

Why Knowledge Does Not Equal Power:
The Network Redundancy Trade-Off¹

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Abstract

We show that if actors are defined as more knowledgeable when they possess more information, and if actors are defined as more powerful when they can extract greater surplus while exchanging resources, there is a fundamental trade-off in the social structural foundations of power and knowledge. This trade-off derives from the opposing implications of having redundant (i.e., directly or indirectly linked) contacts. Insofar as ego's alters are nonredundant, ego can be expected to obtain more knowledge more quickly. And such nonredundancy can also be the basis for great power as ego monopolizes the flow of knowledge between ego's alters. However, the very same mechanism that is behind ego's power as a *provider* of knowledge-- i.e., the possession of nonsubstitutable knowledge on the part of disconnected contacts-- also implies that that ego's alters will themselves be monopolists, thus weakening ego as an *acquirer* of knowledge. Furthermore, while the surplus earned from providing knowledge on monopoly terms is potentially much greater than the surplus earned from acquiring knowledge on competitive terms, the former strategy carries the risk that socially distant actors will not value one another's knowledge. Beyond elucidating the trade-off in the social structural foundation of knowledge and power, our framework also shows how the opposing implications of redundancy are the basis for a broad family of well-known trade-offs (cosmopolitanism vs. localism; exploration vs. exploitation; insider vs. stranger; robust vs. simple identities) whose relationships with one another and with power and knowledge has not been appreciated. For all such tradeoffs, the greater returns afforded by nonredundancy are balanced by the surer returns available from redundancy.

I. Introduction

Does knowledge equal power? While this question is too imprecise to be evaluated systematically, a social structural reframing makes it both more tractable and more salient: *Do the positions in social (network) structure that confer the most power on an actor also grant her with the most knowledge?* This framing of the matter follows naturally from the recognition that both knowledge and power are rooted in social structure. The social structural foundations of power are clear in virtually any definition of power, but especially if we adopt Emerson's view (1962) that the power of one actor over another reflects the dependence of the second on the first, with such dependence decreasing in the availability of alternative sources for the valued resources controlled by the first. The distribution of power thus reflects the structure of exchange opportunities.

The social structural foundations of knowledge are less obvious, in part due to the difficulty of defining what is meant by knowledge and in part due to the fact that it seems possible to obtain some forms of knowledge without interacting with others. And yet, it is widely understood that many important "bits" of knowledge flow through social relations and that certain positions provide better access to such knowledge-flows. Granovetter's (1973) classic argument concerning "the strength of weak ties" is noteworthy in this regard, both for illustrating the social structural foundations of knowledge and for providing a compelling answer to the second part of our question—i.e., the structural positions that are most knowledgeable are those that "bridge" separated social worlds. For instance, it seems clear that if ego in figure 1 wishes to become more knowledgeable, she should build her network according to the NR-strategy, which maximizes nonredundancy among (or social distance between) alters. Insofar as knowledge flows (slowly) through social relations, each cluster (e.g., group, organization, market, or neighborhood) will tend to contain different pools of knowledge, which in turn implies that ego's access to knowledge will be increasing in the number of clusters she can reach. An R-strategy, by contrast, seems inferior because ego's alters would all provide access to the knowledge that has pooled in cluster 1, and none of them provide access to the knowledge in the rest of the network.

The clear and compelling prediction that a network position built following an NR-strategy will optimize ego's knowledge allows us to frame our question more

concretely: *Is such a position also optimal for increasing her power?* Burt's structural holes theory (1992, 2005), which is the first and most systematic attempt to address our question, argues persuasively ego should pursue the NR-strategy regardless of whether she seeks power (labeled "control") or knowledge ("information"). To see the logic behind Burt's reasoning, suppose that each of the clusters in figure 1 were a different region of the world economy. An actor who successfully executed the NR-strategy would not only be very knowledgeable but she would also be a unique middleman, rendering these regions dependent on her for facilitating exchange among them. And such dependence would give her the power to extract surplus in return for such facilitation (Emerson 1962). By contrast, an actor who followed the R-strategy would neither be able to access the knowledge dispersed throughout the world, nor would she have the ability to act as a monopolist. Thus, both knowledge and power seem to be decreasing in the redundancy of ego's alters. The social structural foundations of knowledge and power seem identical.

FIGURE 1 ABOUT HERE

Yet while Burt's approach provides a compelling answer to our question, it also carries an unrecognized implication that leads to the very opposite answer under exactly the same conditions. Indeed, *the very same mechanisms* that produce the described identity in the social structural foundations of power and knowledge also produce a contradiction or trade-off in these foundations. The key to discerning this trade-off is to recognize a crucial assumption embedded in the previous paragraph—i.e., that the resources circulating in each of the clusters differ not only in content but in being *nonsubstitutable* for one another. If the knowledge that circulates in each cluster is the same as-- or even merely regarded as equivalent to-- the knowledge in the first cluster, there is no basis for expecting the NR-strategy to make ego more knowledgeable. Furthermore, ego can hardly charge monopoly prices for transmitting knowledge—or other resources-- between clusters if members of each cluster can obtain equivalent knowledge locally.

And yet, *while nonsubstitutability in the resources held by and available to one's alters is the foundation of ego's power as a transmitter of resources, it undermines her power as an acquirer of resources.* Consider what it takes to *obtain* a valuable resource

on favorable terms. Again following Emerson (1962), ego's power is greater when she has numerous alternative exchange partners. And such exchange partners will only be true alternatives if these alters are *good substitutes* for one another as sources of a good or service that ego desires. Unless each alternative can be substituted for the others, ego's dependence (power) is not reduced (enhanced). Thus, the same assumption that underlies the notion that the NR-strategy turns ego into a powerful middleman-- the premise that different resources circulate in each cluster-- implies that ego will be highly dependent on her alters because she will have only a single source for each resource. Conversely, the R-strategy avoids such dependence. Accordingly, consider the logic behind the common practice of "second sourcing"-- i.e., cultivating at least two suppliers for an input that a firm or government regularly procures (see e.g., Farrell and Gallini 1988). This practice is appealing because it lowers dependence on the first supplier and thereby stimulates the two suppliers to lower their prices (Laumann and Marsden 1982: 333). And insofar as second-sourcing lowers dependence, this is because each of the suppliers is a good substitute for the other as a source for the input in question (cf., Anton and Yao 1987).² In short, because substitutability in the resources available to alters has exactly the opposite implications for ego's power, depending on whether we consider ego's power as an acquirer or as a transmitter of resources, knowledge and power cannot be said to have the same social structural foundations.

The main objective of this paper is to develop and clarify the insight sketched above and thereby to improve our understanding of the social structural foundations of knowledge and of power. Crucial to our approach is that we make no new assumptions or claims, either about the mechanisms responsible for making one actor more powerful than another, or about the mechanisms responsible for making one actor more knowledgeable than the other. Our contribution is rather in showing that when these mechanisms operate together, they have implications that have not been sufficiently recognized in past research. In particular, while Burt's analysis suggests that the social

² Simmel (1950: 156) used the example of "a buyer who is confronted with two competing offers" as a canonical case of the *tertius gaudens*-- "the third who enjoys" advantage because (at least) "two parties compete for (her) favor (p.157)." Since Burt (1992), the term *tertius gaudens* has been applied to any cases of brokerage where ego can extract surplus, including where ego acts as a middleman (e.g., Obstfeld 2006). This usage departs from Simmel's original treatment, and may have helped to prevent the recognition that power-as-provider and power-as-acquirer have opposing structural foundations.

structural foundations of power and knowledge are the same, we show that there is a key trade-off in these foundations. This trade-off derives from the fact that, while nonsubstitutability in the resources available from alters is the basis both for superior knowledge-access and for power as a resource-provider, it simultaneously lowers ego's power as a resource-acquirer.

Our focus on substitutability in the resources held by alters also yields two additional theoretical dividends. First, we show the conditions under which what we call the "network redundancy trade-off" is more and less salient. In particular, the key contingency factor concerns the extent to which actors in a system value resources that originate at great social distance from them-- i.e., whether homophilic tendencies lead them to prefer resources that originate "locally" to those that are more "exotic." An actor who follows the NR-strategy becomes increasingly more powerful and more knowledgeable insofar as he forms more links with actors, each of whom desires to obtain the resources that circulate in other clusters. Indeed, the power such a middleman accumulates will dwarf the penalty he suffers from having only one source for obtaining a given resource when tastes are not a function of social distance. But insofar as tastes tend to be locally-biased (as is often the case, even in our global economy), such a middleman faces the risk that he will be channeling goods that no one wants to "buy." By contrast, the actor following the R-strategy faces no such risk. Thus, while the greatest potential returns come from the NR-strategy, the R-strategy is the surest route to higher returns.

In addition, we show how this network redundancy trade-off relates to a wider set of well-known trade-offs (cosmopolitanism vs. localism; exploration vs. exploitation; stranger vs. insider; robust vs. simple identities) whose relationships with one another and with power and knowledge has not been fully appreciated. Each of these trade-offs can be thought of as balancing the greater potential returns available from nonredundancy in one's relations, activities, or roles against the surer returns that come from redundancy. Thus, while we know of no precedent for our argument that the social structural foundations of power and knowledge are distinct-- and in a key sense are opposed, this

notion should not surprise us because it is just one of a family of ideas to which many of us already subscribe.³

We organize the remaining sections of the article as follows. First, we describe and justify our analytic strategy, which consists of explicit assumptions governing the “priced” transmission of knowledge through social networks. We then derive propositions from these assumptions for the knowledge and power enjoyed by different structural positions distinguished on the basis of the alters’ redundancy, and validate these propositions through computational simulations. We then show how the implications of network redundancy vary depending on the degree of homophily in tastes. In the discussion, we consider the scope of our framework and situate the network redundancy trade-off as a member of a broader set of redundancy trade-offs.

II. Analytic Strategy

Our strategy for comparing the network foundations of knowledge with the network foundations of power is to begin with a very simple model, which captures the main mechanisms and allows us to see their implications, and then to vary a key element of the model in such a manner that affords insight into the scope the argument and suggests links with other processes. The simplicity of our initial model can be seen in two respects. First, we begin by analyzing very small social networks and consider the implications of variations in network structure for a focal actor. The advantage of focusing on these simple structures is that global differences in network structure are produced by varying features of local network structure. Yet we will also check the validity of our analysis for larger and more complex network structures—i.e., those in

³ Perhaps closest to our approach is Bonacich’s (1987) attempt to reconcile the idea that central actors are most powerful in communication and authority networks (e.g., Leavitt 1951) with the classic finding of Cook, Emerson, and Gillmore (1983), which showed that local brokers could be most powerful in divide-the-pie bargaining networks. While our analysis is broadly consistent with Bonacich’s (1987), the most noteworthy difference is that we show that local brokers (e.g., someone following the R- strategy) can be the most powerful actor in a communication network whereas Bonacich’s analysis implies that a middleman-type position will always “win” in such networks. In order to arrive at our result, one must make two analytic moves that have not been made in the prior literature: (a) separating buyer and seller roles; and (b) recognizing that the valuation of resources is often decreasing in the social distance the resource has traveled. Moreover, these two moves are not possible without first shifting analysis from a focus on different rules of dyadic exchange (i.e., positive or complementary vs. negative or substitutable) in divide-the-pie networks to a focus on resource-flow networks (Marsden 1983; Yamagishi, Gillmore, and Cook 1988), with particular attention to nonrival resources (e.g., knowledge) that are retained even after they are transmitted (cf., Buskens and Yamaguchi 1999).

which variation in local network structure has more minor implications for the global structure. The second source of simplicity concerns our assumptions about the activity that transpires in these networks. These assumptions will necessarily limit the scope of our framework as it applies to the relationship between knowledge and power. But we will also see that relaxing these assumptions actually broadens the scope of issues that our framework can illuminate.

Dimensions of Structural Variation

The simplest network structures we examine are portrayed in figure 2. Each of the scenarios depicted is the same in three respects—(a) the number of links (2) possessed by ego; (b) the number of links (2) possessed by each of ego's alters; and (c) the presence of four, fully connected, triads. The differences across these scenarios consist only in how ego's alters allocate their links in the network. Following Burt (1992: 18), we can characterize this variation in terms of the alters' degree of "redundancy" with respect to ego. The first dimension of redundancy, which is illustrated in the distinction between the columns in figure 1, is the extent to which the two alters are directly linked or tied. The second dimension, which is illustrated in terms of differences between the rows of each figure (and the contrast between the R and NR-strategies in figure 1), is structural equivalence, or the extent to which the two alters overlap in their links to third parties. The alters have links to different third-parties in the top networks, while they have identical links to third parties, and hence are fully equivalent, in the bottom networks. And since these networks are so small, such variation in local structure produces substantial differences in the global properties of the network. In particular, the scenario 1 network is a single component (i.e., set of actors who can reach each other, at least indirectly), scenarios 2 and 3 have three components, and scenario 4 has four components. Of course, local variation usually does not have such dramatic implications for global structure. For instance, the networks in figure 3 are exactly the same as those in figure 2, differing only in that the four triads are all linked, thereby creating a single component in each scenario. And this difference can have dramatic implications: whereas resources can flow throughout each of the networks in figure 3, this is true only of scenario 1 in figure 2.

FIGURES 2 AND 3 ABOUT HERE

Assumptions Concerning Action

Having specified the nature of the structural variation we will examine, we now clarify our assumptions regarding the activity that transpires within these networks. We employ two classes of assumptions. We retain the first five assumptions throughout our analysis, though we consider the implications of relaxing each of them in our discussion below. The final assumption is varied at different points of our analysis because understanding its implications is crucial for clarifying the social structural foundations of power and knowledge.

Fixed Assumptions. We retain the following five assumptions throughout our analysis:

1. *Limited Bandwidth:* Each actor has the same limited capacity for transmitting or receiving resources at a given moment in time.
2. *Resources as codified information:* The resources are “bits” of “information” that are “nonrival” in that they are always retained even after they have been transmitted; and they are always transmitted without distortion or ambiguity;
3. *Links as fixed pipes:* The network links represent two-way channels through which bits can flow between linked actors.
4. *Equal but unique endowment:* Each of the actors is endowed with a bit that: (a) the other actors do not possess; (b) neither complements (value increasing in possession of) nor substitutes for (value decreasing with possession of) any other bit; and (c) has the same “intrinsic value” as all other bits—i.e., unless valuations are biased by network position, actors are indifferent between two bits they do not yet possess.
5. *Priced transmission:* A bit b will flow from actor i to actor j only if actor j reciprocates with some other resource r , with the “price” or amount of r transferred: (a) being no greater than the value of b to j (“buyer’s willingness-to-pay”) and no less than the value to i of forgoing the transfer of b (“seller’s willingness-to-sell”); and (b) decreasing in the availability of other exchange partners from whom j could obtain or “buy” b .

While we find these assumptions to be useful in making theoretical progress, they are clearly restrictive and it is important to appreciate their implications. The rationale for adopting the first assumption is perhaps clearest because it is impossible for structural position to generate variation in information unless this assumption holds to some degree. Consider each extreme: (a) cases in which bandwidths vary substantially across actors; and (b) cases in which bandwidth is unlimited. In the first set of cases, structural effects will be swamped because actors with a very high bandwidth will end up with the greatest share of the information in the network. In the second case, structure is similarly irrelevant because differences in information-possession will not last long if all such knowledge is transmitted instantaneously. Thus, we focus on cases where bandwidths are equal and limited because structural effects on information-differences will be most salient under these conditions.

Assumption 2 captures a key aspect of what makes knowledge different from other resources-- i.e., that it can be retained by its possessor even after it is transferred (e.g., Buskens and Yamaguich 1999; Romer 1990).⁴ Yet while this assumption seems to reflect what we mean by “information,” it does not seem to cover all types of “knowledge.” In particular, by bracketing confidentiality and ambiguity, we exclude important aspects of the relationship between power and knowledge (see e.g., Burt 1992: 33-34).⁵ In addition, while assumption 3 casts network structure as an exogenous force, relationships can be open to strategic manipulation in the pursuit of knowledge and power. We return to each of these issues in our discussion below and argue that while the relaxation of these assumptions weakens the trade-off in the social structural foundations of knowledge and power: (a) such relaxation also weakens the *identity* in these

⁴ As we show in models not presented here due to space constraints, the propositions we develop below also apply to resources that are lost as soon as they are transferred (as is the case for most goods and services that are exchanged in the economy), as long as each actor is continually replenished with distinctive resources. Accordingly, the practice of second-sourcing referenced above relies on the same mechanism (inducing competition among substitutable sellers) we discuss as increasing power-as-buyer even though such resources are typically lost after transfer. And such resources are also at play in classic cases of monopoly power (e.g., Standard Oil), with such power deriving from the same mechanism (the absence of competing middleman who can provide access to such resources) we discuss as increasing power-as-seller.

⁵ Note also that we do not focus on “common knowledge”—i.e., knowledge about what others’ know. A very important link between power and knowledge concerns the ability to control common knowledge via monopolization of mass media or legitimate authority (see Chwe 2001; cf., Martin 2002; Foucault 1980; Gramsci 1971). In some sense, social networks are poor media for conveying common knowledge because interactants cannot know about parallel interactions occurring at the same time.

foundations (because each relies on the same mechanism, but in opposite ways); and (b) a full treatment of each issue directs our attention to the broader family of redundancy trade-offs.

Assumption 4 is important first because if actors vary greatly in the value of the resources with which they are endowed, this will overwhelm any structural effects. Conversely, if all actors have the same endowment or if their endowments are equivalent because their bits are substitutable, then the structural effects will also disappear. To make matters concrete, it is useful to think of each actor in our networks as each having unique access to a different information source-- e.g., watching a different television station or reading a different newspaper. While these information sources are different, it may turn out that the same news is reported by each source. If this is the case then the “bits” are substitutes for one another and actors should not be interested in exchanging them. Conversely, the information from the various sources could be complementary in the sense that they are like different parts of a puzzle. We return to this issue in the discussion when we show how the trade-off we identify relates to March’s (1991) contrast between “explorer” and “exploiter” modes of learning. For now though, we examine information acquisition in the form of amassing “bits” whose value does not change in the possession of other bits.

Assumption 5 is crucial in focusing our attention between one extreme, where actors transmit information freely and the other extreme, where information is not transmitted due to exchange failure.⁶ Since power is expressed through exchange, information-access and power will be unrelated under either of these extreme conditions. Assumption 5 captures one reason for exchange failure—i.e., if the minimum price at which the seller is willing to sell exceeds the maximum amount the buyer is willing and able to pay. And by assuming that there is a resource that can be traded for bits, we

⁶ Apart from Burt’s structural holes theory, network-theoretic treatments of knowledge-flow have assumed that knowledge is passed from one actor to another without regard for what the first receives in exchange for transmitting the knowledge (e.g., Granovetter 1973; Buskens and Yamaguchi 1999; Watts 1999). This assumption is reasonable in some cases. But it is clearly unreasonable in others, as reflected by the term “knowledge economy.” More generally, and as Reagans and Zuckerman (2008b) argue, it is awkward to assume that actors generally give something valuable for nothing. Rather, knowledge tends to be transmitted for some kind of (implicit) payment—e.g., (the promise of) knowledge that the buyer has but the seller does not; deference toward the seller (e.g., Blau 1964; Emerson 1962: 39); or even money (e.g., referral fees [e.g., Fernandez, Castilla, and Moore 2000])

bracket another key reason for exchange failure—i.e., when the trading partners cannot agree on a common currency (cf., Espeland and Stevens 1998), whether monetary or in-kind. Finally, our assumptions about the specific price to be paid derive from Emerson's original definition of dependence:

The dependence of actor A upon actor B is (1) directly proportional to A's *motivational investment* in goals mediated by B, and (2) inversely proportional to the *availability* of those goals to A outside the A-B relation (Emerson 1962: 32).

A powerful seller sells goods that are highly valued (Coleman 1972) and avoids competing sellers of such goods (Burt 1977).

Several additional features of assumption 5 deserve attention. First, we analyze bargaining power as a function of the number of sources available to a buyer for acquiring a given resource, but do not incorporate into our main analysis the number of buyers available to a seller. As discussed in Reagans and Zuckerman (2008a), our focus on the number of sources available to a buyer is justified both by the fact that it has a more general effect on power and by the fact that incorporation of the number of buyers available to the seller merely reinforces the lessons from our analysis.

Second, in assuming that the presence of a link between actors means only that the linked actors can transfer resources to one another (assumption 2), we bracket the possibility that linked actors will collude or coordinate their bargaining. The latter meaning of a link is important because a key reason why a structural hole might increase ego's control is because linked actors can act as one (Burt 1992; cf., Caplow 1968; Marx 1852; Simpson and Macy 2001). To clarify the matters at hand, we exclude the possibility of such coordination. However, relaxing this assumption does not eliminate the trade-off we identify. The main reason for this is that, even if we assume that linked actors always bargain as one, this has no implications for variation in redundancy by structural equivalence, as exemplified by the contrast between scenarios 1 and 3 in figures 2 and 3, and the contrast between the NR-strategy and the R-strategy in figure 1. In all these cases, ego's alters are disconnected, thus eliminating any basis for collusion against ego. But as we shall see, the difference in redundancy via structural equivalence is sufficient to capture the network redundancy trade-off.

Third, we assume that all power differences are expressed in price. That is, actors always exercise the power their structural position confers upon them, such that an actor's "power capability" or "potential power" will be reflected in his "realized power" or "power use" (see e.g., Lawler, Thye, and Yoon 2000 for the first distinction; and see Brass and Burkhardt 1993 for the second). This is often not the case for moral reasons and even for strategic reasons. Exchange partners often decide that it is in their interest not to use the power at their disposal-- and even to commit themselves not to use it-- in order to induce cooperative ("win-win") behavior on the part of their exchange partners (see e.g., Fernandez-Mateo 2007; Foss and Foss 2005; Holmstrom and Roberts 1998; Lax and Sebenius 1986; Walton and McKersie 1965). Thus we analyze the differences in the structural power that a set of actors possess, while recognizing that such power may not be exercised.

Variable assumption: Homophilic vs. Uniform Valuation. While assumptions 1-4 are fixed throughout our analysis, we vary one key assumption, which pivots on the role played by valuation or willingness-to-pay in the expression of power. Buyers' valuations are irrelevant if all actors place the same value on all resources. But this dimension becomes highly salient if actors value bits differently depending on their network position. In particular, it is well-known that people who are socially proximate (e.g., live in the same neighborhood, have a similar demographic profile, belong to the same organizations) tend to have similar tastes, both for other people and objects (see Laumann 1973; McPherson, Smith-Lovin, and Cook 2001; Reagans 2005). When such "homophilic" tendencies are strong, the social distance a resource has traveled from its source to ego will be inversely proportional to ego's valuation of that resource. Of course, homophily does not always govern taste. There are certainly cases in which valuation is independent of the social distance traveled (or even increasing in such distance—e.g., in markets for "exotic" goods). Accordingly, we will consider two alternative assumptions that capture such variation:

6a. Uniform valuation: An actor's valuation of bit b is independent of the social distance that b has traveled before reaching that actor.

6b. Homophilic Valuation: An actor's desire for bit b is decreasing in the social distance that b has traveled before reaching that actor.

III. Propositions and Validation

Nonredundancy and Information-Access

With the foregoing assumptions in hand, our argument can be clearly laid out. We begin by considering the question of how redundancy among alters affects ego's access to information, and we then consider the implications of such redundancy for ego's power. The answer to the former question seems evident. If we focus on our simplest network structures, as presented in the scenarios in figure 2, it seems obvious (and clear from prior research; e.g., Granovetter 1973; Burt 1992) that both the absolute amount of information ego obtains as well as the speed at which he obtains a given bit of information is *decreasing in redundancy*. While ego can (indirectly) access all four of the triadic clusters in scenario 1, she can reach just two such clusters in both scenarios 2 and 3, and only one cluster in scenario 4. Thus, by choosing alters who are more redundant with one another, ego sacrifices the opportunity to gain access to a larger amount of information. Indeed, not only does ego access less information as his alters become more redundant, but this is true for *everyone* in the network.

Moreover, in addition to increasing the absolute amount of information that ego receives by connecting clusters that would otherwise be disconnected, nonredundancy also increases the *speed* at which ego acquires information (Burt 1992: 14; Buskens and Yamaguchi 1999: 304), even in structures that would otherwise be connected, as in figure 3. To see this, consider the contrast between scenarios 1 and 4 in figure 3. Without ego's participation in the scenario 1 network, there is only one route for bits to flow from one "side" of the network to the other. Ego's ability to bridge between the two sides-- and in fewer steps than the links between the triads-- both serves to increase the efficiency of the flow of information and also conveys a given bit of information more quickly than others. This is clearer for scenario 1 in figure 2 because any bit that flows from one side of the network to the other must first pass through ego. By contrast, while ego bridges between the two alters in scenario 4 of either figure, his alters are already connected both by a direct and an indirect link. Indeed, the actor who should get information the fastest is

ego's alters' additional contact because she acts as a middleman like ego in scenario 1. And scenarios 2 and 3 again appear to be intermediate cases. While there are two additional pathways between the two alters in scenario 3, neither of these two pathways is direct. And since indirect communication takes more time than direct communication, ego in scenario 3 seems better positioned than ego in scenario 4 to acquire some of the information from one alter before the other receives it. Similarly, even though there is a direct connection between the alters in scenario 2, the limited bandwidth of these links (assumption 1) entails that there will again be instances in which ego obtains information from one alter before the other receives it. In sum:

Proposition Ka: Given assumptions (1)-(5), the amount of information obtained both by ego and the average member of a network is nonincreasing in the degree of redundancy between ego's alters.⁷

Proposition Kb: Given assumptions (1)-(5), increasing redundancy between ego's alters decreases the speed at which ego receives information.

Nonredundancy and Power

Having discussed how access to knowledge (defined as information) is decreasing in the redundancy among ego's alters, we now analyze how power varies with such redundancy. To do so, consider first what assumption 5 implies concerning how profit or surplus is divided in a given transaction. According to this assumption, a bit will be transferred for a price p that is: (a) at least as high as what the seller would earn from not selling it (seller's willingness-to-sell or wts); (b) no higher than the buyer's valuation of the bit (buyer's willingness-to-pay or wtp); and (c) decreasing in the number of alternative sources from whom a buyer could obtain a given bit. As a result, the seller's surplus in a given transaction can be characterized as the difference between price and her willingness-to-sell ($p-wts$), while the buyer's surplus in a given transaction is the difference between his willingness-to-pay and the price ($wtp-p$). The overall surplus to be divided is $wtp-wts$. Note that since we have assumed that bits are easily—i.e.,

⁷ Note that the expected relationship is “nonincreasing” rather than decreasing because there are cases, such as those depicted in the figure 3 networks, in which all actors can reach each other regardless of the degree of redundancy between ego's alters.

costlessly-- transferred, this implies that wts approximates zero. Thus, the seller's surplus equals $p-0=p$ and the available surplus to be divided is $wtp-0=wtp$. When the seller's power is at a maximum-- i.e., when the buyer has no alternatives to that seller, p will approach wtp such that all available surplus goes to the seller. Conversely, as the number of sources available to a buyer increases, p will approach zero and all available surplus goes to the buyer.

Assumption 5 thus provides guidance to how power is expressed in a given transaction. In order to characterize the power of a particular network position, and in particular how redundancy among alters affects ego's power, we must aggregate across transactions. That is, we must ask how redundancy among alters changes the extent to which ego is likely to extract surplus as a buyer and as a seller. And note that two variables-- the number of sources available to a buyer, and the buyer's wtp -- determine the answer to this question. A network position confers seller-power insofar as occupants are frequently able to offer bits to contacts who have high wtp for such bits and have few sources for obtaining them. And a position confers buyer-power insofar as occupants are frequently able to obtain the bits for which they have high wtp from many sources.

Seller Power: Uniform Valuation. With these observations in hand, let us consider how redundancy among alters affects seller-power. To do so, we first adopt assumption 6a, which stipulates that actors do not vary in their valuation of bits-- that is, there is constant wtp regardless of structural position. If we adopt this assumption, seller power will depend only on the frequency at which occupants of a position have bits to sell, and the extent to which their contacts have multiple sources for such bits. And if we return to figure 2, it seems clear that seller power is decreasing in alters' redundancy. First, quite apart from the price that ego can charge for providing bits, nonredundancy expands the number of "sales" that ego can make. Ego in scenario 1 can always resell to one of her alters a bit she has acquired from the other alter. By contrast, as the alters increase in redundancy, opportunities for reselling diminish for the very reasons that underlie proposition *Ka*-- i.e., such redundancy means that the alters can acquire bits without ego's help.⁸ Thus *even if the price is fixed*, nonredundancy increases ego's

⁸ Put somewhat differently, the problem faced by ego in scenario 4 is that ego's alters are structurally equivalent with ego, and this means that the alters do not need ego to obtain anything that ego offers. By

seller-surplus because she can act as the seller (and thus extract at least some surplus) more frequently.

Of course, middlemen are hardly known for being devoted to public service. Indeed, insofar as an actor has built the only bridge between two otherwise disconnected clusters, she will have an opportunity to levy a toll on traffic across that bridge. At the extreme represented in scenario 1 of figure 2, ego is a monopolist who can charge prices as high as alters' *wtp*. By contrast, insofar as redundant alters can obtain ego's information from one another, this will limit the price ego can charge either one of them. For instance, as soon as ego sells a bit to one of his alters in scenarios 2 or 4, her leverage is reduced in selling the same bit to the second alter because the first alter is available as a competing source for that bit. And the indirect links between the alters in scenarios 3 and 4 also facilitate the diffusion from the first alter to the second alter via their common contacts. Furthermore, the implications of such variation across scenarios should be similar, if somewhat more muted, for figure 3. That is, since in all four scenarios the nodes are all connected even without ego's participation, ego in scenario 1 will not always be a monopolist. But the likelihood of being a monopolist should still be decreasing in alters' redundancy. Thus, not only is the information available to ego decreasing in alters' redundancy, but such redundancy decreases ego's power as seller, both because she can make fewer sales and because she will face competition when she does have something to sell.

Buyer Power: Uniform Valuation. Yet let us now consider the surplus that ego obtains as a buyer. Since we have assumed that *wtp* is constant, the determinant of buyer-surplus is the extent to which ego's alters tend to offer the same bit to ego, thus reducing ego's dependence on either of them and driving down the price ego can be expected to pay. And when we compare the scenarios in figure 2 and 3 from this standpoint, we see that *redundancy has opposing implications for buyer and seller power*. In particular, while it is true that ego in scenario 1 will (almost) always be a monopolist in figure 2 (figure 3), it is equally true that he must (almost) always buy from monopolists. Just as the uniqueness of the bits and the disconnection between clusters

contrast, ego in scenario 1 has no common links with his contacts. And scenarios 2 and 3 represent intermediate levels of structural equivalence between ego and her alters.

implies that such a middleman will face no competition as a seller, thus maximizing seller-surplus; the same factors also imply that he will have no alternatives for obtaining any of the bits, thus minimizing buyer-surplus. Conversely, buyer-surplus will increase as redundancy among alters increases. The direct and indirect links between the two alters in scenario 4 mean that these alters will often have the same bit before ego obtains it. As a result, ego in scenario 4 is more likely to have the leverage to negotiate for a lower price. More generally, the greater the redundancy among ego's alters, the more likely are they to offer ego the same bit at a given point in time, thus increasing ego's power as a buyer. And the value of redundancy does not depend on the networks being disconnected, as in figure 2. When the alters are connected at several steps remove, as in the figure 3 scenarios, it now becomes possible even for ego in scenario 1 to sometimes have multiple sources for obtaining a bit. But this will occur much less frequently than it does to ego in scenario 4.

Putting it Together. We have thus arrived at the core of our argument, which may be summarized in the following proposition:

Pa: Given assumptions (1)-(5) and (6a), increasing redundancy between ego's alters simultaneously decreases ego's surplus as seller and increases ego's surplus as buyer.

While (under the assumptions we have adopted) an NR-strategy has unambiguously positive implications for the accumulation of information, it has contradictory implications for power, increasing the potential for surplus as a provider or seller but decreasing surplus as an acquirer or buyer. Exactly the same assumptions produce these contradictory outcomes.

Yet the identification of this trade-off raises a key question: while the same factors that make a middleman knowledgeable and powerful (as seller) also limit his power (as buyer), is the reduction in buyer-surplus due to nonredundancy enough to outweigh the gains in seller-surplus? That is, would we ever recommend that an actor pursue the R-strategy, such as depicted in figure 1? *Proposition Pa* implies that such a strategy will have a key benefit over the NR-strategy: the latter pays monopoly prices while the former pays competitive prices. But the upside to the NR-strategy seems to

dwarf this downside. In particular, seller-surplus from the NR-strategy should increase at an *increasing* rate: each time ego adds a link to a new cluster, she gains access to a new market for the $n-1$ bits he can already access from the existing $n-1$ links, and she gains a new source of bits that he can resell to the existing $n-1$ markets. To be precise, the number of resale opportunities at n links is $n*(n-1)$: There are no such opportunities if ego links to just one cluster, but there are two such opportunities with links to two clusters, six (or four more) with three clusters, twelve (or six more) with four clusters, etc. Each additional nonredundant cluster promises ever-increasing (by two) additional resale opportunities.

By contrast, increases in buyer-surplus from the R-strategy necessarily reach an upper bound. If adding a second source is not enough to drive price down to the seller's *wts* (zero under current assumptions), surely this will be true when the eleventh redundant link is added. Thus, while returns from the addition of nonredundant links increase at an increasing rate, returns to the addition of redundant links increase at a *decreasing* rate. After all, there is only so much juice that one can squeeze from an orange. Put differently, the increase in power resulting from the R-strategy cannot reflect the fact that this strategy *creates more value* than does the NR-strategy, where value-creation is defined as helping actors in the system to obtain more valued resources more quickly. Rather, redundancy between alters helps ego *capture more value* because she can negotiate to obtain valued resources on more favorable terms. As proposition *Ka* suggests, increasing redundancy among alters actually reduces the amount of value that ego creates because fewer bits circulate through the network. By contrast, the middleman position created by the NR-strategy bridges between nonredundant actors who each have information that the other wants, thereby creating value. And the more nonredundant links, the more value that is created, thus increasing the potential for capturing value.

Homophilic Valuation.

It would seem then that despite the fact that an NR-strategy causes ego to lose power as a buyer, overall power is increasing in nonredundancy, just as is access to information. Yet the recognition that the power resulting from the NR-strategy-- but not from the R-strategy -- depends on ego's ability to create value also leads us to recognize its key

weakness. To see this weakness, we relax our assumption that actors all have the same taste or valuation for the bits flowing through the network. In particular, we now assume that valuations decrease with social distance. As discussed above, this assumption of *homophilic valuation* is surely appropriate in many contexts. Indeed, insofar as a network is highly clustered, it will often be the *result* of homophily. And if actors with similar interests or tastes congregate together in social structure, it stands to reason that tastes for information will also be “local.”

In considering how homophilic valuations affect seller and buyer power, it is important to recognize that neither this nor any other change in our assumptions about valuation can change the fact that an extreme middleman position, such as that which results from the NR-strategy in figure 1 or as in scenario 1 in figure 2, will always be a monopolist selling to monopolists. As a result, such an extreme middleman will never obtain any buyer-surplus since his alters will always be able to charge at his *wtp*. And this middleman will always be able to charge a price that is as high as the alters’ *wtp*. However, if the alters’ tastes are homophilic, their *wtp* for the bits the middleman offers them will be lower than it is under uniform valuation. Whereas under uniform valuation, each alter is willing to pay the same price for bits obtained from their own cluster as those that each obtained from the other cluster, this will not be the case under homophilic valuation. The basis for a middleman’s power lies in his ability to create value by facilitating the flow of highly-valued resources. But insofar as he traffics in bits that travel great social distances, he creates less value (under assumption 6b) and hence can extract less surplus. At the extreme—e.g., when buyers have zero *wtp* for bits that originate from actors with whom they do not share at least one common link, he creates no value at all and hence cannot capture any seller-surplus. Yet this reduction in seller power under homophilic valuation is not accompanied by a corresponding increase in buyer power. Regardless of how he distributes his demand (i.e., to bits that are local or more exotic), he will always be compelled to obtain the bits he wants from monopolists.

But homophilic valuation can only aid the actor who follows the R-strategy. On the one hand, alters will tend to have higher *wtp* for the bits ego possesses since those bits tend to have local origins. Seller-surplus may not increase much since ego will still face competition in selling bits but, such surplus should not decrease. And buyer-surplus

should generally change little. For example, if ego in scenario 4 is most interested in the bits he obtains from his own alters, the good news is that he will often have multiple options for obtaining such bits. More generally, changes in an actor's own valuation of bits cannot increase (decrease) her surplus as a buyer unless she redistributes her demand from goods for which she has more (fewer) sources towards goods for which she has fewer (more) sources. Such a redistribution *can*, but often will not, result from homophilic tastes. In general, homophilic tastes simply mean that ego's ability to capture value as buyer will be exercised over a more narrow set of bits.⁹

The following proposition thus summarizes the trade-off we have identified and how it interacts with the nature of valuation:

Proposition Pb: Given assumptions (1)-(5), the negative effect of alter-redundancy on seller-surplus under will be reduced under homophilic valuation (6b) relative to uniform valuation (6a). But the positive effect of alter-redundancy on buyer-surplus should not change with the nature of valuation.

Thus, whereas nonredundancy increases both information-access and overall power (because the increase in seller-power will outweigh the decline in buyer-power) when valuation is independent of network position (6a), nonredundancy can reduce overall power (because the decline in buyer-power will outweigh the rise, if any, in seller-power) when valuation is decreasing in social distance (6b).

Note finally that the threat implied by homophilic valuations can be solved if one knows in advance whether valuations are homophilic or uniform. If we know that demand will be homophilic, it makes sense to follow the R-strategy; if demand is uniform (or even better, if demand is exotic or increasing in social distance) then one should use

⁹ The following thought experiment may be useful. Consider five network positions based on figure 1—(a) the R-strategy of dedicating all four links in one cluster; (b) the NR-strategy of devoting one link to each cluster; and three intermediate solutions—(c) three links to one cluster and one to a second cluster; (d) two links to one cluster and one each to two more clusters; and (e) two links to one cluster and two links to another cluster. A shift from uniform to homophilic taste—e.g., ego now values only the bits that originate from her direct contacts and their contacts-- will not change the buyer-surplus earned by either (a) or (b) or even of position (e). However, homophilic taste will increase buyer-surplus for *both* positions (c) and (d) because of the shift in ego's *wtp* away from the clusters with only one link towards the cluster to which ego has multiple links. Which of these positions benefits most is difficult to say and will vary with the specific way in which the homophily is expressed. More generally, it is clear from a comparison of these cases that greater or lesser homophily on ego's part cannot be said to have a clear impact on the effect of alter-redundancy on ego's buyer power. By contrast, homophilic demand on the part of alters clearly reduces the seller-power of positions with low alter-redundancy.

the NR-strategy. The problem of course is that one rarely knows others' tastes *ex ante*. And this leads to the last implication of our analysis, one that will allow us to connect our framework to a series of redundancy trade-offs discussed in the sociological and organization-theory literature. In particular, the network redundancy trade-off is usefully framed in terms of risk and return. While the *greatest potential returns* are associated with building a network for nonredundancy (because the reduction in buyer-surplus is outweighed by the increases in seller-surplus, which rise at an increasing rate), the *surest returns* are associated with redundancy (because added redundancy increases value-captured in acquiring goods without having to risk the possibility that attempts at value-creation will fail).¹⁰

Validation through Computational Simulation

Model Description. We now check the internal validity of the foregoing propositions, and give them greater precision, through computational simulations that operationalize assumptions 1-6. We begin by simulating the exchange of information in figures 2 and 3 and then investigate whether these propositions are valid in larger more complex networks as well—i.e., those in which variation in local structure has less of an impact on the overall configuration of the network.¹¹

Assumptions 1-3, and part (a) of assumption 4, are operationalized as follows (cf., Buskens and Yamaguchi 1999). First, we endow each actor with a single bit of unique information at the outset of each simulation. The actors then accumulate bits from their contacts until no more bits can be distributed. Such transmission of bits occurs as each actor *i* is randomly selected in a given “round” and one of her contacts *j* is randomly selected. Any such contact is defined as an “interaction.” For each such interaction, if *i*

¹⁰ In a Knightian (1921) sense, the proper term here is “uncertainty” rather than “risk” because we are referring to future events whose probability is unknown. However, the term risk seems more appropriate in that it captures the sense of “taking a risk” with the connotation that one’s own actions are increasing the likelihood that one may experience a negative return. The English language has no parallel expression for uncertainty, which seems to reflect the fact that there are many sources of uncertainty in addition to those generated by one’s own actions.

¹¹ The simulations on figures 2 and 3 were programmed using the IML procedure in SAS. The construction of the complex networks and the simulations on them were programmed using C++. Sample programs are obtainable upon request.

has a bit that the selected contact j does not have, that bit is given to j .¹² And vice versa-- i.e., i receives a bit that j has but i does not.

We operationalize assumption 5, and parts (b) and (c) of assumption 4, by having “dollars” flow from j to i whenever a bit flows from i to j , and vice versa. Dollars are a general medium of exchange, in that every unit has exactly the same value to all participants regardless of how many they already possess. The amount in dollars to be transferred is calculated as follows:

$$\text{price}_{ijb} = \text{wtp}_{jb} * \frac{0.5^{S_{jb}}}{0.5}. \quad (1)$$

This equation has two components. The first is buyer j 's willingness to pay for bit b , which is a fraction of the buyer's total demand for all bits, an amount that is the same for all actors and is equal to the number of bits (and actors) in the network:

$$\sum_b^B \text{wtp}_{jb} = B. \quad (2)$$

While we assume that actors' total wtp is always the same, the distribution of wtp_{jb} across bits b differs depending on whether we assume uniform valuation (assumption 6a) or homophilic valuation (6b). Under uniform valuation, we assume that $\text{wtp}_{jb} = \$1$ for all j and b . Under homophilic valuation, we assume that:

$$\text{wtp}_{jb} = (z_{jb} / \sum_b^B z_{jb}) * B, \quad (3)$$

where b is the actor from which bit b originated, where

$$z_{jb} = a_{jb} + \frac{\sum_{k \neq i, k \neq j}^K (a_{jk} * a_{bk})}{\max(\sum_{k \neq i, k \neq j}^K a_{jk}, \sum_{k \neq i, k \neq j}^K a_{bk})}, \quad (4)$$

and where $a_{jb} = a_{bj} = 1$ when there is a link from actor i to actor j . Thus, z_{jb} is higher when the buyer j is directly connected to actor b ($a_{jb}=1$), who is the source of bit b , and when i and j have many ties in common to third-parties k ($a_{jk}=1$ and $a_{bk}=1$). This measure of proximity is expressed as a fraction of each actor's total proximity to others and then

¹² When i has multiple bits that j does not yet have (or vice versa), a criterion is needed to decide which bit will be passed. The criterion used in the presented results is that the bit that passes is that which maximizes seller-surplus on the logic that the seller need not sell. Our results are robust to changes in this criterion.

multiplied by the actor's total willingness-to-pay B . For instance, consider a member of one of the figure 2 triads who does not have a link to anyone else in the network. Under uniform valuation, these actors would have a wtp_{jb} of \$1 for all fourteen bits. But under homophilic valuation, their wtp_{jb} would be \$7 for the bits that originate from each of her two contacts and \$0 for all other bits.

The second component of price equation (1) is a discount, which is applied to wtp_{jb} and which is increasing in S_{jb} ("sources from which j can obtain b "), which are the number of j 's contacts who have bit b at a given moment, or

$$S_{jb} = \sum_k^K I_{kb}, \quad (5)$$

where k are j 's contacts and $I_{pb}=1$ when k is in possession of bit b , and $I_{pb}=0$ otherwise. The functional form of this discount at different levels of wtp (\$2.00, \$1.00, and \$0.50) is illustrated in figure 4. When j has only one source, price is not discounted from wtp_{jb} and all the surplus is extracted by the seller. But when j has two sources, the price is discounted by 50%; price is discounted by 75% when j has three sources, 87.5% at four sources, etc. As the number of sources increases, virtually all surplus goes to the buyer regardless of wtp_{jb} .

FIGURE 4 ABOUT HERE

It may seem to be a strong assumption that the price declines so markedly. Yet observe that the conditions of the simulation largely approximate a Bertrand game (see e.g., Saloner, Shepard, and Podolny 2000) because: (a) each seller offers exactly the same good; and (b) the nonrival quality of the bit implies that each of the sellers could potentially supply the entire "market." Under such conditions, competition among duopolists tends to approximate perfect competition in that prices are lowered to the seller's willingness-to-sell or marginal cost (which is assumed here to be \$0). More generally, it is important to interpret these calculations not as accurate predictions of what prices would obtain in real exchange but as *general indicators* of whether a given actor tends to be in situations where: (a) as seller, he tends to offer bits that his contacts value highly and for which they have few alternative sources; and (b) as buyer, he tends to have many sources for the bits that he values greatly.

Note finally that, in modeling exchange in the described fashion, we assume: (a) that buyers and sellers know how many options buyers have at a particular moment; and (b) that buyers know their willingness to pay even before they have received a bit. These assumptions clearly do not hold in many cases. For example, it is often possible for an exchange party to bluff, both regarding her willingness to pay and regarding her alternative options; and it is well known that it is difficult to sell an idea if the prospective buyer cannot assess its value before the idea is described (e.g., Teece 1986). Yet while the second of these assumptions will certainly not hold in some circumstances, it does hold in a wide range of cases in which actors know which of their contacts possess a particular piece of news (e.g., who attended a key meeting) but do not yet know the *content* of that news (e.g., what was said at the meeting). And while the second assumption seems inappropriate when there is no way to call a buyer's bluff, it will be more appropriate insofar there is a history of interaction among the actors in a network. An actor who repeatedly sees that a contact can obtain the bits he offers from others will eventually lower his prices to that contact. Thus while our simulation rules define a highly stylized model of how information is actually exchanged, the results should help illuminate how positions vary in how much value they get (give) for (to) transmitting (receive) such information.¹³

Results for Figures 2 and 3. In tables 1-3, we present results from the described simulations on the scenarios depicted in figures 2 and 3. The first set of results, presented in tables 1 and 2, pertain only to the effect of alter-redundancy on information-access, as given in propositions *Ka* and *Kb*. For these tables, we assume uniform valuations-- i.e., all actors have an equal interest in all bits. The second set of results, presented in table 3, speak to propositions *Pa* and *Pb*. For these simulations, we compare

¹³ Note that our rules could be seen as not sufficiently realistic in that actors are likely to know *more*, rather than less, about their options. In particular, we assume that the actors do not know about options for obtaining a bit that will become available if they wait. Allowing actors to be strategic about foregoing purchases adds significant complexity. It is worth noting though that our assumption likely makes it more difficult to validate our propositions because waiting until multiple alters possess a bit only helps if the alters are redundant and thus can be expected to acquire the same bits. So we can expect ego in scenarios 2 through 4 to pay even lower prices for bits (and to sell them for even lower prices) than in scenario 1 if buyers strategically forgo purchases.

results under uniform valuation with those generated under the assumption of homophilic valuation.

The results in tables 1 and 2 help to validate propositions *Ka* and *Kb*. We see in table 1 that ego and all actors receive all fifteen bits in scenario 1 of figure 2 but that information diffuses less widely as ego's alters become more redundant. This is of course a trivial result. Since redundancy among alters implies a forgone opportunity to link to additional clusters, it *must* be the case that actors with redundant contacts will have access to less information. A more interesting result then is that redundancy between one's alters also means that ego will accumulate bits more slowly. By comparing the mean number of interactions that occur in the system until the actors obtain the listed number of bits, we see that ego is relatively slow in all four scenarios to obtain the first set of bits because he has fewer ties than his alters and each of their other contacts. He is thus involved in fewer exchanges of information in a given round; and more interactions occur in the system before he acquires his second bit. But the results change quickly after the initial rounds in a manner that is consistent with proposition *Kb*. In the figure 2 networks, ego in scenario 1 is generally the fastest, apart from his two alters, to acquire his eighth bit; and he catches up to those alters by his eleventh bit, and then generally obtains the fifteenth and final bit before the two alters despite the fact that they have three ties and ego has just two. On average, it takes 173.6 interactions for ego in scenario 1 to obtain all fifteen bits, as compared to the mean speed for the fastest actor (who is virtually always ego) of 168.8, for a "relative speed" of 0.97. By contrast, in no other scenario can ego keep up with the two alters, with ego acquiring the sixth bit 33% less quickly than the fastest actor (relative speed of 0.67) in scenario 4, and at intermediate speeds in scenarios 2 and 3. Analysis of variance (not shown) indicates that these differences are statistically significant.

TABLE 1 ABOUT HERE

And the same pattern of results pertains for the figure 3 scenarios, as presented in table 2. The links across the clusters in these scenarios means that all actors can now receive all bits regardless of ego's participation. Nonetheless, the variation in alter-redundancy has similar, if somewhat attenuated implications for relative speed. Ego acquires those bits much more quickly in scenario 1 than in scenario 4, both in absolute

terms (142.2 interactions in the system vs. 273.2) and relative to the fastest actor in each system (an average of 10% slower versus 25% slower). And again, scenarios 2 and 3 are intermediate cases on both dimensions.

TABLE 2 ABOUT HERE

The top panel in table 3 displays the results from the same simulations but with a focus on the returns to each position due to the flow of dollars in the opposite direction as bits. We see that when uniform valuation is assumed, an NR-strategy not only grants access to more bits more quickly, but also gives ego greater power, as expressed in the total surplus obtained. As stated in proposition *Pa*, the key driver of this variation in surplus is ego's surplus as a seller: nonredundancy makes it more likely that ego will be a monopolist (seller extracts all the available surplus, which is always \$1 under uniform valuation) and increases the number of times that ego can sell a given bit. Thus, we see dramatic declines in both the number of bits transmitted and the average seller-surplus as one moves from scenario 1 to scenario 4. But we also see the advantage of redundancy emphasized in proposition *Pa*: a rise in buyer-surplus. Most starkly, ego in figure 2/scenario 1 will always sell at monopoly prices, she will always buy at monopoly prices as well. By contrast, while ego in scenario 4 captures little seller-surplus, he always captures more buyer-surplus than ego in scenario 1 because he is more likely to have multiple sources for a given bit. Thus, the simulation captures the key insight of the paper-- i.e., that the very same mechanisms imply that the structural position that maximizes information-access will both increase seller-power and diminish buyer-power.¹⁴ And note that even if we assume that linked sellers will collude, thus eliminating the buyer-power ego enjoys in scenarios 2 and 4, the contrast via structural equivalence remains.

TABLE 3 ABOUT HERE

Of course, the decline in buyer-surplus in the top panel of table 3 seems like a small penalty to pay for the large seller-surplus that can be earned. Yet, as stated in

¹⁴ It is worth noting however the slight curvilinearity in total (as opposed to average) buyer-surplus. While ego in scenario 4 always captures more buyer-surplus than does the middleman, the intermediate positions capture even more buyer-surplus. The reason is that in networks such as those in figure 2, where the networks do not form a single component, ego's decision to concentrate his links will lower the total amount of bits (and hence the surplus available in acquiring such bits). Thus, such extreme redundancy is problematic for buyer as well as seller power, but only in such a disconnected structure and only relative to more intermediate levels of redundancy.

proposition *Pb*, this penalty looms much larger if actors' tastes are homophilic. The bottom panel of table 3 presents the relevant results. We see that while redundancy continues to heighten buyer-surplus and to reduce seller-surplus, the latter effect is now much weaker than before. For instance, we see that relative to ego in scenario 3, ego in scenario 1 can now sell less than one more bit, on average, and extracts about the same amount of surplus in these sales. By contrast, ego in scenario 1 both sold many more bits and sold them for a higher price than did ego in scenario 3 under uniform valuation. Overall, we see that following an NR-strategy now generates the *least* amount of total surplus. And the reason for this should by now be clear: the basis for a middleman's power lies in his ability to create value, by bridging between clusters that would otherwise not be bridged, and then capturing value, by levying a toll on traffic across that bridge. But if there is little interest in the goods that could cross the bridge, there will be no value to capture. By contrast, the increased power from an R-strategy has nothing to do with ego's ability to create value. Rather, since it stems from a heightened capacity for capturing value created by others, it is not vulnerable to others' interests or values.

Validation in More Complex Networks.

While the stylized networks depicted in figures 2 and 3 help to clarify the mechanisms underlying our propositions, the scope of these propositions includes larger and more complex networks as well. Analysis of a broad array of larger and more complex structures indicate that the key scope condition concerns the degree of structural differentiation—i.e., the extent to which networks tend to subdivide into clusters or cliques. This scope condition is consistent with our argument. Insofar as all of the actors in the system are linked or if there are no clusters in the network, there will be no variation in structural position along the dimensions covered by our theory—i.e., actors will not vary in the extent to which their contacts are redundant. We illustrate these patterns by presenting results from simulations following the same rules given above and applied to a series of clustered networks consisting of 40 nodes, each of which has 4 links (i.e., “degree” = 4). The networks are generated using the α -model described by Watts (1999), a model that is designed to induce clustering in a network (see Skvoretz, Fararo, and Agneensens 2004). One of the networks created with this procedure is illustrated in

figure 5. Each node is labeled its “ego-density,” where ego-density is defined as the proportion of the focal node’s contacts that are connected to each other. Ego-density captures the first of the two dimensions of redundancy we have discussed, as represented by the contrast between the columns in figures 2 and 3.

FIGURE 5 ABOUT HERE

In table 4, we present results from fifty simulations each conducted on fifty of the 40 node networks described above. The top panel presents results under uniform valuation and the bottom panel presents results under homophilic valuation. The indicators of surplus are defined as above and “slow accumulation” is defined as the number of interactions that occur in the system before an actor accumulates all of the bits it values at all ($wtp > 0$), divided by the total number of such bits. We average the outcome variables over the fifty simulations and examine the associations between the outcome variables and the three indicators of structural position: (a) ego-density, which is defined as above; (b) farness, or “closeness centrality” (Freeman 1979), which is the sum of the geodesic (minimum path-distance) from ego to all other nodes in a network; and (c) Stephenson and Zelen’s (1989) “information-centrality,” which computes centrality based on a similar rationale but considers all path-distances in a matrix, weighting shorter path-distances more.¹⁵ These measures are useful because, unlike ego-density, they capture an ego’s global position in the larger network and thus alters’ degree of redundancy by structural equivalence (including equivalence via multiple steps) rather than just through direct links between alters. For farness, nodes in more redundant positions are more distant from other nodes in the system; for information-centrality, redundant positions are those who have access to other nodes in the system through a limited number of channels. Note that ego-density and farness reflect increasing redundancy between alters while information-centrality reflects decreasing redundancy.

TABLE 4 ABOUT HERE

¹⁵ We calculate information-centrality using the SAS/IML routine described by Rothenberg et al. (1995: 276-277) and implemented by Jim Moody. We are grateful to Jim Moody for making this routine publicly available.

We see from table 4 that each of the measures of structural position correlates with the outcome variables in the manner predicted by our propositions.¹⁶ First, lower redundancy (i.e., lower ego-density and farness, or higher information-centrality) leads to faster accumulation of bits in either panel. In addition, lower redundancy increases both the number of bits an actor can sell and the total seller-surplus she can expect. The other side of the trade-off is clearly visible as redundancy clearly increases buyer-surplus. While redundancy sharply decreases total surplus when valuations are uniform, it moderately increases total surplus when valuations are homophilic. Thus, these results validate our argument that the greater returns that are potentially available through an NR-strategy when valuations are uniform must be balanced against the surer, if more modest, returns available through an R-strategy when greed is localized.

Note finally that these conclusions do not depend on how one measures redundancy. Indeed, perhaps the key result in table 4 concerns the associations among buyer-surplus, seller-surplus, and total surplus. First, we see that buyer-surplus is highly and negatively correlated with seller-surplus in both panels. This effectively captures the key trade-off in our paper without relying on a particular measure of structural position. That is, we see that the network positions (however defined) that obtain the greatest seller-surplus are the same positions that obtain the lowest buyer-surplus. And we see that under uniform valuation, the positions that accumulate the most buyer-surplus are worse off overall because they have sacrificed so much seller-surplus. It is seller-surplus that drives total surplus under uniform valuation. But in a homophilic world, demand is concentrated more locally and so seller-surplus is no longer an important determinant of total surplus. When tastes are localized, power is less about creating value by facilitating the transmission of bits across disconnected clusters but about having multiple options for obtaining bits from fellow-cluster members.

IV. Discussion

To recapitulate the key lesson of the foregoing analysis, it is useful to refer back to figure 1. Existing theory, and a very compelling intuition, suggests that the middleman position

¹⁶ These results pool observations across fifty different structures. Substantively the same pattern of results is observed for each network.

created by the NR-strategy is much more valuable than the position that results from the R-strategy. The middleman position seems valuable both because she will gain access to the information (and other resources) that is contained in all four clusters and because she will be a monopoly broker between the clusters: she is positioned to do an increasing number of deals at an increasing rate as she gets access to more clusters; and she can conduct all such deals at monopoly rates. Of course, gaining access to *information* does not mean that such information will actually be absorbed, and existing theory provides reasons for thinking that actors have particular difficulties obtaining complex and sensitive information from clusters of which she is not a member. We will consider such scope conditions shortly. But the key lesson of the foregoing is that *even when we assume no obstacles in the transmission of information, the increase in information-access experienced by the middleman is accompanied both by an increase his power as seller and a decrease in his power as buyer*. These countervailing effects are joint outcomes of the same condition-- the tendency for disconnected actors to provide access to different pools of resources. To the extent that this condition does not hold, neither side of the trade-off will hold.

We have noted further that while the returns associated with an NR-strategy seem to dwarf the corresponding penalty, this is true only insofar as taste is not homophilic. Where homophily is strong, a middleman may find that the parties on either side of the bridges he has built are simply not interested in what the others possess. And it is typically not possible to mitigate such risk by ascertaining others' tastes *ex ante*. To better appreciate this point, consider the many social worlds in which each of us participates. Involvement in a diverse array of worlds is often personally enriching, but it is only rarely a source of power. To confer power upon us, we must bridge between actors in separate groups, communities, or markets who are disconnected *and* who value one another's resources. But taste is typically local. Indeed, the great irony of the middleman position is that the highly clustered systems that give the middleman strategy its greatest potential are produced by homophilic tendencies that make bridging between such clusters less profitable.¹⁷ Note finally that the risks associated with middleman

¹⁷ We thank Aimee Kane for helping us see this point. And thanks to Rodrigo Canales for pointing out the sliver lining that accompanies this dark cloud: while homophily makes it difficult to bridge across

returns are even clearer if we recognize that actors' willingness-to-pay is often increasing in the number of *sources* they have because information available from multiple sources is more credible (Centola and Macy 2007) and decisions based on multiple sources are easier to justify or legitimate to others (Carroll and Hannan 1989). To the extent that actors require two sources for anything they obtain, the middleman's power will necessarily be limited. But such risks do not pertain to the R-strategy because the increase in buyer power comes from an increased ability to capture value and does not depend on others' tastes.

To be sure, our conclusions can be challenged on the grounds that the redundancy trade-off we have identified apply to a narrow range of conditions, as specified by the restrictive assumptions we have adopted. In particular, while our study appears to be the first sociological treatment of power in the exchange of information-like resources (cf., Marsden 1983; Yamagishi et al. 1988), a full treatment of the relationship between knowledge and power must consider information that is more ambiguous or sensitive, and thus less easily transferred and absorbed, than the "bits" we have modeled. In addition, a full treatment of these issues must allow for endogeneity in the social networks being analyzed. Yet while we must be cautious in carrying the framework beyond the scope of the assumptions we have made, we now show that a consideration of each of these issues-- (a) whether the framework applies to information that is more ambiguous or confidential; and (b) whether it applies when actors can choose their ties-- suggests that the core insights our framework may have wide applicability. In particular, we will see that the trade-off we have identified is part of a wider family of redundancy trade-offs.

A. From Information to Knowledge

A natural objection to our framework is that the "bits" we consider are too easily transmitted and assimilated to represent what we mean by *knowledge* transfer and acquisition. In particular, much valuable knowledge involves information that is

disconnected social worlds, it is the middleman who is often best able to erect such bridges due to the cosmopolitan skills such a position cultivates (see below). Insofar as a middleman becomes an expert at translating or reframing information for different audiences, he gains a greater ability to recognize how a bit from one part of the world can be translated to provide value in another.

ambiguous or confidential. And such knowledge seems more easily transferred between people who are members of the same group or community and thus share many ties in common (cf., Uzzi 1997; Hansen 1999). That is, while breadth of access to *information* may be optimized by nonredundancy (as stated in propositions *Ka* and *Kb*), *knowledge* may be optimized by redundancy. And if this is the case, perhaps our framework applies to a very narrow range of cases and there is no *general* trade-off in the social structural foundations of knowledge and power.

In fact, while this objection suggests important boundary conditions on our framework, it also leads us to a deeper appreciation of the generality of the redundancy trade-off. First, even if redundancy facilitates the acquisition of knowledge, it will still hinder the creation of value in that it cannot facilitate the flow of knowledge from one part of a system to another. Thus, the trade-off can be eliminated only if value-creation is eliminated as a possibility.¹⁸ To see this, consider a form of knowledge that can be transmitted if and only if *i* and *j* have at least *n* ties in common. For instance, if *n*=2 then all knowledge must circulate within (sets of interlocking) closed triads. As a result, neither ego nor her alters in scenarios 1-3 of figures 1 and 2 will ever acquire such knowledge and they will also not be able to exert any power in the exchange of such knowledge. By contrast, ego in scenario 4 will acquire such knowledge and will be able to exert some power in obtaining it because he is not dependent on either of his alters for it. But this does not eliminate the trade-off as much as it illustrates how the trade-off is based on the possibility that some actors create more value than others. Accordingly, observe the role played by the alters' other contact in scenario 4. This is the only scenario in which knowledge will flow between nonredundant actors, and it is because the alters' other contact acts as a middleman between them. More generally, insofar as it is possible for knowledge to flow between actors who are not fully structurally equivalent, those actors who have nonredundant contacts will be in the best position to facilitate that flow (and capture value from it), even if such an actor will be in a weaker position as an acquirer of knowledge.¹⁹

¹⁸ As Rogers and Bhowmik (1970/71: 530) put it, "... communication ... (between) participants who (are) completely homophilous...(is) facile but totally redundant."

¹⁹ This trade-off is not apparent in scenario 4 because the alters' other contact has four links and all other actors only have two. Thus, he seems not to suffer from having fewer options for obtaining the knowledge

Of course, it is possible to devise a rule that would eliminate the possibility of such an intermediary. In particular, one might consider a form of knowledge that can be transmitted if and only if i and j are fully structurally equivalent. Under such a rule, knowledge will be transferred only within the isolated triads in figure 2 or the dyads in both figures that include actors who have no ties outside their common triad. Such a rule clearly impoverishes a social system and indeed, seems to strain the boundaries of what we mean by “knowledge.” This point is captured by additional simulations (not shown) on the figure 2 and 3 scenarios in which knowledge transfer was made more difficult when the actors did not share ties in common. As long as this restriction is not maximally strong, it slows down knowledge diffusion and lengthens the period before which the costs and benefits of redundancy become apparent, but the trade-offs appear just the same. In sum, as long as a form of knowledge can flow between actors who do not share ties in common, the trade-off must reappear in some form even if actors whose alters are more redundant tend both to acquire such knowledge on better terms and to absorb it more easily. The downside is that such actors will be less well-positioned to create (and capture) value as a seller/provider of such knowledge

Note further that we should not be so quick to assume that redundancy is especially valuable for information that is ambiguous or confidential. With regard to ambiguous data, the basis for privileging redundancy derives from the notion that an actor’s “absorptive capacity” (Cohen and Levinthal 1990) is greater insofar as she has already accumulated related knowledge-- that “related knowledge” is “needed to absorb new knowledge (ibid., p.129).” We may apply this principle to an interpersonal context (see Reagans and McEvily 2003) by positing that two people who already share a great amount of knowledge in common should be able to transfer new knowledge more easily than two people who have no knowledge in common (Reagans and McEvily 2003). Furthermore, insofar as redundant actors will tend to share more knowledge in common (as entailed by our assumptions), then propositions Ka and Kb will be less likely to hold.

in question. But imagine if we were to equalize the links by enlarging the size of the groups between which the alters’ other contact serves as a middleman (while ensuring that the groups consist of interlocking triads). Under such conditions, the middleman again has fewer options for obtaining knowledge than do any of the group members, though the middleman is in a better position to create and capture value in facilitating flows across the groups.

At the extreme, an actor who follows an NR-strategy may not be able to learn anything from his contacts, and vice versa.

Yet as pointed out above, this privileging of redundancy will eliminate the trade-off (and the identity) in the structural foundations of power and knowledge only when it is impossible to transfer knowledge between actors who are not structurally equivalent. Moreover, there are at least two reasons to expect a middleman to enjoy *advantages* in acquiring new knowledge even when absorptive capacity is important. First, while it may be easier to absorb new knowledge when one focuses either in the same domain of knowledge or on exchanges with others who share one's knowledge, it is questionable whether the most *valuable* new knowledge is discovered in this manner. Rather, it is widely recognized that significant advances in knowledge often come when knowledge from one domain is applied to other domains to create new combinations and recombinations. In March's (1991) terms, there is a trade-off between exploration and exploitation. Exploration involves wide search for new alternatives to existing activities, while exploitation is characterized by refinement of existing activities. Both are critical to a system's survival over time. Yet they stand in tension with one another because activities cannot simultaneously be devoted to searching widely for new solutions and to improving old approaches. This tension can be cast in terms of network redundancy. In particular, if exploitation involves repeated exposure to the same or highly similar bits of knowledge, this is clearly best achieved through interaction with redundant alters. By contrast, the widest access to new alternatives is obtained from an NR-strategy. Thus, even if a middleman's absorptive capacity is reduced, her enhanced capacity for exploration may more than compensate if a significant advance is made.²⁰

²⁰ We captured this trade-off in an additional set of simulations on the figure 2 and 3 networks. In particular, we modified the rule that a bit was fully transferred in the first passing and we had actors continue to transmit whatever bits they had. This rule makes sense if there is additional (though perhaps diminishing) value in being exposed to the same information multiple times, either to prevent erosion or forgetting or to more fully understand the information, as reflected in March's notion of exploitation and as captured in learning curve models. The results of these simulations show that redundancy increases the *intensity* of exposure to a small set of bits, at the cost of being exposed to a *broad* array of bits. Accordingly, the middleman is most likely to encounter all bits within a particular time frame (and thus make the connections between bits that lead to innovation), while actors whose contacts are more redundant should have the deepest understanding of a particular domain insofar as that is promoted by repeated exposure to it.

Moreover, the middleman may even enjoy enhanced absorptive capacity, at least with respect to knowledge in new domains (see Cohen and Levinthal 1990: 129). The notion of *cosmopolitanism* (Simmel 1950c) reflects the recognition that experience in many and diverse social worlds confers upon an actor a facility with interacting and exchanging productively in new social worlds (cf., Rogers and Bhowmik 1970/1971: 535). Accordingly, Reagans and McEvily (2003) show that actors whose network position is high in “network range” (i.e., low redundancy among contacts) are able to obtain knowledge more easily. Of course, *localism* is valuable just as is cosmopolitanism, but involves a familiarity and facility with a particular “terrain” (e.g., Merton 1968; Gouldner 1957). The upshot then is that while it is reasonable to expect a middleman position to face disadvantages in acquiring information that is hard to interpret without immersion in a particular community, this disadvantage is accompanied by two significant advantages in the acquisition and use of ambiguous information: (a) an enhanced potential for exploration; and (b) a cosmopolitan facility with processing new information.

Furthermore, it is unclear that an NR-strategy is always disadvantageous for acquiring confidential information-- i.e., sensitive matters that the information-holder does not want broadcast widely. On the one hand, the strong, dense ties characteristic of scenario 4 are widely thought to promote the development of mutual trust, the development of common norms, and the means for enforcing such norms-- all of which support the transfer of information that might otherwise make an actor vulnerable in some way (e.g., Coleman 1988; Greif 1993; Uzzi 1997). The key mechanism here involves *identity*-- the classification of some actors (by these same actors and their audiences) as members of a family, group, or community where secrets are (supposed to be) shared and the identification of others as outside that “circle of trust” (Herzfield and Hamburg 2000). Yet recall Simmel’s (1950b) observation that a very different identity also enjoys distinctive advantages in accessing confidential information-- that of the “stranger.” A stranger may be defined as an actor or set of actors who interact regularly with a group or community but are classified both by group members and themselves as outsiders. Salient historical examples include such “middleman minorities” as European Jews and ethnic Chinese in other parts of Asia (Blalock 1967; Bonacich 1973). Since the

stranger's very identity renders him ineligible for full group membership, he cannot compete for status within the group. According to Simmel, this makes him a more dispassionate observer of the group's affairs who is sought out as a confidant because he cannot use such confidences to vie for relative status within the group.²¹

As in the case of ambiguous information, we do not mean to imply that middlemen are always in the best position to acquire confidential information. Rather, the implication is that while there are certain classes of knowledge that may flow more easily between actors with highly redundant alters, there are a parallel set of mechanisms that favor actors whose contacts are nonredundant. And more generally, the trade-off we identify in this paper seems to be members of a wider "family" of redundancy trade-offs-- exploration/exploitation, cosmopolitanism/localism, and stranger/insider. In each case, the advantages that derive an NR-strategy are counterbalanced by advantages that accrue to an R-strategy. And there seems generally to be a risk-return aspect to each trade-off, whereby the potential returns to nonredundancy are far greater but the surest returns accrue to redundancy. As March wrote with regard to exploration and exploitation, "the search for new ideas, markets, or relations has less certain outcomes, and more diffuse effects than does further development of existing ones (March 1991, p.73)." And while middlemen minorities have often enjoyed quite lucrative returns, the risks to such a status are well-known as well.

B. Network Endogeneity

The second objection we consider rests on assumption 3, that networks are fixed pipes. It seems clear that the trade-offs that we have identified would disappear if actors could

²¹ These dynamics are illustrated nicely in Bearman's (2005) analysis of doormen-tenant relations. Two key issues come to the fore that are not apparent in Simmel's treatment. First, the insider and stranger identities are social classifications rather than internally cohesive groups, as Simmel's analysis might seem to imply. As Bearman notes, tenants are interdependent (e.g., because noise and leaks travel between apartments; and because they compete for status in the building's hierarchy) but hardly represent a cohesive group. Second, Bearman points to another trade-off between knowledge and power that inheres in the stranger role-- i.e., that while the stranger may be well-positioned to accumulate a large amount of compromising information on the insiders, he is limited in the extent to which he can exploit it without being sanctioned by everyone in the role structure for violating his role. And this may be why actors can sometimes be particularly effective when they bring together actors who are all members of the same group rather than different groups (see e.g., Fernandez and Gould's [1993] "coordinator"; and Obstfeld's [2005] *tertius iungens*.) Of course, such coordination is limited by the fact that the actors are redundant. Zuckerman and Sgourev (2006) discuss an institution that tries to solve this problem, by creating a common identity among nonredundant actors.

change their ties immediately and effectively to meet their needs and desires.

Accordingly, recent research has emphasized that valuable “structural holes” can be expected to close quickly (Burt 2002) and that it is questionable whether incumbents can sustain a valuable middleman position (Ryall and Sorenson 2007). One might even go so far as to argue that the trade-off identified in this paper is largely moot because network positions are so fluid. But it is important to recognize that network positions are often quite enduring even while being very valuable. For instance, any organization can be depicted as a middleman, in that it (continually) takes an array of inputs and combines them (a producer) or merely retransmits them (a distributor or retailer) as outputs for “downstream” parties. While many such positions are vulnerable to competition, they may be quite sustainable when it is more costly for entrants to replicate the activities performed by the middleman.

Such barriers to entry might seem pertinent only to formal organizations. But our discussion of the stranger and insider identities suggests at least one source for such access constraints-- the need to assume an identity that is appropriate for a particular network position. Insofar as any actor must successfully assume an identity in order to maintain a set of relationships, and insofar as it is difficult quickly to adjust one’s identity, it is often hard to make substantial changes in one’s network position. As such, the network redundancy trade-off may be experienced as a choice between an identity that facilitates the pursuit of an NR-strategy and an identity that facilitates the pursuit of an R-strategy.

Framing of the trade-off in terms of identity links our discussion with yet another redundancy trade-off, as suggested by the following dilemma: “Is it better to have a simple identity or one that is more complex? (Zuckerman, Kim, Ukanwa, and von Rittmann 2003, p.1018)” Complex identities are potentially advantageous because “actors who could potentially be associated with multiple roles or groups retain flexibility in responding to interactants whose more narrowly defined identities induce commitments to restricted lines of action (p.1019).” Padgett and Ansell (1993) label such flexibility “robust action” and attribute it to Cosimo de Medici, who occupied a powerful middleman position in 16th century Florence. But as we have already seen, optimizing for nonredundancy carries great risk as well as potentially great returns. In this case, the

problem is that attempts to assume a complex identity generally fail. By “def(ying) prevailing sociocognitive frames” for interpreting action, the would-be robust actor “risks sowing confusion among potential audiences, thereby producing social penalties in the form of lack of attention or outright rejection (Zuckerman et al., *ibid.*)” In general, actors whose loyalties, skills, or interests are understood (as compatible with one’s own) are preferred. Accordingly, the surest route to survival involves becoming “typecast” in a relatively narrow identity, even if this limits opportunities in the long-run. And in social network terms, such a simple identity entails an R-strategy.

Conclusion: A Family of Trade-Offs

To summarize, we believe that that there are some important boundary conditions beyond which the trade-off we identify in this paper will not be salient. In particular, the trade-off will not be apparent if either: (a) the knowledge in question cannot be transferred between actors who are not structurally equivalent; or (b) if network links can be quickly and easily adjusted. Yet our discussion also suggests that there is a large set of social situations that fall within these boundary conditions. Indeed, while there is little or no precedent for supposing a trade-off in the social structural foundations of power and knowledge, our review of possible objections to our framework suggests that there should perhaps be nothing surprising about this trade-off since it belongs to a larger “family” of redundancy trade-offs long observed in sociology and neighboring disciplines. In each case, there are opposing advantages and disadvantages associated with focusing on redundancy (in relationships, activities, or one’s identity) and nonredundancy, with the former providing more certain but more limited returns relative to the latter.

Beyond simply noticing the homology among these trade-offs, situating the network redundancy trade-off as a member of the larger family directs us to issues that are not otherwise apparent, especially given the relatively static nature of our framework. For instance, while we have depicted the NR-strategy as riskier, a consideration of the kindred trade-offs suggests that the R-strategy may be riskier over the long-term. As March (1991) argues, *both* exploration and exploitation are necessary for a system’s survival even though the uncertainties of exploration and the difficulty of doing both simultaneously leads most organizations to focus on exploitation. The long-term risk is

that a strict focus on refining existing (processes for producing existing) products leaves a firm vulnerable to eventual changes in demand (or the development of superior processes). This risk is familiar from yet another related trade-off, that between generalism and specialism (e.g., Hannan and Freeman 1977; cf., Zuckerman et al. 2003: 1020). While specialists may enjoy advantages when demand for their product is high, generalism serves as a hedge against shifts in demand across specialties over time. The implication for knowledge and power is clear. Even if returns from enlarging knowledge and creating value through an NR-strategy seem less certain than the returns from focusing on value-capture through an R-strategy, there is a sense in which no actor can afford to focus solely on capturing value from others. Rather, the middleman is a position that every actor must try and assume in one form or another so that she brings something unique to the social encounters in which she chooses to participate.

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Table 1:
Results on Bit Diffusion in the Figure 2 Scenarios

Scenario 1 (Low equivalence, no direct tie between alters)										
<i>Mean (n=1000 simulations) # of Interactions In System Before Actor Possesses:</i>										
	2	3	5	6	8	9	11	12	14	15
	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits
Ego	6.4	16.6	37.6	47.9	66.2	76.5	92.9	102.9	125.3	173.6
Alter 1	5.4	11.5	24.9	28.1	46.4	59.4	94.9	118.3	180.3	230.0
Alter 2	5.5	12.4	25.3	28.8	47.0	59.7	94.4	119.1	181.7	228.6
Min of others	5.1	10.9	24.0	43.7	67.1	92.0	195.7	225.6	289.7	305.8
<i>Ego's relative speed in obtaining fifteen bits: (mean of 168.8 interactions for fastest actor)/(mean of 173.6 interactions for ego)=0.97</i>										
Scenario 2 (Low equivalence, direct tie between alters)										
<i>Mean (n=1000 simulations) # of Interactions In System Before Actor Possesses:</i>										
	2	3	4	5	6	7	8 Bits	9 Bits		
	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits		
Ego	6.3	16.9	29.3	42.5	55.3	69.1	85.0	105.6		
Alter 1	5.4	11.7	20.9	31.1	40.6	53.4	72.4	102.0		
Alter 2	5.4	12.0	21.6	31.2	41.3	54.5	71.8	102.1		
Min of others	5.2	11.1	24.8	45.5	67.9	94.5	121.1	148.2		
<i>Ego's relative speed in obtaining nine bits: (mean of 95.7 interactions for fastest actor)/(mean of 105.67 interactions for ego)= 0.91</i>										
Scenario 3 (High equivalence, no direct tie between alters)										
<i>Mean (n=1000 simulations) # of Interactions In System Before Actor Possesses:</i>										
	2	3	4	5	6	7	8 Bits	9 Bits		
	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits		
Ego	6.5	17.5	28.9	39.2	50.5	61.2	72.3	86.0		
Alter 1	5.8	13.3	22.1	30.0	37.0	45.2	54.6	78.0		
Alter 2	5.8	13.2	22.1	29.2	36.5	44.8	55.0	77.3		
Min of others	4.6	8.8	15.7	26.5	38.4	53.3	69.5	88.3		
<i>Ego's relative speed in obtaining nine bits: (mean of 69.56 interactions for fastest actor)/(mean of 86.0 interactions for ego)=0.79</i>										
Scenario 4 (High equivalence, direct tie between alters)										
<i>Mean (n=1000 simulations) # of Interactions In System Before Actor Possesses:</i>										
	2	3	4	5	6					
	Bits	Bits	Bits	Bits	Bits					
Ego	6.3	17.3	31.2	46.1	61.4					
Alter 1	5.7	13.0	24.0	36.9	52.5					
Alter 2	5.5	12.4	23.7	36.8	51.9					
Min of others	4.7	9.1	16.3	26.2	45.0					
<i>Ego's relative speed in obtaining six bits: (mean of 43.35 interactions for fastest actor)/(mean of 61.4 interactions for ego)=0.67</i>										

Table 2:
Results on Bit Diffusion in the Figure 3 Scenarios

Scenario 1 (Low equivalence, no direct tie between alters)										
<i>Mean (n=1000 simulations) # of Interactions In System Before Actor Possesses:</i>										
	2	3	5	6	8	9	11	12	14	15
	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits
Ego	6.3	17.0	37.8	48.7	68.7	78.6	97.6	107.8	128.0	140.4
Alter 1	5.6	13.4	30.8	39.4	56.4	65.2	84.2	95.3	121.1	137.4
Alter 2	5.2	13.2	30.6	38.8	55.7	64.7	83.7	94.8	121.0	137.5
Min of others	5.5	13.0	32.3	41.4	59.8	68.9	88.5	98.5	121.9	136.3
<i>Ego's relative speed in obtaining fifteen bits: (mean of 120.0 interactions for fastest actor)/(mean of 140.4 interactions for ego)=0.85</i>										
Scenario 2 (Low equivalence, direct tie between alters)										
<i>Mean (n=1000 simulations) # of Interactions In System Before Actor Possesses:</i>										
	2	3	5	6	8	9	11	12	14	15
	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits
Ego	6.5	17.1	43.0	55.7	81.3	94.1	120.3	134.5	164.7	183.7
Alter 1	5.5	12.9	33.5	45.4	69.6	82.3	108.5	122.9	154.0	173.7
Alter 2	5.3	12.9	33.6	45.4	69.7	82.4	109.1	123.3	154.8	174.6
Min of others	5.3	12.7	33.5	45.5	69.7	82.4	109.1	122.6	154.3	173.9
<i>Ego's relative speed in obtaining fifteen bits: (mean of 146.1 interactions for fastest actor)/(mean of 183.7 interactions for ego)= 0.80</i>										
Scenario 3 (High equivalence, no direct tie between alters)										
<i>Mean (n=1000 simulations) # of Interactions In System Before Actor Possesses:</i>										
	2	3	5	6	8	9	11	12	14	15
	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits
Ego	6.5	17.2	40.0	51.1	73.0	84.1	107.0	118.7	144.0	159.5
Alter 1	5.8	14.4	32.8	42.1	61.7	71.5	93.4	104.5	129.7	146.6
Alter 2	5.8	14.0	32.7	41.9	61.5	71.3	92.5	103.6	129.2	146.4
Min of others	5.0	11.8	26.7	34.3	49.9	58.2	77.2	87.4	114.6	133.8
<i>Ego's relative speed in obtaining fifteen bits: (mean of 119.8 interactions for fastest actor)/(mean of 159.5 interactions for ego)=0.75</i>										
Scenario 4 (High equivalence, direct tie between alters)										
<i>Mean (n=1000 simulations) # of Interactions In System Before Actor Possesses:</i>										
	2	3	5	6	8	9	11	12	14	15
	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits	Bits
Ego	6.1	16.7	46.9	64.4	99.4	116.5	151.4	169.1	206.6	228.4
Alter 1	5.3	13.0	38.6	55.5	90.7	107.8	142.4	159.8	197.6	219.3
Alter 2	5.4	13.0	39.0	55.2	90.2	107.5	141.5	159.4	197.9	219.3
Min of others	5.2	11.9	27.2	36.2	58.9	68.0	88.1	99.8	131.9	154.2
<i>Ego's relative speed in obtaining fifteen bits: (mean of 152.8 interactions for fastest actor)/(mean of 228.4 interactions for ego)=0.70</i>										

Table 3: Summary Results from 1,000 Simulations in the Figure 2 and Figure 3 Scenarios

<i>Results for Figure 2</i>					<i>Results for Figure 3</i>			
Assuming Uniform Valuation (6a)								
Results for Ego	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 1	Scenario 2	Scenario 3	Scenario 4
N bits obtained	14	8	8	5	14	14	14	14
Avg. buyer surplus	\$0.00	\$0.21	\$0.18	\$0.26	\$0.09	\$0.23	\$0.20	\$0.25
Total buyer surplus	\$0.00	\$1.71	\$1.44	\$1.29	\$1.26	\$3.17	\$2.74	\$3.55
N bits transmitted	15.70	4.21	5.02	2.62	10.89	5.98	7.85	5.01
Avg. seller surplus	\$1.00	\$0.58	\$0.57	\$0.52	\$0.92	\$0.53	\$0.48	\$0.39
Total seller surplus	\$15.70	\$2.46	\$2.88	\$1.35	\$9.99	3.14	\$3.73	\$1.93
Total surplus	\$15.70	\$4.17	\$4.33	\$2.64	\$11.25	\$6.31	\$6.46	\$5.48
Assuming Homophilic Valuation (6b)								
N bits obtained	6	4	4	3	6	4	4	3
Avg. buyer surplus	\$0.00	\$0.74	\$0.54	\$0.90	\$0.00	\$0.76	\$0.54	\$0.91
Total buyer surplus	\$0.00	\$2.97	\$2.16	\$3.59	\$0.00	\$3.05	\$2.17	\$3.65
N bits transmitted	3.70	2.48	3.05	1.86	3.71	2.48	2.88	1.85
Avg. seller surplus	\$1.89	\$2.23	\$1.95	\$2.60	\$1.96	\$2.26	\$2.14	\$2.65
Total seller surplus	\$6.99	\$5.54	\$5.96	\$4.84	\$7.29	\$5.60	\$6.15	\$4.91
Total surplus	\$6.99	\$8.51	\$8.12	\$8.42	\$7.29	\$8.65	\$8.32	\$8.56

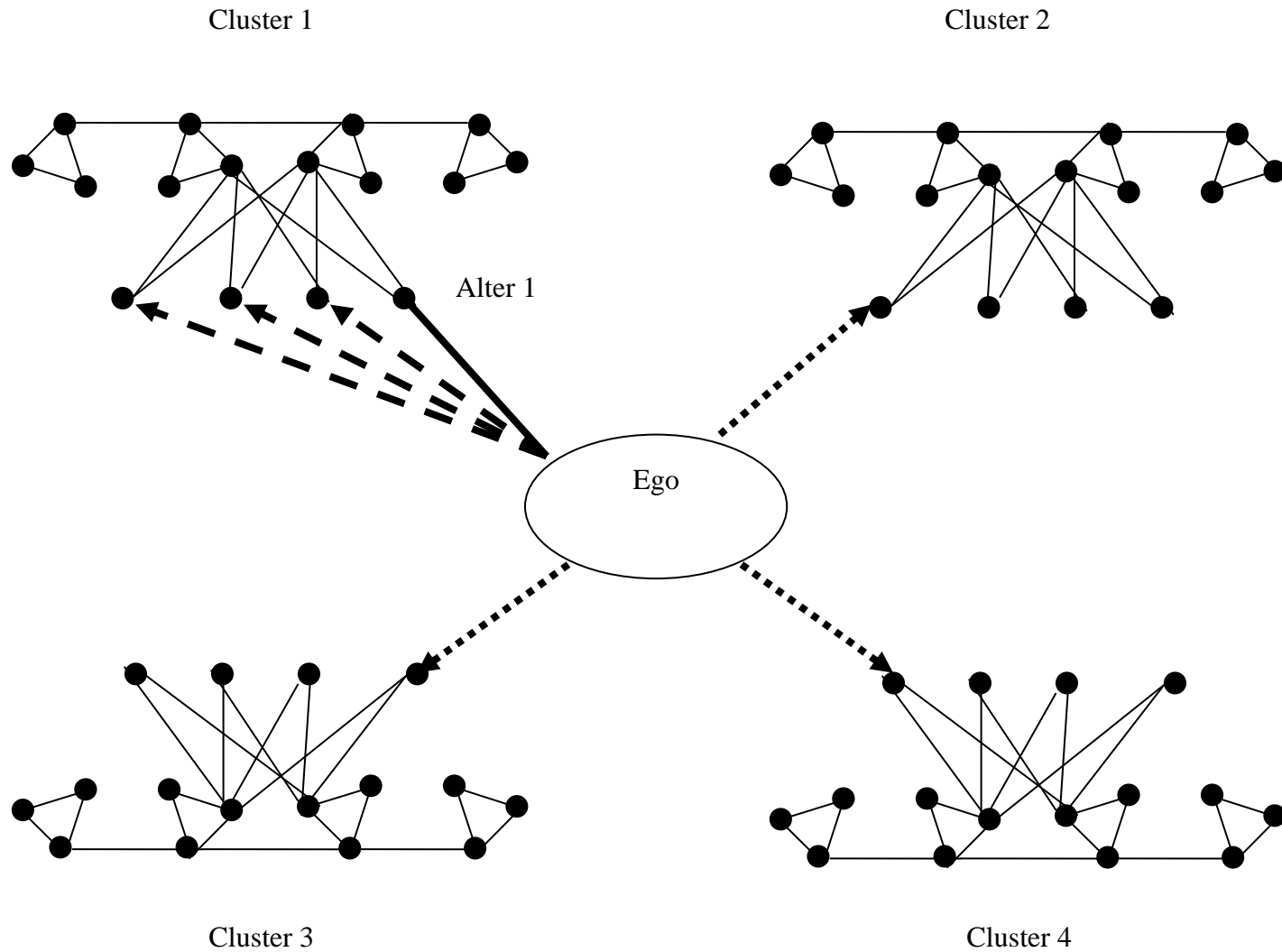
Note: All contrasts between scenario1 and scenarios 2, 3, and 4 are statistically reliable.

Table 4

Summary Statistics and Correlations Matrix, Variables averaged over 50 Simulations on 50 Clustered Networks of Size=40 (N=2000) and Degree=4 for All Actors. Prices Computed According to Equation (1).

Assuming Uniform Valuation (6a)								
	Mean (SD)	1	2	3	4	5	6	7
1. Slow accumulation	20.39 (1.41)	--						
2. Total buyer surplus	14.78 (1.09)	.500	--					
3. N bits transmitted	39.00 (1.22)	-.472	-.735	--				
4. Total seller surplus	24.21 (3.76)	-.452	-.947	.753	--			
5. Total surplus	38.99 (2.74)	-.420	-.898	.738	.991	--		
6. Ego-density	0.28 (0.16)	.528	.859	-.523	-.856	-.830	--	
7. Farness	85.51 (10.43)	.703	.655	-.385	-.614	-.580	.702	--
8. Information centrality	1.24 (0.11)	-.739	-.615	.327	.542	.497	-.701	-.889
Assuming Homophilic Valuation (6b)								
	Mean (SD)	1	2	3	4	5	6	7
1. Slow accumulation	26.12 (2.58)	--						
2. Total buyer surplus	9.56 (3.43)	-.062	--					
3. N bits transmitted	11.67 (1.88)	-.073	-.932	--				
4. Total seller surplus	29.43 (3.22)	.042	-.973	.959	--			
5. Total surplus	39.00 (0.79)	-.097	.365	-.128	-.140	--		
6. Ego-density	0.28 (0.16)	.076	.882	-.909	-.892	.182	--	
7. Farness	85.51 (10.43)	-.086	.765	-.783	-.778	.143	.702	--
8. Information centrality	1.25 (0.11)	-.042	-.721	.770	.743	-.096	-.701	-.889

Figure 1: The Redundancy Dilemma
After Alter 1, Where Should Ego Place Her Next Links?



R-Strategy: Optimize for redundancy	--->
NR-Strategy: Optimize for nonredundancy>

Figure 2: Two Dimensions of Alter Redundancy:
Four Triadic Clusters with No Direct Link between Them

Redundancy via a Direct Tie

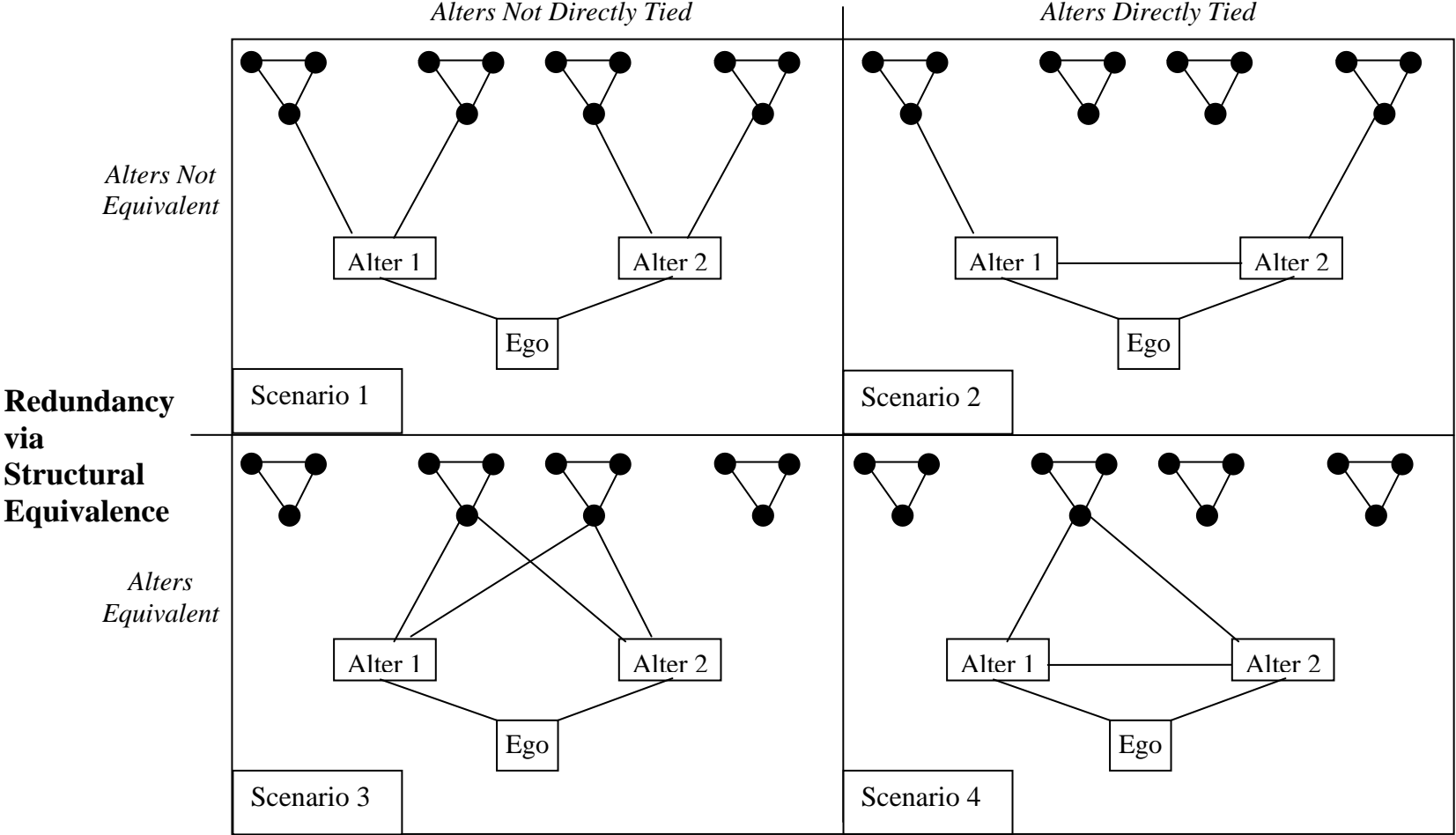


Figure 3: Two Dimensions of Alter Redundancy:
Four Triadic Clusters with Direct Links between Them

Redundancy via a Direct Tie

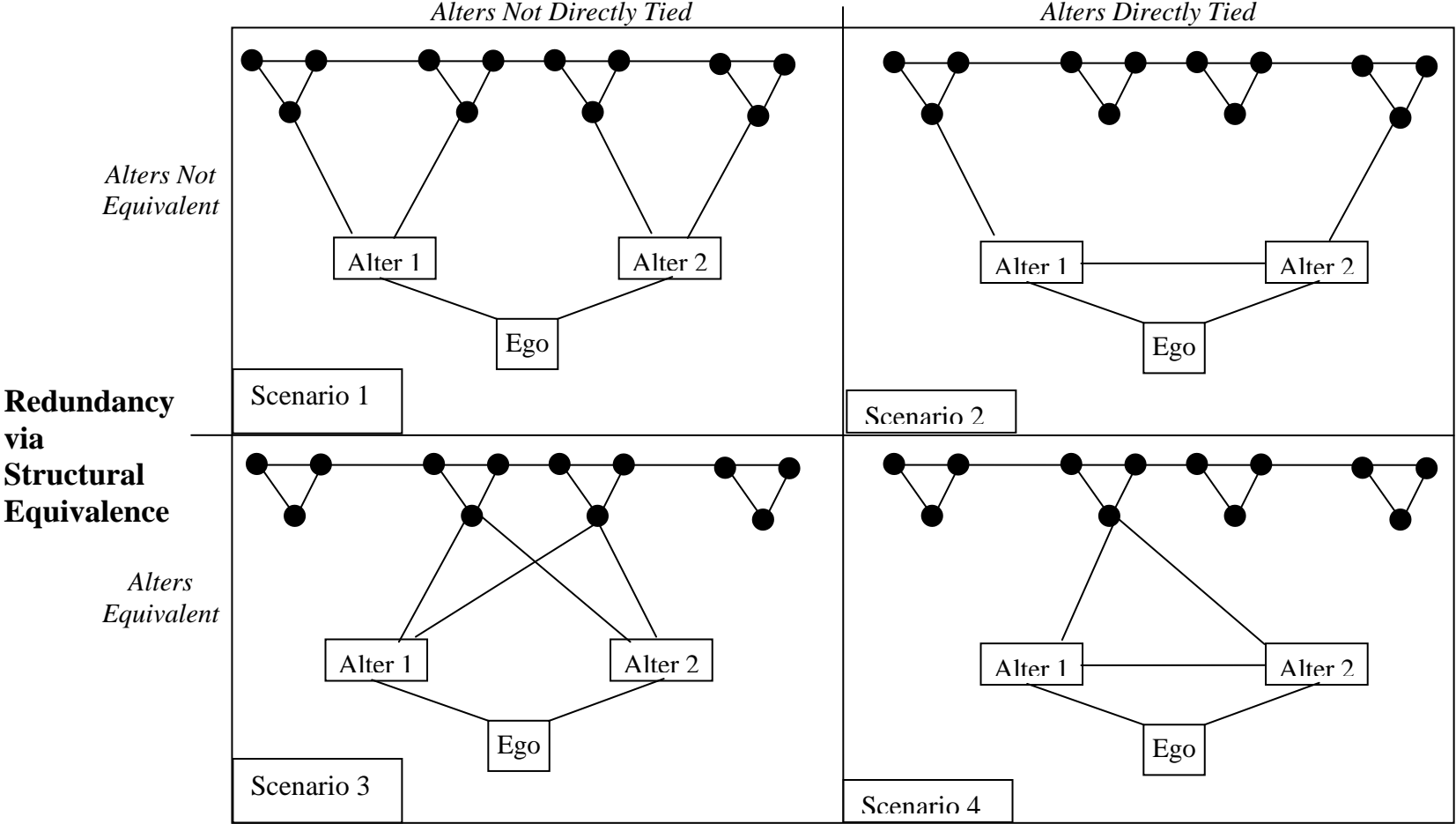


Figure 4: Functional Form of Discount in Price Equation

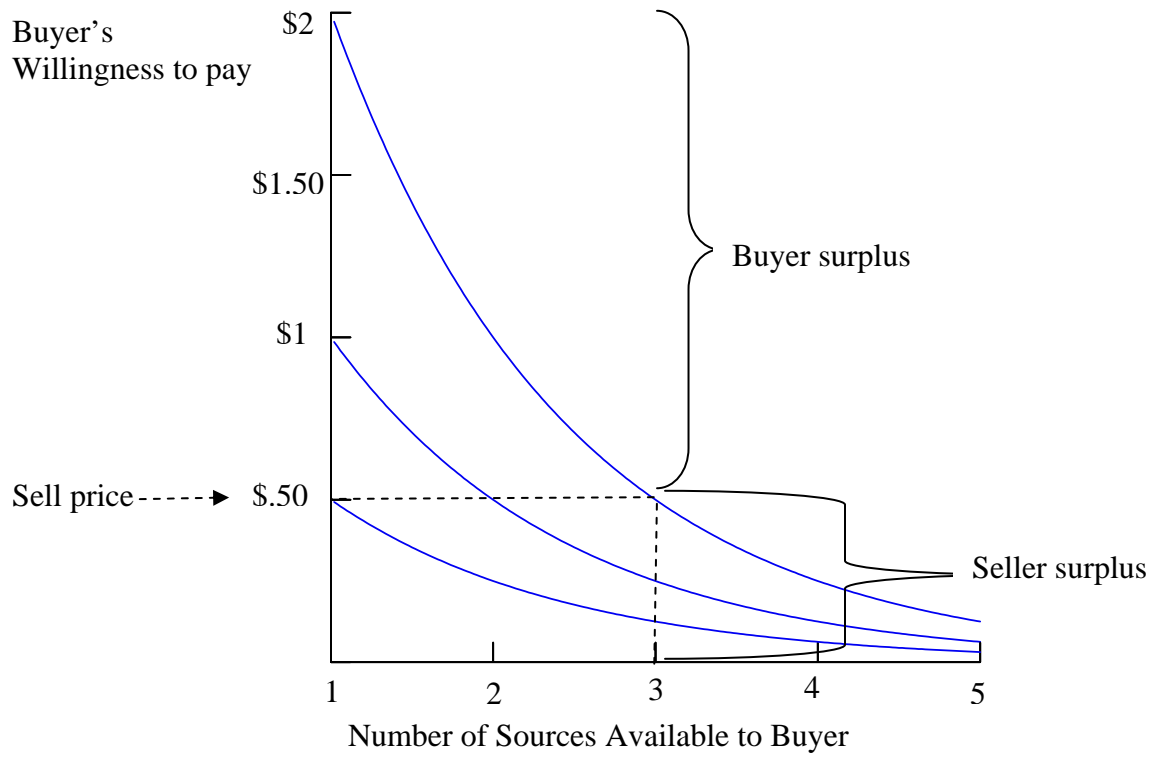
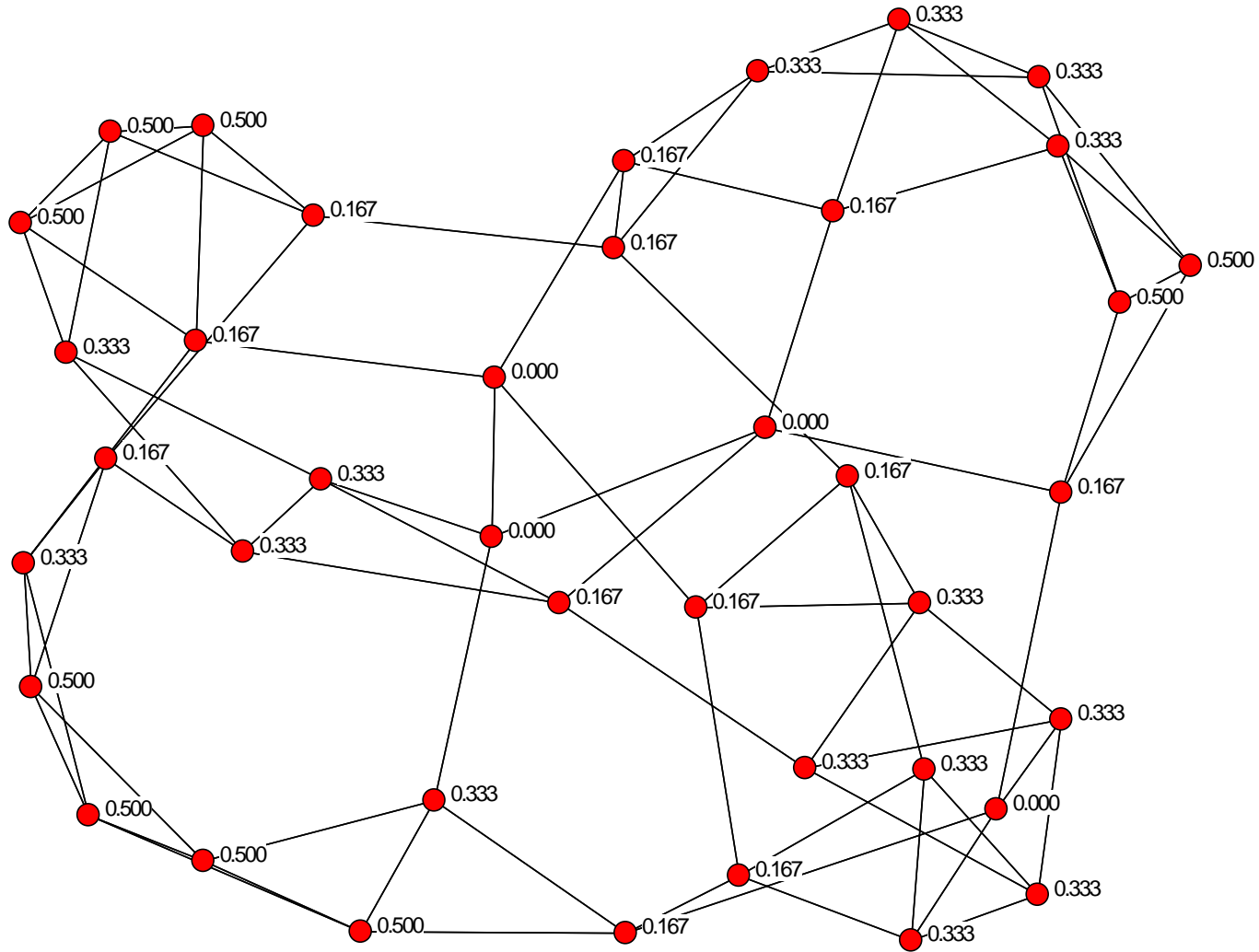


Figure 5: Illustrative 40-Person Network with Degree=4*



* The node labels indicate “ego-density” or the number of links between the node’s contacts divided by the total possible links.