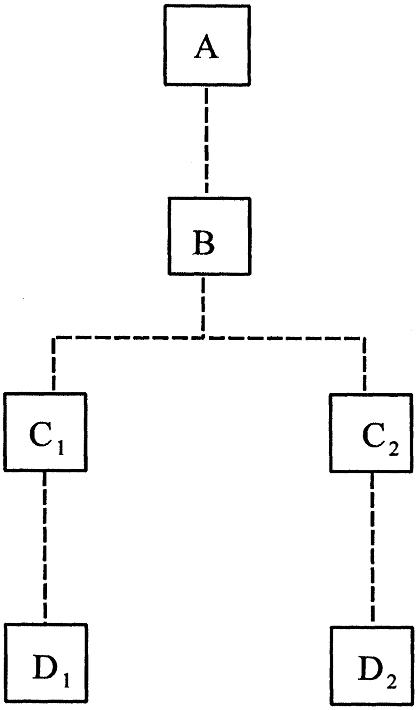
FIGURE 6: NET1248: An Organizational Network with Power between All Four Levels



and P_C would have been numerically equal, but observed $P_C = 3.79$ is more than three times as large as the observed $P_B = 1.25$. The second alternative hypothesis, which reflects an approach founded in neoclassical economic theory, holds that the *B*s are weakened by "sunk costs" and predicts $X = 11.5$ and $Y = 12.5$; but *X* and *Y* are substantially higher. Resistance offers better predictions here than the alternative economic approach.[22] In addition, the prediction from resistance, that *A* exercises both power-at-a-distance over *C* and power locally over *B*, is supported. Finally, that the observed payoff to *B* is substantially lower than observed payoffs to *A* and *C* is consistent with the resistance equations' contention that *B* is squeezed between two more powerful positions.

For NET112, observed means for both *X* and *Y* are significantly different from predictions, but that difference is *not* in a direction supporting the

FIGURE 7: NET1122: A Network with Exclusive Power between Levels Two and Three



alternative prediction, which holds that *A* and *B* are equal in power. Had *A* and *B* been power equals, they would have equally shared the spoils of *B*'s structural advantage over *C*. In fact, *B*'s payoff, $P_B = 5.86$, is less than half of *A*'s payoff, $P_A = 12.76$. Resistance anticipated that *A* would exercise power over *B*, but underestimated the amount of power exercised. The *B* – *C* substructure is strong power, with *B* the high power position and *C*s low. As indicated by $Y = 18.62$, *B* is gaining near the maximum for *Y* of 19 when exchanging with the *C*s. But *A*'s power exercise over *B* is so great that $P_B = 5.86 < 6.\overline{66}$, and *B* just fails to qualify as exercising power. Instead, *A* is exercising power locally over *B* and at a distance over *C*.

In addition to considering each *X* and *Y* prediction individually, it is helpful to look again at the overall power distributions in these networks. The applications of resistance predicted in NET124 that *A* would benefit at the expense of *B*s and *C*s, in NET122 that *A*'s power would not be maximal because the powerless *B* would be unable to push *C* to the extreme, and that in NET112 *A* would share in the spoils as *B* exercised power over the *C*s. That these predictions were all confirmed supports the application of resistance equations employed here.

Power-At-A-Greater-Distance

To find whether the exercise of power can be extended beyond two-step networks and to further test the application of resistance equations in predicting that power exercise, two three-step networks are now investigated. NET1248 of Figure 6 is a straightforward extension of NET124. To $A - B$ and $B - C$ strong power substructures are added $C - D$ strong power substructures. As in each previous step, in the $C - D$ substructures each high power C always excludes one of two low power Ds. Now the widget is worth 30 points to D and the size of the $C - D$ money flow is Z. The payoffs by position are:

$$P_A = X \qquad P_B = Y - X \qquad P_C = Z - Y \qquad P_D = 30 - Z.$$

These are also the payoffs by position in NET1122 of Figure 7, the second three-step network to be investigated. NET1122 is a composite of NET112 (see Figure 5) and NET122 (see Figure 4). Through the first two exchanges it is like NET112, and for the last two exchanges it is like NET122. NET1122 contains a single $B - C$ strong power substructure. For NET1248 and NET1122 both B and C are middlemen; each must sell the widget for more than its cost in order to profit.

Finding whether power exercise is local, at-a-distance, or at-a-greater-distance follows the same logic as before. The position i exercises power over j when i benefits at j's expense. The payoff to any position exercising power will be greater than equipower while the payoff to any position over which power is exercised is less than equipower. Because the widget is worth 30 and there are four positions exchanging, resistance finds that, at equipower, $P_i = 7.5$. For example, when $P_A > 7.5$, $P_B > 7.5$, $P_C < 7.5$, and $P_D < 7.5$, then A is exercising power-at-a-distance over C and at-a-greater-distance over D while B is exercising power locally over C and at-a-distance over D.[23]

Predicting Power-at-a-Greater-Distance in NET1248

Applying resistance to NET1248 is similar to the application to NET124 but with the addition of $C - D$ strong power substructures. Here the widget is worth 30 points and the smallest unit of the money resource is one. Thus Pmax = 30 −1 − 1 − 1 = 27 for any position. Equations 7 and 8 are revised and extended to three resistance equations so that X, Y, and Z are predicted:

$$R^H_{Ab} = \frac{27 - X}{X - X^{t-1}} = \frac{(Y^{t-1} - X^{t-1}) - (Y - X)}{Y - X} = R^L_{Ba} \qquad (7')$$

$$R^H_{Bc} = \frac{27 - (Y - X)}{(Y - X) - (Y^{t-1} - X^{t-1})} = \frac{(Z^{t-1} - Y^{t-1}) - (Z - Y)}{Z - Y} = R^L_{Cb} \qquad (8')$$

TABLE 2: Resource Flows for Power-at-a-Distance in Three Step Networks — Resistance Predictions and Observed Means

Structure	Flow	Prediction	Observed Mean	t	p
NET1248	X	27.0	26.48	1.82	NS
$n = 70$[a]	(B→A)		(2.37)		
	Y	28.0	27.88	.566	NS
	(C→B)		(1.76)		
	Z	29.0	28.65	1.85	NS
	(D→C)		(1.57)		
NET1122	X	15.94	18.59	2.07	< .05
$n = 24$[b]	(B→A)		(6.15)		
	Y	27.07	26.30	1.01	NS
	(C→B)		(3.67)		
	Z	28.07	26.97	1.59	NS
	(D→C)		(3.31)		

Note: Numbers in parentheses are standard deviations.

[a] The 70 periods were obtained from ten groups of seven periods each. Subjects were rotated through positions at the conclusion of each period.

[b] The 24 periods were obtained from twelve groups. Each group participated in two periods, each consisting of ten negotiation rounds. Subjects were rotated through positions at the conclusion of each period.

$$R^H_{Cd} = \frac{27 - (Z - Y)}{(Z - Y) - (Z^{t-1} - Y^{t-1})} = \frac{(27 - Z^{t-1}) - (30 - Z)}{30 - Z} = R^L_{Dc} \quad (9')$$

In each case the factor to the left is for a high power position and the factor to the right is for a low power position. *A* is high in power relative to *B; B* is high in power relative to *C;* and *C* is high in power relative to *D.* To solve, begin with equal power values for $t - 1$ which are $X = 7.5$, $Y = 15$, and $Z = 22.5$. Now there are three equations and three unknowns and the solution is found, as before, by iterating.

Resistance predicts that $X = 27$, $Y = 28$ and $Z = 29$. Therefore, $P_A = 28$, $P_B = 1$, $P_C = 1$, and $P_D = 1$. As in NET124, in NET1248 exclusion in each strong power substructure is predicted to eliminate (or mask) any inclusion and ordering effects. Thus, in NET1248, power is predicted to go to the extreme favoring *A*. But now *A*'s power exercise is predicted to extend through *B* and *C* at a greater distance to *D*.

PREDICTING POWER IN NET1122 WHERE ALL THREE POWER CONDITIONS ARE PRESENT

Because NET1122 is a composite of NET112 and NET122 it combines all three power conditions, ordering, exclusion, and inclusion, in a single structure. Therefore, resistance predictions are derived as they were for those two earlier structures. Adapting equations 10, 8, and 9 to the $A - B$, $B - C$, and $C - D$ substructures respectively,

$$R_{Ab} = \frac{27 - X}{X} = \frac{27 - (Y - X)}{2(Y - X)} = R^{O}_{Ba} \tag{10'}$$

$$R^{H}_{Bc} = \frac{27 - (Y - X)}{(Y - X) - (Y^{t-1} - X^{t-1})} = \frac{(Z - Y^{t-1}) - (Z - Y)}{Z - Y} = R^{L}_{Cb} \tag{8'}$$

$$R^{I}_{Cd} = \frac{27 - (Z - Y)}{2(Z - Y)} = \frac{27 - (30 - Z)}{30 - Z} = R_{Dc} \tag{9'}$$

Resistance predicts $X = 15.94$, $Y = 27.07$, and $Z = 28.07$. As in NET112*A*, acting as gatekeeper, is predicted to gain $P_A = 15.94$ while *B* as high power in the $B - C$ substructure is predicted to gain $P_B = 27.07 - 15.94 = 11.13$. As in NET122, power is being exercised over the last two positions; here $P_C = 28.07 - 27.07 = 1$ and $P_D = 30 - 27.07 = 1.93$. In this case, however, both *A* and *B* are exercising power over *C* and *D*. The alternative prediction is that exclusion is the only power condition present. If so, *A* and *B* are equal in power while *C* and *D* will both be pushed to the minimum payoff: $X = 14$, $Y = 28$, and $Z = 29$.

EXPERIMENTAL DESIGN AND RESULTS

The NET1248 and NET1122 experimental designs are like those of previous experiments. Again ExNET II was employed and again subjects at separate PCs interacted using mouse control. As previously, the network is an important part of the experimental design. For the strong power substructures of NET1248, the *A* subject had two *B* subjects as exclusive alternatives for exchange. When the *A* – *B* exchange was completed, ExNet II automatically connected two *C* subjects to the *B* holding the widget and, upon the completion of the *B* – *C* exchange connected two *D* subjects to the *C* holding the widget. Thus only seven subjects were needed to cover the fifteen positions shown in Figure 6. For NET1122, each session required five subjects, one each in *A* and *B*, two in *C* and one in *D*. Only one *D* is needed because ExNET II automatically connected that subject to the *C* who purchased the widget. For both structures, *A* was allocated one widget each round while *B*, *C*s, and *D*s were allocated 30 $ resources. For NET1248 there were ten sessions each with seven periods: Between periods, subjects were rotated to new positions to produce new parings.

NET1122 had twelve sessions each with two periods between which subjects were rotated to produce new parings. Data are averaged within periods. As in previous structures, the number of data points is exchanges × periods × sessions. Thus there are $3 \times 7 \times 10 = 210$ data points for NET1248 and $3 \times 2 \times 12 = 72$ data points for NET1122.

Experimental results for NET1248 are displayed in Table 2. Resistance predictions are strongly supported. The observed means for *X*, *Y*, and *Z* are not significantly different from their predicted values. Resistance predicts $P_A = 27$ and the observed mean is $P_A = 26.48$. Resistance predicts that *B*s, *C*s, and *D*s benefit minimally and observed values are $P_B = 1.40$, $P_C = .77$, and $P_D = 1.35$.[24] Only *A* exercised power. That is to say, *A* exercised power locally over *B*s, at-a-distance over *C*s and at-a-greater-distance over *D*s. In fact, the exercise of power by *A* over *all* others is not significantly different from the maximum.

Research results for NET1122 also support resistance predictions: *Y* and *Z* were not significantly different from predicted values. *X* is slightly larger than predicted, which indicates that the effect of ordering is stronger than expected, just as it was in NET112. At the same time, the alternative predictions, which assert that exclusion is the only structural power condition present, do not fit NET1122's results well; the predictions which take inclusion and ordering into account are substantially closer to observed values.

Furthermore, results for NET1122 are like a composite of NET112 and NET122. The ordering effect which increases *X* in NET112 beyond equipower similarly increases *X* in NET1122. In fact, both are inflated somewhat beyond predicted values. In NET122, *A* fails to push *X* to the maximum because *B* is weakened by inclusion when exchanging with *C*. The equivalent part of NET1122 finds *B* failing to push *Y* to the maximum because *C* is weakened by inclusion when exchanging with *D*. More generally, experimental results for the three structures are mutually supportive. Results for NET1122 indicate that results for both earlier structures were not accidental, adding further support to resistance predictions.[25]

In NET1122 both *A*'s and *B*'s mean observed payoffs are higher than equipower: $P_A = 18.59 > 7.50$ and $P_B = 7.71 > 7.50$. By contrast payoffs to *C* and *D* are lower than equipower: $P_C = .67$ and $P_D = 3.03$. As predicted, *A* is exercising power at-a-distance over *C* and at-a-greater-distance over *D* while *B*'s very small power exercise is over *C* and *D*.

Discussion

This investigation has extended the scope of Network Exchange Theory beyond the study of local power exercise. New theory predicts local power and power-at-a-distance by dealing with the interdependence of activity across structures as affected by multiple power conditions. For these predictions, resistance equations are applied to an array of contrasting structures and alternative predictions were proposed. In all cases, experimental tests supported resistance predictions over alternatives.

Previously it seemed that theories of network exchange would have little to say about centralized power structures. For example, Cook and colleagues assert a "decentralization principle" such that "networks tend to form into systems organized around multiple foci of power" (302; also see Cook & Emerson 1984). Experimental evidence for their principle was the $A - B - C - B - A$ five actor line discussed earlier where the *B*s were found to be high power and the *C* low power. Marsden's (1983) simulation also found that power was not centralized; he found that middle positions had earnings similar to central positions.[26]

I will now show, however, that power centralization is near its maximum in some of the networks investigated here. Since it does not appear to have previously been given a precise meaning, the first step of the demonstration is to define power centralization. Here power *centralization* is defined in terms of power *concentration* and closeness *centrality*: power centralization is the concentration at the central position of resources gained from exchange.[27] Let power be centralized when power exercise is concentrated in the most central position and let the power concentration, C_i at any position *i* be the ratio of *i*'s payoffs to $P_i$max. Here is the power centralization of three two-step networks as measured by the concentration of power exercise at their central positions: NET124 $C_A = 17.78/18 = .998$; NET122 $C_A = 14.96/18 = .831$; NET112 $C_B = 5.86/18 = .326$

Power is most centralized in NET124, and somewhat less so in NET122. In NET112 power is not centralized because power concentration at A, which is not central, is greater than at *B* that is central ($C_A = 12.76/18 = .709 > C_B = .326$). It is immediately obvious that placing exclusionary strong power substructures at each step, as in NET124, strongly favors power centralization. That it does is seen in NET1248, which, like NET124, has exclusionary strong power substructures at each step, and where $C_A = 26.48/27 = .981$. By contrast, when only one strong power substructure is present, as in NET122 and NET112, power may or may not be centralized as determined by the placement of the substructure in the larger structure.

Because this research shows that power can be highly centralized in exchange networks, to avoid falsification, the decentralization principle needs to be scope-limited to networks in which resources do not flow between positions. Cook and colleagues discovered decentralization in their 5-actor line, but NET122, where power is centralized at *A*, is also a $C - B - A - B - C$ 5-actor line. It appears then that it is not the network's configuration, but the distance that resources can flow — together with the presence and placement of strong power substructures — that determines whether power is centralized.

Theory and results offered here agree with and build on Weber's analysis of power centralization. He focused on the separation of actors from ownership of their positions to find power centralized in bureacracy and decentralized in feudalism ([1918] 1968: 956-1110). Actors who own their positions cannot be excluded from them, whereas actors who are separated from ownership can be excluded. In feudal structures, because all own their positions, there are no strong power substructures. Arguably the feudal hierarchy itself does not produce the power differences of feudal society. Instead, those differences flow from the distribution of estates, the size and numbers of which roughly correspond to status in the hierarchy.[28] By contrast, in Weber's ideal type bureaucracy, exclusion is by dismissal and, because lower officials are separated from ownership of their positions and excludable by their superiors, there are strong power substructures linking each pair of levels. Dismissal is still a form of exclusion today and ownership of position is still important. For example, Pfeffer cites Ford hiring then firing Knudson and hiring and then firing Iacocca as instances of the "power of position" (1992:127).[29]

Whereas Weber's theory and theory offered here are consistent, for now comparisons of the two should be considered tentative at best. Certainly power exercised through a hierarchy gives a different appearance from power exercise in the experimental structures studied here. If anything, the experimental structures are more like industrial networks where power is exercised horizontally. Today, the study of power-at-a-distance has only begun. For the future, we can be consoled that appearances alone are not decisive in limiting the predictive power of theory. At issue instead is whether the cases in question share common theoretical qualities. For example, previous research on local power exercise in exchange networks found that exchange relations and resource pool relations, though they do not give the same appearance, are affected similarly by power conditions.[30] By extension, to explain power-at-a-distance inside and outside the laboratory, we should look to evidence of strong power substructures and to structural power conditions of exclusion, inclusion and ordering before rejecting theory application because the appearances of the relations and structures differ.

Furthermore, future work may show that inclusion and ordering help to explain power conditions frequently found in contemporary organizations. It is well known that middle managers, who cannot discharge subordinates, face special difficulties. Middle managers may be formally superordinate, but, like the middle *B* in NET122, are squeezed between a high power superior and a subordinate not weakened by exclusion. For academics the obvious example is the unenviable position of department chair at research universities. The chair can be demoted by the dean but cannot discharge professors. By contrast, ordering may contribute to power-at-a-distance. In NET112, ordering allowed *A* to exercise power over the *B*s and at-a-distance over the *C*s. Because they act as gatekeepers controlling the flow of resources entering state agencies, division heads and/or governing boards of those agencies, like *A* in NET112, may be powerful because they are advantaged by ordering.

Based on earlier forms of social exchange theory, the resource dependence perspective (see Aldrich 1976; Cook 1977; Jacobs 1974; Pfeffer & Salancik 1978; Provan, Beyer & Kruytbosch 1980) analyzes power extending horizontally across networks of organizations. This research might offer important refinements to that perspective. In Jacobs's (1974) founding paper, there are "two components of dependence" (51), first "the number of alternative suppliers" (50) and second the "substitutability . . . or . . . essentiality of a good or service to a particular organization" (50). The theory of this article sees alternative suppliers as offering opportunities for exclusion while essential goods and services are bases for inclusion. Furthermore, theory offered here suggests that resource dependence must look beyond the alternatives of any focal organization to whether the focal organization is itself an alternative for others. For example, in both NET112 and in NET124, *B*s have a single supplier in *A* and sell to two *C*s. Nevertheless, the *B*s in NET124 are much weaker because each is an alternative for *A*.

Though this is the first study to apply formal theory to indirect power and to experimentally test it, something has already been learned. For example, it was found that power-at-a-distance is little attenuated when extended beyond two to three steps as long as strong power substructures are found at each step. Further, this research is the first to find that ordering and inclusion facilitate and inhibit the extension of power exercise. Relations between power-at-a-distance and power centralization have been formalized allowing the structural conditions which centralize power to be differentiated from conditions which decentralize it. It was also shown that there is no general principle of power decentralization across all exchange networks. Finally, for all structures studied here, middlemen were disadvantaged. Nevertheless, no general principle that "All middlemen are disadvantaged" will be proposed. As suggested below, networks can be built where middlemen should be advantaged.

More generally, it has been shown here that varying amounts of power-at-a-distance can be predicted across contrasting structures and that investigation of those predictions is tractable to laboratory experimentation. In fact, the theory of this investigation points to a program of new research. Future work could include:

- The investigation of strong power structures working in opposed directions. All middle positions studied here were weak, but not all need be weak. Using the terminology developed here, in NET212 the middle position is high power in both its strong power substructures. It should gain payoffs near its maximum.
- The study of power-at-a-greater-distance. This research has shown that power exercise is not substantially attenuated at three steps, but only

when there is a strong power substructure at each step. Is power attenuated at four or more steps? Alternatively, can some amount of power-at-a-distance be extended beyond two steps when only the initial step is a strong power substructure?

- The inquiry into power stability and legitimacy. When applied to power in hierarchies, this research raises questions concerning whether power-at-a-distance can be stable without legitimacy. Certainly Weber asserted that power in hierarchies could not ([1918] 1968:213, 954). Unfortunately, little is known about power stability in exchange networks. While well suited to the study of power, its experimental designs have been ill suited to investigate stability.[31] Nevertheless, Legitimacy Theory is well developed (Dornbusch & Scott 1975; Thomas, Walker & Zelditch 1986; Walker, Rogers & Zelditch 1988; Zelditch & Walker 1984). Since recent work by Walker and colleagues (2000) points to how legitimacy theory applies to power in exchange networks, the issue of stability can now be investigated — an investigation which should enrich both theories.
- The examination of the effect of coalitions on the extension of power. Investigating strong power structures, Simpson and Macy (2001) have shown that coalitions can countervail power over their members. In networks with power-at-a-distance, coalitions could have further effects. A coalition which countervails power at one step may well block power exercise for all subsequent steps. Alternatively, that coalition could clear the way for its members to benefit from subsequent power exercise.

Notes

1. Sometimes public officials do not obey duly elected officials. The classic study of elected officials failing to institute their policies because of bureaucratic resistance is Lipset's (1950) investigation of agrarian socialism.

2. Compare Hall (1999:110), Mintzberg (1983:143), Perrow (1986:259), Pfeffer 1992, and Scott (1998:199).

3. See Willer (1992) for an explication of the predictive logic common to competing theories. This discussion is not intended to suggest that there are no interdependencies in resource pool networks (see the discussion of distal effects below), only that the interdependencies of power-at-a-distance pose new problems for theory.

4. The theory applied and extended here is Network Exchange Theory (NET). As a result of a series of experimental studies, today its scope is substantially broader than it was ten years ago. NET is a multilevel theory so actor, relational and structural scope conditions are stated separately. Studies focusing only on exclusionary networks have frequently used an "adjusting" actor which raises offers when excluded and lowers offers when included (Markovsky, Willer & Patton 1988; Thye, Lovaglia & Markovsky 1997). For game

theoretic analyses, a minimally rational actor capable only of accepting its best offer has been used (Willer & Skvoretz 1997b). Here and in other articles when a variety of structural power conditions are encountered, a strategically rational actor is employed which seeks to maximize and, when negotiating with other actors, settles at equiresistance (Willer 1981, 1999; Willer & Skvoretz 1997a). Normally, actors' values and beliefs reflect the structures in which they act; but more complex models for false beliefs are readily constructed. Social relations to which NET has been fruitfully applied include resource pool relations (Lovaglia et al. 1995), coercive relations (Willer 1987) and, as here, exchange relations where resources are alienated and appropriated (Brennan 1981; Willer 1987). Structural conditions of power to which NET has been previously applied include exclusion, inclusion, and ordering as in this study, together with null connection, hierarchy/mobility, and analogs of these conditions for coercive structures.

5. These comments are not critical of Stolte and Emerson (1977), an important paper which instituted the investigation of structural power conditions. To the contrary, their paradigm has performed an important service by offering a level playing field on which competing theories have been tested.

6. Beyond precluding power-at-a-distance, there are other important differences between resource pools and the exchanges for which they were substituted. For example, as Van Assen (2001) has pointed out, the payoff matrices of only some not all exchanges correspond to those of resource pools.

7. In the Yamagishi et al. (1988) experiments a large proportion of exchange resources are not accounted for in the analysis. In experiment 1, a total of 1500 units of each resource were input in each experiment. As they explained, for each of "60 transaction periods, 25 units of *x* were given by the computer to the occupant of position A_1 and 25 units of *y* to the occupant of position A_2" (842). And 60 x 25 = 1500 total possible points. Examination of results shows that the subjects of each experimental session together averaged only 460 points, which is less than 1/3 of the total possible. Yamagishi, Gillmore, and Cook do not report on location of the 1500 – 460 = 1040 missing units of *x* and *y* in experiment 1. In their experiment 2 the location of about half of the input resources are not reported. Without knowing the location of the missing resources, it is difficult to understand why some positions scored better than others.

8. In the experiments there were a number of time periods called rounds for negotiation and exchange. In NET124 for each round, *B* and *C* were allocated 20 $ units. After the first round, A, *B*, and *C* retained all unused $ units. As payoffs accumulated, *B* and *C* began rounds with more and more units of $. So it was technically possible to pay more than 20 for the widget, thus taking a loss. Actually payoffs accumulated across the rounds of each period similarly in all of the experimental designs. Period means indicate that subjects in NET124 never took losses over a period; and only once did a subject in *C* pay an average of 20 for a period, thus breaking even. In NET1248, subjects broke even in four periods and only in one period did a subject take a loss.

9. This article does not assert that two resources flowing in opposite directions are necessary for power-at-a-distance. Instead it asserts that, since power can occur only between positions which contend for resources, to extend power beyond local exercise, resources need to move across structures (see above). As one anonymous reviewer points

out, the resource pool design could be extended by making divisions sequential such that the quantity gained by *B* when dividing with *A* is the amount divided by *B* and C. Certainly such a system could be made workable, but only if a division with *C* is required of *B* — for otherwise any rational *B* would simply keep all that had been gained from the *A* – *B* division. While this extension may have certain advantages, it has the disadvantage, like all resource pool designs, of being far removed from exchange relations outside the laboratory.

10. Since $P_A = X$, $P_B = Y - X$ and $P_C = 20 - Y$, $P_A + P_B + P_C = X + Y - X + 20 - Y = 20$.

11. Here equal power is not defined as equal payoffs for that would make a direct comparison of utilities, which is not legitimate. Below I calculate equal power payoffs from equal resistance for equipower resistance expressions and make only ratio comparisons of payoffs, thus avoiding a comparison of utilities. That payoffs are then numerically equal is a conclusion, not the criterion.

12. Not mentioned is the condition when $P_B = 6.\overline{66}$, a value which indicates that *B* is at equipower. Again the size of *B*'s payoff is irrelevant to *A*'s power exercise over *C*. Let *V* be the value of the widget to the *n*th position. When $P_B = V/n$, $P_A > V/n$ and $P_C < V/n$, the increment of A's payoff above equipower can only have stemmed from C.

13. Since $P_B = Y - X$, when *B* buys the widget for *X* , *B* must sell it for $Y > X$ to profit.

14. That research includes successfully predicting payoffs in strong and weak power structures (Lovaglia et al. 1995; Skvoretz & Willer 1993), inclusively connected networks (Patton & Willer 1990), networks with mixed connections (Willer & Skvoretz 1997a), cross-national investigations (Willer & Szmatka 1993) and coercive structures (Willer 1987). Also see note 4 above.

15. Though it has been suggested that the core be applied to these networks, Shibik (1982) suggest that the core does "not adapt with ease even to the finite extensive form, let alone infinite-horizon games" and that "any attempt to model in extensive form is tantamount to specifying process" (286). In fact, the experiments that test predictions are iterated games while resistance captures elements of power processes that the core cannot.

16. To reiterate, Pmax is the actor's best hope. There are three positions and the least any will accept is one. Total payoff across the network is 20. Thus for any position, Pmax = 20 – 1 – 1 = 18.

17. Applications of resistance to strong power structures like this include Willer and Markovsky (1993) and Willer (1999).

18. While this iterative solution reflects the step-by-step development of power so frequently observed in strong power structures, this article seeks to predict equilibrium exchange ratios, not the rate of change of power over time.

19. After the first round, *A*, *B* and *C* retained all unused $ units. As payoffs accumulated, *B* and *C* began rounds with more and more units of $. Thus it was technically possible to pay more than 20 for the widget. Only in NET124 was one period mean for Y = 20, but none was higher.

20. Experiments were conducted at a large state university using undergraduate subjects. A panel of 42 subjects was recruited and organized into six experimental groups of seven subjects each. If all seven subjects attended the session, five were selected randomly for the experiment. Each week subjects were shuffled among groups generating new groupings. Since subjects could not identify others by position, no subject could infer with whom s/he was negotiating. The first six of nine sessions each used a new group of five subjects. For each of the three further sessions, four subjects were new and one overlapped from one of the first groups.

21. Rotating subjects through positions has been used for more that twenty years to control for individual differences. Controlling for individual differences by rotation allows stronger inferences from power differences by position to structural conditions. By generating new subject pairings, each session gives more than one datum point. Lovaglia and colleagues (1995) find that mean payoffs by position are not significantly different when subjects are rotated and when they are held in a single position.

22. In fact, Y is 10.4% smaller than predicted, which indicates that the effect of inclusion is *stronger* than predicted. This result is not exceptional. Willer and Skvoretz (1997a) studied five different inclusive structures and they found inclusion effects to be 14.8% stronger than predicted. Thus far, no one has proposed an alternative method to increase the precision of predictions for effects of inclusion (or ordering), but one direction could be suggested. Tversky and Kahneman (1992) found that losses have stronger effects than gains while Thye, Lovaglia, and Markovsky 1997 found that being excluded (a loss) had more effect than being included (a gain). If their findings apply, the potential losses given by the negative Pcon values through which inclusion effects are calculated will need to be adjusted by a constant (larger than 1) to more accurately reflect their effects.

23. That two positions can jointly exercise power was already seen in NET112, where A and B were predicted to exercise power over C. (See Table 1.)

24. $P_C = .77$ is smaller than one because C was not always successful in selling the widget for more than was paid for it. Because the exchanges in these networks occur as repeated games, the rationality of exchanging should be evaluated, not for each exchange individually, but across exchanges. Because $P_C = .77$ is greater than $P_C = 0$, it is not irrational for C to buy the widget and occasionally not profit when the alternative is not to buy and never to profit.

25. As explained earlier, to facilitate comparisons to NET1248, predicted and observed values for NET1122 are rescaled from widget = 20 to widget = 30 points. Prior to rescaling $X = 10.01$, $X_o = 11.64$ and $sd_x = 3.86$, $Y_p = 17.11$, $Y_o = 16.63$ and $sd_y = 2.32$ while $Z = 18.11$, $Z_o = 17.42$ and $sd_z = 2.13$.

26. For his simulation, Marsden hypothesizes that positions with many connections to others are price makers who set exchange ratios for those with fewer connections who are price takers (1983:703-4; also see Marsden 1982). That is to say, relative degree determines relative power. By the terminology used here, Marsden's network is NET136 where the central A with three Bs is degree 3 and the Bs each connected to A and two Cs are also degree 3. Each C is degree 1. Since relative degree determines relative power, the simulation found that central and middle positions have similar payoffs while payoffs of peripherals are lower. It has been known since Markovsky, Willer and Patton (1988),

however, that degree is *not* a power condition which suggests that the simulation will not accurately predict power events in exchange structures. For example, NET122 studied here is analogous to Marsden's NET136 in that degree of *A* and each *B* is the same (at two) while degree of each *C* is less (at one). Presumably, the simulation would find power to be ordered $A = B > C$ whereas theory and experimental results reported here show the order to actually be $A > C >$ B.

27. I use the index for "closeness centrality," which is the reciprocal of sum of the distance of shortest paths from a node to all other nodes of the network. For example, in NET124 and NET1248, *A* has the largest index and is most central. Closeness centrality is particularly easy to find for the networks studied. Because all are tree networks, there is only one path from any *i* to any *j*. (A tree is an acyclic connected network. There is no path from any node *i* which connects back to *i*.) *A* is also the Jordon Center for both. For closeness and Jordon Center, see Wasserman and Faust (1994:184-85). Since all networks studied here are trees, closeness centrality and Jordon Center agree for all.

28. While not producing power differences, feudal hierachies may well have produced differential influence. Status Characteristics Theory suggests that status differences in feudal hierarchies produced influence relations from top to bottom. See Willer, Lovaglia, and Markovsky (1997) and Bell, Walker, adn Willer (2000).

29. See also the case study cited by Kotter (1989:493).

30. As Cook, Molm, and Yamagishi point out, "negative connection" and "exclusion" refer to the same power condition (1993: 313). That condition has theoretically similar effects in the structures composed of resource pool relations studied by Stolte and Emerson (1977), Cook and Emerson (1978) and Cook and colleagues (1983) as in the structures composed of exchange relations studied by Brennan (1981) and Willer (1987).

31. In the design used by Cook and associates (1993), subjects are given information only on payoffs to self. Not being able to compare payoffs of self to others, subjects do not know when power is being exercised over them. In the design by Willer and associates, subjects know when power is being exercised because they know payoffs to self and others. Being rotated across positions, however, each subject has an equal opportunity to exercise power and to be subject to its exercise.

References

Aldrich, Howard. 1976. "Resource Dependence and Interorganizational Relations: Local Employment Services Offices and Social Services Sector Organizations." *Administration and Society* 7:419-54.

Barnard, Chester. 1956. *The Functions of the Executive*. Harvard University Press.

Bell, Richard, Henry Walker and David Willer. 2000. "Power, Influence, and Legitimacy in Organizations: Implications of Three Theoretical Research Programs." Pp. 131-78 in *Organizational Politics,* edited by Samuel B. Bacharach and Edward Lawler. JAI Press.

Bienenstock, Elisa Jayne, and Phillip Bonacich. 1992. "The Core as a Solution to Exclusionary Networks." *Social Networks* 14:231-44.

———. 1993. "Game-Theory Models for Exchange Networks: Experimental Results." *Sociological Perspectives* 36:117-35.

Bonacich, Phillip. 1992. "Power in Positively Connected Exchange Networks: A Critical Review." *Advances in Group Process* 9:21-40.

Bonacich, Phillip, and Elisa Bienenstock. 1995. "When Rationality Fails." *Rationality and Society* 7:293-320.

Brennan, John S. 1981. "Some Experimental Structures." Pp. 189-204 in *Networks, Exchange and Coercion,* edited by David Willer and Bo Anderson. Elsevier/Greenwood.

Clower, Robert, and John Due. 1972. *Macroeconomics.* Richard Dorsey.

Cook, Karen S. 1977. Exchange and Power in Networks of Interorganizational Relations." *Sociological Quarterly* 18:62-82.

Cook, Karen S., and Richard M. Emerson. 1984. "Exchange Networks and the Analysis of Complex Organizations." Pp. 1-30 in *Research in the Sociology of Organizations,* vol. *3,* edited by Samuel Bacharach and Edward J. Lawler. JAI Press.

Cook, Karen S., Richard M. Emerson, Mary R. Gillmore, and Toshio Yamagishi. 1983. "The Distribution of Power in Exchange Networks: Theory and Experimental Results." *American Journal of Sociology* 89:275-305.

Cook, Karen S., Linda Molm, and Toshio Yamagishi. 1993. "Exchange Relations and Exchange Networks: Recent Developments in Social Exchange Theory." Pp. 296-322 in *Theoretical Research Programs: Studies in Theory Growth,* edited by Joseph Berger and Morris Zelditch Jr. Stanford University Press.

Cook, Karen S., and Toshio Yamagishi. 1992. "Power in Exchange Networks: *A* Power-Dependence Formulation." *Social Networks* 14:245-66.

Corra, Mamadi. 2000. "Ordering as a Structural Power Condition." Paper presented at the American Sociological Association Meeting. Washington, D.C.

Corra, Mamadi, and David Willer. 2002. "The Gatekeeper." *Sociological Theory* 20:180-207.

Dahl, Robert. 1957. "The Concept of Power." *Behavioral Science* 2:201-18.

Dornbusch, S.M., and W. R. Scott. 1975. *Evaluation and the Exercise of Authority.* Jossey-Bass.

French, J.R.P. 1956. "A Formal Theory of Power." *Psychological Review* 63:181-94.

Friedkin, Noah E. 1992. "An Expected Value Model of Social Power: Predictions for Selected Exchange Networks." *Social Networks* 14:213-30.

———. 1993a. "An Expected Value Model of Social Exchange Outcomes." Pp. 163-93 in *Advances in Group Processes,* vol. 10 edited by E.J. Lawler, B. Markovsky, K. Heimer, and J. O'Brien. JAI Press.

———.1993b. "Structural Bases of Interpersonal Influence in Groups." *American Sociological Review* 58:861-72.

Hall, Richard. 1999. *Organizations: Structures, Processes and Outcomes.* Prentice-Hall.

Jacobs, David. 1974. "Dependency and Vulnerability: An Exchange Approach to the Control of Organizations." *Administrative Science Quarterly* 19:45-59.

Kalai, E., and M. Smorodinsky. 1975. "Other Solutions to Nash's Bargaining Problem." *Econometrica* 43:513-18.

Kotter, John P. 1989. "Power, Dependence and Effective Management." Pp. 487-99 in *Classic Readings in Organizational Behavior,* edited by J. Steven Ott. Brooks/Cole Publishing.

Krackhardt, David. 1990. "Assessing the Political Landscape: Structure, Cognition, and Power in Organizations." *Administrative Science Quarterly* 35:342-69.

Lipset, Seymour Martin. 1950. *Agrarian Socialism.* University of California Press.

Lovaglia, Michael, John Skvoretz, David Willer, and Barry Markovsky. 1995. "Negotiated Outcomes in Social Exchange Networks." *Social Forces* 74:123-55.

Lukes, Steven. 1974. *Power: A Radical View.* Macmillan.

Markovsky, Barry. 1992. "Network Exchange Outcomes: Limits of Predictability." *Social Networks* 14:267-86.

Markovsky, Barry, David Willer, and Travis Patton. 1988. "Power Relations in Exchange Networks." *American Sociological Review* 53:220-36.

Marsden, Peter V. 1982. "Brokerage Behavior in Restricted Exchange Networks." Pp. 201-18 in *Social Structure and Network Analysis,* edited by P.V. Marsden and N. Lin. Sage Publications.

———. 1983. "Restricted Access in Networks and Models of Power." *American Journal of Sociology* 88:686-717.

Mintzberg, Henry. 1983. *Power in and around Organizations.* Prentice-Hall.

Nagel, Jack. 1968. "Some Questions about the Concept of Power." *Behavioral Science* 13:129-37.

Newman, Peter. 1965. *The Theory of Exchange.* Prentice-Hall.

Patton, Travis, and David Willer. 1990. "Connection and Power in Centralized Exchange Networks." *Journal of Mathematical Sociology* 16:31-49.

Perrow, Charles. 1986. *Complex Organizations: A Critical Essay.* McGraw-Hill.

Pfeffer, Jeffrey. 1992. *Managing with Power.* Harvard Business School Press.

Pfeffer, Jeffrey, and Gerald Salancik. 1978. *The External Control of Organizations.* Harper & Row.

Pfiffner, John, and Frank Sherwood. 1960. *Administrative Organization.* Prentice-Hall.

Provan, Keith, Janice M. Beyer, and Carlos Kruytbosch. 1980. "Environmental Linkages and Power in Resource-Dependence Relations between Organizations." *Administrative Science Quarterly* 25:200-25.

Raiffa, Howard. 1953. "Arbitration Schemes for Generalized Two-Person Games." In *Contribution to the Theory of Games. II: Annuals of Mathematics Studies,* edited by H. Kuhn and A. Tucker. Princeton University Press.

Robinson, Joan. [1933] 1969. *The Economics of Imperfect Competition.* Macmillan.

Salancik, Gerald R. 1986. "An Index of Subgroup Influence in Dependency Networks." *Administrative Science Quarterly* 31:194-211.

Scott, W. Richard. 1998. *Organizations: Rational, Natural, and Open Systems.* Prentice-Hall.

Shibik, Martin. 1982. *Game Theory in the Social Sciences: Concepts and Solutions.* MIT Press.

Simon, Herbert A. [1947] 1976. *Administrative Behavior.* Free Press.

Simpson, Brent, and Michael Macy. 2001. "Embedded Social Dilemmas: Low-Power Coalitions in Exchange Networks." *Social Psychology Quarterly* 64:88-100.

Simpson, Brent, and David Willer. 1999. "A New Method for Finding Power Structures." Pp. 270-84 in *Network Exchange Theory,* edited by David Willer. Praeger.

Skvoretz, John, and David Willer. 1993. "Exclusion and Power: A Test of Four Theories of Power in Exchange Networks." *American Sociological Review* 58:801-18.

Stolte, John, and Richard M. Emerson. 1977. "Structural Inequality: Position and Power in Exchange Structures." Pp.117-38 in *Behavioral Theory in Sociology,* edited by Robert J. Hamblin and John H. Kunkel. Transaction Books.

Szmatka, Jacek, and David Willer. 1995. "Exclusion, Inclusion and Compound Connection in Exchange Networks." *Social Psychology Quarterly* 58:123-31.

Thomas, George M., Henry A. Walker, and Morris Zelditch Jr. 1986. "Legitimacy and Collective Action." *Social Forces* 65:378-404.

Thompson, Victor. 1961. *Modern Organization.* Knopf.

Thye, Shane, Michael Lovaglia, and Barry Markovsky. 1997. "Responses to Social Exchange and Social Exclusion in Networks." *Social Forces* 75:1031-49.

Tversky, A., and D. Kahneman. 1992. "Advances in Prospect Theory: Cumulative Representation of Uncertainty." *Journal of Risk and Uncertainty* 5:297-323.

Van Assen, M.A.L.M. 2001. "Two Representations of Negotiated Exchange: A Review and Comparison." Pp. 137-81 in *Essays on Actor Models in Exchange Networks and Social Dilemmas,* edited by M. Van Assen. Groningen, The Netherlands: RUG.

Walker, Henry A., Larry Rogers, and Morris Zelditch Jr. 1988. "Legitimacy and Collective Action." *Social Forces* 67:216-28.

Walker, Henry A., Shane Thye, Brent Simpson, Michael Lovaglia, David Willer, and Barry Markovsky. 2000. Network Exchange Theory: Recent Developments and New Directions." *Social Psychology Quarterly* 63:324-37.

Wasserman, Stanley, and Katherine Faust. 1994. *Social Network Analysis: Methods and Applications.* Cambridge University Press.

Weber, Max. [1918] 1968. *Economy and Society.* University of California Press.

Willer, David. 1981. "The Basic Concepts of Elementary Theory." Pp. 25-53 in *Networks, Exchange and Coercion,* edited by David Willer and Bo Anderson. Elsevier/Greenwood.

———. 1987. *Theory and the Experimental Investigation of Social Structures.* Gordon & Breach.

———. 1992. "Predicting Power in Exchange Networks: A Brief History and Introduction to the Issues." *Social Networks* 14:187-212.

———. 1999. *Network Exchange Theory.* Praeger.

Willer, David, Michael Lovaglia, and Barry Markovsky. 1997. "Power and Influence: A Theoretical Bridge." *Social Forces* 76:571-604.

Willer, David, and Barry Markovsky. 1993, "The Theory of Elementary Relations: Its Development and Research Program." Pp. 323-63 in *Theoretical Research Programs: Studies in Theory Growth,* edited by Joseph Berger and Morris Zelditch Jr. Stanford University Press.

Willer, David, and John Skvoretz. 1997a. "Network Connection and Exchange Ratios: Theory, Predictions and Experimental Tests." Pp. 199-234 in *Advances in Group Process,* vol. 14, edited by Barry Markovsky, Michael Lovaglia, and Lisa Troyer. JAI Press.

———. 1997b. "Games and Structures." *Rationality and Society* 9:5-35.

Willer, David, and Jacek Szmatka. 1993. "Cross-National Experimental Investigations of Elementary Theory: Implications for the Generality of the Theory and the Autonomy of Social Structure." Pp. 37-81 in *Advances in Group Processes,*vol. 10, edited by Edward J. Lawler, Barry Markovsky, Karen Heimer, and Jodi O'Brien. JAI Press.

APPENDIX: Axioms for Power-at-a-Distance

The position *i* exercises power over *j* when *i* benefits at *j*'s expense. When *i* is exercising power, its payoff is *greater* than at equal power. To determine whether *A*'s power is local, power-at-a-distance, or both, find the position(s) *j, k, . . . z* which are the source of *i*'s payoff increment; their payoffs will be *less* than equipower. The following criteria formalize these points. Here n is the number of positions in the sequence and V is the value of the widget to the last position. It is shown in the text that, at equipower, $P_A = V/n$, $P_B = V/n$ and $P_C = V/n \ldots$; thus $X = V/n$, $Y = 2V/n$, $Z = 3V/n \ldots J = (n-1)V/n$.

The following criteria define local power and power-at-a-distance when $n = 3$ which covers the five networks of Table 1. When $V = 20$, the equipower baseline gives $X = 6.66$ and $Y = 13.33$; thus $P_A = 6.66$, $P_B = 6.66$, and $P_C = 6.66$. Payoffs for the Table 1 networks are given in parentheses.

1. Iff $X > V/n$ & $P_B < V/n$, *A* is exercising power locally over *B* because *A* is benefiting at *B*'s expense ($X > 6.66$ & $P_B < 6.66$).
2. Iff $P_B > V/n$ & $P_C < V/n$, *B* is exercising power locally over *C* because *B* is benefiting at *C*'s expense ($P_B > 6.66$ & $Y > 13.33$).
3. Iff $X > V/n$ & $P_C < V/n$, *A* is exercising power at-a-distance over C. Because some of *A*'s payoff is from *C*, *A* is benefiting at *C*'s expense and at a distance ($X > 6.66$ & $Y > 13.33$).

Further criteria are added when longer networks like NET1248 are encountered. These criteria define power exercise only in the *A* —> *B* —> *C* direction. Criteria for power in the *C* —> *B* —> *A* direction apply the same two rules: (1) determine whether the position is benefiting more than at equipower and (2) locate the position(s) benefiting less than equipower which are the source of the benefit.

Willer, David, Shane Thye, Brent Simpson, Michael Lovaglia, Henry Walker, Barry Markovsky, and Robb Willer. 2002. "Network Exchange." Pp. 109-144 in *New Directions in Sociological Theory: The Growth of Contemporary Theories,* edited by Joseph Berger and Morris Zelditch Jr. Rowman & Littlefield.

Yamagishi, Toshio, Mary R. Gillmore, and Karen S. Cook. 1988. "Network Connections and the Distribution of Power in Exchange Networks." *American Journal of Sociology* 93:833-51.

Zelditch, Morris, Jr. 1992. "Interpersonal Power." Pp. 994-1001 in *Encyclopedia of Sociology* edited by Edgar F. Borgatta and Marie L. Borgatta. Macmillan.

Zelditch, Morris, Jr., and Henry Walker. 1984. "Legitimacy and the Stability of Authority." Pp. 1-25 in *Advances in Group Process,* vol. 1, edited by Edward J. Lawler. JAI Press.