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Centrality Asymmetry and Partner Complementarity as Influences on Alliance Dissolution

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Research on interfirm alliances indicates that partner firms' asymmetry in network centrality increases the likelihood of alliance dissolution because it gives rise to a power imbalance and opportunism in the partnership. We contend that this view of centrality asymmetry does not consider the binding force that network resource complementarity can provide in an alliance, which motivates partners to ally for the long term. We propose that centrality asymmetry can have both divisive and cohesive forces in an alliance, which – when considered together – lead to a prediction that centrality asymmetry has a U-shaped relationship with alliance dissolution. Moderate levels of asymmetry lead to lower rates of dissolution than high and low levels of asymmetry. The degree of cooperation between partners and the degree of external competition reduce the effects of centrality asymmetry on alliance dissolution because they mitigate power imbalances while encouraging partners to strengthen the alliance to withstand competitive challenges.

Introduction

Firms cooperating in an alliance expect that their partnership could result in synergy and resource exchange (Dyer and Singh, 1998; Gulati, 1998; Lavie, 2006). The relationships between alliance partners, however, may contain a power imbalance arising from an asymmetry in their endowment of network resources (Gulati, 1995). Alliance partners may possess different levels of network centrality (hereafter asymmetric centrality) when linked to an interfirm network, which entitles them to access various information sources and network resources (Borgatti and Halgin, 2011; Podolny, 1994). The high-centrality firm of an alliance has more network resources and would be advantaged in attracting potential partners. Meanwhile, the low-centrality firm has relatively limited partnering opportunities and its network resources are dependent on its high-centrality partner (Ahuja, Polidoro and Mitchell, 2009; Gulati and Gargiulo, 1999). Such a power imbalance arising from asymmetric centrality gives rise to problems of partner compatibility, coordination and opportunism (Greve *et al.*, 2010; Ma, Rhee and Yang, 2012), which could ruin the foundation of cooperation and increase the likelihood of alliance dissolution (Polidoro, Ahuja and Mitchell, 2011).

Although prior studies point to the hazards of centrality asymmetry for alliance longevity, they forego a discussion of its potential benefits. Indeed, partners' asymmetry in network centrality

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could also lead to complementarity in network resources. Low-centrality firms can access the network resources possessed by high-centrality firms (Gulati and Gargiulo, 1999; Stuart, Hoang and Hybels, 1999), and high-centrality firms would need low-centrality partners to diversify alliance portfolio and strengthen network power (Lavie, 2007; Rothaermel, 2001). As these benefits of centrality asymmetry to interpartner cooperation are under-researched, we contend that current knowledge about the effect of centrality asymmetry on alliance longevity is incomplete.

In this study, we examine interfirm relationships in an alliance from a network perspective. We explore how centrality asymmetry creates both a power imbalance and a network resource complementarity in the partnership. Our central premise is that we need to consider both the hazards and benefits of centrality asymmetry to assess its overall effect on alliance longevity. Following this logic, we depart from the extant view that greater centrality asymmetry leads to a higher likelihood of alliance dissolution (Greve *et al*., 2010; Polidoro, Ahuja and Mitchell, 2011). Instead, we propose that the relationship between centrality asymmetry and alliance dissolution is non-monotonic.

Furthermore, prior research suggests that cooperation between partners and competition in the external environment enhance cohesion in alliances (Castellucci and Ertug, 2010; Das and Teng, 2001; Kogut, 1989). We propose that interpartner cooperation and external competition also modify the power contest and partner complementarity in the partnership, exerting a moderating effect on the influences of centrality asymmetry on alliance dissolution. We test these arguments with a sample of 486 Japanese firms and their 693 overseas equity alliances operating in 39 foreign countries during the 1990–2009 period. Using event history analysis at the dyad level of alliances, we find a U-shaped relationship between partners' centrality asymmetry and the likelihood of alliance dissolution, as well as the negative moderating effects of interpartner cooperation and external competition on this relationship.

Designed in this manner, our study aligns well with and expands the theme of this Special Issue on understanding the processes underlying interfirm cooperation (Kundu, Munjal and Lahiri, 2019). We investigate the nuanced influence of partner asymmetry on alliance dissolution, which is a core question of alliance management and interfirm cooperation. We study the dynamics in the interplay between alliance partners based on their complementarity and power arising from network resources, thus providing insight into what determines longevity in interfirm cooperation. As we also consider the connections of the external competitive landscape as set in an international context, our paper joins the other studies of this Special Issue in uncovering the firm strategy of using alliances for competition and international expansion.

More generally, our study extends traditional and ongoing discussions on partners' asymmetries in resources and the consequences of the same on the stability and longevity of alliances (e.g. Asgari *et al*., 2018; Cui, Calantone and Griffith, 2011; Kogut, 1989; Pangarkar and Klein, 2001; Park and Ungson, 1997). We advance research in the domain with a conceptual and empirical identification of the non-monotonic effect of centrality asymmetry on alliance dissolution (e.g. Ahuja, Polidoro and Mitchell, 2009; Greve *et al*., 2010; Gulati, 1998; Polidoro, Ahuja and Mitchell, 2011). By so doing, we gain insight into the power contest between partners and their considerations about contribution and gains in asymmetric alliances (e.g. Alvarez and Barney, 2001; Diestre and Rajagopalan, 2012; Katila, Rosenberger and Eisenhardt, 2008).

Background

Partners may terminate an alliance for multiple reasons, including unresolvable disputes, interpartner competition or the emergence of new options that exceed the benefits of the current cooperation (e.g. Asgari *et al*., 2018; Greve, Mitsuhashi and Baum, 2013; Park and Russo, 1996). Aside from these reasons, asymmetries between partners have been identified as a major reason for alliance dissolution. Studies on international alliances focus on asymmetries in partners' characteristics such as company culture, management styles and firm vision, all of which create frictions and reduce alliance longevity (e.g. Inkpen and Beamish, 1997; Makino *et al*., 2007). Studies looking at industry conditions highlight that partner asymmetries in capabilities and strategies increase the likelihood of alliance dissolution (e.g. Alvarez and Barney, 2001; Cui, Calantone and Griffith, 2011; Dussauge, Garrette and Mitchell, 2000; Kogut, 1989). This line of research adopts

the view that partners with similar resource profiles are less concerned with opportunism and have lower coordination costs (Chung, Singh and Lee, 2000; Podolny, 1994). It suggests that homophilic partners, or partners with similar attributes, seem to have a better fit and will maintain a long partnership.

We move beyond internal resources and capabilities to consider asymmetries in network resources. Network resources include information from the network, access to other firms, a firm's reputation and status in its network, and partnering opportunities (Gulati and Gargiulo, 1999; Lavie, 2007; Stuart, 1998). In an interfirm network, where firms are tied by alliance partnerships, firms with many alliances occupy a central position and enjoy the benefits of being well connected to others. A high centrality signals to the network a firm's quality in interfirm collaborations (Podolny, 1994). High-centrality firms can collect industrial and environmental information through multiple partners, which is an informational advantage in resource allocation and decision-making (Borgatti and Halgin, 2011). Consequently, high-centrality firms are valued as potential partners and find new partners readily (Gulati and Gargiulo, 1999; Stern, Dukerich and Zajac, 2014). In comparison, low-centrality firms are limited in information acquisition through networks. They have loose connections to networks, which constrain them in presenting themselves to potential partners. Low centrality can be a signal of poor quality in partnering, which impedes others from approaching them (Ahuja, Polidoro and Mitchell, 2009). As such, high centrality entitles a firm with competitive advantages and, therefore, power over its alliance partners (Casciaro and Piskorski, 2005; Castellucci and Ertug, 2010).

Prior research on centrality asymmetry stresses its influence on alliance formation, suggesting that firms tend to form alliances with others that have similar or higher levels of centrality (Ahuja, Polidoro and Mitchell, 2009; Chung, Singh and Lee, 2000; Gulati and Gargiulo, 1999). Recently, researchers have started to associate centrality asymmetry with alliance dissolution, arguing that centrality asymmetry increases the likelihood of alliance dissolution (Greve *et al*., 2010; Polidoro, Ahuja and Mitchell, 2011). However, this line of research has highlighted the hazards of centrality asymmetry while sidestepping its benefits (see Table 1).

Theory and hypotheses

Hazards of centrality asymmetry

The homophily view of alliances posits that partner similarity increases the likelihood of effective cooperation in an alliance (Chung, Singh and Lee, 2000), while partners with high asymmetries may face the problems of power imbalance, misappropriation and unbalanced contribution and gains (e.g. Alvarez and Barney, 2001; Diestre and Rajagopalan, 2012; Katila, Rosenberger and Eisenhardt, 2008).

First, misappropriation may be more likely to occur in centrality-asymmetric alliances due to asymmetric network resources. Low-centrality firms have relatively weak network support to resist misappropriation from partners. They also have limited network channels to disseminate messages about partners' misdemeanours. The weak network power disadvantages low-centrality firms in the cooperation with high-centrality partners and leads to an imbalance in their commitment. High-centrality firms could use their power to commit fewer resources to the alliance but take the lion's share of benefits in an unfair split of gains (Castellucci and Ertug, 2010). Consequently, low-centrality firms would terminate a partnership to avoid opportunism (Greve *et al*., 2010). Meanwhile, high-centrality partners face a problem of free-riding, where low-centrality firms may exploit their high-centrality partners' prestige and social network without contributing much in return (Podolny, 1993, 1994; Polidoro, Ahuja and Mitchell, 2011).

Second, the power imbalance arising from centrality asymmetry may harm the interests of both partners. A substantial power imbalance between partners may entitle the more powerful party to benefit at the beginning of an alliance, such as by taking majority ownership of the joint venture (Ahuja, Polidoro and Mitchell, 2009). However, the power imbalance also reduces the frequency of dyadic resource exchange and eventually erodes the benefits for both parties (Piskorski and Casciaro, 2006). Finally, there is the issue of unbalanced gains. High-centrality firms have a large pool of partners and can enable multiple combinations of partners' resources to create new capabilities (Lahiri and Narayanan, 2013; Lavie, 2007; Wuyts and Dutta, 2014). Compared to their low-centrality partners, they can expropriate more value from the alliance. Such unbalanced gains

Table 1. Studies on the longevity of centrality asymmetric alliances

Centrality asymmetry	Prior studies		This study	
	Longevity	Main drivers	Longevity	Main drivers
High	Nondurable	• Power imbalance (Greve *et al*., 2010; Polidoro, Ahuja and Mitchell, 2011)	Nondurable	• Power imbalance (Greve *et al*., 2010; Polidoro *et al*., 2011) • Reduced dyadic exchange (Piskorski and Casciaro, 2006)
Intermediate	–	–	Durable	• Moderate power imbalance and partner complementarity (Gulati and Sytch, 2007; Jiang, Tao and Santoro, 2010; Stuart, Hoang and Hybels, 1999) • Reduced interpartner competition (Gimeno, 2004; Silverman and Baum, 2002; Singh and Mitchell, 1996)
Low	Durable	• Power balance • Partner compatibility (Chung, Singh and Lee, 2000; Stuart, Hoang and Hybels, 1999)	Nondurable	• Little partner complementarity (Ahuja, Polidoro and Mitchell, 2009; Eisenhardt and Schoonhoven, 1996)

erode mutual trust between partners and increase internal frictions (Das and Teng, 1998, 2001).

In sum, prior research consistently argues that centrality asymmetry undermines the cooperative foundation of alliances and leads to a greater likelihood of alliance dissolution. Polidoro, Ahuja and Mitchell (2011) found that alliances between high-centrality and low-centrality firms are more likely to dissolve. We illustrate this previously argued relationship between centrality asymmetry and alliance dissolution arising from power imbalance in Figure 1(a). The y-axis is the likelihood of alliance dissolution. The x-axis shows the partners' centrality asymmetry. Plot 1 shows that the likelihood of alliance dissolution increases as the level of centrality asymmetry increases.

Benefits of centrality asymmetry

Despite the aforementioned hazards, centrality asymmetry may have a positive influence on an alliance as well. Firms with different network resources could complement each other and become mutually dependent (Alvarez and Barney, 2001; Mitsuhashi and Min, 2016). When centrality asymmetry is at a moderate to high level, partners may have non-overlapping network resources that provide one another with complementary benefits.

Low-centrality firms can benefit from an alliance with a high-centrality firm in network resources. They can use high-centrality partners' connections to the network to acquire information, network support (Eisenhardt and Schoonhoven, 1996; Singh and Mitchell, 2005; Stuart, Hoang and Hybels, 1999) and new partnering opportunities (Dussauge, Garrette and Mitchell, 2004). Also, the partnership with high-centrality firms *per se* is an endorsement of its quality that conveys a positive signal to the network, showing the low-centrality firms' value and credibility in partnering (Benjamin and Podolny, 1999; Podolny, 1993). As the accumulation of network resources requires a stable, long-term engagement (Makino *et al*., 2007), low-centrality firms need to maintain durable alliances with high-centrality firms to secure these benefits.

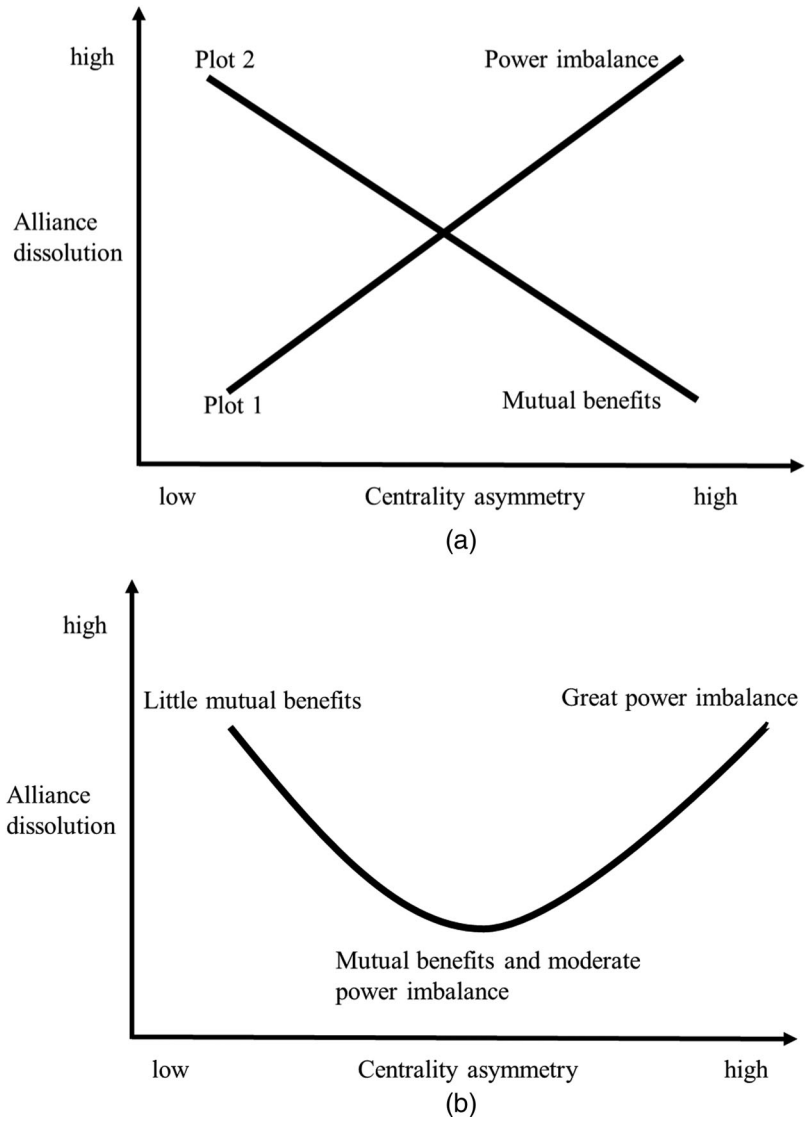


Figure 1. Centrality asymmetry and alliance dissolution

High-centrality firms can also benefit from alliances with low-centrality firms. First, high-centrality firms often need a diverse alliance portfolio to enlarge their knowledge pool and reduce technological risks and market uncertainty (Jiang, Tao and Santoro, 2010; Rothaermel, 2001). Low-centrality firms that are loosely connected with the network can contribute unique knowledge and information that is complementary to high-centrality firms (Lavie, 2006; Wuyts and Dutta, 2014), which creates a weak-tie effect (Granovetter, 1973). Second, high centrality endows firms with power over their low-centrality partners and provides them with greater benefits from centrality-asymmetric alliances. Research suggests that low-status partners need to commit more internal resources compared to their high-status partners as compensation for the latter bearing uncertainty in cooperation and a prestige discount (Castellucci and Ertug, 2010; Yan and Gray, 1994). By analogy, low-centrality firms may need to contribute more to centrality-asymmetric alliances. Studies have shown that the high-centrality partner can usually possess the majority of shares in equity alliances

and a greater share of the returns from the alliance (Ahuja, Polidoro and Mitchell, 2009; Greve *et al*., 2010). Third, a high-centrality firm may ally with a low-centrality firm as a competitive strategy. High-centrality firms can strengthen their alliances with low-centrality partners and prevent the latter from allying with other rival firms (Gimeno, 2004). This tactic enables high-centrality firms to reduce rivals' partnering choices and maintain their competitive advantages in network power (Silverman and Baum, 2002; Singh and Mitchell, 1996). In short, low-centrality partners could be valuable to an alliance by contributing complementary network resources to high-centrality firms.

We add the benefits of centrality asymmetry in Figure 1(a). As illustrated in Plot 2, an increase in centrality asymmetry creates mutual benefits that reduce the likelihood of alliance dissolution.

U-shaped effects of centrality asymmetry

To summarize the above, we contend that centrality asymetry creates hazards and benefits to the alliance longevity at the same time. Figure 1(a) presents the conceptual relationship. First, as centrality asymmetry increases, power imbalances and frictions increase, as does the likelihood of alliance dissolution (Plot 1). Second, as centrality asymmetry continues to increase, its benefits increase, resulting in a decrease in the likelihood of alliance dissolution (Plot 2). Taken together, power imbalances and benefits drive alliance dissolution in opposite directions. According to prior research (Haans, Pieters and He, 2016), when two opposing forces such as these interact with one another, the consequence is a U-shaped curve, which is what we expect to emerge in the relationship between centrality asymmetry and alliance dissolution likelihoods (Figure 1b).

We outline the U-shaped relationship through three distinct cases of alliances with low, intermediate and high-centrality asymmetry. In an alliance with a low-centrality asymmetry, partners not only have a low level of power imbalance but also little mutual benefit of partnering. Such low-asymmetric alliances fail to create sufficient cohesive forces to hold the alliance together and thus have a high dissolution likelihood. In an alliance with an intermediate level of centrality asymmetry, partners create mutual benefits arising from their complementarity while dealing with an intermediate level of power imbalance. Such a combination is manageable because the hazards of centrality asymmetry are not at an unduly high level and partners still have significant mutual benefits that motivate both to continue with the alliance. As such, intermediate-asymmetric alliances have a relatively low dissolution likelihood. Finally, in high-asymmetric alliances, partners have a high level of power imbalance, which offsets any mutual benefits they may have. As prior studies likewise argue (Alvarez and Barney, 2001; Greve *et al*., 2010; Polidoro, Ahuja and Mitchell, 2011), high-asymmetric alliances have a high dissolution likelihood. Taking the above together, and based on prior research as extended by the premises we propose herein, we propose a U-shaped effect of centrality asymmetry on alliance dissolution.

H1: Alliance partners' asymmetry in network centrality exerts a U-shaped effect on alliance dissolution: intermediate levels of centrality asymmetry are associated with lower dissolution rates than high or low levels of centrality asymmetry.

Cooperation intensity

Partners that have cooperated in the past and established a strong dyadic relationship could have reduced rivalry and competition (Das and Teng, 2000; Kogut, 1989). Cooperation also facilitates the development of mutual trust and reciprocity and improves the performance of an alliance (Kim, 2011; Kim and Parkhe, 2009). We contend that interpartner cooperation also negatively moderates the effect of centrality asymmetry on alliance dissolution.

First, cooperation reduces the level of power imbalance arising from centrality asymmetry with the sharing of network resources. Prior cooperation facilitates information sharing between alliance partners, thus reducing the power imbalance arising from information asymmetry due to the asymmetric network centrality (Borgatti and Halgin, 2011). Partners' gaps in other network resources could be filled through intensive and long cooperation. The low-centrality partner may have accumulated both prestige and access to the network by working with its higher-centrality partner. In addition, cooperation allows partners to develop relation-specific assets in the course of an alliance and the partners become mutually

dependent (Dyer and Singh, 1998; Lavie, 2006; Zollo, Reuer and Singh, 2002).

Second, cooperation also reduces the potential opportunism arising from centrality asymmetry by facilitating mutual trust and coordination. Whereas asymmetry in network information and partnering experience impedes decision-making and the handling of interpartner conflicts, cooperation allows partners to collect information about each other and develop a knowledge-based trust (Uzzi, 1997), laying a foundation for more coordinated activities in the alliance (Kavusan, Noorderhaven and Duysters, 2016). Consequently, mutual trust and specialization reduce the possibilities that partners commit opportunistic behaviours for short-term benefits. Thus, we propose that prior cooperation between alliance partners negatively moderates the effect of centrality asymmetry on alliance dissolution.

H2: The effect of partners' centrality asymmetry on alliance dissolution decreases with the intensity of interpartner cooperation (wings of the U shape become less steep).

External competition

We further contend that the effect of centrality asymmetry on alliance dissolution will be smaller when the external competition that the partners commonly face increases to high levels.

A firm may use its alliances to withstand the effects of external competition and impose competitive pressure on rivals (Gimeno, 2004; Silverman and Baum, 2002). When cooperating in alliances, both high-centrality and low-centrality firms may face the pressures of a competitive environment (Hannan and Freeman, 1977). Low-centrality firms are less capable of finding a new partner (Ahuja, Polidoro and Mitchell, 2009; Gulati and Gargiulo, 1999). In case of alliance termination, low-centrality firms have to face the harsh environment alone and have less chance of surviving (Eisenhardt and Schoonhoven, 1996). As such, external competition forces them to attach a greater level of importance to current partnerships and tolerate a power imbalance in the alliance. For high-centrality firms, the competition to obtain suitable alliance partners pervades the network. High-centrality firms realize that their low-centrality partners may also be sought by competitors aiming to expand their portfolio of alliances (Uzzi, 1997). Termination of the current alliance is equivalent to handing over their low-centrality partners to rivals (Gimeno, 2004; Jiang, Tao and Santoro, 2010). As such, high-centrality firms would respond to external competition by strategically consolidating their current alliances.

Therefore, high external competition directs partners' attention away from internal conflicts to focus on dealing with external threats such that centrality asymmetry becomes less relevant in their relationships. Partners could bear the power imbalance and opportunism arising from a high centrality asymmetry to a greater degree, while they could also tolerate a low centrality asymmetry which leads to a lack of network resource complementarity. Thus, the effect of either high or low centrality asymmetry on alliance dissolution becomes smaller in the presence of intensive external competition. We hence propose that external competition negatively moderates the effect of centrality asymmetry on alliance dissolution.

H3: The effect of partners' centrality asymmetry on alliance dissolution decreases with the intensity of external competition (wings of the U shape become less steep).

The Fuji–Xerox alliance is an example that shows the relationship between centrality asymmetry and alliance longevity. This is an alliance between Xerox, a leading high-tech firm in photocopier technology from the USA, and Fuji, a giant photography firm with great industrial networks in Japan (Gomes-Casseres, 1997). Although Fuji and Xerox have highly asymmetric network resources in the Japanese market, their equity alliance has endured for decades. First, their early cooperation in the 1960s and 1970s laid a good foundation of mutual trust and complementarity. Second, when other competitors such as Canon and Ricoh grew to be industrial giants and exerted strong competitive pressure on the Fuji–Xerox alliance, this only encouraged Fuji–Xerox to maintain their alliance throughout the 1980s and 1990s. When competitors went alone in the photocopier market, Fuji and Xerox cooperated closely all the time in technology development and market expansion. The alliance thus helped the partners dominate the market in the early years and then contend with harsh competition in later years. The long duration of this joint venture illustrates how cooperation intensity and external competition can strengthen

the bond between network resource asymmetry and alliance longevity.

Data and methods

Sample

We tested our hypotheses with data on Japanese equity alliances (joint ventures) located in foreign countries. The database Japanese Companies Overseas provides the joint-venture-level data of Japanese public and private firms that have undertaken foreign direct investment (FDI). These Japanese firms document the establishment and termination of their overseas subsidiaries and report operational information on an annual basis. We complemented this dataset with parent-firm-level data from Nikkei Economic Electronic Databank System (NEEDS). Many network studies focus on the firms in a particular industry, such as the chemistry industry (Ahuja, 2000; Polidoro, Ahuja and Mitchell, 2011), financial institutions (Podolny, 1994) and the wine industry (Benjamin and Podolny, 1999). We use a multi-industry design, but with firms that operate in the manufacturing sector. The overseas operations of manufacturing firms involve substantial interactions between partners in production, marketing and sourcing.

We analysed only the dyad of alliance partners, a basic form of interfirm relationship in alliances (e.g. Ahuja, Polidoro and Mitchell, 2009; Diestre and Rajagopalan, 2012; Polidoro, Ahuja and Mitchell, 2011). We focused on joint ventures formed by two Japanese partner firms. Each firm owns 5–95% of the equity shares. We viewed other minor partners (if any) that own less than 5% of the equity shares as portfolio investors and excluded them from the analysis. Using these criteria, we constructed a panel, which has 693 joint ventures formed by two of 486 Japanese firms. These joint ventures spread over 39 countries. The sample has a joint-venture-year structure and a total of 5,694 observations in the 1990–2009 period. There are 471 unique dyads, with some dyads owning more than one joint venture.

Variables and measure

Dependent and independent variables. The dependent variable *alliance dissolution* is a binary variable that takes value 1 when an equity alliance dissolves and 0 when it continues. We denoted a dissolution as having taken place when a joint venture was terminated or when one firm took over its partner's equity shares and converted the joint venture to a wholly owned subsidiary (Asgari *et al.*, 2018; Polidoro, Ahuja and Mitchell, 2011). As the database Overseas Japanese Companies tracked joint ventures on an annual basis over the years, we denoted the disappearance of a joint venture from the source data as a termination (Delios and Beamish, 2001). We identified a takeover event to have taken place when a partner increased its equity shares in the joint venture to above 95%. The sample has 243 cases of alliance dissolution, of which 184 are terminations (76%) and 59 are partner takeovers (24%). The average alliance longevity is 11.2 years.

We constructed three time-varying independent variables. To test H1, we computed *centrality asymmetry* as the difference in the partners' eigenvector centrality. Widely used in social network analysis, eigenvector centrality measures the centrality of a focal firm by weighing it against the degree centrality of its partners (Bonacich, 1987). Thus, eigenvector centrality considers the collective centrality of a firm's networks by assigning the focal firm a higher centrality score (as compared to degree centrality) when its partners have high centrality. We identified the interfirm network as the network of all Japanese firms (2,689 in total) connected by their overseas equity alliances. We used UCINET 6 to calculate the normalized eigenvector centrality of the two partners and took the absolute difference of their centrality scores to construct the variable *centrality asymmetry*, which has a mean of 0.05 and a standard deviation of 0.2.

Cooperation intensity was used to test H2. Following similar studies (Kogut, 1989; Park and Russo, 1996; Polidoro, Ahuja and Mitchell, 2011), we determine its value using the number of existing joint ventures operated by the two partners commonly in the previous year.

We used *external competition* to test H3. Prior research suggests that a high density of firms in a geographically defined niche indicates high interfirm competition (Baum and Singh, 1994; Miller and Eden, 2006). We measured *external competition* by the log of the number of all Japanese subsidiaries, including both joint ventures and wholly owned, existing in a host country in the previous year.

Dyad-level controls. To capture the characteristics of a dyad, we constructed dyad-level variables.

Total capital is the sum of partners' capital, which measures the size of a dyad. We used it to control for the size effect of firms' alliance activities: larger firms can allocate more managerial resources to alliances (Gulati, 1995). As performance could affect a firm's decision to divest foreign investments (Berry, 2013), we included *ROA*, which is the sum of the two firms' return on assets (e.g. Diestre and Rajagopalan, 2012; Jensen, 2008; Polidoro, Ahuja and Mitchell, 2011). We also included *local experience*, which measured partners' capabilities of running foreign subsidiaries. It is computed as the sum of the log of years of operating all their subsidiaries in a host country (Makino and Delios, 1996).

Using data from the publication Keiretsu Overview, we created a binary variable *Same Business Group* to denote partners' business group affiliation, which could affect Japanese firms' alliance behaviour and overseas investment strategy (Gaur and Delios, 2015; Lincoln and Gerlach, 2004). It takes value 1 if the two firms were affiliated with the same business group and 0 otherwise. *Common partners* is the number of third-party firms that have joint ventures with both partners (Park and Ungson, 1997). *Resource complementarity* is a proxy for the mutual dependence of partners, computed as the ratio of non-overlapping industries (four-digit industrial codes) of the partners to the sum of all industries of the partners (Gulati, 1995). Following prior studies and based on the idea that firms in the same industries are competitors (Chen, 1996; Hannan and Freeman, 1977), we created *interpartner competition* (Asgari *et al*., 2018; Gimeno, 2004), which is the number of industries (four-digit industrial codes) in which both partners are present but not collaborating in alliances. We used UCINET 6 to compute *constraint asymmetry*, the absolute difference in the network constraints of partners, and included it as a control variable. The network constraint measures one's network power based on the network theories of 'structural holes' and 'brokers' (Burt, 1995; Jensen, 2008).

Joint-venture-level controls. *Employees* is the log of the total employees of the joint venture. *Age* is the years since the formation of a joint venture. We created a binary variable *performance* to denote whether the joint venture had above-average performance in sales among its peers of the same industry (Berry, 2013). It took value 1 if the joint venture's sales growth ratio exceeded that of the industry mean, and 0 otherwise. To control for the ownership structure, we included *ownership inequality*, which is the standard deviation of partners' equity shares in their joint ventures (Park and Russo, 1996).

Other controls. *Country investment risk* is a composite index created by the International Country Risk Guide (ICRG), which measures the investment risk of host countries (Knack and Keefer, 1995). Higher scores in this variable denote lower risks.

Endogeneity and inter-dyad correlation

We addressed possible endogeneity in two ways. First, we inserted a 1-year lag between the dependent and explanatory variables to reduce the simultaneous endogeneity. Second, omitted variables that are unobservable may correlate with the independent variables, giving rise to endogeneity concerns. Following previous studies (Stuart, 1998; Sytch and Tatarynowicz, 2014), we used an *autoregression term* of the dependent variable as a strong method to reduce any possible bias (Lincoln, Guillot and Sargent, 2016). This term is the lagged mean of partners' alliance dissolution in all other alliance relationships. Suppose that firm i and firm j have an alliance at time t. Firm i also has alliances with firms h and g, and firm j has an alliance with firm k at time t−1; then the autoregression $\text{term}_{ij,t} = (\text{dissolution}_{ih,t-1} + \text{dissolution}_{ig,t-1} + \text{dissolution}_{jk,t-1})/3$. The autoregression term had a range of [0, 1].

In addition, alliance dyads might correlate with one another due to the sharing of the same partners, creating inconsistent estimates (Lincoln, 1984). Following similar studies (Cameron, Gelbach and Miller, 2011; Kleinbaum, Stuart and Tushman, 2013), we used a post-estimation remedy *multiway cluster-robust standard errors*, which allowed us to cluster observations by firm, dyad and joint venture simultaneously. This statistical method also reduces the heteroscedasticity in centrality asymmetry across alliances.

Results

Event history analysis

Table 2 presents sample statistics and inter-item correlations. The correlations suggest a low risk of multicollinearity between explanatory variables.

Table 2. Descriptive statistics and inter-item correlations of main variables

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Alliance dissolution	1.00																	
2	Centrality asymmetry	0.04*	1.00																
3	Cooperation intensity	−0.03*	0.08*	1.00															
4	External competition	0.00	0.05*	0.04*	1.00														
5	Total capital	−0.02	0.18*	0.16*	0.00	1.00													
6	ROA	−0.02	−0.12*	0.02	0.04*	0.17*	1.00												
7	Local experience	0.03*	0.13*	0.19*	0.42*	0.19*	0.05*	1.00											
8	Same business group	0.01	−0.02	−0.03*	0.00	−0.01	−0.04*	0.08*	1.00										
9	Common partners	−0.03*	−0.06*	0.21*	−0.06*	0.14*	−0.02	0.22*	0.18*	1.00									
10	Resource complementarity	0.00	0.20*	−0.12*	0.02	0.15*	0.04*	0.18*	0.07*	−0.07*	1.00								
11	Interpartner competition	0.00	−0.02	0.14*	−0.07*	0.16*	−0.06*	0.30*	0.15*	0.50*	−0.22*	1.00							
12	Constraint asymmetry	0.00	0.21*	0.30*	0.01	0.12*	−0.15*	0.13*	0.05*	0.14*	0.12*	0.11*	1.00						
13	Employee	−0.07*	0.15*	0.14*	0.00	0.30*	0.08*	0.15*	0.01	0.05*	0.17*	0.01	0.08*	1.00					
14	Age	0.03*	−0.06*	0.02	−0.10*	0.02	0.07*	0.41*	−0.05*	0.07*	0.00	0.05*	−0.04*	0.14*	1.00				
15	Performance	−0.03*	−0.04*	0.03*	−0.18*	−0.06*	−0.03*	−0.05*	0.02	0.04*	−0.02	0.01	0.02	0.01	0.06*	1.00			
16	Ownership inequality	0.04*	−0.06*	−0.09*	0.08*	0.01	0.09*	0.08*	0.05*	−0.05*	0.10*	−0.09*	−0.03*	0.07*	0.07*	−0.03	1.00		
17	Country investment risk	−0.03	0.00	−0.01	−0.26*	0.04*	0.00	−0.05*	0.03	0.06*	0.09*	0.09*	0.01	0.17*	0.00	0.00	−0.05*	1.00	
18	Autoregression term	0.15*	0.16*	−0.01	0.00	0.01	−0.07*	0.08*	0.01	−0.01	0.11*	0.05*	0.11*	0.03*	0.02	−0.02	0.03*	0.00	1.00
	Mean	0.04	0.05	0.03	6.32	14.94	0.07	6.75	0.04	0.48	0.72	1.15	0.31	4.97	11.12	0.29	0.18	23.86	0.05
	Standard deviation	0.20	0.20	0.04	1.12	0.78	0.07	2.00	0.21	0.85	0.21	1.74	0.44	1.74	8.36	0.45	0.15	7.39	0.06

N = 5,694.

*$p < 0.05$ (two-tailed tests); the original values of *centrality asymmetry* and *cooperation intensity* are divided by 100.

Table 3 presents the results of a discrete-time event history analysis at the joint-venture level. All regressions are fitted with pooled probit models and adjusted with *multiway cluster-robust standard errors*. Every model contains dummies for country fixed effects and industry fixed effects. We report estimated coefficients instead of hazard ratios because they are easy to interpret: a positive coefficient means that an explanatory variable increases alliance dissolution, while a negative coefficient indicates the opposite effect. The standard errors of estimates are in parentheses.

Model 1 is the baseline regression. It includes all the explanatory variables except *centrality asymmetry*. The variable *autoregression term* has a positive estimate in each regression ($p < 0.001$), indicating that it captures an effect of an upward-biased estimation of *alliance dissolution*. The key explanatory variable *centrality asymmetry* enters Model 2 and has a positive and significant coefficient ($\beta = 0.423$, $p < 0.05$), which is consistent with the finding of prior work that centrality asymmetry increases alliance dissolution (Polidoro, Ahuja and Mitchell, 2011).

Model 3 tests H1 that centrality asymmetry exerts U-shaped effects on alliance dissolution. *Centrality asymmetry square* has a positive coefficient ($\beta = 3.081$, $p < 0.001$), while *centrality asymmetry* has a negative coefficient ($\beta = -3.666$, $p < 0.001$). Following previous studies (Haans, Pieters and He, 2016), we did three statistical tests to confirm that a U-shaped relationship exists between *centrality asymmetry* and *alliance dissolution*. First, we employed a nested model test using the likelihood ratios of the two regressions. We find that Model 3 substantially improves the fit of the dependent variable relative to Model 2 (F value = 13.4, $p < 0.001$). This means that *centrality asymmetry square* aids in explaining the variance of *alliance dissolution*, that is, our non-monotonic model is superior to the linear model. Second, we run a statistical test with Stata command *utest* and confirm the existence of a U-shaped curve (Lind and Mehlum, 2007): the slope of the nonlinear curve is steep at both ends while it flattens in the middle; the threshold of the U shape is located within the range of *centrality asymmetry*. Third, we add the cubic term of *centrality asymmetry* in the regressions and confirm that there is no S-shaped relationship.

We illustrate the relationship between centrality asymmetry and the likelihood of alliance dissolution by plotting its marginal effect, holding all other covariates at their mean level (see Figure 2a). We consider that the total marginal effect of a variable in nonlinear regressions is a function of the values of all other covariates (Wiersema and Bowen, 2009). There are three distinct regions in this approximate visualization. First, when *centrality asymmetry* takes values between 0 and 0.52, it has a negative and significant marginal effect. For instance, when *centrality asymmetry* is zero, its marginal effect is to cause a 22.7% reduction in the likelihood of *alliance dissolution* ($p < 0.01$), and this diminishes to 0.2% ($p < 0.01$) when *centrality asymmetry* increases to 0.52. Second, values of *centrality asymmetry* between 0.52 and 0.84 represent a transition region where asymmetry has no significant effect on alliance dissolution, which corresponds to the bottom of the U shape. Third, when *centrality asymmetry* is greater than 0.84, it has a positive and significant marginal effect. For instance, when *centrality asymmetry* takes a value of 0.84, its marginal effect is to increase the likelihood of alliance dissolution by 2.6% ($p < 0.1$). Both the magnitude and the significance of the marginal effect increase as *centrality asymmetry* increases further. In general, these results provide consistent support for H1.

Model 4 tests H2, which predicts that the effect of *centrality asymmetry* on alliance dissolution decreases when partners have more cooperation. To test this, we add the interaction terms *centrality asymmetry* × *cooperation intensity* and *centrality asymmetry square* × *cooperation intensity* together in Model 4. Both coefficients (0.64 and −0.005) have a small p-value (0.039 and 0.036). A nested model test provides an F-value of 4.67 ($p = 0.096$), suggesting an improvement in fitting by adding the interaction terms. A marginal effect analysis shows that when *centrality asymmetry* is one standard deviation above the mean (0.25), a 1% increase in *cooperation intensity* (i.e. partners have one more joint venture), on average, leads to a decrease in *alliance dissolution* by 2.0%. These results suggest a negative moderating effect of *cooperation intensity* on the U-shaped relationship: when the extent of interpartner cooperation increases, *centrality asymmetry* reduces *alliance dissolution* less when asymmetry is low and increases dissolution less when asymmetry is high. We can see this in Figure 2(b). The solid curve represents the marginal effect of *centrality asymmetry* taking into consideration *cooperation intensity* at one standard

Table 3. Event history analysis on the longevity of Japanese equity alliances

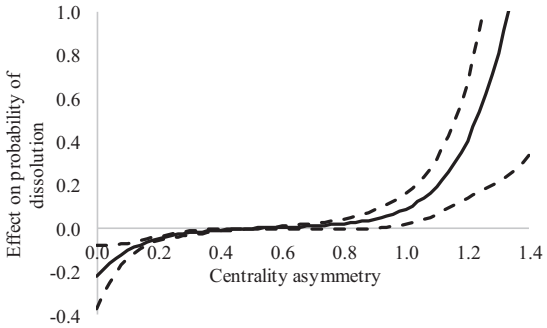
	(1) Baseline model	(2) Centrality asymmetry	(3) U-shaped relationship	(4) Cooperation intensity	(5) External competition	(6) Full model
Centrality asymmetry [H1]		0.423*	−3.666***	−6.348***	−19.531**	−20.070**
		(0.197)	(0.885)	(1.873)	(6.108)	(6.289)
Centrality asymmetry square [H1]			3.081***	5.134***	16.685***	17.254***
			(0.658)	(1.388)	(4.628)	(4.717)
Centrality asymmetry × cooperation intensity [H2]				0.640*		0.645*
				(0.277)		(0.295)
Centrality asymmetry square × cooperation intensity [H2]				−0.005*		−0.005*
				(0.002)		(0.002)
Centrality asymmetry × external competition [H3]					2.353**	2.024*
					(0.867)	(0.827)
Centrality asymmetry square × external competition [H3]					−2.017**	−1.788**
					(0.659)	(0.618)
Moderators						
Cooperation intensity	−2.336^{+}	−2.326^{+}	−1.869	−2.857*	−1.949	−2.927*
	(1.301)	(1.273)	(1.212)	(1.412)	(1.236)	(1.423)
External competition	0.395^{+}	0.314	0.223	0.216	0.234	0.228
	(0.232)	(0.232)	(0.221)	(0.219)	(0.221)	(0.219)
Dyad-level controls						
Total capital	0.010	0.008	0.008	0.010	0.006	0.010
	(0.055)	(0.056)	(0.057)	(0.057)	(0.057)	(0.057)
ROA	−0.558	−0.462	−0.741	−0.799	−0.750	−0.817
	(0.500)	(0.528)	(0.527)	(0.529)	(0.529)	(0.531)
Local experience	0.033	0.030	0.027	0.031	0.026	0.030
	(0.029)	(0.030)	(0.031)	(0.030)	(0.031)	(0.030)
Same business group	0.104	0.105	0.103	0.087	0.089	0.071
	(0.142)	(0.145)	(0.148)	(0.146)	(0.144)	(0.143)

(Continues)

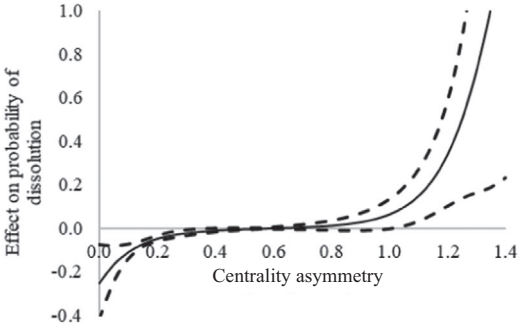
Table 3. Event history analysis on the longevity of Japanese equity alliances

	(1) Baseline model	(2) Centrality asymmetry	(3) U-shaped relationship	(4) Cooperation intensity	(5) External competition	(6) Full model
Common partners	−0.123*	−0.113*	−0.120*	−0.125*	−0.119*	−0.125*
	(0.056)	(0.057)	(0.058)	(0.056)	(0.059)	(0.057)
Resource complementarity	0.117	0.071	0.193	0.194	0.202	0.204
	(0.214)	(0.213)	(0.225)	(0.225)	(0.225)	(0.226)
Interpartner competition	0.013	0.018	0.019	0.012	0.021	0.014
	(0.026)	(0.028)	(0.028)	(0.029)	(0.029)	(0.030)
Constraint asymmetry	−0.012	−0.040	−0.010	0.006	−0.015	0.002
	(0.077)	(0.079)	(0.079)	(0.081)	(0.081)	(0.083)
Joint-venture-level controls						
Employees	−0.059*	−0.084***	−0.084***	−0.084***	−0.082***	−0.082***
	(0.024)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
Age	0.008^{+}	0.011*	0.010*	0.010*	0.010*	0.010*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Performance	−0.156*	−0.137^{+}	−0.118	−0.119	−0.115	−0.115
	(0.072)	(0.072)	(0.073)	(0.073)	(0.073)	(0.073)
Ownership inequality	0.462^{+}	0.610**	0.613**	0.615**	0.607**	0.603**
	(0.240)	(0.234)	(0.232)	(0.233)	(0.232)	(0.233)
Other controls						
Country investment risk	−0.005	−0.006	−0.007	−0.007	−0.007	−0.007
	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Autoregression term	3.711***	3.580***	3.563***	3.579***	3.520***	3.543***
	(0.567)	(0.567)	(0.558)	(0.570)	(0.558)	(0.570)
Constant	−2.853**	−2.369*	−2.030^{+}	−2.014^{+}	−2.007^{+}	−2.027^{+}
	(1.087)	(1.118)	(1.126)	(1.132)	(1.123)	(1.130)
Log-likelihood	−911.16	−889.91	−883.20	−880.87	−879.57	−877.30
Chi-square	201.13	209.33	229.78	245.60	230.91	256.22

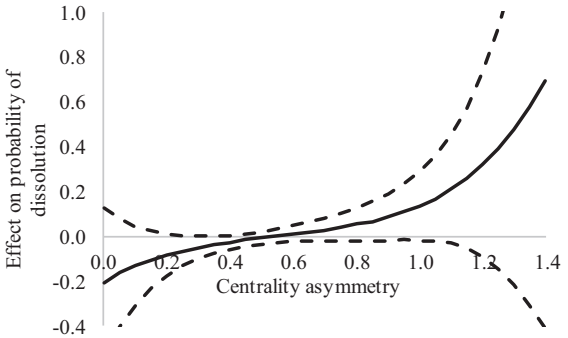
N = 5,694; the dependent variable is *alliance dissolution*; all models include country fixed effects and industry fixed effects; estimations use a pooled probit model; robust standard errors in parentheses are clustered by firm, dyad and joint venture.
+p < 0.10.
*p < 0.05.
**p < 0.01.
***p < 0.001 (two-tailed tests).



(a) Marginal effect of centrality asymmetry



(b) Marginal effect of centrality asymmetry when *cooperation intensity* is one standard deviation above the mean



(c) Marginal effect of centrality asymmetry when external competition is one standard deviation above the mean

Figure 2. (a) Marginal effect of centrality asymmetry; (b) marginal effect of centrality asymmetry when cooperation intensity *is one standard deviation above the mean; (c) marginal effect of centrality asymmetry when* external competition *is one standard deviation above the mean.* Note*: Dashed lines indicate the 95% confidence intervals*

deviation above its mean value. The solid curve becomes slightly flatter at both ends, suggesting that the marginal effect of *centrality asymmetry* at low or high values becomes smaller in the presence of *cooperation intensity*. These analyses provide strong support for H2.

Model 5 tests H3 that external competition negatively moderates the effects of *centrality asymmetry* using the variable *external competition*. The coefficient of the interaction of *centrality asymmetry* × *external competition* is positive ($\beta = 2.353$, $p < 0.01$) and that for *centrality asymmetry square* × *external competition* is negative ($\beta = -2.017$, $p < 0.01$). A nested model test provides an F-value of 7.25 ($p = 0.027$), suggesting an improvement in fitting. A marginal effect analysis shows that when *centrality asymmetry* is one standard deviation above the mean (0.25), a 1% increase in *external competition* (i.e. 10 more Japanese subsidiaries in a host country) leads to a 0.04% decrease in *alliance dissolution*. Figure 2(c) shows the marginal effects of centrality asymmetry taking into consideration *external competition* at one standard deviation above its mean value. The statistical results and plots provide strong support for H3. Model 6 presents the full specification inclusive of all explanatory variables and interaction terms. The estimation shows similar statistical effects as in the prior models.

Robustness checks

We tested whether the effects of centrality asymmetry are robust over different types of alliance dissolution (see Table 4). We differentiated between two scenarios of alliance dissolution: Model 7 considers dissolution by takeovers, while Model 8 considers all other dissolutions. The results indicate that the same U-shaped relationship exists

Table 4. Robustness checks

	(7) Takeovers	(8) Excluding takeovers	(9) Non-vertical alliances	(10) Vertical alliances	(11) Non-exploration alliances	(12) Exploration alliances
Centrality asymmetry [H1]	−43.390*	−18.325**	−21.364**	−65.532	−22.017***	−142.827**
	(19.527)	(6.040)	(6.649)	(68.464)	(6.254)	(54.600)
Centrality asymmetry square [H1]	41.600**	15.966***	18.413***	223.302	18.815***	1915.201*
	(15.998)	(4.530)	(5.141)	(426.191)	(4.666)	(956.575)
Centrality asymmetry × cooperation intensity [H2]	1.124	0.784**	0.654*	1.780^{+}	0.813^{+}	−0.163
	(1.514)	(0.302)	(0.320)	(0.997)	(0.464)	(1.920)
Centrality asymmetry square × cooperation intensity [H2]	−0.087	−0.006*	−0.005*	−0.073^{+}	−0.007^{+}	0.245
	(0.115)	(0.002)	(0.003)	(0.044)	(0.004)	(0.252)
Centrality asymmetry × external competition [H3]	5.869*	1.666*	2.187*	8.998	2.411**	23.361*
	(2.978)	(0.805)	(0.875)	(10.870)	(0.888)	(9.883)
Centrality asymmetry square × external competition [H3]	−4.523*	−1.527*	−1.939**	−32.874	−2.077**	−349.997^{+}
	(2.150)	(0.603)	(0.676)	(68.975)	(0.654)	(184.116)
Moderators						
Cooperation intensity	1.171	−5.035***	−3.135*	0.596	−4.574***	4.137
	(2.674)	(1.316)	(1.500)	(4.138)	(1.274)	(3.719)
External competition	0.132	0.242	0.125	1.626*	0.326	−0.147
	(0.440)	(0.211)	(0.222)	(0.754)	(0.238)	(0.626)
Dyad-level controls						
Total capital	0.224*	−0.041	−0.002	0.274	0.002	0.117
	(0.095)	(0.063)	(0.055)	(0.179)	(0.067)	(0.190)
ROA	1.155	−1.495*	−0.565	−2.282^{+}	−1.082^{+}	1.326
	(1.048)	(0.588)	(0.612)	(1.281)	(0.583)	(1.585)
Local experience	0.008	0.040	0.028	−0.031	0.041	−0.040
	(0.059)	(0.039)	(0.031)	(0.086)	(0.033)	(0.101)
Same business group	0.284	−0.004	0.065	0.173	0.123	0.093
	(0.287)	(0.180)	(0.149)	(0.410)	(0.175)	(0.523)

(Continues)

Table 4. Robustness checks

	(7) Takeovers	(8) Excluding takeovers	(9) Non-vertical alliances	(10) Vertical alliances	(11) Non-exploration alliances	(12) Exploration alliances
Common partners	−0.319*	−0.076	−0.154*	−0.048	−0.131^{+}	−0.343^{+}
	(0.128)	(0.060)	(0.061)	(0.162)	(0.073)	(0.192)
Resource complementarity	−0.791*	0.460^{+}	0.201	0.290	−0.076	0.902
	(0.359)	(0.275)	(0.238)	(0.606)	(0.246)	(0.622)
Interpartner competition	0.032	0.003	0.043	−0.117	−0.007	0.018
	(0.056)	(0.036)	(0.028)	(0.077)	(0.034)	(0.078)
Constraint asymmetry	0.011	0.036	0.011	−0.205	0.054	−0.330
	(0.175)	(0.091)	(0.093)	(0.193)	(0.093)	(0.217)
Joint-venture-level controls						
Employees	0.023	−0.115***	−0.091***	−0.147^{+}	−0.081**	−0.119
	(0.051)	(0.027)	(0.027)	(0.088)	(0.027)	(0.088)
Age	0.012	0.007	0.010^{+}	0.015	0.010^{+}	0.037**
	(0.009)	(0.006)	(0.006)	(0.012)	(0.006)	(0.013)
Performance	−0.044	−0.126	−0.131	0.002	−0.195*	0.200
	(0.154)	(0.086)	(0.084)	(0.199)	(0.084)	(0.188)
Ownership inequality	4.553***	−0.563*	0.575*	2.250**	0.496*	1.918**
	(0.733)	(0.284)	(0.248)	(0.706)	(0.242)	(0.672)
Other controls						
Country investment risk	0.012	−0.010	−0.004	−0.033	−0.002	−0.053*
	(0.018)	(0.010)	(0.010)	(0.022)	(0.010)	(0.023)
Autoregression term	2.185*	3.502***	3.365***	4.858***	4.092***	2.547**
	(1.105)	(0.542)	(0.631)	(1.121)	(0.588)	(0.940)
Constant	−11.291***	−1.012	−5.048***	−10.766*	−2.246^{+}	2.350
	(2.000)	(1.148)	(1.288)	(4.570)	(1.305)	(3.205)
Log-likelihood	−232.21	−695.61	−714.57	−130.41	−699.82	−142.89
Chi-square	178.25	218.70	703.53	797.41	247.98	256.47
Observations	5,070	5,694	4,733	936	4,605	1,047

All models include country fixed effects and industry fixed effects; estimations use a pooled probit model; robust standard errors in parentheses are clustered by firm, dyad and joint venture.

+p < 0.10.

*p < 0.05.

**p < 0.01.

***p < 0.001 (two−tailed tests).

between *centrality asymmetry* and *alliance dissolution* in both scenarios.

We further checked whether the U-shaped effects of centrality asymmetry varied across alliance types. We coded two binary variables, *vertical alliances* and *exploration alliances*, to denote alliance types. *Vertical alliances* take value 1 if the equity alliance has vertical missions assigned by partners, namely, information collection or funding (Phene and Tallman, 2012). *Exploration alliances* take value 1 if the alliance has exploration missions, namely, R&D or expansion to new business (Rothaermel and Deeds, 2004). We developed subsamples using these two variables. Models 9 and 10 in Table 4 are the regressions on the groups of non-vertical alliances (83% of the observations) and vertical alliances (17%). Models 11 and 12 are the regressions for the groups of non-exploration alliances (82%) and exploration alliances (18%). The focal U-shaped relationship between centrality asymmetry and alliance dissolution is robust across the checks, although the moderating effects do not emerge in all tests (as of a critical p-value of 0.05). This may be a consequence of reduced power from the small size of the subsamples in Models 10 and 12.

Discussion and conclusion

We investigated how alliance partners' centrality asymmetry affects the dissolution rates of their equity alliances. Prior research investigating the effects of centrality asymmetry has stressed the hazards of centrality asymmetry while overlooking its benefits (e.g. Greve *et al*., 2010; Polidoro, Ahuja and Mitchell, 2011). Considering the hazards and benefits of centrality asymmetry in tandem, we proposed the hypothesis and found empirical support that a moderate level of centrality asymmetry leads to a lower likelihood of alliance dissolution relative to low or high asymmetry. We also found that interpartner cooperation and external competition reduced the effects of centrality asymmetry.

Our research contributes to research on interfirm alliances and networks. First, our study intersects with research on alliance partners' asymmetric interdependence from the angle of network resources (Casciaro and Piskorski, 2005; Gulati and Sytch, 2007). Prior studies largely viewed a firm with fewer network resources as the dependent party in an alliance and suggested a higher dissolution likelihood of highly asymmetric alliances (Ma, Rhee and Yang, 2012). The view that centrality asymmetry monotonically increases alliance dissolution (e.g. Alvarez and Barney, 2001; Greve *et al*., 2010; Polidoro, Ahuja and Mitchell, 2011), however, has not provided sufficient explanation for the fact that centrality asymmetry exists prevalently in alliances and is associated with distinctive lengths of alliance longevity. To explain such discrepancies, we stressed the value of low-centrality partners and explored the benefits of centrality asymmetry in terms of creating network resource complementarity and reducing interpartner competition. The opposite forces of power imbalance and complementarity arising from centrality asymmetry lead to a nonlinear relationship between centrality asymmetry and alliance dissolution. Prior studies also have not explored the moderating factors that lead to the dissolution of the alliances with low centrality asymmetry and the persistence of high-centrality asymmetry alliances. We investigate how partner cooperation and external competition modify this relationship. As such, our theory and analyses depict alliance dissolution rates over a full range of centrality asymmetries, thereby extending previous research.

Second, our study joins the discussion on the partner dissimilarity and asymmetry and the consequences for alliance stability and longevity (e.g. Asgari *et al*., 2018; Cui, Calantone and Griffith, 2011; Kogut, 1989; Pangarkar and Klein, 2001; Park and Ungson, 1997; Reuer and Zollo, 2005). Prior studies patronize either a homophily view – that partners with similar network resources are compatible and harmonious or a complementary perspective – that dissimilarity and resource matching are the main drivers in firms' alliance activities (e.g. Ahuja, Polidoro and Mitchell, 2009; Castellucci and Ertug, 2010; Chung, Singh and Lee, 2000; Dyer and Singh, 1998; Gulati and Gargiulo, 1999; Jensen, 2008; Lavie, 2006). The homophily view has a convincing explanation for the shorter longevity of alliances with high centrality asymmetry (Polidoro, Ahuja and Mitchell, 2011), but it does not explain why alliances between two low-centrality firms are rare (Ahuja, Polidoro and Mitchell, 2009), nor does it provide reasons for the empirical finding that the alliances formed by two high-centrality firms are non-durable (Polidoro, Ahuja and Mitchell, 2011). The complementary perspective explains well the formation of alliances between complementary partners but does

not line up with the logic of partner compatibility (Chung, Singh and Lee, 2000; Podolny, 1993, 1994).

Our research suggests that neither perspective explains sufficiently firms' partnering patterns independently, and researchers need to consider both perspectives to interpret firms' partnering patterns. Since both compatibility and complementarity generate the benefits in a dyadic relationship, partners should manage similarity and asymmetry to reach a point where it enhances alliances' longevity. Further on this point, our study also links alliance research and strategy research by reflecting the strategic philosophy of 'optimal distinctiveness' (Miller and Chen, 1996; Zhao *et al.*, 2017), which suggests that firms want to be similar to peers to gain legitimacy while being distinctive in certain aspects to maintain competitive advantages. Both perspectives converge on the viewpoint that 'an intermediate level of distinctiveness' from peers is the optimal strategy when firms seek less conflict and more acceptance in interfirm relationships.

Third, our findings on the downside of high centrality shed light on the dynamics in network structures, providing new implications for alliance management. Although network research highlights high centrality and its advantages in information and partnering opportunities (e.g. Borgatti and Halgin, 2011; Gulati and Gargiulo, 1999; Podolny, 1993), we revealed that high-centrality firms might not always have a long and stable partnership with another high-centrality partner. Interpartner competition, the lack of mutual benefits and redundancy in network resources could drive central firms away from each other. Central firms still need to choose partners with moderately lower or higher centrality if they aim for enduring partnerships. In this sense, our study modifies the prior ideas on the Matthew effect in network dynamics, that central firms always gain high-centrality partners and become more central in the network (e.g. Gulati and Gargiulo, 1999; Podolny, 1993).

Futhermore, prior studies mainly suggest that low-centrality firms, traditionally viewed as the weak party in terms of network resources, need to overcome their dependence by offering competitive capabilities or making sacrifices in value splitting (Alvarez and Barney, 2001; Diestre and Rajagopalan, 2012; Katila, Rosenberger and Eisenhardt, 2008). We added that low-centrality firms could also leverage their value in network resources to gain power in a dyadic relationship. As a tactic of alliance strategy, low-centrality firms could attain a more durable alliance by partnering with a firm that has moderately higher centrality, which helps them expand their networks and progress to central positions of the network. Therefore, our study supplements research on peripheral firms that have received less attention in prior work (for an exception, see Ahuja, Polidoro and Mitchell, 2009).

Finally, our study reveals the interplay between internal cooperation and external competition in alliances regarding partner asymmetry in network resources. As competition and cooperation are at the core of dyadic relationships (Das and Teng, 2000; Park and Ungson, 2001; Ritala, 2012), our findings on partners' responses to internal cooperation and external competition provide supplementary implications. Specifically, our study suggests that they have a moderating effect on alliance longevity by modifying the effect of centrality asymmetry. We found that firms with prior cooperation could reduce power imbalances and enhance cohesion, which led to a lower hazard of centrality asymmetry and a longer alliance duration. Centrality-asymmetric partners could also respond to external competition by reducing their concerns with centrality asymmetry. These findings provide a nuanced view of interpartner relationships in an alliance.

We noted some limitations of our research. First, due to the availability of data, we were unable to identify cases of intended alliance termination due to contract expiration or realized goals (Dussauge, Garrette and Mitchell, 2000; Reuer and Zollo, 2005). This should not, however, substantively bias our results because Japanese manufacturing firms have a tradition of long-term collaborative relationships (Lincoln and Gerlach, 2004) and 90% of the terminations of Japanese overseas joint ventures are unintended (Makino *et al.*, 2007). Second, we analysed dyadic relationships and assumed that partners face the same level of external competition. Yet, the same competitive environment could arouse different reactions from partners in distinctive network positions. For the same reason, there is research potential in studying partner asymmetries in triadic relationships or multiple-party alliances. Moreover, future research could explore how centrality asymmetry leads to other outcomes, such as reflected in financial

performance or the dynamics in alliance management and governance.

In conclusion, we contend that centrality asymmetry creates a hazard from power imbalances, but a benefit from network resource complementarity. When we balance the two and how strongly they manifest themselves across alliances with varying levels of asymmetry, we illustrate how a U-shaped relationship emerges between centrality asymmetry and the likelihood of alliance dissolution, as well as how this relationship is negatively moderated by partners' prior cooperation and the external competition they commonly face. As such, our study provides deep insight into the challenges and gains of interpartner cooperation in alliances based on their distinctive network resources.

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