RECIPROCITY AND POWER IN THE VENTURE CAPITAL MARKET[*]

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Abstract

Existing research on networks has paid little attention to directional interorganizational exchange networks. Consequently, it has been difficult to examine the extent to which firms may be able to extract rents from the networks by choosing not to reciprocate exchanges. Investment data from the venture capital industry are appropriate to examine this phenomenon. Venture capitalist firms often invite other venture capitalists to join their syndicates to continue funding a start-up company. Such invitations serve as sources of competitive advantage as they reduce the invited venture capitalists' cost of search for profitable investments. Following the principle of reciprocity, we would expect that venture capitalists would balance their invitations to continue the exchange relationship. In this paper, rather than taking the assumption as given, we identify the conditions in which pressures for reciprocity are weakened or strengthened. Specifically, drawing on resource dependence arguments, we propose that reciprocity is most likely to occur when neither partner can exercise significant power derived from dependence for future exchanges. Furthermore, drawing on sociological theories of power, we argue that reciprocity is more likely to occur when members are embedded in a dense network of past unreciprocated exchanges. We utilize venture capital investment data from 1984 to 1992 to examine the patterns of reciprocity. We discuss the implications of the findings for the theories of network formation and network advantage.

1. Introduction

The proposition that market transactions are embedded in a rich set of social networks is fast becoming orthodoxy for economic sociology (Granovetter, 1985). A growing body of research documents the roles of interlocking directorates, trade associations, joint-ventures and other quasi-administrative relations in organizing economic exchange (Swedberg; 1994, Powell and Smith-Doerr, 1994; Gulati and Gargiulo, 1999). Concurrent with the empirical contributions are developments in network theories of action and performance (Burt, 1982; Coleman, 1990). Despite the impressive advancement in the literature, very few papers focus on directionality of exchange ties between organizations. The few exceptions focus on exchanges aimed at market avoidance, such as cross-equity holdings or director interlocks (Lincoln, Gerlach and Takahashi, 1992), but little is known about market exchanges. The lark of appropriate data, which would allow a researcher to trace the patterns of exchange over time, is one of the critical impediments to a better understanding of directionality of exchange ties. For example, the researcher only knows that a joint-venture has been formed, and that this organizational form provides an umbrella for continued exchanges between the two parties. However, he or she cannot pin-point specific transactions undertaken within the joint-venture. Consequently, the researcher presumes that fair reciprocal transactions occur in both directions assuming that otherwise the relationship would terminate. Given the assumption of reciprocity most analyses of interorganizational networks presume that network advantage is achieved through mutual cooperation and trust rather than exploitation and unfair exchanges (Powell, Koput and Smith-Doerr, 1996).

In this paper we attempt to extend the existing literature on interorganizational networks by considering the directionality of exchange transactions between venture capitalists in the United States. The analysis of directional exchange ties allows us to examine the assumption of reciprocity in exchanges between firms. In the paper, we posit that the assumption of reciprocity should not be taken as given. Instead we propose to identify conditions which foster or weaken pressures

for reciprocity. Specifically, drawing on resource dependence arguments, we propose that reciprocity is most likely to occur when neither partner can exercise significant power derived from dependence for *future* exchanges (Pfeffer and Salancik, 1979). Furthermore, drawing on Blau's (1964) sociological theories of power, we argue that reciprocity is more likely to occur when members are embedded in a dense network of *past* unreciprocated exchanges.

Our analysis of the conditions in which pressures for reciprocity are weakened or strengthened aims at adding to the rich literature pertaining to competitive advantage derived from network positions. Prior literature on interorganizational exchange ties suggests that the main benefits of networks lie in the efficient information transfer, joint problem solving, and trust that leads to additional investments which would not otherwise take place for the fear of expropriation (Uzzi, 1996, 1997). In this paper, we highlight that location in the network of dependence for future transactions may actually lead to exploitation. Certain locations allow incumbents to reap power benefits and obtain more benefits than then give out. Consequently, the benefit comes from at the cost of exchange partners. In contrast, certain positions in the network of past obligations acts to sharpen that trust.

The remainder of the paper is organized as follows. We begin with an outline the empirical setting in order to highlight the importance of reciprocity in the venture capital context. Subsequently, we discuss the concept of reciprocity. We, then, move to discuss the networks of dependence on future relations and show its impact on reciprocity. In the following section, we discuss reciprocity in the context of networks of prior obligation. The remaining sections provide empirical support for our claims and a conclusion.

2. Empirical setting

The private equity market is an important source of funds for start-up firms, private middle market firms, firms in financial distress and public firms seeking

buys-out financing that are not able to raise capital in the debt market or the public equity market (Sahlman, 1990). In the past, equity investments in unquoted companies were undertaken by a number of banks and finance houses, wealthy individuals and large corporations. However, such investments were generally seen as a specialized and largely peripheral element of a wider corporate finance activity. While these sources of finance could provide substantial amounts of capital, they were not organized as an easily recognizable source of finance. This condition imposed large search costs on entrepreneurs, effectively restricting the growth of the market. It is only after professionally managed equity investment firms came into being around the 1960s that the market for private equity grew at an unprecedented rate. Although in 1980 venture capital firms managed $4.5 billion in funds, by 1990 that amount had grown to over $36 billion reaching $100 billion by the end of the decade (Wright and Robbie, 1998). The industry is responsible for transforming very risky ventures into information technology giants. Examples of such transformations are Microsoft, Intel, Apple Computers and Netscape.

A venture capital firm raises money, called a fund, from wealthy individuals, insurance companies and other institutions that are interested in investing in entrepreneurial companies, but that lack the ability to identify investment opportunities. Funds are usually organized as partnerships. The senior members of the venture capital firm are general partners, while the investors are limited partners. The venture capital firm manages the fund's money by investing in entrepreneurial companies. The venture capital firm provides capital to entrepreneurial companies in return for an ownership stake. At the end of a fixed period of time, usually 10 years, the fund is dissolved. At this point, the venture capital firm distributes proceeds to the limited partners in the fund and keeps a fraction of the proceeds as profit. Although a fund dissolves, a venture capital firm is likely to persist as it often manages more than one fund at a time. The extent to which a venture capital firm is able to attract investments to its new funds depends on its past ability to generate high returns for its limited partners in previous funds. The

higher the return on investment paid to the limited partners at liquidation, the easier it is for a venture capitalist to raise funds for subsequent funds, and keep a greater percentage of the terminal wealth of the fund. Hence, venture capitalists seek to invest in companies characterized by rapid growth trajectories and those with significant prospects of going public or being acquired by a publicly traded firm.

Venture capitalists receive an extremely large number of business plans requesting funding. Only 1% of these applications receives venture capital financing (Sahlman, 1990). Although the high rate of rejection is a consequence of the very high required rates of return, it is also a testimony to the quality of projects. There are substantially more projects of low quality as compared to those yielding high returns. Once the business plan is accepted by venture capitalists and initial funds are transferred, venture capitalists disburse subsequent investments in rounds. Financing at each round may be provided by one or more venture capitalists. If a number of venture capitalists provide capital for a start-up, venture capitalists are said to work in a syndicate. At each round new venture capitalists may join the syndicate, while some previous ones may leave.

During each round of financing the firm receives enough capital to move it to the next major milestone in its development. Although the incumbent venture capitalists hold the right of first refusal in subsequent rounds of financing, they make no commitment to support the start-up in the future. By disbursing funds in this way venture capitalists essentially buy real options on the future performance of the company - benefiting from potential upside, but protecting themselves from potential failures. Despite the careful selection process undertaken by venture capitalists and the options approach to financing, the distribution of returns on start-up companies is very skewed. As many as 8 out of 10 investments do not earn significant returns for the venture capitalist (Bygrave, 1994). By some estimates, if one were to eliminate the top 10 per cent of an average venture capitalist's investments, the return would be barely positive (Huntsman and

Hoban, 1980). Thus, the stellar performers are clearly responsible for the success or failure of venture capitalists. Small differences in the proportion of well performing start-ups differentiate the successful from the unsuccessful venture capitalists.

Given the conditions in the venture capitalist market, it is easy to see that access to the syndication networks and reciprocity in referring deals to each other for syndication are critical to firm performance. The process of search for business ideas requires substantial time investments and is fraught with uncertainty. Venture capitalists need to assess numerous projects of uncertain quality before they can identify those that can potentially yield high returns. Even after the investments are chosen, they require extensive monitoring and time involvement in order to appraise the value of the start-up for future investment. Invitations to join syndicates from other venture capitalists allow the focal venture capitalist to by-pass many of these costly search processes before making an investment (Podolny, 1998). In fact, we can expect that venture capitalists who get more than they send in invitations will get access to numerous investment opportunities and will be better off. In contrast, those who spend a lot of their time researching deals to which they invite others, but do not receive equivalent invitations, will be severely disadvantaged. Consequently, studying the processes of reciprocity in the context of the venture capital market is of paramount importance to understanding how networks may be a source of competitive advantage.

3. The concept of reciprocity

Reciprocity is a mutually contingent exchange of benefits between two or more units. It entails the act of receiving a benefit from a partner in return for a benefit given to that partner (Gouldner, 1960; Powell, 1990). Sahlins (1965) defines restricted exchange as applicable "[...] to transactions which stipulate return of commensurate worth or utility within a finite and narrow period." Organizational sociologists studying interorganizational networks have largely focused on this

definition of reciprocity (Lincoln, Gerlach and Takahashi, 1992) and we follow this tradition.

Reciprocity has long been considered one of the primary social mechanisms in both social and economic relations (Gouldner, 1960). Given that most social and economic relationships are non-coercive, and individuals can easily change their exchange partners, individuals will seek exchanges which will be most beneficial for them (Blau, 1964). Consequently, whenever actors are involved in a relationship in which they give more than they receive, it is in their interest to withdraw from the relationship and seek an alternative one. Thus, when individuals have a common interest in continuing their exchange, it is necessary that the benefits that they receive be roughly equal. Similar arguments have been applied by organizational researchers who identify reciprocity as a critical feature of interorganizational relationships (Larson, 1992; Ring and Van de Ven, 1992). Oliver (1990) explicitly states that to maintain a long-term cooperation between two or more firms it is necessary to engage in reciprocal exchanges. Khanna, Gulati and Nohria (1998) suggested that firms use the record of reciprocity of their past partners to make decisions regarding future exchanges. Presumably, past reciprocity serves as an indicator of a partner's reliability and trustworthiness.

In the view of the above, we should expect that firms will attend to their past obligations in order not to lose their interorganizational relationships. Specifically, for a dyad *i*, *j* we expect that the balance of *i*'s past transactions with *j* will have a significant effect on whether *i* is willing to form a tie with *j*. When *j* did not reciprocate past transactions from *i* to *j*, thereby creating an unpaid balance, then *i* is less likely to initiate future exchanges with the non-reciprocating partner *j*. In contrast, when *j* has invited *i* to its syndicates many times, a credit was created, which can only be repaid through *i* inviting the exchange partner *j* to its syndicates. Consequently, we hypothesize:

Hypothesis 1: Venture capitalist *i* is more likely to invite venture capitalist *j*, if *i* is indebted to *j* for past invitations more than *j* is indebted to *i*.

4. Departures from equilibrium

Although reciprocity is often seen as an 'all or none' matter, it is probably best viewed as a quantitative variable on a continuum. At one extreme, the benefits exchanged may be identical or of equal value. In this case, exchange does not redistribute wealth, rather it acts to cement social relationship. It acts to increase trust and solidarity between exchange partners. For example, these exchange conditions are present in Kula rings described by Malinowski (1922). At the other logical extreme, one party may give nothing in return for the benefits it has received. In these circumstances, exchange does little to solidify social bonds. Rather, the process of unequal exchange redistributes wealth and leads to creation of rents associated with exchange (Sørensen, 1996). For example, some European feudal relations involved taxation without any benefit. Each of the limiting cases is probably a relatively infrequent social phenomenon. A more common case involves one party receiving somewhat more than it has given. In the remainder of the paper we deal with two sources of power of actor *i* over actor *j* which lead to greater or smaller pressures for reciprocity.

4.1. Networks of dependence on future transactions

Freedom of exchange is one of the critical assumptions underlying the theory of reciprocity. Individuals in unreciprocated exchanges withdraw from the relationship and move to a different one. Thus, only reciprocated relationships survive. However, the assumption of perfect mobility is often inappropriate. In fact, there exist substantial reasons to believe that venture capitalists do not have unrestricted freedom to choose to partner with any venture capitalist of their choosing. Following earlier research efforts, we believe that the network of past transactions will determine the structure of opportunity for future transactions (Gulati, 1995).

The reliance on past transactions to shape future transactions is largely caused by adverse selection and moral hazard problems associated with entry of new venture capitalists into an existing syndicate. The adverse selection problem is created as investors from prior rounds have superior information regarding the venture (Admati and Pfleiderer, 1994). The information asymmetry creates a large disincentive for the outsiders to buy into the start-up by giving its management a superior offer for further financing needs. Although the asymmetry protects the incumbent venture capitalists, it also creates problems for attracting coinvestment participants should the incumbent venture capitalists have insufficient funds to take the start-up to the next phase of development. Since the value of the equity cannot be ascertained by the outsiders, the insiders have an incentive to overstate the value of the equity. However, the outsiders suspecting that the equity is overpriced will want a lower price, thereby driving all good value deals from the market, leaving only poor quality deals available for future coinvestment. This is, of course, a representation of the classic lemons problem outlined by Akerlof (1974).

Even if the venture capitalists can overcome the adverse selection problems with appropriate contract design, there are further problems associated with free-riding with respect to monitoring the start-up firm. In addition to providing funds, venture capitalist firms also provide extensive management support and control to the start-up firms in which they invest. The monitoring of the ventures is a costly activity and up to 50 per cent of venture capitalist time is spent monitoring investments (Sahlman, 1990). When venture capitalists syndicate their investment in a start-up each of the venture capitalists has an incentive to free-ride on the monitoring efforts of other members of the syndicate. Since all venture capitalists are subject to the same pressures, they exert inefficient effort in monitoring of the venture. Thus, in equilibrium there is insufficient monitoring to the disadvantage of the venture capitalists and the start-up firm.

Past syndication ties, however, tend to reduce the information asymmetry costs and alleviate the risk of opportunism associated with syndication (Gulati, 1995). Over time, these relationships accumulate into a network that becomes a growing repository of information on the availability, competencies and reliability of prospective partners. The more the emerging network internalizes information about potential partners, the more venture capitalists resort to that network for cues on the structure of their future syndicates. Actors who are central in these networks not only possess more information about the reliability and quality of other actors, but simultaneously their own qualities are also known by more actors. Thus being central in a syndication network grants a venture capitalist access to numerous other partners. In contrast, less central venture capitalists have only limited access to others.

In turn, the access to numerous partners makes the focal venture capitalist less dependent on any particular partner. In contrast, venture capitalists with few connections are at a disadvantage. Few venture capitalists are able to assess the trustworthiness of a low centrality partner. Consequently, they will be unlikely to accept syndication invitation fearing the adverse selection problem. Similarly, few venture capitalists will be willing to take the risk that the focal venture capitalist will not free-ride on monitoring investments. Consequently, the low centrality venture capitalist is largely dependent on a few existing contacts for future syndicated deals.

Given these arguments it can be expected that the existence of past interactions will determine the structure of opportunity for future syndicates. Furthermore, venture capitalist centrality in the structure of opportunity will significantly affect the dependence of that venture capitalist on his or her exchange partners. As predicted by exchange theory (Cook and Emerson, 1978; Yamagishi, Gillmore and Cook, 1988), the differences in dependence lead to a creation of a power structure. The power structure allows incumbents of certain roles in the network to make claims on others (Emerson, 1976; Burt, 1976). Theories of power argue

that power of *i* over *j* is proportional to dependence of *j* on future transactions with *i*. Thus, if *i* has many exchange partners and *j* has few, then *i* does not depend on *j* as much as *j* depends on *i*. Consequently, *i* can threaten to stop transactions with *j*, unless *j* submits to *i*'s demands. Specifically, *i* can demand that *j* allows *i* into *j*'s syndicates, even though *i* does not invite *j* to *i*'s syndicates as frequently. Under circumstances of equal power prolonged imbalance in invitations would lead to a termination of a relationship. However, when differences in power, derived from dependence on future transactions, is large, the less powerful party, *j*, cannot afford to withdraw from the relationship. Even though the powerful partner *i* benefits more from the relationship, the benefits of the less powerful party *j* that accrue from the relationship with *i* are still greater than would be the case if *j* sought to send or receive invitations to join a syndicate elsewhere. The less powerful partner endures the exploitation hoping that the current relationship will lead to other relations that will reduce the dependence on *i*. Thus, we hypothesize:

Hypothesis 2: Given that venture capitalist *i* is indebted to venture capitalist *j* for past invitations, *i* is less likely to invite *j* to join a syndicate, when *i* has greater network centrality than *j*.

4.2. Networks of past obligations

Thus far, we have argued that on average reciprocity will exist due to instrumental reasons. Past obligations will be repaid with an equivalent benefit in order to maintain a relationship in the future. Reciprocity exists not because each partner feels grateful for past favors, but rather because each partner is forward looking and each hopes to benefit from the help of the other. Furthermore, we argued that when actors cannot change their exchange partners easily, a structure of dependence for future transactions emerges. The structure generates power differentials in which power of one actor over another is derived from the latter's dependence on the former for future benefits. More powerful actors obtain more benefits than they give to their less powerful exchange partners, while still main-

taining the relationship with them in the future. In this section, we consider networks of past obligations. We examine their influence on power of one actor over another and so on the extent of reciprocity between two actors.

In early sociological accounts past obligations formulated the basis for social power (Blau, 1964). People who help others obligate them to reciprocate and thus acquire power over them. The latter have to accede to the former's requests, and until this reciprocation takes place, there is an imbalance of power. Blau (1964:135) underscored the issue by pointing to 'the power of accumulated obligations,' and to the fact that 'by giving orders to others and imposing his will upon them, the ruler or leader cashes in on some of the obligations they owe him for whatever services he has rendered and thus depletes his power.' The power of accumulated obligations is undoubtedly an important factor of social life. However, the extent to which reciprocity is practiced within a dyad depends on the broader network in which the dyad exists. Specifically, we argue that it depends on the structure of obligations to third parties.

Obligations to third parties allow to control the second-order free-riding problems which plague most efforts to maintain effective norms (Coleman, 1990). These problems are particularly apparent when a member of community, *i*, violates norms by, for example, not reciprocating to *j*. Although the aggrieved party *j* severs future relationships with *i*, it is unclear whether other parties will also do so. Coleman's (1990) arguments suggest that *i* is unlikely to be sanctioned by other parties, since each individual party has to bear the cost of sanctioning by severing a tie with *i*, but receives only a fraction of the benefits. Since all third parties are subject to the same free-riding dilemma, no punitive action occurs. Coleman (1990) argues that any mechanism which imposes cost on third-parties for not punishing *i* or confers a benefit on punishing the offending individual will increase the chances of collective action. He suggested that closely-knit networks are particularly effective at sustaining the norms of reciprocity as closely-knit networks allow for transfer of benefits to punishing third-parties in the form of

psychic benefits or prestige. Several research papers confirmed the basic tenets of the theory (Gargiulo and Benassi, 1999; Hansen, Podolny and Pfeffer, 1999).

In this paper we enhance Coleman's arguments by pointing to the importance of past unsettled debts in exchange networks. We argue that past unsettled debts between the focal dyad and its alters will also be a powerful force for enforcing the norms of reciprocity. When debts exist, alters can threaten not to reciprocate to *i* who does not want to reciprocate to *j.* Alters may not want to curtail their interactions with *i*, as such a reaction may be costly to them. However, when the alters themselves face a cost that others will not reciprocate to them if they fail to abandon their transactions with *i*, their preferences may change. When the costs of foregone reciprocities is greater than the cost of withdrawing from transacting with *i*, the punishment of *i* is likely to occur. Consequently, when there exists a structure of past obligations between *i*, *j* and *k*, a collective sanctioning of *i* is likely, and so *i* is more likely to reciprocate to *j*.[1]

In order to illustrate this abstract argument in more detail, consider a simple example of how reciprocity between *i* and *j* is affected by the structure of obligations to common alter *k* . If venture capitalist *i* is indebted to *j*, and *j* is indebted to *k*, and *k* is indebted to *i* as shown on Figure 1, then the return of debt by *i* to *j* should be faster than if the obligation connection through *k* did not exist. The main reason for the faster reciprocity is that when *i* does not want to reciprocate to *j*, *j* can tell *k* that she will not repay her debts to *k* until *i* reciprocates to *j.* Since *k* is indebted to *i*, *k* can tell *i* that no debt will be repaid until credit is received from *j* which in turn in contingent on payment by *i* to *j.* Consequently, *i*'s failure to reciprocate to *j* is made costly through common obligation to *k*. When *i* fails to return the favor to *j*, he loses the benefit he would have received from *k*.

[1] The reader will note that although this argument beras many resemblances to the argument that reputations are more quickly tarnished in closed networks (Burt and Knez, 1998), the two arguments are essentially different. Reputation is essentially a forward-looking phenomenon and actors care about reputations to enter into future transactions. Reputation effects also only require that actors know each other and do not require that obligations eidst. We disentangle the two effects in the empirical section.

Consequently, the common obligation connection through *k* gives *j* power to request that *i* extend an invitation back to *j*. Thus, we hypothesize:

Hypothesis 3: Given that venture capitalist *i* is indebted to venture capitalist *j* for past invitations, *i* is more likely to invite *j*, when *j* is indebted to *k* and *k* is indebted to *i*.

5. Research Sources and Analyses

5.1. Data and Variables

5.1.1. Data Sources and Dependent Variable

Data for this paper were gathered from the Venture Economics SDC database. This database purports to record all investments of venture capital firms. It has been extensively used by financial economists studying venture capital investments (Lerner, 1994; Gompers, 1995) as well as by organizational sociologists (Podolny, 1998; Sorenson and Stuart, 1999).While the data prior to 1979 are considered to be at best incomplete, the last 20 years of data are of high quality. Consequently, we utilize data only form 1979 onward. We allow 5 year of network creation and hence our analyses begin in 1984. Analyses end in 1992. For analysis we selected the top 89 venture capitalists each of which invested at least $25 million during the observation period. In order to create the network we utilize investments in the telecommunications industry.

Table 1 provides a summary of the data. The dependent variable, $T_{t,i\ j}$, is a binary variable at the dyad level generated from the investment data. $T_{t,i\ j}$, takes the value of 1 when in a six month period *t*, venture capitalist *i* invites venture capitalist *j* to join a syndicate of which *i* has previously been a member, while *j* has not. Only the first instance of invitation has been considered. Continuations of past syndicates in the same start up company have been disregarded.

5.1.2. Network Variables

We observe the development of the network in six-month intervals over the period 1984 to 1992. In order to create the network we transformed the raw data into annual two dimensional affiliation matrices $\mathbf{A}_t$ of size 89 * 89. In each matrix the $a_{i,j}$ element is equal to the number of times venture capitalist *i* invited venture capitalist *j* to join a syndicate, of which *i* is not yet a member, in a window of time prior to time *t*. We have derived the matrices for 5 year windows. This approach suffers from the drawback that the frequency of co-investments for a pair of actors can be large if both actors are affiliated with many events, regardless of whether these actors are attracted to each other. Thus, it is necessary to standardize the frequencies in order to study the pattern of interactions, independent of the marginal propensity of actors to be affiliated with many events (Bonachich, 1972). In order to derive such a measure we need to consider: the number of investments common to both venture capitalists ($\mathbf{A}_t\mathbf{A}_t^T$), the number of investments in which neither venture capitalist participates ($(\mathbf{I}-\mathbf{A}_t)(\mathbf{I}-\mathbf{A}_t)^T$), and the numbers of investments made by one of the venture capitalists, but not the other $(\mathbf{I}-\mathbf{A}_t)\mathbf{A}_t^T$ and $\mathbf{A}_t(\mathbf{I}-\mathbf{A}_t)^T$. For each pair of venture capitalists, we arrange these frequencies in a two-by-two contingency matrix that classifies all deals according to whether or not the venture capitalists *i* and *j* have participated.

	VC *j* participates	VC *j* does not participate
VC *i* participates	n_{11}	n_{12}
VC *i* does not participate	n_{21}	n_{22}

Bonachich (1972) shows how to derive a measure of the proclivity of two venture capitalists to syndicate that is independent of the number of syndicates that each venture capitalist undertakes. For venture capitalists *i* and *j* this measure, $Q_{i,j}$, is defined as:

$$q_{i,j} = \frac{n_{11}n_{22} - \sqrt{n_{11}n_{12}n_{21}n_{22}}}{n_{11}n_{22} - n_{12}n_{21}} \qquad (5.1)$$

The measure is bound between 0 and 1 with greater numbers indicating greater proclivity to syndicate on the same investments. We used the $q_{i,j}$ measure to define $Syndicationtion_{t,i\leftrightarrow j}$ - the extent to which the two venture capitalists *i* and *j* have had past interactions. We also used this measure to define the mutual connections that the two venture capitalists have, $CommanAlters_{t,i\leftrightarrow j}$, by multiplying $\mathbf{Q}_t$ by itself (Gulati and Gargiulo, 1999).

The resulting matrix $\mathbf{Q}_t$ was used to identify prominent actors in the process of co-investment. We will consider a venture capitalist organization to be prominent if it is involved extensively in co-investments with other prominent venture capitalist organizations. We define prominence measure, $p_{i,t}$, of venture capitalist *i* within a set of actors as a function of prominence measures of those with whom the venture capitalist co-invests. Thus, if we take the i^{th} column of the $\mathbf{Q}_t$ matrix, which contains entries indicating which actors coinvest with *i*, we can multiply these entries by prominence measures of the other venture capitalists to obtain a linear combination measuring the prominence of *i*:

$$p_{i,t} = \mathbf{Q}_{1,t}p_{1,t} + \mathbf{Q}_{2,t}p_{2,t} + \mathbf{Q}_{87,t}p_{87,t} \qquad (5.2)$$

Thus, mathematically, we have 87 equations, one for each venture capitalist, all of which depend on all the indices. So, we have a system of 87 linear equations with 87 unknowns. If we take the entire matrix $\mathbf{Q}_t$ and put the set of prominence indices into a vector $\mathbf{P}_t = [p_1, p_2,\ldots,p_{89}]$, we can write this system of equations as

$$\mathbf{P}_t = \mathbf{Q}_t^T\mathbf{P}_t \qquad (5.3)$$

Rearranging terms we obtain

$$(\mathbf{I} - \mathbf{Q}_t^T)\mathbf{P}_t = \mathbf{0} \qquad (5.4)$$

where $\mathbf{I}$ is the identity matrix of dimension equal to the number of venture capitalists, and $\mathbf{P}_t$ and $\mathbf{0}$ are vectors of length equal to the number of venture capitalists. This equation is identical to a characteristic equation, in which p_t is an eigenvector of $\mathbf{Q}_t$ corresponding to an eigenvalue of 1. One solution to this system is to force $\mathbf{Q}_t$ to have such an eigenvalue - by standardizing the $\mathbf{Q}_t$ matrix

to have column sums of unity. Thus, the eigenvector associated with the unity eigenvalue of the standardized $\mathbf{Q}_t$ will give us a vector of prominence indices $\mathbf{P}_t$. Effectively, such a transformation will allow us to discover the relative, rather than the absolute, prominence of actors in our matrix controlling for the prominence of others. Following methods used by Gulati and Gargiulo (1999), the prominence indices were subsequently transformed into two variables: sum of centralities defined as $p_{j,t} + p_{i,t}$ and difference in centralities defined as $p_{j,t} - p_{i,t}$. In this definition $p_{j,t} - p_{i,t}$ is larger to the extent that the receiver of the tie is more central than the sender.

All of the above measures were based on information regarding the venture capital pair prior dealings, without consideration of directionality of ties. However, we also calculated directional measures. The tendency to discharge gifts when one received more gifts than one sent was captured in $NetObligation_{t-1,i \to j}$, defined as $\mathbf{Q}_{t,i,j} - \mathbf{Q}_{t,j,i}$. The measure is larger when the venture capital firm has already sent more gifts than it received. Since the flow of unreciprocated gifts is unlikely to continue, we expect a negative coefficient on this measure. We also define a measure of reciprocity obligations to common alters ($ObligationCommonAlters_{t-1,i \to j}$)

5.1.3. Investment variables

In order to define similarity of investment profiles, we analyzed the similarity in the geographic regions, industries and stages of investment in which dyads engage. In order to define geographic similarity we define a vector of the proportion of investments in key markets (California, Massachusetts, New York, Midwest and Texas) for each of the venture capitalists. Subsequently, we multiply one vector by the transpose of the other and divide by the number of markets in which either firm invests (in our example this is five). Consequently, we obtain a measure of geographic similarity of investments which varies between 0, when firms undertake investments in completely different geographic markets, to 1, when the firms undertake all of their investments in the same geographic markets. Thus, if Venture Capitalist *i* invests 10% in California, 50% in Massachusetts,

10% in New York, 30% in Midwest and nothing in Texas and Venture Capitalist *j* invests 30% in California, 10% in Massachusetts, 10% in New York, nothing in Midwest and 30% in Texas, we define the following two vectors.

$$Geo_i = [10\%, 50\%, 10\%, 30\%, 0\%]$$
$$Geo_j = [30\%, 10\%, 10\%, 0\%, 30\%]$$

$$GeoOverlap_{i,j} = 5 * (Geo_i * Geo_j^T) \quad (5.5)$$

In our case the measure of geographic similarity is 5*(10%*30% + 50%*10% + 10%*10% + 30%*0% + 0%*30%) = 0.45. We repeat the same procedures to obtain similarity across the key industries and stages of investment for each dyad *i, j.* As before, the vectors are updated every six months with the appropriate window.

We defined the two remaining similarity measures ($IndustryOverlap_{t,i,j}$ and $StageOverlap_{t,i,j}$) in a similar manner. Industry overlap measures the similarity in the types of sub industries in the telecommunications industry that the venture capitalist *i* and *j* invest. The greater the value of $IndustryOverlap_{t,i,j}$ the greater the similarity in industries invested. Stage overlap measures the similarity in investment profiles across different stages of start-up development (seed, development, pre-IPO). The greater the coefficient of overlap, the more *i* and *j* invest in similar stage businesses.

5.2. Results

Using panel logistic regression, we estimated different models nested in the following

model:

$$
\begin{aligned}
T_{t,i\to j} = {} & \acute{a} + b_1 Syndication_{t\text{-}1,i\leftrightarrow j} + b_2 CommonAlters_{t\text{-}1,i\leftrightarrow j} + \\
& b_3 CentralitySum_{t\text{-}1,i\leftrightarrow j} + b_4 CentralityDifference_{t\text{-}1,i\leftrightarrow j} + \\
& g_1 Geo0verlap_{t\text{-}1,i,j} + g_2 IndustryOverlap_{t\text{-}1,i,j} + g_3 StageOverlap_{t\text{-}1,i,j} + \\
& d_1 NetObligation_{t\text{-}1,i\to j} + d_2 ObligationCommonAlters_{t\text{-}1,i\to j} + \\
& k_1 NetObligation_{t\text{-}1,i\to j} * CentralityDifference_{t\text{-}1,i\leftrightarrow j} + \\
& k_2 NetObligation_{t\text{-}1,i\to j} * CommonAlters_{t\text{-}1,i\leftrightarrow j} + \\
& k_3 NetObligation_{t\text{-}1,i\to j} * ObligationCommonAlters_{t\text{-}1,i\to j} + \\
& e_{t\text{-}1,i?j}
\end{aligned}
$$

Table 2 reports the results of the model. Model 1 provides baseline estimates of the probability that venture capitalist *i* will ask venture capitalist *j* to join the syndicate in which *i* is already present. We include four network measures of past association and three measures of similarity in the type of investments. Consistent with earlier work on the dynamics of networks (Gulati and Gargiulo, 1999), we find that past dealings with a partner increase the likelihood of syndication from *i* to *j* in the current period. Similarly, the presence of common alters, which Gulati and Gargiulo (1999) called structural embeddedness, increases the likelihood of syndication from *i* to *j*. The sum in centrality of the two actors $p_{j,t} + p_{i,t}$ is negative. This result stands in contrast to earlier findings of network dynamics in which central firms are more likely to enter into transactions. This result may be an outcome of the way in which we defined our dependent variable. A tie from *i* to *j* is created only when *i* invites *j* into a syndicate, but we do not log a tie which was created when firms initially formed a syndicate. Thus, we interpret the finding to mean that firms of higher centrality are more likely to form syndicates at the same time, rather than invite each other in later rounds of financing. The difference in centrality of the two actors $p_{j,t} - p_{i,t}$ is positive suggesting that when centrality of

the receiver *j* is higher than the centrality of the sender *i*, *i* is more likely to invite *j*.

As expected, the similarity in the type of investments is also a significant predictor of a tie forming from *i* to *j*. Both geographic overlap and similarity of investment stages have a strong positive effect on the likelihood of *i* inviting *j* to join a syndicate. The effect of industry similarity is in the right direction, but statistically insignificant. Last, I include the obligation variable, which captures the tendency to reciprocate past obligations. The variable is insignificant implying that on average venture capitalists do not reciprocate favors given to them by others. In model 2 we add the interaction of obligation-by-difference in centrality. The inclusion of the interaction significantly improved the statistical fit of the model (l = 145). The inclusion of the interaction term changed the sign on the reciprocity term to negative, as expected, and made the term statistically significant. This leads us to a conclusion that the existence of reciprocity is highly contingent on the differences in centrality of the actors. Actors of similar centrality adhere to the rule of reciprocity, balancing debts soon after they occur. In contrast, exchange transactions between partners with unequal centrality are less likely to be following the rule of reciprocity. Specifically, non-central firms are no less likely to invite the central partners into a syndicate, even when the more central partner does not return the invitations.

In model 3 we add a term capturing obligations to common alters. The effect is negative and significant. This suggests that the presence of common alters to whom the dyad is obliged decreases the likelihood of that *i* will invite *j* to join a syndicate. The improvement in model fit is statistically significant (l = 21). In model 4 we add an interaction term obligation-by-obligation to common alters. The improvement in model fit is statistically significant (l = 15). The effect is negative and significant. It indicates that given that *i* is indebted to *j*, *i* is more likely to invite *j* to a syndicate when *i* and *j* are obliged to common alters.

In model 5 we added an interaction term common alters-by-obligation. The term intends to capture the extent to which having common third parties (without considerations of obligation) affects reciprocity within the dyad. The effect is not statistically significant suggesting that the sheer fact of interaction with common third parties does not affect reciprocity within the dyad. Rather, as shown in model 4, it is the obligations to the common third parties that lead to greater reciprocity within the dyad.

5.3. Discussion

Our results provide support for the hypothesis (**H**$_1$) that past debts need to be repaid in order to continue a relationship. However, our data suggest that the pressures for reciprocity are not a widespread feature of the venture capital community. Rather, the effect of reciprocity is present only when one controls for power relationships, as proxied by centrality, between venture capitalists. The effect of power relations on the departures from the main effect of reciprocity is consistent with our theoretical predictions (**H**$_2$). The effects are illustrated on a prototypical diagram in Figure 2. The prototypical diagram is drawn using equation:

$$T_{t,i\to j} = a + b_4 CentralityDifference_{t\text{-}1,i\leftrightarrow j} + d_1 NetObligation_{t\text{-}1,i\to j} + k_1 NetObligation_{t\text{-}1,i\to j} * CentralityDifference_{t\text{-}1,i\leftrightarrow j}$$

with coefficients taken from model 4 for three levels of $CentralityDifference_{t,\, i\leftrightarrow j}$ = [-1, 0, 1]. These levels of $CentralityDifference_{t,\, i\leftrightarrow j}$ represent situations in which *i* is less central than *j*, *i* and *j* are of equal centrality and *i* is more central than *j*. The diagram clearly indicates that when the receiver *j* is more central than the sender *i*, past unreciprocated debts of *j* to *i*, lead to a significantly smaller decrease in the likelihood that *i* will continue a sending invitations to *j* than would be the case if *i* were of higher centrality than *j*.

Our analyses also lend statistical support to the hypothesis (**H**$_3$) that being embedded in networks of past obligations enhance the processes of reciprocity. The effects are illustrated on a prototypical diagram in Figure 3. The prototypical diagram is drawn using equation:

$$T_{t,i\to j} = \acute{a} + d_1 NetObligation_{t\text{-}1,i\to j} + d_2 ObligationCommonAlters_{t\text{-}1,i\to j} + k_3 NetObligation_{t\text{-}1,i\to j} * ObligationCommonAlters_{t\text{-}1,i\to j}$$

The effects were drawn for no obligation $NetObligation_{t,\ i\to j} = 0$, some obligation $NetObligation_{t,i\to j} = 10$, and significant obligation $NetObligation_{t,\ i\to j} = 20$. First, we observe a negative main effect of *i*'s and *j*'s obligations to others. The effect is negative since if *i* and *j* have many obligations, they need to repay them first before entering into a relationship with each other. More importantly, however, the diagram indicates that the although the effect of past obligations on reciprocity is statistically significant, it is reasonably small in comparison with the main effect. Despite the small effect of past obligations to alters on reciprocity, it is worth bearing in mind that pure presence of alters (holding obligation constant) has no statistical effect on reciprocity within dyad *i, j.*

5.4. Limitations

Our analysis is subject to certain limitations. We believe that future versions of this paper would profit from incorporation of two more variables pertaining to venture capitalists and venture capitalist dyads. First, it is necessary to include the information about the past success of venture capitalists with developing start-up companies. Venture capitalists which have had considerable success exiting their investments by IPO, such as Kleiner Perkins, are sought after as desirable exchange partners. Not only can affiliations with such successful venture capitalists provide access to high quality management provided by these venture capitalists, but also such affiliations can increase one's own status. Consequently, it can be expected that certain venture capitalists, particularly the less successful ones, will be willing to invite the successful venture capitalists into their

syndicates not expecting full reciprocity. The benefit of association with successful venture capitalists in terms of improved management and certification will most likely outweigh the costs borne by unequal exchange. We are in the process of collecting data on IPO success of these companies and will incorporate appropriate measures in the next draft of the paper. Second, our analysis should include measures of success of prior syndicates between *i* and *j*. The inclusion of this variable is mandated by the theoretical postulate that prior affiliations serve as a source of information about the quality of actors. Our treatment in this paper presumed that affiliations convey that venture capitalists are of high quality. However, this need not be true, as past relationships could have been subject to serious problems leading to withholding of future relations. Once data on IPO are collected we will be able to include the measures of past success of *i* and *j*. Last, since we focused on investments in telecommunications, we did not examine the entire network of syndication. Consequently, actors in our network could have been connected by networks outside the telecommunications industry, whereas our analysis could indicate that there is no relationship between them. This problem is not unique to our study as many network analyses draw a network border where their data ends. Our network border was determined similarly - we do not yet possess investment data pertaining to the entire venture capital industry. Until we complete collection of full dataset, our conclusions will be based on this restricted sample.

6. Conclusion

Networks are seen as mechanisms through which information travels through markets (Gulati, 1995). Thus, firm advantage often lies in having broad structures of opportunity and access to non-redundant information. Networks also facilitate trust and encourage continued cooperation in which both sides benefit more than each would be able to obtain if they operated individually. The existence of this joint gain has been documented and provides a major justification for an organizational form that only 20 years ago was considered anti-competitive and thus welfare reducing. However, underlying the notion of joint gain is a significant assumption that reciprocity and equity in interorganizational exchange holds.

While the assumption is by and large appropriate since reciprocity is critical to tie maintenance, it still remains an assumption which may or may not hold in certain conditions. In this paper we attempted to outline some initial conditions in which the assumption is and is not appropriate.

We pointed to power differentials as the main force interfering with the operation of reciprocity. The support for our power hypothesis sheds a different light on operations of networks and the sources of network advantage. It points to a view of networks as "prisms" (Podolny, 1998) in which network positions act as a main source of stratification of organizational fields. In this view, ties to others, and in particular to high centrality others, allow firms to accrue network benefits at the expense of other actors. Those with many central affiliations can enjoy their network advantages by obtaining resources from others other without equal compensation. In contrast, those with low centrality need to provide these resources if they want to maintain a relationship with central others. As such, our findings provide a substantially different interpretation of network centrality. The accounts of network advantage, which emphasize cooperation, would identify the advantage of network centrality with access to substantial amount of information and ability to attract many trusted and cooperative partners. In contrast, our analysis emphasizes that the advantage can also accrue from unreciprocated exchanges with the non-central others. The extent to which it is the unreciprocated exchanges or the access to information that is responsible for advantages of centrality is an empirical question. Our intent here was merely to point out that network advantage comprises benefits from one-way transfers in addition to the widely described joint benefits of cooperation.

Our theoretical analysis also identified that obligations to common third parties around the dyad should contribute to the pressures for reciprocity. Most analyses which involve third party effects posit that the mere existence of third parties should enhance cooperation within a dyad (Burt and Knez, 1995; Gulati, 1995). Researchers argue that the likelihood of cooperation is increased through information transfer about uncooperative behavior to the common alters. The

presumed sanctioning of the non-cooperative party imposes an additional cost on violating rules and hence makes it less likely. Our analysis has significantly departed from this conception of third-party effects. We postulated that it is necessary that the dyad and the third parties are actually obliged to each other to reciprocate, which was supported by the data. Although it was not our hypothesis, we found that mere presence of others did not increase the pressures for reciprocity. These findings perhaps suggest that researchers studying third-party effects should be very sensitive in their theoretical and empirical specification in order not to confuse the effects of knowing common others and being obliged to them. The former may have significant implications for the way in which information travels through the network. However, it may elicit little punitive action. This is often evidenced in other settings where individuals gossip about a non-compliant individual, yet are unwilling to take a censoring action. The mechanism based on common obligations may be substantially more important to network governance and punishment of non-cooperative actors.

Methodological Appendix

I conducted a number of additional tests to address concerns of interdependence across observations resulting from my dyadic approach, which led to the presence of the same organization across multiple dyads. I employed a procedure similar to the Multivariate Regression Quadratic Assignment Procedure (MRQAP), routinely used by researchers studying dyads (Krackardt 1987, 1988; Manley 1992). My approach differs from MRQAP in that I used the random-effects logit model instead of ordinary least squares regression for each iteration of the simulation. As a result, I randomized the key network variables for each time period for each industry. I ran 500 iterations of a completely specified random effects model with a new randomized independent network variable obtained by random permutations of the rows and columns in each venture capital syndicate matrix for each industry and year. The coefficients obtained were compared with those obtained in the original formulation. The percentage of frequency with which the independent variables exceeded their original values divided by the number of permutations plus 1 (101) indicates the statistical reliability (pseudo t-test) of the original results." This test can be interpreted like conventional tests of significance: a result of less than 5 % (or, even better, 1 %) provides evidence that the original estimates are indeed accurate. The benefit of a randomization procedure is that obtaining satisfactory results does not require an assumption of independent observations, a random sample, or a specified distribution function. This procedure allowed us to assess the efficiency of my results, a primary concern resulting from any dyadic interdependence.

The manner in which I specified my network effects makes my model akin to the p* logit models proposed by Wasserman and Pattison (1996). Building on the pioneering work by Holland and Leinhardt (1970) and on Strauss and Ikeda (1990), P* models produce pseudo-maximum-likelihood estimators of the probability of observing a binary tie x_{ij}, conditional on the rest of the data, without having to make the implausible assumption that the observations

(dyads) are independent. Specifically, these models build into a logistic regression parameters that capture possible sources of interdependence of the observed dyads-such as reciprocity, transitivity, in and out degree of each dyad member, and network density-and obtain estimators of the effect of these parameters on the conditional probability of = 1). My models include network parameters that are similar to the ones of a typical p* model-transitive triads, the degree of each dyad member, and network density-but I measured these parameters on the network at (t - 1), while a strict pseudolikelihood estimation requires parameters measured on the same network that contains the predicted tie. Since the inclusion of the (t - 1) parameters cannot be considered an adequate safeguard against the potential effects of nonindependent observations, I used the above mentioned MRQAP-like procedure to test the robustness of the results and limit concerns of interdependence. The percentage of frequency with which the results in the random-sample simulations exceeded the original estimates was far less than 5% in all instances. Thus, I can say with some confidence that for these data reasonable coefficients were obtained.

The problem of cross-sectional dyadic interdependence can also be understood as one of model misspecification (Lincoln 1984). If a statistical model incorporated all essential nodal (organization-level) characteristics that influence venture capital syndicate formation, no unobserved effects resulting from common nodes would remain. To capture any organization-level effects across dyads sharing the same organization, I controlled for each organization's cumulative history of venture capital syndicates. Organization history is an important factor that captures any residual organizational propensities to engage in venture capital syndicates (Heckman and Borjas 1980). As noted earlier, I also ran separate estimations in which I included a host of financial attributes of each of the organizations in the dyad, including its size, performance, liquidity, and solvency. In addition to these controls, the models used here account for unobserved heterogeneity and adjust for such systematic biases resulting from

missing variables. I expected the unobserved heterogeneity term (***r***) to capture any residual dyad-level effects not included in the model.

Unobserved Heterogeneity

An issue that arises when analyzing data on a time series of cross-sections, or panel data, is the possibility of unobserved time-invariant effects known as "unobserved heterogeneity." This is of particular concern for this study with respect to the claim that the prior history of venture capital syndicates between two organizations affects the future likelihood of their entering a venture capital syndicate. There are two distinct explanations for this empirical regularity, if it occurs (Heckman 1981a, 1981b). One explanation is that a genuine behavioral effect exists, whereby, because of the prior venture capital syndicates it has experienced, a dyad's preferences are altered in the future. In econometric terms, such a behavioral effect is called "state dependence"-the likelihood of an event is a function of the state of the unit.

If state dependence alone encapsulated the empirical reality, there would be no problem; however, there is another possibility that, if not accounted for, could lead to spurious results: dyads may differ in their propensity to enter venture capital syndicates because of unobserved factors. In this instance, such unobservable effects could result from permanent differences between dyads in their preferences for venture capital syndicates, such as geographical proximity, not captured by the independent variables. If this noise were systematic for the same unit over time, it could lead to a serial correlation among the error terms for those observations, which would yield consistent but inefficient coefficients, rendering any statistical testing inaccurate. Furthermore, prior venture capital syndicate experience may appear to be a determinant of future venture capital syndicate formation solely because it is a proxy for temporally persistent unobservable factors that determine venture capital syndicate formation and nonformation. Improper treatment can lead to spurious effects appearing with attempts to assess the influence of past experience concurrent decisions; this

phenomenon is also termed "spurious state dependence" (Black et al. 1990; Heckman 1981a, 1981b; Hsiao 1986),

In a statistical sense, the problem of unobserved heterogeneity relates to model specification (Peterson and Koput 1991). If a model is completely specified, no such problem occurs, but most statistical models suffer from some degree of omitted variable bias. Another way to confront this problem is to refine the risk set studied. In the current design, I include all possible dyads for each year as the set of dyads at risk of entering a venture capital syndicate. It is quite likely that some of these dyads are in fact not at risk of entering an venture capital syndicate in some or even all observation periods, while other dyads have a higher propensity to ally. This suggests the possibility of misspecification of the risk set unless adequate allowances are made for such unobserved differences in propensity. One way to deal with such a bias is to clean up the risk set by eliminating records unlikely to experience the event, a process analogous to removing men from pregnancy studies. The difference in propensity is frequently a result of unobservable factors, however, making it impossible a priori to weed out records from the sample on reasonable grounds without biasing the sample.

Two approaches frequently used to address problems of unobserved heterogeneity are fixed- and random-effects models. Fixed-effects models treat the unobserved individual effect as a constant over time and compute it for each unit (dyad). The method entails estimating a constant term for each distinct unit and including dummy variables for each and is similar to least squares with dummy variables (LSDV) regression models (Hannan and Young 1977; Mizruchi 1989). Random-effects models treat the heterogeneity that varies across units as randomly drawn from some underlying probability distribution. Both types of models have shortcomings. Both assume that the unobserved effects are time invariant. Fixed effects models are applicable only to repeatable events (Yamaguchi 1991), do not allow the inclusion of time-independent covariates (Judge et al. 1985; Reader 1993), and involve estimating a large number of

parameters, which grows with sample size (Chamberlain 1985). This approach can be problematic when there are many groups but only a few observations in each group (Chamberlain 1985). Random-effects models are more tractable but also assume that the unobserved effect is not correlated with any of the exogenous variables in the system (Chintagunta, Jain, and Vilcassim 1991; Hausman and McFaden 1984).

To address concerns of heterogeneity, I employed a random-effects panel logit model, developed by Butler and Moffitt (1982), for the statistical analysis. My decision to employ a random-effects model was based on the following. First, estimates computed using fixed-effects models can be biased for panels over short periods (Chintagunta et al. 1991; Heckman 1981a, 1981b; Hsiao 1986). This is not a problem with random-effects models. As all the dyads in my sample were present for fifteen years, random effects was clearly the favored approach. Second, fixed-effects models cannot include time-independent covariates, a limitation that would have meant excluding several variables, and an analysis without some of these variables would have been severely limited.

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Table 1

Summary Statistics

Variable	Mean	St. d.	$T_{i\rightarrow j}$	Syndication $_{i\leftrightarrow j}$	Common Alters $_{i\leftrightarrow j}$	Net Obligation $_{i\rightarrow j}$	$Centrality_j$ - $Centrality_i$	$Centrality_j$ + $Centrality_i$	Obligation Alters $_{i\rightarrow j}$
$T_{i\rightarrow j}$	.01	.10	-						
Syndication $_{i\leftrightarrow j}$	1.01	6.14	.15	-					
Common Alters $_{i\leftrightarrow j}$	11.1	54.9	-.001	.03	-				
Net Obligation $_{i\rightarrow j}$	0	8.57	.10	.69	-.00	-			
$Centrality_j$ - $Centrality_i$	0	1.10	-.003	-.04	-.00	.00	-		
$Centrality_j$ + $Centrality_i$	1.4	1.13	-.012	.06	.15	-.00	.00	-	
Obligation Alters $_{i\rightarrow j}$	0	78	.01	.20	.00	.29	-0.002	.00	-

Table 2
Likelihood of forming a tie $i \rightarrow j$

	Model 1	Model 2	**Model 3**	**Model 4**	**Model 5**
$Syndication_{i \leftrightarrow j}$	.047***	.046***	.047***	.047***	.077***
Common Alters $_{i \leftrightarrow j}$	.080***	.080***	.080***	.080***	.079***
$Centrality_j$ + $Centrality_i$	-.099***	-.092**	-.097***	-.098***	-.099**
$Centrality_j$ - $Centrality_i$	.058**	.017*	.018*	.008*	0.001
$Geographic\ Overlap_{i,j}$	.488***	.501***	.455**	.499**	.492***
$Industry\ Overlap_{i,j}$	.31	-.05	.25	.11	.14
$Stage\ Overlap_{i,j}$	1.37***	1.41***	1.40***	1.38***	1.40***
$Net\ Obligation_{i \rightarrow j}$	.0005	-.014***	-.007**	-.011***	-.005
Common Alters $Obligations_{i \rightarrow j}$			-.0001**	-.0003***	-.003***
$Net\ Obligation_{i \rightarrow j}$ * $Centrality\ Difference_{i,j}$		.018***	.0177***	.018***	.0177***
$Net\ Obligation_{i \rightarrow j}$ * Common $Alters_{i \leftrightarrow j}$					.00001
$Net\ Obligation_{i \rightarrow j}$ * Obligation $Alters_{i \leftrightarrow j}$				-.00001***	-.00001***
Constant	-5.15***	-4.88***	-5.14***	-5.30***	-5.33***
Log Likelihood	-7536	-7391	-7370	-7355	-7350

Figure 1: Structure of Obligations

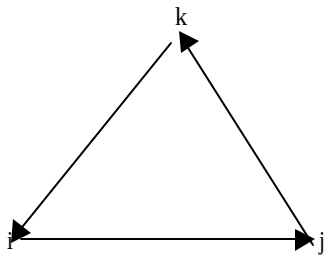

Figure 2:
When does reciprocity occur?

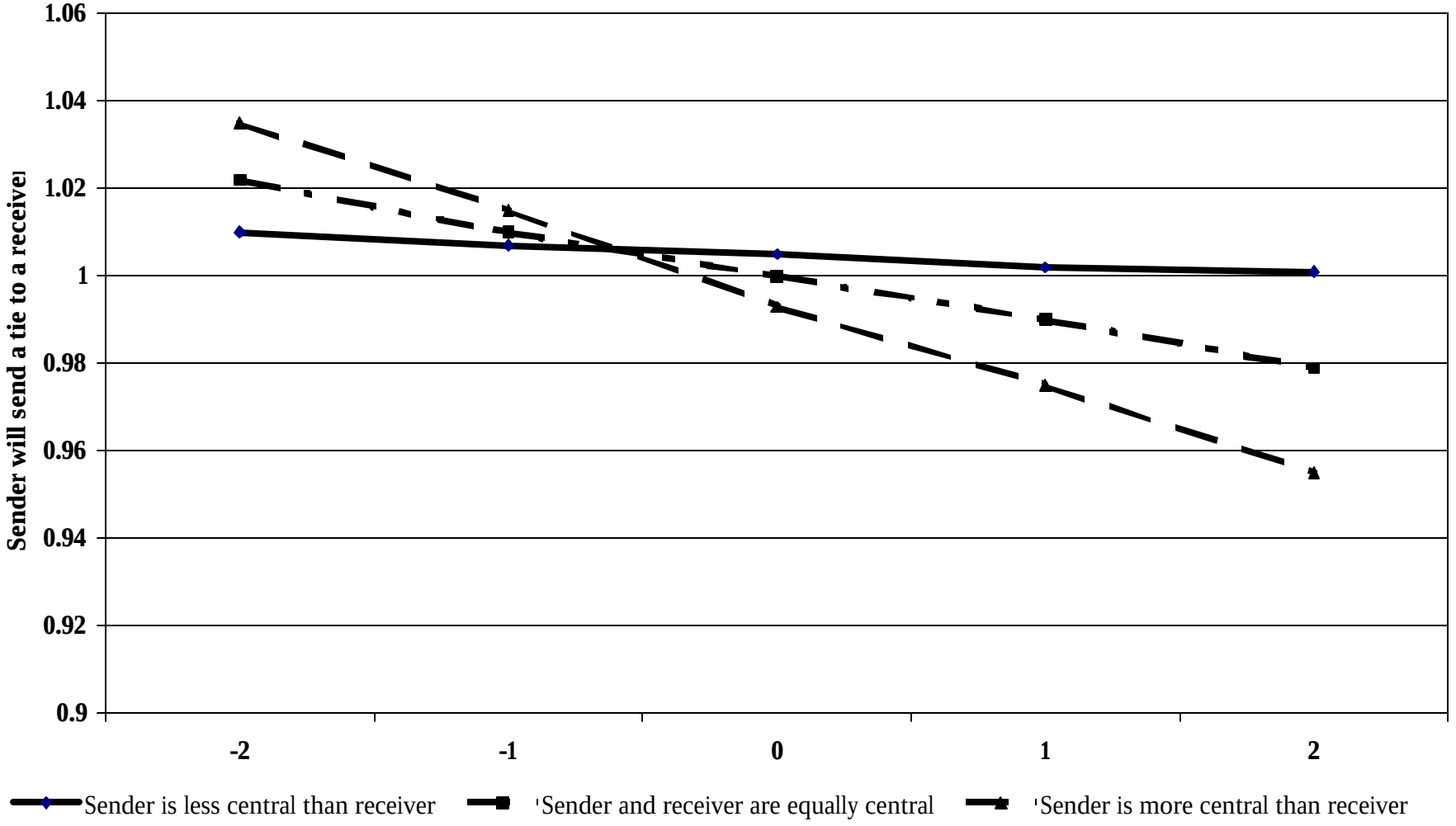

Figure 3:
When does reciprocity occur?