EMBEDDEDNESS, TIE DISSOLUTION, AND THE STABILITY OF INTERORGANIZATIONAL NETWORKS

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ABSTRACT

Previous literature has shown that interorganizational networks tend to be stable, but evidence of that stability stems from analysis showing that existing network structure reinforces itself through the formation of new ties. However, discontinuation of existing ties also affects the degree of network stability. If the same factors that lead to tie replication also lead to tie dissolution, then networks will be less stable than might otherwise appear. This paper investigates how two types of network embeddedness affect the dissolution of interorganizational ties. We distinguish between *ab initio* and evolving embeddedness, to account for the influence of social factors inherent in the network structure at the time of alliance founding, as well as the impact of factors that arise during the evolution of network structure. We argue that combined embeddedness between partners at alliance founding and common partners in the evolving structure reduce the hazards of dissolution, whereas social asymmetry and competitive intensity increase the likelihood of dissolution. We also argue that the presence of common partners is particularly important in stabilizing relationships that are at special risk of dissolution, those characterized by high partner asymmetry and mutual competitive intensity. This highlights the more general principle that the lubricant of social structure is most valuable when the incentives to behave opportunistically are especially sharp. We use longitudinal data on joint ventures formed by global chemical firms to test the hypotheses.
One of the central insights of the sociological view of markets is that interorganizational social structures create and reinforce a stable social order (White, 1981; Burt, 1988). In this vein, the literature on interfirm collaboration emphasizes that the social structure influences patterns of alliance formation (Walker, Kogut and Shan, 1997; Gulati and Gargiulo, 1999; McEvily and Zaheer, 1999), such that the network of firms’ previous relationships serves as a map for future associations and gives rise to embeddedness of relationships. Research suggests that such interorganizational networks generate social stability by acting as repositories of information (Gulati, 1995; Koka and Prescott, 2002) and as means of enhancing trust and enforcing obligations (Gulati and Gargiulo, 1999; Gulati and Westphal, 1999; Gulati, Nohria and Zaheer, 2000). It is possible that such an inference over-states the stability of social order, however, because most evidence of the stability of interorganizational networks is based on patterns of alliance formation, without considering alliance termination. The argument that interorganizational networks reproduce themselves over time assumes that tie dissolution follows patterns consistent with the self-reproduction of the pre-existing social structure. This is a strong assumption. To assess the validity of this assumption we shift the focus from how network embeddedness influences the genesis of interorganizational ties to how embeddedness affects the mortality of ties.

Studying tie dissolution complements extant literature in three ways. First, examining how firms’ embeddedness in a network structure affects the mortality of interorganizational ties will inform the literature on network dynamics. Embeddedness is the degree to which an actor has direct and indirect ties to other actors in a network, where an organizational network consists of all actors that operate within a defined commercial or social space. Several studies argue that the presence of highly embedded actors contributes to the stability of network structures, given that the formation of new ties is more likely to involve organizations that are already central to the social structure (i.e., have many ties to other actors) (Powell, Koput and Smith-Doerr, 1996; Walker et al., 1997; Gulati and Gargiulo, 1999; Rosenkopf, Metiu and George, 2001). However, a given structure of interorganizational relationships changes not only through the formation of new linkages but also through the dissolution of existing ties. Hence, to understand how embeddedness affects the aggregate balance of network dynamics we also need to
examine the influence embeddedness exerts on tie dissolution. On the one hand, it is possible that embeddedness enhances the longevity of alliances, by reinforcing the stability of social structures. On the other hand, it is also plausible that embeddedness results in the formation of redundant ties, which provide overlapping information and control mechanisms. Such redundancy could create higher hazards of dissolution and so attenuate the self-reproducing nature of network structures.

Second, we investigate how firms’ positions in the social structure both at the time of tie formation and in subsequent years affect the hazards of dissolution of an interorganizational tie. This distinction between the *ab initio* and evolving effects of embeddedness on tie dissolution contributes to sharpen our understanding of the two main types of advantages that arise from embeddedness: information gathering and social monitoring (Gulati, 1995; Gulati and Gargiulo, 1999; Koka and Prescott, 2002). The ties within a network of interorganizational relationships offer conduits for informational benefits, through which organizations can access information about alliance opportunities and potential partners. In addition, besides helping organizations identify alliance opportunities and appropriate partners, the embedding of interorganizational relationships in a wider network structure helps create social controls that deter opportunistic behavior. Informational benefits tend to be more prevalent at the time of alliance formation, by helping organizations choose appropriate partners, while social control benefits accrue even after the formation of an alliance. By considering embeddedness both at founding and in the evolving network structure, we can assess whether the different types of benefits are more prevalent. Further, investigating the effects due to firm’s position in the network structure at alliance founding and in the evolving structure will shed light on the appropriate time-scales for social network research (Granovetter, 1992; Zaheer, Albert, and Zaheer, 1999).

Finally, we analyze whether the social monitoring benefits emanating from the social structure enable firms to mitigate the hazards inherent in two types of particularly volatile relationships: ties between firms occupying dissimilar structural positions and ties between partners exhibiting high levels of competitive intensity. Previous research has discussed the difficulties involved in collaboration between socially asymmetric allies (Podolny, 1994; Gulati and Gargiulo, 1999) and the fundamental
tension between competition and collaboration underlying interfirm collaboration (Khanna, Gulati and Nohria, 1998; Dussauge, Garrette and Mitchell, 2000). We examine whether embeddedness especially helps firms lubricate the friction that emanates from social asymmetry and competitive intensity.

**THEORY DEVELOPMENT**

*Ab Initio* Embeddedness

Uncertainty about the capabilities and reliability of potential partners is one of the major hindrances to creating collaborative relationships. As a means of overcoming such hindrances, organizations can use their ties to other organizations to obtain information about alliance opportunities and about the capabilities and reliability of potential collaborators (Gulati, 1995; Walker et al., 1997). In addition, observing the position organizations occupy in the social structure also conveys information relevant for selecting partners. Organizations occupying central positions in a network structure tend to be seen as more capable to work in collaboration and as more trustworthy (Zaheer and Venkatraman, 1995; Gulati et al., 2000). Thus, the literature on alliance formation suggests that organizations that are more deeply embedded in the pre-existing social structure are more likely to form new alliances, due both to the availability of information about their capabilities and to their intrinsic status.

Here we argue that where partners are positioned within a network structure when they first form an interorganizational linkage will also affect the longevity of the linkage. Firms that are more deeply embedded in a network structure are less likely to experience informational constraints in the search for partners. The information accruing to firms located in central positions of the network structure helps them identify the best alliance opportunities and select appropriate partners – those possessing appropriate resources and demonstrating reliable collaborative behavior. In addition to assisting partner selection, relationships between highly embedded actors encourage flow of information, which facilitates collaboration and enhances trust (Gulati, 1995; Walker et al., 1997). Thus, deeper embedding of interorganizational collaboration in social networks leads to enhanced trust between partners based on superior information about each other (Gulati and Singh, 1998; Gulati et al., 2000), which enables firms to mitigate interorganizational hazards. Alliances between firms that know more about each other and
that are more confident about each other’s reliability are less vulnerable to the hazards of collaboration. These benefits are likely to increase with the combined embeddedness of the partners as greater combined embeddedness of two actors indicates a greater span for collecting and disseminating information about each other.

**Hypothesis 1a:** The greater the combined embeddedness of two firms at alliance founding, the lower the hazard of alliance dissolution at any subsequent point.

The history of prior direct ties between a pair of firms conditions the benefits of combined embeddedness. Prior direct ties are relationships that allies have formed with each other in the past. The informational benefits associated with organizations’ structural position are more relevant when partners lack a history of prior direct ties. Prior direct ties between two organizations provide information about each other’s capabilities and reliability, and thus help assuage the uncertainty associated with future collaboration (Gulati, 1995). In the absence of a prior direct tie between two firms, their current structural position often functions as a surrogate, enabling them to learn about each other through their partners and partner’s partners. When two firms have collaborated prior to the formation of an additional alliance, their current structural position conveys less new information, given that prior collaboration provides them with the means to observe each other’s competencies and collaborative behavior directly. Nonetheless, notwithstanding the decreased informational benefits of combined embeddedness in the presence of prior direct ties between two firms, the current combined embeddedness of two firms may still provide information about new opportunities for collaboration and so increase the propensity of alliance formation between them (Gulati and Gargiulo, 1999).

In parallel, though, alliances between highly embedded firms with prior direct ties could increase the hazards of tie dissolution, due to the reasons of redundancy and over-embeddedness. Firms that have direct ties and are deeply embedded in the network structure may have other direct or indirect ways to access targeted resources. Therefore, ties between partners that have both high combined embeddedness and prior direct ties are more likely to be redundant. Operating alliances requires substantial resource investment and managerial attention (Powell et al., 1996; Zollo, Reuer and Singh, 2002). As partners
develop collaborative routines with multiple partners, they may review the scope of existing alliances to accommodate new opportunities, with the goal of eliminating redundant ties. As a result, alliances formed between firms with high combined embeddedness and that have prior direct ties are more likely to have common ground with other existing ties. The redundancy involved in such alliances makes it more likely that the firms will dissolve the ties.

The negative consequences associated with over-embeddedness constitute another factor that makes alliances between highly embedded firms with prior direct ties more susceptible to dissolution. Over-embeddedness results when an actor has so many linkages to other actors that it struggles to operate independently. Negative consequences of over-embeddedness include the diminished ability to pursue instrumental goals (Uzzi, 1997; Portes, 1998), propensity to form unproductive relationships (Gulati et al., 2000), and restricted mobility outside the pool of existing relationships (Granovetter, 1985; Uzzi, 1997). Highly embedded allies may encounter such problems after forming an additional direct tie with each other, which may then lead them to dissolve the tie.

**Hypothesis 1b**: The presence of prior direct ties between two firms will weaken the degree to which the firms’ combined embeddedness at alliance founding reduces the hazard of alliance dissolution.

Previous literature argues that network social structure affects the pattern of linkage formation by reducing the likelihood that socially asymmetric organizations will form ties with each other. Social asymmetry reflects differences in the centrality of two actors. The argument is that firms anticipate some of the difficulties involved in collaboration between socially asymmetric allies and prefer to partner with structurally homophilous firms, that is, firms that occupy similar positions in a network (Podolny, 1994; Gulati and Gargiulo, 1999). Poorly embedded firms have limited attractiveness as partners of more central firms because their peripheral position signals that they possess little to offer. Moreover, affiliation with less embedded partners may harm the reputation of firms that are more deeply embedded in the network of interorganizational relationships.

Nonetheless, firms with asymmetric positions do sometimes ally. For instance, a firm occupying a central position in a network structure can enter an alliance with a poorly embedded ally in order to gain
access to a new technology (Gulati and Gargiulo, 1999), important inventions (Ahuja, 2000a), or any other resource that it cannot obtain from other organizations (Mitchell and Singh, 1996). We argue that, even in the presence of such instrumental goals that motivate the creation of alliances between socially asymmetric partners, these alliances face higher hazards of dissolution.

Ties between socially asymmetric partners face a high risk of dissolutions for two types of reasons, one stemming from inherent problems and the other from tendencies toward short horizons for success. First, despite the instrumental goals that encourage the formation of an alliance that spans higher social distance, such a linkage, once formed, is vulnerable to ongoing operating problems, unbalanced information flow, reputational imbalance, and ambiguous exchange ratios. Structural asymmetry may be paralleled by incompatibility of operating systems and practices (Chung, Singh and Lee, 2000), creating operating problems that interfere with the collaboration. Further, the information flow between the asymmetric partners may be highly unbalanced, in either direction. The more central firm may derive more private benefits from the alliance than its partner because it has a wider portfolio of relationship skills, collaborative relationships, and absorptive capacity that it can use to realize benefits from the information it receives (Cohen and Levinthal, 1990; Zollo, et al., 2002). Alternatively, the centrality may provide a larger information pool from which the peripheral partner can draw. The potential for unbalanced information flow can affect the amount of resources partners allocate to the alliance and increase competition between them, thereby contributing to the instability of the partnership (Khanna et al., 1998). In terms of reputational benefits, meanwhile, the asymmetry might well favor the less embedded partner, whose reputation can be enhanced through collaboration with a prominent ally. For the prominent ally, that collaboration may entail reputational costs (Podolny, 1994). Relationships between partners occupying dissimilar structural position can also face difficulties in arriving at a mutually-beneficial exchange ratio or restoring exchange balance in a relationship as it evolves (Emerson, 1972; Cook, 1977). Also, collaboration between asymmetric partners is more likely to experience relative bargaining power shifts, which is a source of alliance instability (Das and Teng, 2000).
Second, alliances between asymmetric partners commonly are likely to entail a fairly narrow exchange on at least one partner’s end. Given that one partner is relatively peripheral to the other it is likely to bring a fairly specific resource to the exchange. In such situations partners are likely to dissolve even successful relationships once the goals driving their formation are achieved. For instance, once the firm that is more deeply embedded in the network structure accesses the specific new technology, important inventions, or resources that made the collaboration alluring, the central firm may terminate the partnership. By forming the alliance but abbreviating its duration, the central firm gains the benefits of socially asymmetric collaboration and, at the same time, restrains the possibility of problems such as undesired reputational consequences or information loss to peripheral partners.

**Hypothesis 2:** The greater the social asymmetry between partners at alliance founding, the greater the hazard of alliance dissolution.

**Evolving Embeddedness**

The previous section discussed how firms’ position in the network structure at the outset of an interorganizational relationship affects the longevity of that tie. A network structure is in a permanent state of flux, however, with some existing ties being dissolved and other ties being formed. We now shift focus from the effects of embeddedness *ab initio* to the effects occurring *in medias res*, i.e., effects that arise from the on-going social structure. Previous research has shown that a given network structure typically changes only gradually, given that new ties are more likely to arise between firms that are already deeply embedded in the pre-existing network structure. Whereas we concur with the endogeneity of network dynamics in terms of alliance formation, we want to investigate the way in which discontinuation of ties affects changes in social structure. Usually, several years elapse between the formation of a tie and its dissolution, and the social structure can evolve over time. It is plausible that changes in embeddedness that arise from the evolving social structure affect the hazard of alliance dissolution. We will focus particularly on the role of common partners in an evolving network structure as conduits for monitoring and enforcing responsible behavior by partners. The common partners between two organizations encompass the set of direct ties which are common to both organizations.
The presence of common partners attenuates opportunism by a firm’s allies. Although network structure at alliance founding helps predict whether allies will act responsibly, firms also need to monitor and encourage responsible behavior during the life of a relationship. The presence of common ties with other actors in a social structure contributes to monitoring and helps organizations enforce social norms and obligations.

In a Hobbesian state of nature, what is problematic about alliances is not so much that some actors are more likely than others to behave opportunistically but the difficulty to distinguish between reliable actors and opportunistic actors. Common partners are important precisely because they make that distinction more evident, for two reasons. First, third party relationships give higher social visibility to norm-breaking behavior. If in a relationship between two firms one partner exploits the vulnerabilities of the other, the occurrence of such behavior can be revealed to common partners and, through them, disseminate more rapidly and reach a larger number of firms in the network (Gulati et al., 2000).

Second, norm-breaking behavior is not only more likely to be known by other parties, but also more likely to be punished (Portes, 1998; Gulati and Gargiulo, 1999). The presence of third party relationships amplifies the opportunities for the imposition of sanctions to norm breaking. Even if the firm that opportunistic behavior affects is unable to impose sanctions on the partner, because the negative impact arrives through indirect routes, common partners may inflict penalties on the norm-breaker. In many cases such punishment occurs in the form of reputational damage that affects not only all other current ties but also any potential future alliance of the norm-breaker. The fear of loss of reputation deters firms linked by common actors from behaving opportunistically. By increasing the cost of opportunism, the existence of common partners mitigates interorganizational hazards.

The social monitoring effects that common partners create are effective throughout the life of an alliance. The common partners between two firms by the time they create an alliance confer the deterrent effects. As the number of common partners of two firms increases after alliance formation, meanwhile, these social monitoring effects become stronger. Further common partners help enhance firms’
embeddedness in local networks (Gulati and Gargiulo, 1999). This reinforces the concern for local reputation and, as a consequence, further assuages interorganizational hazards.

**Hypothesis 3**: The more common partners that two allies possess at any point of network evolution, the less the hazard of alliance dissolution.

Common partners also help attenuate risks of norm-breaking behavior that arise in asymmetric and competitive partnerships. When ties are formed between socially symmetric firms, the structural similarity of the partners and the attendant relatively congruent routines, processes and objectives provide some measure of stability to the relationship. However, in ties between socially asymmetric firms few of these stability enhancing factors are active; the hazards of collaboration are relatively higher. It is in this setting that that the benefits provided by common partners are likely to be most valuable. The existence of common partners increases the costs of opportunistic behavior and thereby contributes to alleviating the hazards inherent in collaboration. In the presence of common ties between socially asymmetric partners, norms and reputational pressures within the community of related firms may decrease the likelihood that one partner will exploit the learning vulnerabilities of the other, thereby reducing the instability inherent in socially asymmetric associations. Thus, while ties between symmetric partners may be safeguarded by multiple factors, in the case of ties between asymmetric partners fewer of these safeguarding factors are present enhancing the importance of common partners as mechanisms of stability.

**Hypothesis 4**: The more common partners that two allies possess at any point of network evolution, the less that social asymmetry of the two firms at alliance founding will increase the hazard of alliance dissolution.

Alliances with high levels of competitive intensity also face dissolution risks. Firms that produce similar products for similar markets represent a competitive threat to each other (Pfeffer and Novak, 1976). They can, for example, enter or reinforce their presence in markets where the competitors are present and, by doing, so, affect each other’s performance and viability (Barnett, 1997). Recognizing this competitive intensity, firms may resort to cooperation strategies to gain power relative to each other (Thompson, 1967). Consistent with this logic, previous research has argued that interfirm ties enhance the
likelihood of coordination, tacit or otherwise, and shown that firms exhibiting higher levels of competitive intensity may form alliances in an attempt to manage their competitive interdependence (Pfeffer and Novak, 1976; Kogut, 1988). Some scholars have argued that two firms operating in the same markets, being aware of their mutual interdependence and knowing that competitive aggressions can be retaliated, may curb competitive actions and engage in less vigorous competitive interactions (Karnani and Wernerfelt, 1985; Gimeno and Woo, 1996). However, in the face of extremely strong competitive incentives, the stability of such mutual forbearance is likely to be fragile (Stigler, 1964; Baum and Korn, 1999). Therefore, even though firms exhibiting high levels of competitive intensity may use interfirm ties to manage their competitive interdependence, these alliances are inherently less stable and face higher hazards of dissolution.

Competitive intensity can arise at any point of alliance evolution. Two firms may be rivals when they form a relationship. Alternatively, the firms may become rivals during the course of an alliance. In either case, the competition raises the likelihood that the alliance will terminate.

**Hypothesis 5a**: The greater the competitive intensity between two allies at any point of network evolution, the greater the hazard of alliance dissolution.

As we discussed above, though, embeddedness through common ties can deter opportunistic behavior by increasing the costs to norm breaking. The social monitoring effects associated with the presence of common partners enable firms to mitigate the hazards inherent in relationships characterized by competitive intensity. After the formation of an alliance with a partner possessing similar resources and operating in similar markets, a firm may learn about the partner’s vulnerabilities and encounter opportunities to exploit those weaknesses. The incentives to engage in such attempts may exceed the potential costs of retaliation. The presence of common ties between the firm and its partner can be a more effective deterrent than the threat of direct retaliation, because it magnifies the scope for reprisal. Punishment to aggressive behavior can occur in the form of competitive retaliation by any other common partner. Competitive retaliation usually occurs in the form of price competition and can be costly to both the aggressor and the firms retaliating against the aggressor. Firms may prefer enforcement through
common partners. Penalty to norm breaking can occur in the form of social exclusion. By engaging in opportunistic behavior, a norm-breaker puts at risk not only the relationship with a specific partner but also the remaining current alliances as well as future collaboration. Consistent with the arguments above, and highlighting the principle that the social structural lubricant of common partners is most valuable when the incentives to behave opportunistically are the greatest, we hypothesize that:

**Hypothesis 5b**: The more common partners that two allies possess at any point of network evolution, the less that competitive intensity between the two firms will increase the hazard of alliance dissolution.

**DATA AND METHODS**

To test our hypotheses, we used data on the duration of technology-related joint ventures formed amongst the leading firms in the global chemical industry. We identified the leading firms in the chemicals industry from lists that are published annually by trade journals such as *Chemical Week* and *C&E News*. These journals made possible the identification of 107 firms from Western Europe, Japan and the United States – the core of the global chemicals industry. Collecting reliable data on joint venture formation and dissolution in a comprehensive fashion is very difficult for smaller firms. Past network studies have used a similar strategy of focusing on the leading firms in an industry (Gulati, 1995; Gulati and Gargiulo, 1999). For 10 of the above mentioned firms financial and other data were not reliably available, limiting the final analysis to the remaining 97 firms.

This empirical setting is appropriate for several reasons. First, technological collaboration is a significant feature of this industry and affects firms’ technological performance. Second, firms invest a significant amount of financial and managerial resources in the formation of a joint venture. Whereas firms often do not expect other informal interorganizational alliances such as research agreements to last a long period of time, firms incur significant set up costs in the case of joint ventures and expect them to continue. Hence, the dissolution of a joint venture is more meaningful than the discontinuation of other types of interorganizational arrangements. Third, the fact that joint ventures usually last many years allows for the observation of cumulative modifications in the social structure subsequent to alliance formation and to examine how these changes affect tie dissolution. Finally, both the formation and the
dissolution of joint ventures by leading companies tend to receive attention in the media, which enables researchers to identify both events. The empirical literature on alliance dissolution has predominantly focused on joint ventures (Blodgett, 1992; Park and Russo, 1996; Park and Ungson, 1997; Dussauge et al., 2000).

Due to the difficulty involved in the observation of the dissolution of interorganizational ties, the authors of many previous studies have not been able to distinguish between ties formed by the firm and those maintained by the firm at any point in time (Ahuja, 2000b). Absent data on dissolution, prior research has considered all ties formed in the previous 3, 4, or 5 years to represent the network structure in a given year. Whereas such a procedure can be appropriate to the study of alliance formation, it introduces two problems in the analysis of alliance dissolution. First, it overlooks that the network structure evolves not only through the formation of new ties but also through the dissolution of existing alliances. Second, implicit in that procedure is that the network structure is renewed after a few years, since ties that are older than 3, 4 or 5 years are not taken into account. By considering both ties formed and dissolved we can account directly for changes in network structure.

We collected data on the joint venture formation activity of the 97 companies between 1979 and 1991. The period of analysis starts in 1979 because that is when data on interfirm collaboration began to be more systematically reported by news media databases (Hagedoorn and Schakenraad, 1989; Gulati, 1995). To identify joint venture formation and dissolution we used multiple archival sources including general business news media, government publications and industry specific electronic databases. This extremely labor intensive task entailed studying over 130,000 news stories to identify the joint ventures formed by these firms between 1979 and 1991. A significant further data effort was required to trace the life histories of these joint ventures. In this second phase of data collection we analyzed news stories across the period 1979-2004 to verify either a) the joint venture’s dissolution by 1991 or b) its survival to 1992 (the last year of the study) and beyond, as evidenced by news stories about activity in the joint venture. Finally, for the statistical analysis of dissolution we used only the joint ventures formed from
1983 onwards. The joint ventures from 1979 to 1982 were used to create a baseline network (Gulati, 1995).

The joint venture activity of the firms in our sample resulted in the creation of 201 dyadic ties between 1983 and 1991. For 164 of these ties we were able to establish either the date of dissolution or survival beyond 1992 (the last year of this study). For several of the remaining dyads we were able to identify the continuity of joint venture operations after founding but found no reference to dissolution even until 2004. The most accurate assumption to make about these cases is that they continued to be active through the end of the period of analysis for at least two reasons. First, the success in identifying dissolution in the majority of cases indicates that joint venture dissolution tends to be reported, at least for this set of firms, and, hence, absence of reports on dissolution is best construed as evidence of continuity of these ventures. Second, the fact that media reported other news on these joint ventures made it likely that their dissolution would have been reported had it occurred. We also tested the sensitivity of the results to variations in this assumption and, as we report later, found that there was no substantive impact made by this assumption on our results.

**Dependent variable**

**Joint Venture Dissolution** – The dependent variable in our study is the likelihood that two firms will dissolve a joint venture in a given year. We created a dummy variable for each dyad in each year until the year of dissolution or until 1992, whichever occurred first. This dummy variable was one if the firms dissolved the joint venture in that given year and zero otherwise.

**Independent variables**

**Combined Embeddedness at Founding** (H1a, H1b) – We measured the combined embeddedness of two firms at founding as their combined centrality in the network structure in the year preceding alliance formation. Following Mizruchi (1993) and Gulati and Gargiulo (1999), we measured the position of each firm in the network using Bonacich’s (1987) eigenvector measure of network centrality. This measure results in higher centrality scores for firms that are linked to many firms, which are in turn linked to many other firms (i.e., centrality is high for firms with many direct and indirect ties). Higher centrality scores
correspond to higher levels of embeddedness. In each year, the centrality score of each firm took a value in relation to the most central firm in that year. To measure the combined centrality of each dyad in each year, we computed the geometric mean of the centrality scores of the two members of the dyad. We computed the centrality scores using UCINET 5 (Borgatti, Everett, and Freeman, 1999). To test Hypothesis 1b we interacted combined embeddedness at founding with a dummy set to one if the partners had a direct tie by the time they created the alliance and to zero otherwise.

**Socially Asymmetric Dyads at Founding (H2, H4)** – Following Mizruchi (1992), we used a dummy variable to identify dyads involving partners with asymmetric levels of embeddedness in the network structure. We set the dummy variable to unity if one of the firms in the dyad had centrality score lower than the mean while the other had centrality score equal or greater than the mean in the year preceding the creation of the joint venture. Otherwise, the variable was set to zero. To test Hypothesis 4, we interacted this dummy variable with the number of firms’ common partners in the previous year.

**Common Partners in Previous Year (H3, H4, H5b)** – We measured the number of common partners between two firms in the evolving network structure as the number of common partners they had in the network structure in the year preceding the observation year.

**Competitive Intensity (H5a and H5b)** – Consistent with the argument of functional equivalence, we measured competitive intensity between two firms as the similarity in their resources, both upstream (technologies) and downstream (product and geographic markets served). To measure the similarity of the technical resources that two firms possessed, we considered the distribution of firms’ inventions across 80 technological classes that chemical companies use. Previous studies have used patents as indicators of technological resources (Griliches, 1990; Patel and Pavitt, 1995; Hall, Jaffe and Trajtenberg, 2001). For each firm in the sample, we counted the number of patent applications in each technological class in a given year. Then, for each firm we computed the proportion of all patents in each technological class. The variable took the value $2 - \sum_{k=1,80} (PP_{ikt} - PP_{jkt})^2$, where $PP_{ikt}$ ($PP_{jkt}$) corresponds to the proportion of patents that firm $i$ (firm $j$) applied for in technological class $k$ in year $t$. To measure similarity in market resources we considered the average of firms’ similarity in terms of both geographic and product markets.
For geographic similarity, we considered the number of subsidiaries that each firm owned in each of 156 countries in each year. For each firm we identified all the subsidiaries it owned in the period between 1983 and 1991 and computed the proportion of subsidiaries in each country. We measured geographic similarity as 

$$2 - \sum_{k=1}^{156} (PS_{ikt} - PS_{jkt})^2,$$

where $PS_{ikt}$ ($PS_{jkt}$) corresponds to the proportion of subsidiaries that firm $i$ (firm $j$) owned in country $k$ in year $t$. To capture product-market similarity between two firms, we used the proportion of sales they obtained in each of 120 market segments defined at the level of 4-digit SIC code. This variable took a value equal to 

$$2 - \sum_{k=1}^{120} (PI_{ikt} - PI_{jkt})^2,$$

where $PI_{ikt}$ ($PI_{jkt}$) corresponds to the proportion of sales that firm $i$ (firm $j$) obtained in market $k$ in year $t$. The measure of competitive intensity is the interaction between technological and market similarity. Higher scores in this variable indicate higher levels of competitive intensity between firms. This variable was lagged one year. Finally, to test Hypothesis 5b, we interacted this measure with the number of common partners possessed by the two firms in the previous year.

Control variables

**Combined Embeddedness in Previous Year** - To account for the possibility that firms’ combined embeddedness in the evolving structure affects the propensity of tie dissolution, we included a variable calculated in the same way as Combined Embeddedness at Founding but referring to the network structure in the year preceding the year of observation.

**Socially Asymmetric Dyads in Previous Year** – To control for the possibility that firms’ social asymmetry in the evolving network structure affects the likelihood of tie dissolution, we included a dummy variable calculated in the same way as Socially Asymmetric Dyads at Founding but referring to the network structure in the year preceding the year of observation.

**Direct Ties at Founding** We control for the effect of direct ties on alliance dissolution with a variable that measures the cumulative number of prior joint ventures formed between the partners until the year preceding the founding of a new alliance.

**Common Partners at Founding** – We control for the effect of common partners between two firms at the founding of a joint venture between them. Consistent with prior research we measured this variable as
the number of common partners shared by previously unconnected firms in the network structure in the year preceding that of alliance formation (Mizruchi, 1992; Gulati and Gargiulo, 1999).

Resource Similarity – Because the measure of competitive intensity results from the interaction between technical and market similarity and to control for the direct effect of resource similarity on alliance dissolution, we added these two measures as control variables. To avoid multicollinearity, we orthogonalized the measure of Competitive Intensity (Draper and Smith, 1981; Sine, Shane and DiGregorio, 2003).

Financial measures - We included several financial controls to account for the possibility that differences between firms in terms of financial performance or financial resources affect their propensity to dissolve a joint venture. The control variable for “Performance” subtracted the lesser from the greater value within each dyad, using return on assets to measure performance. For “Size”, “Liquidity”, and “Debt-equity”, we used the ratio of the lesser to the greater value within the dyad. Size was total assets possessed by each firm in the chemical industry. Liquidity was the ratio of current assets to current liabilities. Finally, we included the Debt-Equity ratio to address leverage issues. We lagged these variables by one year.

Chemical R&D – To control for the possibility that differences between two firms in relation to their investment in R&D have an impact on the likelihood of technological alliance dissolution, we included the variable “Chemical R&D”. This variable is the ratio between the amount that each firm invested in R&D in the chemical industry, from the lesser to the greater number, in the year preceding the observation year.

Chemical Patents – To control for the possibility that asymmetry between two firms in relation to the number of patents they possess has an impact on the likelihood of alliance dissolution, we added the control variable “Chemical Patents”. We measured this variable as the ratio between the number of chemical patents that each firm possessed, from the lesser to the greater number, in the year preceding the observation year.
**Transregional dummy** – We included a dummy variable to control for the possible effect of cultural differences on alliance dissolution (Parkhe, 1993). This variable was set to one when the parent firms were based in different regions (US, Europe, or Japan) and to zero otherwise.

Table 1 reports descriptive statistics and the correlation matrix for the variables.

********** Table 1 about here **********

**Model estimation and econometric issues**

We used accelerated event-time regression to test the effect of the independent variables on the likelihood of alliance dissolution (Mitchell, 1989). The accelerated event-time method assumes that the event times (time of alliance dissolution in our study) are distributed according to a parametric baseline distribution that would hold if all independent variables were zero. The method then estimates effects of covariates as exponentially multiplicative accelerations or decelerations of the baseline distribution. The accelerated event-time method suits our longevity analysis for two reasons. First, the method incorporates the information that the duration of an alliance may be right-censored, i.e., some dissolutions did not occur before the end of the period of observation. Second, this model takes a flexible set of parametric distributions. Following previous studies of joint venture dissolution, we modeled the duration of alliances using the Weibull distribution (Barkema et al., 1997; Dussauge et al., 2000), which has the following probability density function:

\[
f(y; \lambda, \theta) = \frac{\lambda y^{\lambda-1}}{\theta^\lambda} \exp \left[-\frac{y}{\theta}\right], \quad y \geq 0, \lambda > 0, \theta > 0 \quad \text{(Equation 1).}
\]

The parameters \( \lambda \) and \( \theta \) determine the shape and the scale of the distribution, respectively. When \( \lambda = 1 \), the probability density function in Equation 1 collapses to an exponential distribution. Using the parameter \( \phi = \theta^{-\lambda} \) to simplify the notation we can obtain the following hazard function from the Weibull distribution:

\[
h(y; \lambda, \phi) = \lambda \phi y^{\lambda-1} \quad \text{(Equation 2).}
\]

We can use the equality \( \phi = \alpha \exp(X^T \beta) \) to model the relationship between the hazard of dissolution and the covariates, which leads to the following hazard function:
where $X^T$ represents the transpose of the covariate matrix and $\beta$ represents a vector of coefficients. Given that our model incorporates both time-invariant (ab initio embeddedness) and time-varying (evolving embeddedness and controls) covariates, the hazard function becomes

$$h(y_{ijt0,t}) = h_0(y) \exp(X_{ijt0-1}^1\beta_1) \exp(X_{ijt-1}^2\beta_2) \quad \text{(Equation 4)},$$

where $y_{ijt0,t}$ represents the observation in year $t$ of an alliance between firms $i$ and $j$ created in year $t_0$, $h_0(y)$ corresponds to the baseline hazard function, $X^1$ and $X^2$ contain the transpose matrix of time-invariant and time-varying covariates, and $\beta_1$ and $\beta_2$ contain the corresponding coefficients. The subscripts on $X^1$ and $X^2$ in Equation 4 indicate that variables were lagged one year to ensure temporal precedence to the dependent variable.

**RESULTS**

Table 2 presents the results of the accelerated event-time models. The natural logarithm of the shape parameter is statistically greater than zero at p-levels < 0.001 in all models. Thus, we can reject the null hypothesis that the shape parameter is equal to one, which shows that the likelihood of joint venture dissolution accelerates with the passage of time since founding.

********** Table 2 about here **********

Model 1 of Table 2 contains the control variables, while Model 2 introduces the combined embeddedness measures. The initial results offer moderate support for Hypothesis 1a. Consistent with the prediction, the coefficient on “Combined Embeddedness at Founding” in Model 2 is negative and moderately significant, showing that combined embeddedness of two firms at the founding of an alliance somewhat reduces the likelihood of dissolution of that alliance at any subsequent point. The coefficient on “Combined Embeddedness in Previous Year”, on the other hand, is not statistically significant. These results support our argument that the informational benefits of combined embeddedness accrue to partners ab initio and that subsequent changes in their level of embeddedness do not affect the hazards of alliance dissolution.
The results in Model 3 support Hypothesis 1b. This model added the variable “Combined Embeddedness at Founding * Dummy Direct Ties at Founding”, in order to test whether the effect of “Combined Embeddedness at Founding” is weaker when partners had prior direct ties. The coefficient on this variable is positive and statistically significant, revealing that, in the presence of direct ties, partners’ combined embeddedness at founding contributes less to alliance survival. Moreover, the influence of “Combined Embeddedness at Founding” increases in Model 3, reinforcing the support for Hypothesis 1a.

The results in Model 4 support Hypothesis 2. This model adds the variable “Socially Asymmetric Dyads at Founding”, with significant positive results, showing that the social asymmetry between two firms at the formation of an alliance increases the hazards of alliance dissolution. The coefficient on “Socially Asymmetric Dyads in Previous Year” is not statistically significant, meanwhile showing that the problems inherent in socially asymmetric partnerships primarily affect interfirm collaboration based on ab initio asymmetry rather than through increasing or decreasing pressure over time.

It is noteworthy that the addition of the variable “Socially Asymmetric Dyads at Founding” in Model 4 attenuates the impact and the significance of the variable “Combined Embeddedness”. Partners occupying central positions in the network structure have high combined embeddedness and are, at the same time, socially symmetric. Thus, part of the effect due to combined embeddedness in these cases is likely captured by the variable “Socially Asymmetric Dyad at Founding”.

The results in Model 5 support Hypothesis 3. This model added the variable “Common Partners in Previous Year”, which has a significant negative coefficient. This result shows that the presence of indirect ties between two firms in the evolving network structure mitigates the hazards of alliance dissolution (the coefficient on the control variable “Common Partners at Founding” also is negative). As we expected, therefore, it appears that the occurrence of new common ties in the evolving network structure helps firms to further alleviate interorganizational hazards.

Once we account for the number of common partners, the effect of combined embeddedness at founding is no longer significant. One possible explanation for this occurrence is that the existence of common ties between partners at founding also provides them with some of the informational benefits
associated with their combined embeddedness. Another possibility is that the presence of common partners, by simultaneously providing partners with ways to enforce positive collaborative behavior, supersedes the informational benefits stemming from combined embeddedness.

The results in Model 6 support Hypothesis 4. The model shows that the presence of common partners means that social asymmetry at founding has less impact on the hazard of dissolution. The coefficient on “Socially Asymmetric Dyads at Founding” is still significantly positive as in previous models, but the coefficient on the variable “Socially Asymmetric Dyads at Founding * Common Partners in Previous Year” is significantly negative. This reveals that although alliances between partners occupying dissimilar structural positions are more likely to be dissolved, the presence of common partners mitigates this impact and makes socially asymmetric dyads less likely to be discontinued.

Model 7 supports Hypothesis 5a. The coefficient on “Competitive Intensity” in Model 7 is significantly positive, showing that partnerships between firms with higher levels of similarity in both technological and market resources are subject to higher hazards of dissolution.

Finally, Model 8 does not support Hypothesis 5b. We expected to find that embeddedness through common partners diminishes the impact stemming from competitive intensity. As predicted, the coefficient on this interaction variable “Competitive Intensity * Common Partners in Previous Year” was negative, offering some evidence that competitive intensity between partners contributes less to the hazard of alliance dissolution when firms are connected through indirect ties. However, the coefficient was not statistically significant.

Several control variables influenced the hazard of dissolution. Alliances between partners with a history of prior collaboration are less likely to be dissolved. The similarity of technological resources is also conducive to the stability of collaboration. Finally, alliances between partners exhibiting asymmetric levels of performance are more likely to be terminated.

We also assessed the sensitivity of the results. As noted earlier, we were unable to unambiguously establish dissolution before 1992 or survival beyond that year for a few of the joint ventures in our sample. Given that we detected continuity of operations of most of these joint ventures,
the most accurate assumption to be made in these cases was that these alliances were right censored, surviving until the end of our period of analysis. Although we believe this to be the appropriate assumption, we checked whether our findings are robust to alternative assumptions. We ran additional models, assuming that the 37 dyadic relationships for which we did not find unambiguous evidence of survival beyond 1992 lasted only 4, 5, or 6 years after the year of formation. Models resulting from these different assumptions about the survival of these joint ventures produced results very similar to the ones reported in Table 2. To avoid making any particular assumption about the duration of these 37 dyadic relationships, we also ran additional models dropping the respective observations from our sample. The results of these models were also very similar to the ones reported in the paper, again showing that our findings are robust.

DISCUSSION AND CONCLUSION

Previous research has emphasized the persistence of network structures (Walker et al., 1997; Gulati and Gargiulo, 1999). Stability is an important prerequisite of order. Interorganizational networks would do little to mitigate the uncertainty involved in interfirm collaboration if interorganizational ties did not follow certain patterns of formation and dissolution. However, studies on the stability of interorganizational networks have focused on the effects of embeddedness on the pattern of tie formation. We extended that line of research by examining the influence that embeddedness exerts on tie dissolution.

Our investigation of the hazards of dissolution of the joint ventures formed by global chemical firms between 1983 and 1991 reveals that the structure of network relationships not only affects the pattern of tie formation, as previous research has shown, but also influences tie longevity. Network structure affects tie dissolution in five ways. First, the combined embeddedness of two firms at the time they create an alliance reduces the hazards of alliance dissolution. This finding is consistent with the argument that firms occupying central positions in the social structure enjoy informational benefits that enable them to select appropriate alliance partners (Gulati and Gargiulo, 1999). These informational advantages, however, are less valuable when prior direct ties connect partners. Alliances between allies that are deeply embedded in the network structure and that have a history of previous collaboration are
more vulnerable to the problems associated with the dark side of embeddedness (Granovetter, 1985; Uzzi, 1997; Portes, 1998; Gulati et al., 2000) and, therefore, experience higher hazards of dissolution.

Second, ties formed between firms occupying dissimilar positions in the network structure are not only less likely to occur, as shown in previous studies, but also end sooner. The fact that dissolution risks rise with social asymmetry likely stems from two sources. Such alliances commonly have more specific goals (Mitchell and Singh, 1996; Gulati and Gargiulo, 1999; Ahuja, 2000a) that, once achieved, precipitate the dissolution of the partnership. Moreover, asymmetric alliances commonly incur problems that arise from the structural heterophily, such as incompatibility of organizational routines (Chung et al., 2000), asymmetry in the benefits that partners can obtain from the alliance (Khanna et al., 1998), and the incidence of attempts to restore balance in a socially imbalanced relationship (Emerson, 1972; Cook, 1977).

Third, the presence of common ties between two firms reduces interorganizational hazards. This finding corroborates the argument that embeddedness confers social monitoring benefits (Portes, 1998; Gulati et al., 2000). The existence of common partners can act as an enforcement device, increasing the costs to norm-breaking behavior. Common ties formed after the birth of an interorganizational tie reinforce reputational concerns. Therefore, the effects of embeddedness occur not only at the outset of an interfirm alliance but also emanate from the evolving network structure.

Fourth, the existence of common ties between socially asymmetric allies means that structural asymmetry has less impact on the hazards of alliance dissolution. This result offers additional evidence of the social monitoring benefits stemming from common partners. Not only do common ties mitigate interorganizational hazards, but they also attenuate the friction typical of certain relationships, such as those between actors with asymmetric levels of embeddedness in the social structure.

Finally, collaborations between firms exhibiting higher levels of competitive intensity experience higher hazards of dissolution. This result is consistent with the argument that competitive interdependence, at the same time it increases the incentives for coordination, also makes interfirm ties more unstable (Stigler, 1964; Baum and Korn, 1999). At the same time, though, we also found limited
evidence that common ties between partners somewhat attenuate the tension associated with competitive intensity.

By investigating the effects of embeddedness on the dissolution of interorganizational ties we expected to help elucidate three overarching questions. First, we were interested in understanding whether the impact of embeddedness on tie mortality reinforces or attenuates previous findings about the stability of interorganizational networks. Second, we wanted to distinguish between effects due to ab initio embeddedness and those stemming from the evolving network structure. Finally, we intended to examine whether embeddedness helps firms lubricate the friction inherent in certain types of relationships.

In terms of the stability of interorganizational networks, most of our findings reveal that the effects of embeddedness on alliance dissolution exhibit a pattern consistent with that characterizing the impacts on tie formation. Previous studies have shown that ties are more likely to be formed between firms that are already deeply embedded in the pre-existing network structure, between firms in similar structural positions, and between partners connected by indirect ties. Following this pattern, we found that such alliances are not only more likely to be formed but also less likely to dissolve. Hence, embeddedness has a reinforcing dual effect on network dynamics: as prior research shows, new ties both tend to mirror the pre-existing social structure; in addition, as this paper shows, the ties are more likely to persist for a longer period. The only exception to that pattern refers to ties between highly embedded partners that are already connected by direct ties.

The finding that alliances between highly embedded firms that have already collaborated in the past experience higher hazards of dissolution does not necessarily contradict the evidence of the stability of networks. It is possible that as firms become highly embedded in a network structure and develop relational capabilities (Zollo et al., 2002) they learn to substitute existing ties. For instance, these firms may be able to change the scope of existing alliances to accommodate new collaboration opportunities, thus making some of the existing ties redundant. Besides this substitution effect, a tie-reconstitution effect may also arise. Previous research has analyzed the propensity of organizations to reconstitute accidentally broken interlock ties (Palmer, 1983; Stearns and Mizruchi, 1986). An analogous effect might be in place.
in the case of ties resulting from the formation of joint ventures. It is plausible that firms reconstitute some of the ties that they have dissolved by creating new joint ventures with the same partners.

The second overarching implication of our findings relates to the distinction between *ab initio* and evolving embeddedness. The results of this study suggest that embeddedness related to the structure at alliance founding and embeddedness related to the evolving network structure affect the longevity of alliances differently. Our findings suggest that the informational benefits of embeddedness accrue *ab initio*, whereas the social monitoring effects associated with common partners have an on-going effect. The presence of common partners enhances the longevity of interorganizational alliances even when the common ties between partners emerge after the outset of an alliance. Hence, making such a distinction can enable researchers to build synchronic measures of the firms’ position in network structures so as to avoid attributing to time-varying covariates effects that are actually associated with the conditions in which a social exchange is initiated, or vice-versa (Granovetter, 1992; Zaheer et al., 1999).

Further, the findings show that combined embeddedness and social asymmetry at founding have a lingering effect, which does not disappear with subsequent changes in firms’ position in the social structure. This impact of partners’ position in the social structure at the time they create an alliance is consistent with the argument of social imprinting (Stinchcombe, 1965). Whereas previous studies on the persistence of network structures representing alliances (Walker et al., 1997) and interlock ties (Marquis, 2003) have focused on the patterns of ties formed, we found evidence of an imprinting effect on the pattern of ties that are dissolved. Also, given that joint ventures are *de jure* organizations, our findings add a nuance to the literature on social imprinting by explaining how the position of parent organizations in the social structure at the founding of a joint venture affects the longevity of the newly created organization.

The third overarching question refers to the role of the social monitoring benefits stemming from the social structure in mitigating the hazards of relationships inherently more vulnerable to conflicts. Previous research has shown that both competitive forces and social factors affect the hazards of dissolution of interorganizational market relationships (Baker, Faulkner and Fisher, 1998). We examined
whether embeddedness through common partners, besides directly contributing to diminishing hazards of alliance dissolution, also contributes to reducing the hazards emanating from social asymmetry and competitive intensity. Our findings offer evidence of this dual effect of common ties, most notably in the case of social asymmetry. The presence of common partners contributes to social order not only by making ties more stable but also by lubricating relationships particularly susceptible to friction.

Future research can examine the impact of social factors on the dissolution of other types of interorganizational ties. We focused on technological collaboration in the form of joint ventures, given the interest of partners in the continuation of such collaboration, which makes the termination of these ties a meaningful event to be investigated. Besides this theoretical motivation, the predominance of the focus on joint ventures in the literature on alliance dissolution (Blodgett, 1992; Park and Russo, 1996; Park and Ungson, 1997; Dussauge et al., 2000) is also due to an empirical reason. Both the formation and the dissolution of joint ventures by leading companies tend to receive attention in the media, which enables researchers to identify both events. One avenue for future work is to analyze whether our findings are generalizable to other kinds of interorganizational relationships.

Another potential area to be explored in future inquiry relates to the extent to which social factors affect other alliance outcomes. Firms’ concern with partners’ collaborative behavior can affect not only the hazards of alliance dissolution but the effectiveness of interorganizational collaboration. Future studies can, for example, investigate whether partners with prior direct ties and also richly connected by indirect ties are better able to exchange knowledge and learn from each other. The informational and reputational benefits associated with firms’ position in a network structure can not only affect the patterns of alliance formation and dissolution, but also enhance the flow of resources through network ties. Social considerations can affect network dynamics by influencing what flows through a given network structure at different points in time, even if the ties of such structure remain relatively stable over time. Whereas this study expands our understanding of network dynamics by shifting the focus from the genesis to the mortality of ties, one next step is to consider the dynamics in the content of networks.
REFERENCES

Ahuja, G.


Barkema, H.G., O. Shenkar, F. Vermeulen, and J. Bell

Barnett, W.P.

Baum, J.A.C., and H.J. Korn

Blodgett, L.L.

Bonacich, P.

Borgatti, S.P., M.G. Everett, and L.C. Freeman

Burt, R.S.

Chung, S., H. Singh, and K. Lee

Cohen, W.M., and D.A. Levinthal

Cook, K.S.

Das, T.K., and B. Teng

Draper, N.R., and H. Smith

Dussauge, P., B. Garrette, and W. Mitchell
Emerson, R.M.

Gimeno, J., and C.Y. Woo

Granovetter, M.

Griliches, Z.

Gulati, R.
Gulati, R., and M. Gargiulo
Gulati, R., N. Nohria, and A. Zaheer
Gulati, R., and H. Singh
Gulati, R., and J.D. Westphal

Hagendoorn, J. and J. Schakenraad

Hall, B.H., A.B. Jaffe, and M. Trajtenberg

Karnani, A., and B. Wernerfelt

Khanna, T., R. Gulati, and N. Nohria

Kogut, B.

Koka, B.R., and J.E. Prescott
Marquis, C.  

McEvily B., and A. Zaheer  

Mitchell, W.  

Mitchell, W., and K. Singh  

Mizruchi, M.S.  


Palmer, D.  

Park, S.H., and M.V. Russo  

Park, S.H., and G.R. Ungson  

Parkhe, A.  

Patel, P., and K. Pavitt  

Pfeffer, J., and P. Nowak  

Podolny, J.M.  

Portes, A.  

Powell, W.W., K.W. Koput, and L. Smith-Doerr  
Rosenkopf, L., A. Metiu, and V.P. George

Sine, W.D., S. Shane, and D. DiGregorio

Stearns, L.B., and M.S. Mizruchi

Stigler, G.J.

Stinchcombe, A.L.

Thompson, J.D.

Uzzi, B.

Walker, G., B. Kogut, and W. Shan

White, H.C.

Zaheer, S., S. Albert, and A. Zaheer

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Table 1 – Summary Statistics and Correlation Matrix

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Correlation Matrix:

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Table 2 – Accelerated Event-Time Regression Estimates of Influences on Alliance Dissolution
(Positive coefficient = higher likelihood of dissolution; robust standard errors in parentheses)

| Model | Combined Embeddedness at Founding (H1a: -) | Combined Embeddedness at Founding * | Dummy Direct Ties at Founding (H1b: +) | Socially Asymmetric Dyads at Founding (H2: +) | Common Partners in Previous Year (H3: -) | Socially Asymmetric Dyads at Founding * | Common Partners in Previous Year (H4: -) | Competitive Intensity (H5a: +) | Competitive Intensity * | Common Partners in Previous Year (H5b: -) | Common Embeddedness in Previous Year | Direct Ties at Founding | Socially Asymmetric Dyads in Previous Year | Common Partners at Founding | Similarity Technological Resources | Similarity Market Resources | Size Ratio | Performance Difference | Liquidity Ratio | Debt-equity Ratio | Chemical R&D Ratio | Chemical Patents Ratio | Transregional Dummy | Constant | Ln(Weibull Shape Parameter) | Log pseudo-likelihood | Wald chi-square | Observations |
|-------|------------------------------------------|----------------------------------|--------------------------------------|---------------------------------------------|------------------------------------------|---------------------------------------|--------------------------------------|----------------------------------------|----------------------------------|------------------------------------------|----------------------------------------|--------------------------------------|------------------------------------------|--------------------------------------|----------------------------------------|----------------------------------------|--------------------------------------|----------------------------------|-------------------|-------------------|-------------------|------------------|-----------------------|------------------|------------------|------------------|-----------------|----------------|-------------------|----------------|------------------|-----------------|
| 1     | -1.734 †                               | 5.481**                          | 1.204**                              | 1.204**                                     | -2.086 *                                 | -2.086 *                             | 8.882**                              | -2.595***                             | -0.455                          | -0.205†                                 | -1.390†                               | 0.124                   | -0.205†                               | 1.139†                               | 0.512***                               | 1.521                   | 0.138               | 8.152†                         | -0.455              | -0.921               | -0.138            | 0.014           | 0.771                   | -0.777             | 50.08**                       | 690                 |
| 2     | -3.416**                               | 6.308***                         | -1.394 *                             | -1.394 *                                    | -1.882 †                                 | -1.882 †                             | 9.477**                               | -2.144 **                            | 0.848                           | 0.977†                                  | (1.000)†                              | 0.045                   | 0.977†                                  | 1.083†                               | 1.416**                               | 1.439                   | 0.247               | 8.497†                         | 0.311               | -0.563               | -0.399            | 0.606           | 0.747                   | -76.40           | 33.36***                       | 690                 |
| 3     | -1.979†                                | 11.236**                         | -2.496**                             | -2.496**                                    | -1.900 †                                 | -1.900 †                             | 4.977**                               | -2.414 **                            | 0.903                           | 0.936†                                  | (1.000)†                              | 0.039                   | 0.936†                                  | 1.330†                               | 1.372**                               | 1.416                   | 0.105               | 8.961†                         | -0.399              | -0.577               | -1.396            | 0.645           | 0.768                   | -74.10           | 44.94***                       | 690                 |
| 4     | -0.143                                 | 10.686**                         | -2.365**                             | -2.365**                                    | -2.119 *                                 | -2.231 *                             | 4.977**                               | -2.199 *                              | 0.903                           | 0.936†                                  | (1.000)†                              | 0.031                   | 0.936†                                  | 1.491†                               | 1.569**                               | 1.416                   | 0.319               | 12.275**                        | -0.266              | -0.626               | -1.179            | 0.661           | 0.746                   | -64.08           | 45.95***                       | 690                 |
| 5     | -0.211                                 | 9.842†                           | -2.119 *                             | -2.119 *                                    | -0.211                                    | -0.583                                | 4.977**                               | -2.179 †                              | 0.903                           | 0.936†                                  | (1.000)†                              | 0.031                   | 0.936†                                  | 1.088†                               | 1.454**                               | 1.416                   | 0.319               | 11.956**                        | -0.240              | -0.688               | -1.176            | 0.630           | 0.768                   | -63.81           | 63.93***                       | 690                 |
| 6     | -0.016                                 | 9.086**                         | -0.583                                | -0.583                                      | -0.583                                    | -0.583                                | 4.977**                               | -2.179 †                              | 0.903                           | 0.936†                                  | (1.000)†                              | 0.031                   | 0.936†                                  | 1.136†                               | 1.510**                               | 1.416                   | 0.319               | 11.931**                        | -0.211              | -0.770               | -1.219            | 0.637           | 0.757                   | -62.48           | 62.34***                       | 690                 |
| 7     | 0.013                                  | 14.971*                         | 1.319                                | 1.319                                      | 1.190                                    | 1.190                                 | 4.977**                               | 1.190                                 | 0.903                           | 0.936†                                  | (1.000)†                              | 0.031                   | 0.936†                                  | 1.745†                               | 1.510**                               | 1.416                   | 0.319               | 12.065**                        | -0.211              | -0.770               | -1.219            | 0.637           | 0.757                   | -62.48           | 62.34***                       | 690                 |
| 8     | 0.011                                   | 14.971*                        | 1.319                                | 1.319                                      | 1.190                                    | 1.190                                 | 4.977**                               | 1.190                                 | 0.903                           | 0.936†                                  | (1.000)†                              | 0.031                   | 0.936†                                  | 1.745†                               | 1.510**                               | 1.416                   | 0.319               | 12.133**                        | -0.211              | -0.770               | -1.219            | 0.637           | 0.757                   | -62.48           | 62.34***                       | 690                 |

Two tailed test for control variables; One-tailed test for independent variables
P-levels: † p<0.10 ; * p<0.05; ** p< 0.01, *** p<0.001