ARE NETWORK EFFECTS REALLY ALL ABOUT SIZE? THE ROLE OF STRUCTURE AND CONDUCT

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Rooted in neoclassical economics, network effects research has revolved around size, arguing that the more users a network has, the more valuable that network will be to each user. I argue that a network's structure (feasibility of transactions, centrality of members, structural holes, network ties, the number of roles each member plays) and its conduct (opportunistic behavior, reputation signaling, perceptions of trust) also have significant impacts on a network's value to users and to network providers. Network research that neglects structure and conduct and focuses only on size can lead to wrong strategies or a misleading research agenda. Copyright © 2012 John Wiley & Sons, Ltd.

INTRODUCTION

The performance of firms in many industries— from banking to telecommunications to social networks—depends on their offering of products that exhibit network effects. A product exhibits network effects if its value to users depends not only on benefits from the product itself but also on access to the network of people using that product or a compatible one (Katz and Shapiro, 1985, 1992; Farrell and Saloner, 1986; Liebowitz and Margolis, 1994; Economides, 1996; Sheremata, 2004). For example, the value that an e-mail user derives from his/her e-mail software depends not only on the ease of use and other benefits of the software but also on the network of people with whom he/she can communicate using e-mail.

To the extent that users derive value from being members of a network, an important question is, what is it about a network that bestows value on network members? Early research exploring the phenomenon of network effects has been grounded largely in neoclassical economics and, in answering this question, has focused primarily on the role of network size. Witness the following three definitions from frequently cited network effects papers:

1. 'The benefit that a consumer derives from the use of a good often depends on the number of other consumers purchasing compatible items,' Katz and Shapiro, (1986: 822).
2. 'A good is often more valuable to any user, the more others use compatible goods,' Farrell and Saloner, (1986: 940); and
3. 'A network externality exists when the value of consuming a particular product or service increases in the number of consumers that use compatible products or services,' Gandal, (1994: 160; 1995: 599).

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This emphasis on size has been extended to the normative advice for managers whose firms compete in network markets (Benson and Farrell, 1994; Shapiro and Varian, 1999). For example, firms have been urged to exploit direct network effects by building an early lead in network size and pricing strategically, or to take advantage of indirect network effects by, for example, boosting complements early in the life of a product that needs complements (Benson and Farrell, 1994; Schilling, 2002; Shapiro and Varian, 1999).

This paper builds on recent research that treats a network as more than a black box whose size is important (Swann, 2002; Dellarocas, 2003; Suarez, 2005; Soh, 2010) and argues that two factors influence the value a network member or provider can derive from network effects: network structure (of which size is only one component), and network conduct. In particular, I argue that the value each network member and network provider derives from a network will be influenced by (a) the feasibility of transactions, (b) the centrality of its members, (c) the structural holes and ties within the network, (d) the number of roles each member can play, as well as by (e) the level of opportunistic behavior, (f) the members' reputation, and (g) the perceptions of trust. I also argue that a strategy for attaining dominance in a network market that is rooted only in network size, without explicitly exploring these components of structure and conduct, is likely to overlook important sources of competitive advantage. The propositions of this paper suggest that focusing on size alone can be misleading to both researchers and managers.

Why is it important to research the value that network users and providers can derive from a network?[1] And why is there a need to explore beyond network size? First, products and services that exhibit network effects cut across all kinds of industries from health care (health maintenance organizations [HMOs]) to financial services, to high tech (computers and communications). Some of these industries, such as online social networks, have increasingly complex networks and business models that management scholars and practicing managers alike are struggling to understand. We need good theory to help us understand what is

going on in network industries. Besides, to the extent that 'there is nothing so practical as a good theory' (Lewin, 1951: 169), theory-grounded research about network effects could help managers make better decisions in a world in which, increasingly, some of the most complex products and services exhibit network effects.

Second, over the past decade, social network theory (SNT) has been emerging as a theoretical perspective for exploring strategy questions. An important part of that evolution is linking firm performance to social network constructs such as structural holes, network ties, and network centrality. This paper links social network constructs to network-related value creation and capture, and to competitive advantage. In doing so, it potentially contributes to clarifying the elusive but important connection between SNT and firm performance.

Third, network effects are strategic resources (Shankar and Bayus, 2003). Studying how network members or providers derive value from networks can help us identify where strategic resources originate and how they translate into economic rents—important research questions that have received little attention despite the tremendous amount of research about the resource-based view of the firm (RBV) (e.g., Helfat and Peteraf, 2003; McEvily and Chakravarthy, 2001). To the extent that network structure and conduct also contribute to value creation and capture, understanding that contribution explicates the linkage between product-market position (PMP) and resources/capabilities.

Fourth, treating network size as the sole determinant of a network's value to users is tantamount to omitting variables, which biases estimates and makes research results difficult to interpret. It can also be misleading to managers.

BACKGROUND INFORMATION

The protagonist in this paper is a firm that is a network member or provider, and whose goal is to have a competitive advantage in the markets in which it competes. (The protagonist could also be a consumer/member of the network whose goal is to satisfy its consumption needs.) The network can, depending on its properties, contribute to the firm's competitive advantage (or to satisfying the consumer's needs). Before exploring why and how the structure and conduct of a network can

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[1] A network provider is a firm that provides a core component or subsystem of the infrastructure of a network that enables network members to stay connected and to undertake network transactions. Network providers are usually members of the network.

make such a contribution, it is insightful to define competitive advantage and explain what is meant by a network being 'valuable' and a network 'provider.'

A firm has a competitive advantage when it earns a higher-than-average rate of profitability in the markets in which it competes (Grant, 2005; Besanko *et al.*, 2010). To have a competitive advantage, a firm often must create and/or capture value better than its competitors (Afuah, 2002, 2009; Besanko *et al.*, 2010). A firm creates value when the benefits it offers to customers exceed the cost of offering those benefits. It captures value when the price it obtains for the benefits exceeds the cost of offering them. (End-consumers can also capture value in the form of consumer surplus when the benefits they receive from a network are greater than the price they pay for the benefits.) Thus, a network contributes to a firm's competitive advantage when it enhances value creation and/or capture. I will refer to a network as being 'valuable' to a firm—whether the firm is a network provider or a network member—when the network contributes to the firm's value creation and/or capture, and therefore to the firm's competitive advantage. It is valuable to a consumer when it contributes to satisfying the consumer's needs.

The other important term that needs more clarification is 'network provider.' A network provider supplies a core component or subsystem of the infrastructure needed for network members to stay connected and undertake network transactions. Depending on the type of network, network providers have also been called network sponsors, network owners, platform sponsors or owners, and network suppliers (e.g., Rochet and Tirole, 2003). Good examples of network providers are eBay, with a network of registered users who buy and sell using the infrastructure the firm provides; Facebook, with a social network that thrives in the infrastructure it built; cell phone companies, with their networks of subscribers and associated infrastructures; credit card companies, such as Visa, with networks of cardholders and merchants; Toyota's supplier networks (Dyer and Nobeoka, 2000); and computer networks (such as Wintel) in which Microsoft and Intel are major providers since the former supplies core software and the latter offers the microprocessor architecture. Of course, there are networks that have no 'providers.' These include informal networks whose infrastructure is largely virtual, such as those for know-how

trading described by Schrader (1991). Such networks are valuable largely to their members.

THE ORIGINS OF SIZE'S DOMINANCE

Now consider a network in which the following four neoclassical economics assumptions that are implied or explicitly stated in past network effects literature (Katz and Shapiro, 1985; Farrell and Saloner, 1986; Gandal, 1994) hold:

1. Every member of the network can transact with every other member and benefit equally from transacting with each member (*Assumption 1*).
2. There is resource/capabilities homogeneity across network members and across network providers (*Assumption 2*).
3. All network members are rational and have identical information about each other and about all possible transactions within the network (*Assumption 3*).
4. Information flows seamlessly from member to member (*Assumption 4*).

If such a network has N members, the first member can undertake transactions with the remaining N−1 members. If all N members can transact with each other, there are N(N−1) possible connections in the network. And since each connection gives members an opportunity to create and/or capture value or satisfy a need, the value of the network is proportional to the N(N−1) connections. The connections that take place in such a network with N=4 and N=8 are shown in Figure 1, where the connection from, say, A to B is counted separately from the connection from B to A (so-called two-way network).

Now consider a rational new consumer who wants to join a network. If the consumer joins the N=4 network, the number of connections in that network rises from 4(4−1)=12 to 5(5−1)=20. In other words, the value that consumer's membership adds is 8 (proportional to 8) because the consumer's decision to join increased the number of connections by 8. If the consumer joins the N=8 network, the number of possible connections changes from 8(8−1)=56 to 9(9−1)=72, for an added value that is 16 (proportional to 16). Therefore, with each additional network member, the provider of an N=8 network gets more 'new' value than the provider of an N=4 network. In general,
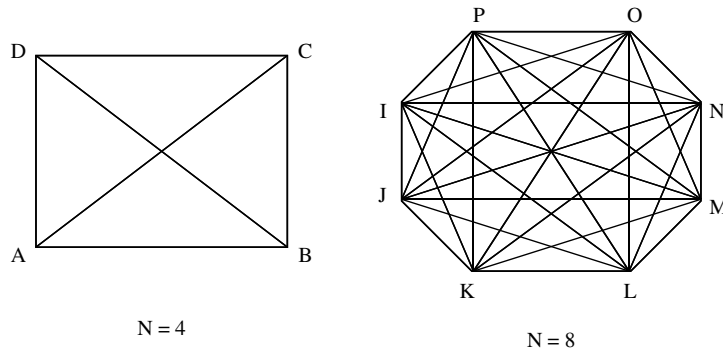
Figure 1.   Size determines value

as N grows very large, the number of possible connections $N(N-1)=N^2-N$ approaches N^2 and the value of the network rises proportionately.[2] Thus, when Assumptions 1–4 hold, the expected value to each network user and provider from network effects increases with the square of network size. I will refer to this result as *the size hypothesis*.

Critical size and normative advice

When a rational customer wants to buy a product that exhibits network effects, he or she considers not only the benefits from the product but also the value bestowed by the network. Put differently, a customer will choose to join a product's network not only because of the expected value from network effects but also because of the benefits from the product itself. Early in the life of a product and its network, the network's size, N, is very small and the expected value, which is proportional to N^2-N, is also very small. Thus, in this early stage, the dominant influencer of a customer's choice of network is likely to be the benefits from the product. However, as N increases, N^2-N increases rapidly. Beyond some size, N_c (the *critical size*), the value from network effects dominates since it is proportional to N^2-N. This dominance continues until some agent, such as a technological innovation, renders the network obsolete or enables network providers to improve product benefits enough to overcome the network size advantage.

One implication of the size hypothesis is that, beyond the critical size, N_c, a lead in network size—even a very small lead—can grow exponentially, enabling the network provider(s) to dominate the market or win a standard, relegating competitors to niche markets or oblivion (Arthur, 1989; David, 1985). Not surprisingly, a great deal of the normative advice offered to firms in network industries has been rooted in the size hypothesis. For example, it has been suggested that early in the life of a network (before it reaches its critical network size), network providers are better off pursuing actions that would give their products an early lead in network size (Bensen and Farrell, 1994). They might, for example, team up with competitors to flood the market with one version of the product, or entice new network members with free or low-priced products (e.g., Shapiro and Varian, 1999; Khazam and Mowery, 1994). Other researchers have argued that investment in continuous learning and innovation can enable a firm to build a stock of related knowledge and routines to locate, evaluate, and assimilate new knowledge (Sheremata, 2004; Zahra and George, 2002). This stock of knowledge can enable a firm to offer products with customer benefits that are superior enough to overcome a competitor's network size advantage (Schilling, 2002; Sheremata, 2004).

Beyond network size: the importance of network structure and conduct for strategy

Assumptions 1–4 enabled me to derive the size hypothesis and make predictions about the importance of network size in some industries. However, simplifying assumptions can strip off important insights, especially information for making normative prescriptions. Clearly, the four assumptions do not reflect the circumstances in most network industries and may be depriving researchers of

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[2] Among other things, size lowers coordination costs, raises switching costs, and increases barriers to entry, thereby potentially contributing to both value creation and capture (Besanko *et al.*, 2010).
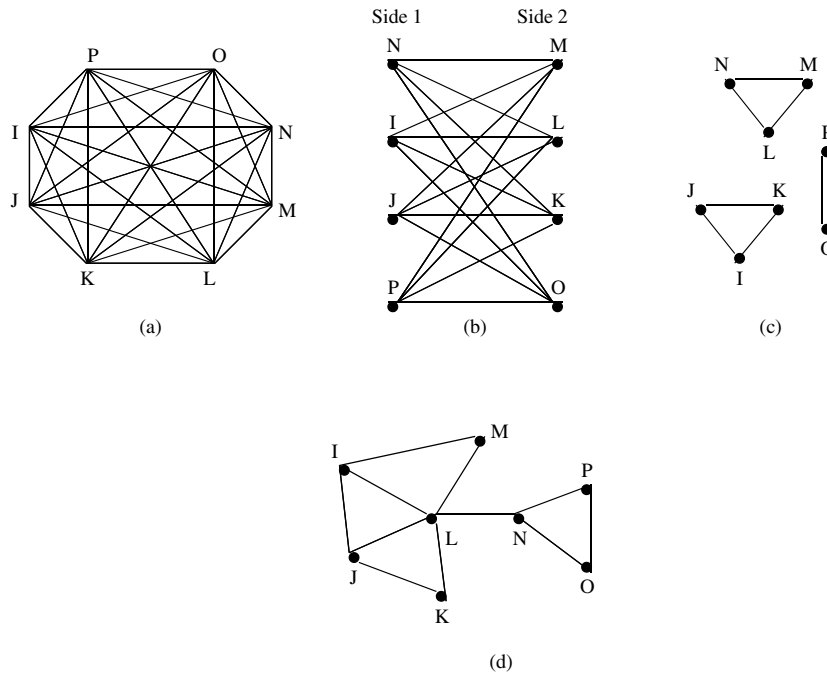
Figure 2. Structure also determines value

paths to important constructs and solutions to interesting questions. In what follows, I relax the assumptions in search of other network insights, beyond the size hypothesis, that are potential sources of competitive advantage. I group these characteristics by network structure and network conduct.

STRUCTURE

A network's structure is the number of members, the relationships among them, and the heterogeneity and relative characteristics of members and their relationships (Tirole, 1988; Burt 2001; Besanko *et al.*, 2010). In this construct, network size becomes one of several important factors. Below, I inductively derive the other factors by relaxing Assumptions 1–4, and show how they too, like size, might contribute to competitive advantages for network users and providers.

Transaction feasibility

In a phone network, where the primary transaction is making or receiving calls, anyone with a network phone number can call any other person with a network phone number. Therefore *Assumption 1*

holds: 'Every member of the network can transact with every other member of the network.' Assumption 1 does not hold in a credit card network, however, because cardholders can transact with merchants but not with other cardholders. Nor does it hold for a social network such as Facebook where groups of members control who can join a conversation. In fact, *Assumption 1* does not hold for many networks, and therefore their structures are anything but that in Figure 1. To see why, consider the four structures of Figure 2. All of them have eight members. However, in Figures 2b, 2c, and 2d, not all members can transact with each other. Figure 2b is an example of a *two-sided* network, in which there are two distinct groups that provide benefits to the other (Rochet and Tirole, 2003; Parker and Van Alstyne, 2005). The more members that participate in Side 1, the more valuable the network is for members of Side 2, and vice versa. When a new member joins Side 1, the increase in the value of the network is proportional to 8, but only for Side 2 members and the network provider. A credit card network is an example of a two-sided network because it has two groups of members: cardholders and merchants. Whether network members gain value from an additional member depends on (a) which side the new member joins and (b) where the focal members reside.

Figure 2c is an example of three subnetworks within a larger network, such as a social network (e.g., Facebook) in which people of the same persuasion gravitate toward their own group. The value added when a member joins one of the subnetworks in Figure 2c is proportional to 6 if the new member joins the two-member subnetwork, and proportional to 8 if the new member joins one of the two three-member subnetworks.

All three networks in Figure 2 have 8 members each. However, the network in Figure 2a, in which each member can transact with all other members, is the most valuable to each member and to the network provider(s), followed by the network of Figure 2b, and then that of 2d. The network in Figure 2c is the least valuable. Effectively, despite the fact that all four networks have the same size, the value they create varies with their structures.

> *Proposition 1a: The more that each network member can transact with every other member, the more valuable the network is likely to be to each member and to the network provider(s).*

Centrality and structural holes

To the extent that not every network member can transact with every other member, each member's position in the network is likely to be different, and therefore should have a different impact on how much value the member adds to or captures from the network. To see how, consider Figure 2d. L can transact with more members than anyone else. If L decides not to transact with J or K, it can still transact with I, M, or N. J and K have fewer choices than L. Because it is more centrally located than other members, L is said to have a high degree of centrality (Sparrowe *et al*., 2001). The addition of a centrally located actor such as L adds more incremental value to a network than the addition of a less centrally located member such as J or M. More importantly, a centrally located member can create and/or capture more value from the network than a less centrally located one (Paruchuri, 2010; Soh, 2010; Sparrowe *et al*, 2001). As we will see later, if a centrally located member is opportunistic, the impact on other members and the network provider(s) can be negative.

> *Proposition 1b: The more central a non-opportunistic member's position in a network, the*

more valuable the member is likely to be to other network members and the network provider(s).

In Figure 2d, L also has another important position: it is the only member that bridges the structural hole between subnetworks IJKM and NPO (Burt, 1992, 2000, 2001). By providing a nonredundant link between the two subnetworks, L adds value not only to its own IJKM subnetwork, but also to the NPO subnetwork and to the overall network. N plays a similar role for its own NPO subnetwork. A member that bridges a structural hole brings more value to the network than one that does not (McEvily and Zaheer, 1999; Burt, 2000; Pollock, Porac, and Wade, 2004; Fleming and Waguespack, 2007). If the bridge that it makes between the two subnetworks is nonredundant, the member is a monopoly as far as the bridge is concerned, and therefore has bargaining power during some transactions between the two subnetworks. How much value the member can create or capture depends on the type of network and the circumstances. For example, an investment bank that bridges the hole between start-ups that want to go public and private investors can capture a lot more value than engineers who bridge the hole between their firm and the subnet-network of outside engineers and scientists during know-how trading (Pollock *et al*., 2004; Schrader, 1991).

> *Proposition 1c: Members that bridge structural holes in a network are more likely to create and/or capture more value than members that do not.*

While the effect of a member being centrally located in a network, or of bridging a structural hole, is usually positive for that member, the effect on a network provider is not as straightforward. Because a new centrally located member of a network, or one that bridges structural holes, adds more value than a less strategically located one (Burt, 2001), their addition can be good for the network provider. However, if these strategically located members are opportunistic, their presence can attract other opportunistic types and/or drive non-opportunistic types, thereby reducing value creation and capture (Akerlof, 1970).

Network ties

According to *Assumption 4*, information flows seamlessly through a network. That may not be

true for some networks. For example, during innovation, an actor may want to move large amounts of information, some of it tacit. Tacit information can be difficult and costly to transfer (von Hippel, 1994). Hansen (1999) found that the transfer of knowledge through a network is a function of the type of knowledge being transferred and the type of ties the transfer uses. Tacit knowledge is best transferred through strong ties (frequent and close relations) while explicit knowledge (such as information about where to find complex knowledge) is best transferred through weak ties (infrequent and distant relations). For example, in online auctions, determining the value of an antique or a work of art can involve tacit and complex knowledge. A buyer may need to see, feel, and touch the object. The buyer may also need to talk to experts. What's more, the buyer may need to evaluate the seller and the seller's information about the object to establish authenticity, and so on. The frequent and close relationships of strong ties enable a firm to build a reputation or trust, both of which reduce transaction uncertainty about partners. Strong ties also allow a firm to gain experience in interacting with the partner, thereby reducing uncertainty. Some evidence of this is provided by Suarez (2005), who found that in making their decisions about which technology to adopt, cellular phone operators paid more attention to the decisions made by other operators in countries with which the operators had strong ties.

If the item to be exchanged is a new experience good—a new product or service whose quality is difficult to ascertain before use—two options are available to the seller to help the buyer establish the good's quality: (1) advertising, pricing, and branding to signal the quality of the good (Nelson, 1970; Milgrom and Roberts 1986), and (2) letting the buyer use the good to determine its value before paying for it. Advertising, pricing, and branding information has both explicit and tacit components, and therefore requires both strong and weak ties for effective transmission within a network. Thus, if the seller decides to signal the quality of an experience good within a network, its effectiveness in doing so will depend on the related strong and weak ties in the network. If the seller decides to let the buyer evaluate the good before purchase, it runs the risk that once the buyer uses the good the buyer may not have the incentive to pay for it (Arrow, 1962). Strong ties between buyer and seller will (a) allow the seller to, for

example, build a reputation for retaliation that will scare buyers into having an incentive to pay for the good; (b) allow buyer and seller to build enough trust between them to discourage the buyer from behaving opportunistically; or (c) allow the buyer to build a reputation for being a bad transaction partner, thereby enabling the seller to find another buyer.

Clearly, both weak and strong ties are important drivers of the value users derive from their networks: weak ties for locating what needs to be exchanged and strong ties for making exchanges (Hansen, 1999; Granovetter, 1985). Thus, a focus on network size alone, without attention to the number and nature of ties within the network, can be misleading. A large network without such ties is likely to be less valuable to members and to the network provider than a smaller one that has them.

Proposition 2: The more that the ratio of strong-to-weak ties matches the ratio of tacit-to-explicit knowledge, the more valuable the network is likely to be for members and the network provider(s).

Roles played by each network member

The number and distribution of roles played by each actor in a network also influences the network's value. To see how, consider the network structures in Figure 3. Each structure has six actors. To keep the discussion tractable, let's assume that *Role1* players are sellers while *Role2* players are buyers. In the structure in Figure 3a, each of the six actors is simultaneously a buyer and a seller, and can sell to or buy from five others. Since each of the N members can undertake $2(N-1)$ transactions, the total number of possible transactions is $2N(N-1)=60$. In the structure in Figure 3b, each member can sell or buy, but not both. Among the six members there is one seller and five buyers. The one seller can sell to five of the six members but each buyer can buy only from the one seller, making the total number of transactions $N-1=5$. Clearly, the second structure is not as valuable to buyers as the first one *even though both structures have the same network size* (six members).

In Figure 3c, where there are three buyers and three sellers, each seller can sell to three buyers and each buyer can buy from three sellers, for a total of $(N_b)(N_s)=9$. Electronic commerce
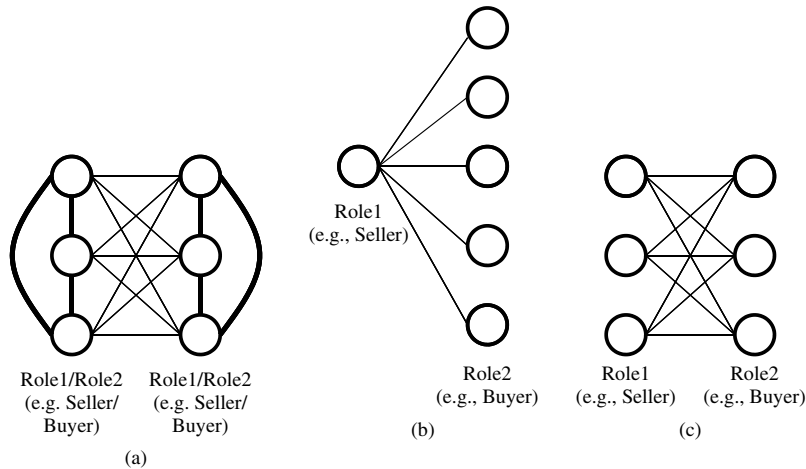
Figure 3.   The role played by each actor in a network impacts potential value creation and capture

networks provide some examples. The structure of Figure 3a is similar to eBay's initial network of registered users who traded in personal collectibles. Each of these members was both a potential *seller* and a potential *buyer*. The structure of Figure 3b is more similar to Amazon.com's network before competitors moved in, when Amazon was the only seller in its network. Clearly, eBay's network was more valuable to each of its customers who wanted an antique (and to eBay) than Amazon.com's was to each of its customers who wanted a book. Both companies' networks have since evolved into more complex structures.

> *Proposition 3: The more critical roles that each network member plays, the more valuable, on average, the network is likely to be to each member and to the network provider(s).*

Heterogeneity of capabilities and the inverted U-shape of size

Contrary to *Assumption 2*, capabilities are usually not homogeneous across network members or network providers (Peteraf, 1993; Mahoney and Pandian 1992). Consequently, different members and providers of a network are likely to have different abilities to add or capture value from it. For example, an international telephone network is more valuable to a person who is capable of speaking many languages than it is to a person who speaks only one. If a firm wants to successfully engage in know-how trading of the type described by Schrader (1991), it needs the absorptive capacity to evaluate, value, and assimilate know-how

from partners, as well as the know-how it can use for exchange. Members who make nonredundant bridges to structural holes are likely to have some distinctive capabilities. For example, in investment banking, a bank with the right client relationships is in a better position to bridge structural holes between segments of clients than one that does not have such prized relationships (Pollock *et al.*, 2004). In innovation, gatekeepers must have the ability to translate internal communications codes into what the outside world can understand and vice versa so as to be able to bridge structural holes between their internal company networks and external ones (Allen, 1984). And a network member who has valuable difficult-to-imitate capabilities is likely to have more bargaining power over fellow network members than one without such capabilities. It will therefore be in a better position to appropriate more of the value created in the network than other members.

> *Proposition 4a: A network is likely to be more valuable to members and providers that possess distinctive value-appropriating capabilities than to those that do not posses such capabilities.*

If valuable capabilities are scarce, difficult-to-imitate, and nontradable, a network member or provider with such capabilities can profit from them as the network grows and value increases as a function of N^2-N, provided the capabilities are scalable. However, if scalability of capabilities is limited—for example, because they are difficult to replicate—such a firm may be unable to obtain the

additional capabilities it needs to manage exponential growth. After a certain network size, each new member is likely to have a negative effect on network value. (For example, a congested telephone network may start dropping calls.) Thus, when a network that requires scarce difficult-to-replicate resources reaches some size, the addition of new members may actually reduce the value each member derives from network growth.

Proposition 4b: The lower the scalability of a firm's resources for creating and/or capturing value in a network, the more that a plot of network value to the firm versus network size is likely to have an inverted U-shape.

CONDUCT WITHIN A NETWORK

Beyond the structure of a network, the conduct of its members also has an impact on value. I will explore the conduct factors by focusing on *Assumption 3*. In particular, I explore the effect of opportunistic behavior and remedies such as reputation and trust on the network value.

Opportunistic behavior

Opportunistic behavior here refers to self-interest with guile, and 'incomplete or distorted disclosure of information, especially to calculated efforts to mislead, distort, disguise, obfuscate or otherwise confuse' (Williamson, 1985: 47). In a world of *Assumption 3*, there is no information asymmetry and network members are rational. In such a world, it is difficult for a network member to behave opportunistically during transactions (Williamson, 1985, 2002). However, in the real world, network members are boundedly rational and unlikely to know, or to be able to obtain, all of the information they need for many transactions. The result is information asymmetry, which creates an opening for opportunistic behavior. For example, a seller of collectibles may decide to conceal information not only about him or herself but also about the collectible. Those network members that bridge structural holes or are centrally located in a network may also decide to use the power their position creates opportunistically for self-gain rather than for the interest of the network (Sparrowe *et al.*, 2001). Thus, each additional opportunistic member may make the network less valuable to

other members and network provider(s). At the extreme, a network could suffer from a lemons problem in which high quality members exit the network, leaving behind only low quality ones (Akerlof, 1970). The result can be a network that contributes little or no value to each member's or provider's value creation and/or capture.

However, some researchers have argued that network members that are opportunistic in some activities may be good for the network provider(s). For example, Conner and Rumelt (1991) argued that some level of software piracy can be good for suppliers of software and PCs. Their rationale was that since the marginal cost of 'supplying' that extra stolen unit is zero, and users who steal software build switching costs by learning how to use it, these users may buy more compelling versions of the software later. In learning how to use the software, pirates can also ascertain the value of the software, improving their chances of paying for more protected versions. Besides, a larger network of users can attract new paying members, especially businesses. This piracy model is an exception rather than the rule. The pirates are opportunistic only when dealing with the software supplier and not when transacting with other members of the network. Thus, on average, opportunistic behavior has a negative effect on value creation and capture.

Proposition 5: The more opportunistic behavior there is in a network, the less valuable, on average, the network is likely to be to members and the network provider(s).

Reputation effects

Network members can develop a reputation for retaliation, honesty, trustworthiness, and dependability (e.g., Agarwal, Ganco, and Ziedonis, 2009; Arend, 2009; Fombrun and Shanley, 1990; Ring and Van de Ven, 1992). Members that want to develop such a reputation will be deterred from engaging in short-term opportunistic behavior by the fear of ruining their reputation and foregoing gains from future transactions. At the same time, a network member's reputation serves as a signal to other members that it is a worthwhile partner in the relevant transaction. A member with a reputation for retaliation sends a signal to potential transaction partners that it will retaliate against

any partner that engages in opportunistic behavior. Similarly, when network members gravitate to partners with good reputations, less reputable members may be forced to clean up their acts or leave a network.

The economics literature that has explored the impact of reputation on networks sees opportunism as being driven by adverse selection and moral hazard, and the reputation mechanisms put in place to deter them as depending on which of these effects the mechanism is targeting (e.g., Dellarocas, 2003; Li, 2010). Recall that in adverse selection, some members of a network have information about their type—opportunistic—that other members do not have. Thus, reputation mechanisms can help network members know more about each member's type. The activities of the online auction company eBay offer a good example of how a firm can help build and communicate reputation effects and curb the effects of adverse selection. Buyers and sellers who engage in transactions on eBay are able to post compliments, criticisms, and other comments in the eBay Feedback Forum. eBay uses this information and members' transaction records to compile buyer profiles and add color-coded symbols for potential trading partners to see. Such ratings give network members some information about the opportunistic potential of each candidate.

In moral hazard, transacting network members have the same information—there is information symmetry—when they enter a contract but, after the contract, one party takes an opportunistic action that the other party cannot observe. In these cases, reputation mechanisms are designed to encourage more honest behavior by threatening actors with future punishment. eBay's ratings are a good example of reputation mechanisms, too. The fear of poor ratings and a loss of future business discourage sellers and buyers from reneging on terms they agreed to when contracting a sale.

Proposition 6a: The higher the reputation of network members for retaliation, honesty, trustworthiness, and dependability, the larger is the impact of network size on network value to its members and to the network provider(s).

Effect of trust

Chiles and McMackin (1996: 85) defined trust as 'the expectation that an exchange partner will not engage in opportunistic behavior, even in the face of countervailing short-term incentives... and uncertainty about long-term benefits.' A network member would undertake a transaction with a partner if the member trusts either the partner or the object of exchange. (When you buy a car, you can trust the person selling you the car or you can trust the car itself.) Thus, the fear of opportunism in a network can be reduced when trust is built into the objects of exchange. Trust can be built into products, know-how, or other objects of exchange by having reputable experts authenticate them. Experts have (or can find) some of the information that an opportunistic partner would hide about its products. By using such experts, a network can reduce the amount of information asymmetry on the objects of exchange. For example, to decrease information asymmetry and fraud in its community of registered users, eBay gets experts to authenticate specialty items such as sports autographs, original paintings, and other collectibles offered for its online auction. It also offers warranty services, online dispute resolution, and seller identity verification.

Trust can also be built into transacting partners (Zaheer, McEvily, and Perrone, 1998; Lado, Dant, and Tekleab, 2008). According to Granovetter (1985) and Uzzi (1997), personal relationships can generate trust and discourage opportunism. For example, in an attempt to create a sense of community, eBay encourages online interaction among its registered buyers and sellers by hosting discussion boards, chat rooms, a newsletter, user home pages, and a 'giving board' for charitable donations to user-identified causes. Transacting partners who believe they will engage in transactions again are less likely to be opportunistic in the short term if doing so reduces their opportunities for profitable future transactions (Fudenberg and Tirole, 1992). Fear of opportunism can also be reduced by limiting the damage to transacting parties in the event there is an incidence of opportunism. For example, eBay has a buyers' protection program for its community of registered users. The program offers insurance for items it lists for auction.

Proposition 6b: The greater the perception of trust in a network, the more valuable that network is likely to be to members and to the provider(s).
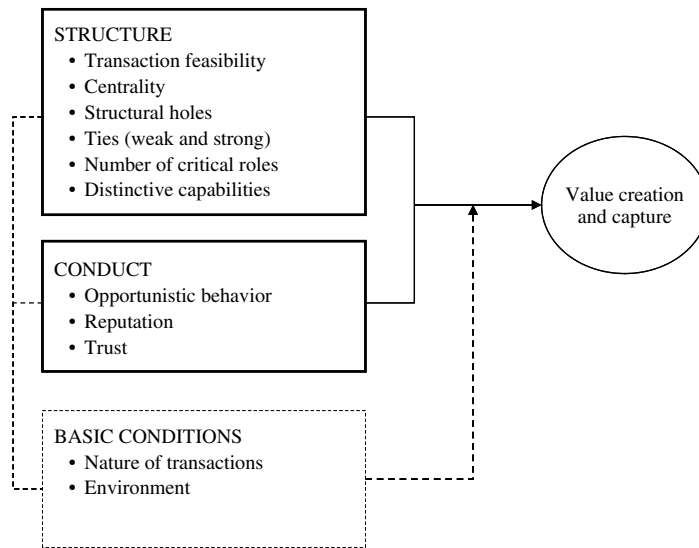
Figure 4. The role of structure, conduct, and basic conditions in network-related value creation and capture

In addition to reputation and trust, strong ties and the threat of social sanctioning can also reduce opportunism, thereby improving the value of a network to users and providers (Uzzi, 1997; Westphal and Khanna, 2003; Devers *et al*., 2009). How? The close and frequent relations of strong ties can enable members to learn more about each other, thereby decreasing information asymmetry. Close and frequent relationships can also lead to an increase in the level of trust (Uzzi, 1997). Both a reduction in information asymmetry and an increase in trust can decrease opportunistic behavior (Uzzi, 1997). Social sanctioning occurs when members of a network ostracize or distance themselves from a member that does not conform to the norms and values of the network (Westphal and Khanna, 2003; Devers *et al*., 2009). The threat of sanctioning can be enough to prevent some members from opportunistic behavior.

BASIC CONDITIONS

The nature of the transactions carried out in a network and the environment in which they are pursued also play important roles in network-related value creation and capture. These two factors have a direct effect on network structure and conduct, and a moderating effect on the influence of structure and conduct on value creation and capture (Figure 4).

Nature of transactions as antecedent and moderator

One of the key distinguishing factors between networks is the nature of the transactions that each network is used for. A cell phone network, used for communications, is different from a credit card network used to mediate between cardholders and merchants. These differences often imply differences in infrastructures, feasibility of transactions, distinctive capabilities, levels of trust, structural holes, and other constructs. Consider the example of an investment bank's network of initial public offering (IPO)-seeking start-ups and potential investors, versus a cell phone network. In the former network, the investment bank mediates between investors who want to buy stocks and the start-ups that want to issue the stocks—a two-sided network (Pollock *et al*., 2004; Parker and Van Alstyne, 2005). In a cell phone network, the provider enables each customer to make or receive calls from any other customer—a one-sided network. These two networks, designed for very different transactions, also have different structures, suggesting that the nature of the transactions for which a network is earmarked has a direct effect on its structure.

To see the moderating effect of the nature of transactions, consider trust, a conduct construct. In an investment bank's network of IPO-seeking start-ups and potential investors, each firm's stock is an experience good to potential investors since

it is difficult to tell, at purchase, if the stock will perform well. Besides, the potential payoff—both positive and negative—can be very high. Therefore, potential investors need to be able to trust either the investment bank or the start-up since they have the information advantage. Contrast this with a cell phone network where a lot less trust is needed to make or receive a phone call. Effectively, the nature of transactions moderates the relationship between trust and the value of a network to members and the provider. Similar arguments can be made about the nature of the transactions that determine the other structure and conduct constructs, and the moderating effect on their impact on value.

Environment

The other basic condition is the environment in which networks operate—in particular, the macro-environment made up of the political, economic, social/demographic, technological, and natural (PESTN) environments (Afuah, 2009). To keep the discussion tractable, I will focus on the technological component of PESTN. From the introduction of the telephone network, whose study gave birth to the expression *network externalities* (Rohlfs, 1974) to the birth of the Internet and cell phones, new technologies have played a key role in the value that network members and providers derive from a network (Shapiro and Varian, 1999). Consider, for example, a technological discontinuity in which different technologies, each backed by a different network of firms, are vying for the standard or dominant design. Because they may possess distinctive capabilities for exploiting the technology or have been endowed with some other asset, some firms are likely to be centrally located relative to the other members of their networks (Khazam and Mowery, 1994). For two reasons, such centrally located firms are more likely to have a strong influence on the process of standardization or emergence of a dominant design than other members of their networks. First, since centrally located firms have been associated with better innovation performance (Sparrowe *et al.*, 2001; Gilsing *et al.*, 2008; Soh, 2010), they may be able to generate the types of ideas or products that would foster better ties, build trust, reduce opportunism and so on, making their network better suited for value creation and capture than competing ones. Second, centrally located firms can use

their positions to convince more network members to support a particular design or standard. Additionally, the fact that there are different technologies and their networks of backers competing for a standard or dominant design means there are likely to be structural holes between these networks. Gatekeepers and boundary scanners have an opportunity to bridge these holes, given their ability to act as transducers between such networks (Fleming and Waguespack, 2007; Allen, 1984). Effectively, the technological environment has both a direct and moderating effect on structure and conduct constructs.

SUMMARY AND DISCUSSION

The value that users derive from many products depends not only on the product's customer benefits but also on its network of users. Past research has established that network size is a primary determinant of value from a network. The goal of this paper is to show that factors *beyond* network size determine the value of a network to its members and provider(s). Starting with the neoclassical economic assumptions that underpin past network effects research, I showed that, in the context of these rather ideal conditions, the value of a network of size N to its members or its provider is proportional to $N^2 - N$. I called this relationship the *size hypothesis*. By relaxing these assumptions to better reflect the conditions that prevail in many network industries, I argued that the structure of a network and the conduct of its members are important determinants of the value that members and network providers derive from that network. In particular, I argued that the value of a network will be determined in part by the feasibility of transactions in a network, the centrality of its members, the structural holes and ties within the network, the roles that each member can play, as well as the opportunistic behavior, reputation, and perceptions of trust. These constructs are moderated by some basic conditions (Figure 4). Table 1 summarizes the relevant propositions and some potential strategic implications for a network provider.

Strategic implications

There are important strategic implications from the suggestion that a network's structure and conduct have an impact on the value a network member or

provider can create or capture. I consider two of these implications: more focus on factors beyond size, and timing.

Focus on more than size

The first and most obvious strategic implication is that structural factors and conduct factors play important roles in shaping network value and are therefore important drivers of strategic action throughout the life of a network. Since these strategic implications are summarized in Table 1, I will discuss only three of them here. First, if members who are centrally located or who bridge structural holes add more value to a network (Propositions 1c), network providers might be wise to pursue such members first. That is, rather than go after just any member for the sake of increasing the size of the network, as suggested by the size hypothesis, a network provider may want to target those non-opportunistic members who are likely to be centrally located or form nonredundant bridges to structural holes. The risk is that if such actors are opportunistic, they may become handicaps rather than enablers of value creation and capture.

Second, because networks are more valuable when each member plays more than one role (Proposition 3), network providers may want to pursue activities that initially attract members who play more than one role in the network. Building a network with such members may ultimately make the network more valuable and more attractive to potential members than a network built on size alone. eBay offers a good example. When the company started out, its network of registered users was largely made up of individuals who wanted to sell and buy collectibles—a so-called consumer-to-consumer network. The network eventually evolved to include business-to-consumer activities.

Third, since high levels of opportunism in a network can reduce the network's value to members (Proposition 5), a primary goal should be to build one that has little or no opportunism. To the extent that reputation effects and trust (Proposition 6) reduce the level of opportunism, network providers may want to pursue activities that establish an early lead in members with a reputation for honesty, trustworthiness, dependability, and retaliation. An initial lead in size for an auction network is of little use to each member if the network is full of opportunistic behavior. In fact, the larger an opportunistic network, the *less* valuable the network may become to each user. eBay again serves as a good example. It moved early to establish a rating system to curb both adverse selection and moral-hazard-based opportunism.

Timing

Then there is the question of timing. In the neo-classical world of the size hypothesis, most of the jostling for size supremacy takes place before the critical size, N_c, has been reached. Firms use a product's benefits to customers, pricing moves, alliances, and other measures to secure an early lead because, beyond N_c, such a lead becomes difficult to overcome (without riding a new technological trajectory or another discontinuity). In the world beyond the size hypothesis, competition for leadership can continue throughout the life of a network since many structural and conduct features can still influence the value that customers perceive in a network, regardless of network size.

Future directions for inquiry

To keep the core arguments of the paper tractable, I limited exploration of the interaction between structure and conduct constructs to just one: the interaction between opportunism and network ties. Since structure conditions conduct and vice versa, exploring other structure-conduct interaction effects could reveal some interesting insights. For example, since reputation can spill over from a more reputable network member to less reputable ones (Kang, Mahoney, and Tan, 2009; Basdeo *et al.*, 2006; Stuart, 2000), future research could look into the role that strong and weak ties play in reputation spillovers. What type of ties are best for which reputation signals and when?

Another area for further inquiry is the intersection between economics and sociology, which is becoming more and more important to strategy theory development. Networks are one of the few contexts for exploring the interplay of the RBV, the PMP (market power view), and SNT. For example, customers may be attracted to a firm's network because the network is large, because it has the right mix of weak and strong ties, or because it has structural holes that the customers could bridge. At the same time, a large network may give a firm enough market power to collect monopoly rents. Thus, SNT constructs can be linked not only to

Table 1.   Beyond size: revisiting strategic implications

	Construct	Proposition	Possible strategic advice to network provider
STRUCTURE	Number of possible connections	**P1a**: The more that each network member can transact with every other member, the more valuable the network is likely to be to each member and to the network provider(s).	Network infrastructure should be built to maximize possible transactions.
	Centrality	**P1b**: The more central a non-opportunistic member's position in a network, the more valuable the member is likely to be to other network members and the network provider(s).	Attract members who play central roles first.
	Structural holes	**P1c:** Members that bridge structural holes in a network are more likely to create and/or capture more value than members that do not.	Span structural holes first, and do so with non-opportunistic members.
	Network ties	**P2**: The more that the ratio of strong-to-weak ties matches that of tacit-to-explicit knowledge, the more valuable the network is likely to be for network members and the network provider(s).	Invest in building the right ties within network.
	Number of roles played by each actor	**P3**: The more critical roles that each network member plays, the more valuable, on average, the network is likely to be to each member and to the network provider(s).	Build an early lead in the number of members who play many roles.
	Distinctive capabilities	**P4a:** A network is likely to be more valuable to members and providers that posses distinctive value-appropriating capabilities than to those who do not posses such capabilities.	Attract members with distinctive capabilities. For example, in a two-sided network, help or set price lower for side whose members have distinctive resources.
		P4b: The lower the scalability of a firm's resources for creating and/or capturing value in a network, the more that a plot of network value to the firm versus network size is likely to have an inverted U-shape.	
CONDUCT	Opportunistic behavior	**P5:** The more opportunistic behavior there is in a network, the less valuable, on average, the network is likely to be to members and the network provider(s).	Limit number of members with opportunistic behavior. Reduce opportunism in network.
	Reputation effects	**P6a:** The higher the reputation of network members for retaliation, honesty, trustworthiness, and dependability, the larger is the impact of network size on network value to its members and to the network provider(s).	Pursue activities that build a reputation for retaliation, honesty, trustworthiness, and dependability in network.
	Trust	**P6b:** The greater the perception of trust in a network, the more valuable that network is likely to be to members.	Pursue activities that build trust in the network.

resources but also to drivers of market power. It would be insightful to determine the extent to which network effects are a strategic resource rather than a PMP or vice versa, and how changes to SNT constructs drive things in one direction rather than another.

Perhaps one of the more interesting contexts in which some of the propositions of this paper could be empirically explored is the dotcom boom and burst of the late 1990s and earlier 2000s. During the boom, one of the few theory-grounded management concepts used to support performance predictions was *network effects* (Downes and Mui, 1997). The primary argument then was deeply rooted in the size hypothesis and went something like this: because the Internet exhibits network effects, firms that established an initial advantage in network size would attract new customers more rapidly and increase in size to a point where the provider of the network would dominate its market, locking competitors out (e.g, Downes and Mui, 1997). Future empirical research could explore the extent to which poor business models, a lack of complementary assets (Teece, 1986), or too much focus on size and not enough attention to the constructs of this paper was responsible for the bust of the dotcoms.

Finally, to keep the paper's arguments tractable, the discussion on the direct and moderating effects of basic conditions on structure and conduct was limited to two constructs and the technological component of the PESTN environment. Future research could explore the other constructs as well as the political, economic, social/demographic and natural components of PESTN.

CONCLUSION

To understand how competitive advantage is attained and maintained in the increasingly common network industries of today's economy, it is important to understand the concept of network effects. Moreover, network markets provide unique contexts for drawing on the RBV, SNT, and PMP theoretical perspectives to explore strategy phenomena. Unfortunately, research about network effects has not only been rooted in neoclassical economics, it has also been largely about size. By relaxing the assumptions that underpin the size hypothesis and then drawing on other theoretical perspectives, we can better understand how networks bestow value on network members and

enable network providers to create and/or capture value. Drawing from areas outside of neoclassical theory allows for the unraveling of more of the secrets about the link between competitive advantage and network effects. Size may not be everything, after all.

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