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STEPPING IN AND STEPPING OUT: STRATEGIC ALLIANCE PARTNER RECONFIGURATION AND THE UNPLANNED TERMINATION OF COMPLEX PROJECTS

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Research summary: *I add to work that emphasizes the stability of strategic alliances by considering the consequences of alliance partner reconfiguration. I offer two contrasting perspectives: (1) alliance partner reconfiguration leads to disruption, hence increases the risk of subsequent project termination; (2) partner reconfiguration leads to adaptation, hence decreases this risk. Data on 1,025 interfirm Australian mining alliances (2002–2011) shows that on average alliance partner reconfiguration increases the risk of project termination. For firm exit from an alliance, the effect is contingent on a firm's resource base, but not for firm entry. Surprisingly, I do not find that alliance partner reconfiguration is beneficial in a dynamic environment. I discuss the implications of these findings for the literature on strategic alliance dynamics and that on strategic alliance outcomes.*

Managerial summary: *This paper studies what happens when over time strategic alliances change their original membership. The research shows that both entry in and exit from an alliance increase the risk of project termination. Hence, weathering difficult times and managing conflict by keeping teams stable should be a prime directive if project survival is the alliance partners' overriding concern. In addition, I find that the exit of a firm with a comparatively large resource base increases the hazard of termination more than if the departing firm has a relatively small resource base. Therefore, one cannot underestimate the importance of trying to keep on board those alliance partners who bring a critical resource to the table.*

INTRODUCTION

Where classic work on alliances has offered theories about the antecedents of interfirm alliance formation (e.g., Ahuja, 2000; Oliver, 1990) and about the initial configuration of firms at the time of founding (Baum, Calabrese, and Silverman, 2000), recently there has been growing interest in post-formation alliance dynamics, such as how alliances are modified (e.g., Mariotti and Delbridge, 2012), or dissolved (e.g., Greve *et al.*, 2010; Polidoro, Ahuja, and Mitchell, 2011), and how changing alliance patterns aggregate to influence network architecture (e.g., Ahuja, Soda, and Zaheer, 2012). This work has found that alliances frequently undergo significant change over their lives (Greve, Mitsuhashi, and Baum, 2013). For instance, Reuer, Zollo, and Singh (2002) found that 44 percent of the alliances formed between U.S. biotech and pharmaceutical firms underwent significant post-formation change of some kind.

One salient type of post-formation change is a change in the partner composition of an alliance—a firm entering the alliance or a firm leaving it, for example. By *strategic alliance*

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partner reconfiguration, I refer to structural changes in the set of firms that is jointly involved in an alliance over time. From the nascent research on post-formation alliance dynamics one can infer possible antecedents of alliance partner reconfiguration, including the relative importance of the alliance (Reuer *et al.*, 2002), resource incompatibility between partnering firms (Greve *et al.*, 2010), reduced individual attachment (Broschak, 2004), the attractiveness of options outside the alliance (Greve *et al.*, 2013), and power inequalities (Rowley *et al.*, 2005). Yet, our understanding of the possible *consequences* of strategic alliance partner reconfiguration is limited. To address this gap, I study the process of strategic alliance partner reconfiguration and test theoretical predictions about its consequences. Specifically, by integrating multiple strains of prior research I propose and test two contrasting theoretical perspectives on this subject matter:

On the one hand, alliance partner reconfiguration could lead to *disruption.* Alliance partners tend over time to develop interfirm routines for working together (Levinthal and Fichman, 1988; Zollo, Reuer, and Singh, 2002). In an alliance that is reconfigured after formation these routines are likely to be upset—disrupting established patterns of interaction and coordination mechanisms (Chung and Beamish, 2010; Summers, Humphrey, and Ferris, 2012) crucial to alliance effectiveness (Gulati, Wohlgezogen, and Zhelyazkov, 2012). In fact, resetting the clock theory (Amburgey, Kelly, and Barnett, 1993) proposes that severe changes, such as changes in the configuration of partners, "reset the clock" on the liability of newness that starts ticking when a collaborative venture was originally formed, hence increasing the risk of failure.

On the other hand, alliance partner reconfiguration could lead to *adaptation.* Alliances derive their value from allowing collaborating partners to gain access to new knowledge and technologies (Dyer and Singh, 1998), to share risk (Das and Teng, 2001), or to pool resources and capabilities (Chung, Singh, and Lee, 2000). Changes in the environment in which an alliance operates may erode the value of the initial configuration of partners established at the time of alliance formation (Bakker and Knoben, 2015; Volberda, 1996). Partner reconfiguration, whether by adding a new member, or by dropping one, may thus be an opportunity to recalibrate the alliance to a changing environment (Wiersema and Bantel, 1993). In contingency-theory this is seen as making a "structural adjustment to regain fit", which may actually be beneficial (Donaldson, 1987; Van de Ven, Ganco, and Hinings, 2013).

This article puts these contrasting theoretical perspectives to the test by studying the effect of two basic forms of alliance partner reconfiguration: firm entry into an alliance, and firm exit from an alliance. While I acknowledge that other types of reconfiguration may exist, and that more complex patterns of alliance reconfiguration can be imagined, my purpose in this exploratory endeavor is to hone in on these two important factors to develop them in sufficient depth.

I focus on alliances that have been formed to carry out complex projects. I draw on a dataset of mineral exploration projects in the Australian mining industry over the 2002–2011 period. Mineral exploration is complex and costly, requiring the commitment of substantial resources (Hartman and Mutmansky, 2002). Hence mining firms often form alliances to share risk and pool resources. What sets mineral exploration alliances apart is that they are production-oriented rather than learning-oriented (Greve *et al.*, 2010), meaning that their primary goal is to "to pool resources from multiple firms and increase economies of scale beyond the capacity of single firms" (Greve *et al.*, 2010: 305; Williamson, 1975). The dependent variable in this study is the unplanned termination of the mineral exploration project that the alliance carries out. I used a Cox proportional hazards model to empirically track partner changes to the alliance involved with the project over time and relate these changes to the subsequent hazard of an unplanned project termination. An unplanned termination can be a financial catastrophe for the firms involved with a mining project. The costs and risks notwithstanding, there is a considerable amount of partner reconfiguration as firms "step in" and "step out" of projects and mine sites are opened and closed.

I seek to make the following contributions. First, this research contributes to the body of research on strategic alliance dynamics (e.g., Ariňo and De la Torre, 1998; Das, 2006; Das and Teng, 2002; Doz, 1996; Khanna, Gulati, and Nohria, 1998; Ring and Van de Ven, 1994). Databases such as SDC and MERIT-CATI are often used to study alliances, but they usually report on the initial formation of strategic alliances—not on subsequent changes to them (Bakker and Knoben, 2015; Schilling, 2009). While alliance stability is often assumed (Chung and Beamish, 2010), my empirical study using data

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over a sufficiently long time span shows that structural alliance partner reconfiguration occurs quite frequently in the context of production-oriented alliances. This finding is a departure from the conventional view of strategic alliances that emphasizes the stability and the inertia resulting from embedded relationships between actors (see Greve *et al.*, 2013; cf. Uzzi, 1997, 1999).

Second, this study extends our current understanding of strategic alliance outcomes. Prior research has reported daunting alliance failure rates (Kale, Dyer, and Singh, 2002; Lunnan and Haugland, 2008), but has so far developed an incomplete picture of the factors leading to dissolution (Rogan, 2014). I find that alliance partner reconfiguration is a contributing factor in the unplanned termination of mining projects. To develop a more precise theory I propose two moderators of the partner reconfiguration—termination relationship: (1) the resource base of the member firm entering or departing the alliance vis-à-vis that of the alliance as a whole; and (2) the level of dynamism in the environment of the alliance. Hence I identify an important variable heretofore overlooked in much of the alliance performance research—post-formation partner reconfiguration—and uncover possible factors attenuating its effects.

Finally, by taking into account multiple mechanisms by which alliance partner reconfiguration influences outcomes, this research extends theory regarding the trade-offs between the disruptive and adaptive consequences of change. As I will elaborate later, my findings support the view that alliance reconfiguration is disruptive rather than adaptive (which is interesting given the high prevalence of alliance partner reconfiguration that I find among mineral exploration projects). In the closing sections of this paper, I will address the apparent puzzle this presents: If alliance partner reconfiguration is indeed mostly disruptive, then why do I observe it occurring so frequently?

ALLIANCE PARTNER RECONFIGURATION IN COMPLEX PROJECTS

Theoretical perspectives on alliance configuration and reconfiguration

Gulati (1995) defines a strategic alliance as "any independently initiated interfirm link that involves exchange, sharing, or co-development" (86). Over the past decades, alliances have been studied from a variety of theoretical perspectives. Whereas traditionally researchers looked at what types of firms tend to form alliances and how they select their partners (e.g. Dickson and Weaver, 2005; Eisenhardt and Schoonhoven, 1996; Hitt *et al.*, 2000), often taking a resource-based perspective (e.g., Das and Teng, 2000; Eisenhardt and Schoonhoven, 1996), recent years have seen alliance research that includes concepts as diverse as reputation (Zhelyazkov and Gulati, 2013), outside options (Greve *et al.*, 2013), flexibility (Bakker and Knoben, 2015), signalling (Reuer and Ragozzino, 2014), experience spillovers (Zollo and Reuer, 2010), and contractual change (Argyres, Bercovitz, and Mayer, 2007).

While seminal work focused on alliance configuration—the make-up of the alliance network at the time of formation—researchers are increasingly investigating alliance dynamics, including the post-formation evolution of alliances (e.g., Ariño and Ring, 2010; Gulati *et al.*, 2012; Marion *et al.*, 2015). For example, the literature on alliance instability (e.g., Das and Teng, 2000; Inkpen and Beamish, 1997) has shown that resource incompatibility (Greve *et al.*, 2010), reduced individual attachment (Broschak, 2004), distrust between partners (Puranam and Vanneste, 2009), the absence of preexisting ties (Gulati, 1995), power inequality between partners (Rowley *et al.*, 2005), and the attractiveness of outside options (Greve *et al.*, 2013) reduce alliance stability.

An important perspective that has come out of this body of research centers on the role of coordination in strategic alliances (Gulati *et al.*, 2012). Gulati *et al.* (2012) posit that, in addition to concerns about cooperation in strategic alliances, alliance research should study coordination—the "deliberate and orderly alignment or adjustment of partners' actions to achieve jointly determined goals" (Gulati *et al.*, 2012: 537). By an emphasis on post-formation adjustment, this framework offers at least two critically important insights into the occurrence of alliance partner reconfiguration.

First, cooperation in and of itself does not ensure alliance success. It is a strongly-held view in alliance research that partners must cooperate with one another, and that factors such as trust (Puranam and Vanneste, 2009), partner specific investment (Levinthal and Fichman, 1988), contractual safeguards against opportunism (Lui and

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Ngo, 2004) and mutual commitment (Broschak, 2004) promote increased cooperation. Nonetheless, these alone do not necessarily suffice as "[d]espite best intentions, partners may find it difficult to efficiently combine the resources they bring to the table, to synchronize their actions, or to realize the planned payoffs" (Gulati *et al.*, 2012: 536–537). Even when partner interests are perfectly aligned and the degree of cooperation is high, tasks need to be allocated and coordinated efficiently to reach alliance goals (Gulati *et al.*, 2012). Moreover, whereas there are a number of factors that lead to inertia in alliances, including embeddedness in a network of direct and indirect prior ties between partners (Chung *et al.*, 2000; Greve *et al.*, 2013; Li and Rowley, 2002)—and the trust (Puranam and Vanneste, 2009), partner-specific experience (Zollo *et al.*, 2002), and possible reputational consequences (Zhelyazkov and Gulati, 2013) that flow from that—these do not alleviate the need for post-formation adjustments to alliances in the face of challenges that become apparent only when partners are actually engaged in the implementation phase (Gulati *et al.*, 2012).

Second, not every contingency can be foreseen, let alone planned for, at the time of alliance formation—no matter how carefully firms choose initial partners and venture governance (Gulati *et al.*, 2012). In fact, the literature on strategic alliance dynamics (e.g., Ariňo and De la Torre, 1998; Das, 2006; Das and Teng, 2002; Doz, 1996; Khanna *et al.*, 1998; Reuer, 2001; Reuer *et al.*, 2002; Ring and Van de Ven, 1994) has proposed that "[m]anaging the alliance relationship over time is usually more important than crafting the initial formal design" (Doz and Hamel, 1998: XV). This appears to be especially true of alliances engaged in executing projects that are highly complex and for which the number and variety of coordination issues can prove to be overwhelming (Gulati *et al.*, 2012). Given bounded rationality, alliance managers are likely to devise suboptimal alliance designs for a variety of reasons (Gulati, Sytch, and Mehrotra, 2008).

Thus, the literature provides important clues as to why alliance reconfiguration occurs, and what factors make its occurrence more likely. However, researchers often treat alliance reconfiguration as a dependent variable without looking beyond that to study its effects (Chung and Beamish, 2010). Hence we know considerably less about the consequences of strategic alliance reconfiguration—to which I now turn.

The consequences of strategic alliance reconfiguration

I focus in this paper on production-oriented alliances that are formed to undertake complex projects. How does the partner reconfiguration of such an alliance influence the performance of the project that it was formed to undertake, and the likelihood of it being terminated? As said earlier, I consider two types of alliance partner reconfiguration: firm exit, that is, a firm with an ownership stake leaving a project; and firm entry, a firm not previously in the alliance taking up an ownership stake in it. I expect that both entry and exit will impact on the hazard of subsequent project termination, but in different ways.

Firm exit refers to the decision of an individual firm to withdraw from an interfirm alliance. Hence firm exit is not the same as project termination. Similar to Greve *et al.* (2010), I distinguish between a member firm ceasing to be in an alliance, and project termination in which case an entire project, and thus the alliance as a whole, is brought to an end. Nonetheless, the exit of a firm can be a major shake-up for an alliance (Greve *et al.*, 2010). Firms are unlikely to make this decision lightly given the potential for future penalization of this act (Li and Rowley, 2002) and potential negative reputational consequences (Zhelyazkov and Gulati, 2013). Still, unlike other decisions that pertain to the alliance as a whole, the decision to withdraw from an alliance is typically made unilaterally by one member and can be taken for instrumental reasons (Greve *et al.*, 2013), benefitting the exiting firm but not necessarily the alliance as a whole (Khanna *et al.*, 1998). There are three reasons why I would expect the exit of a firm from an alliance to increase the relative risk of subsequent project termination.

First, firm exit is likely to disrupt established cooperation mechanisms and patterns of interaction. As an alliance evolves partners learn to coordinate tasks more effectively, and a pattern of collaboration is gradually built and refined (Greve *et al.*, 2010; Khanna *et al.*, 1998; Levinthal and Fichman, 1988). This has three aspects: (1) over time alliance partners make project-specific investments, for instance in specialized equipment and or in a particular expertise, that may not easily be transferred to other projects (Williamson, 1975);

(2) individuals in boundary-spanning roles tend to develop personal relationships with their counterparts in partner firms (Ring and Van de Ven, 1994), promoting the development of trust (Levinthal and Fichman, 1988); and (3) partners develop interorganizational routines for working together (Nelson and Winter, 1982; Zollo *et al.*, 2002). Together these processes gradually lead to the development of relation-specific assets (Levinthal and Fichman, 1988), which facilitate effective coordination. When a partner ceases to be a member of an alliance, the pattern of collaboration is disrupted, relationship-specific assets eroded, and established coordination processes undermined (Chung and Beamish, 2010; Summers *et al.*, 2012), all of which jeopardizes the attainment of alliance goals (Gulati *et al.*, 2012).

Second, firm exit triggers a change process that diverts attention from operating to reorganizing (Chung and Beamish, 2010). When a firm exits an alliance, the partners that remain need to adapt to the new situation. This process of realignment is especially challenging as firms will typically pursue common benefits as well as firm-specific goals (Khanna *et al.*, 1998). As a consequence, there is likely to be a temporary increase in transaction, agency, and administrative costs (Chung and Beamish, 2010; Reuer and Ariño, 2002) following a firm exit. As resources such as time, attention, and energy are diverted away from tasks that support attaining alliance goals, performance is likely to suffer (Chung and Beamish, 2010; Inkpen and Beamish, 1997).

Finally, when a member firm departs, an alliance loses access to the skills, capabilities, or tangible assets of the exiting firm (Das and Teng, 2000). Access to these may have been the very reason for the collaboration in the first place (Singh and Mitchell, 1996). All else being equal, losing access to a needed resource is likely to increase the risk of project termination.

For the above reasons, I expect that, all else being equal, firm exit from an alliance increases the risk of unplanned project termination. Later, I will explore moderators of this relationship. For now, I formulate my first hypothesis as follows:

> *Hypothesis 1: Firm exit from an alliance increases the hazard rate of unplanned project termination.*

Firm entry refers to a new firm entering an existing alliance to take up an ownership stake in the project. To some extent the consequences of firm entry overlap those of firm exit. First, as in the case of a firm departing, adding a new member to an existing alliance disrupts established cooperation mechanisms and patterns of collaboration (Chung and Beamish, 2010; Summers *et al.*, 2012). When a new member enters an alliance, existing coordination regimes are changed, as are resource and power dependencies (Inkpen and Beamish, 1997). Not only does the new firm need to be fitted into the alliance, but the other members need to adapt to the new status quo. Moreover, the entry of a firm increases the size and complexity of the alliance—and the larger and more diverse an alliance becomes, the greater the coordination costs (Whetten, 1981).

Also, as when a firm exits an alliance, when a firm enters one it is likely that attention will be temporarily diverted away from operating toward reorganizing (Chung and Beamish, 2010), as the new member is socialized, slotted into communication routines, and in general aligned to the ways of doing things (Beckman, Burton, and O'Reilly, 2007). This can be especially difficult in light of the ongoing relationships within an alliance, and the already agreed-upon ways of working together (Levinthal and Fichman, 1988). The one to two punch of relationship-specific asset erosion and the need to reestablish a new pattern of coordination is likely to increase the risk of subsequent project termination.

While the above arguments may seem to indicate that adding a new member to an alliance is likely to increase the risk of subsequent project termination to the same extent as does the departure of a member, there is an important difference: the decision to leave an alliance is typically made unilaterally whereas the decision for firm entry is one made jointly by the firm entering the alliance and the firms already in it. As a consequence, it is relatively more likely that in the case of firm entry the new member is needed and the addition orchestrated by the alliance as a whole. The addition of a new member firm does not necessarily mean that the initial alliance configuration was insufficient (Gulati *et al.*, 2012), but it does indicate that the new member may provide an opportunity for the alliance to alleviate a shortcoming.

Where exactly the tipping point is between these contrasting arguments in general is a tricky issue. In the context of our specific empirical setting, however, we can state that, as in other extractive

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industries, cost reduction is one of the keys to effective competition (Harrigan, 1986). This puts enormous pressure on the financial profit margins to be obtained from forming and maintaining alliances (Harrigan, 1986; Stuckey, 1983). Firm entry will put pressure on such profit margins at least for the short term, because of the higher coordination and adjustment cost that comes with it, increasing the risk of failure (Chung and Beamish, 2010; Whetten, 1981). For this reason, I expect that in the context of production-oriented mining alliances the termination-increasing arguments for firm entry outweigh the termination-decreasing arguments. However, while I do not expect that the fact that firm entry, in contrast to firm exit, is a joint decision negates all of the above arguments, I do expect it will serve to offset, to a degree, the risks associated with firm entry. My second hypothesis, therefore, is:

Hypothesis 2: Firm entry into an alliance increases the hazard rate of unplanned project termination, but the effect is smaller than that of firm exit.

While in and of itself the number of firm exits and entries is likely to be an important factor impacting alliance functioning and project success, I expect that the extent of influence that entry and exit wield depends on *the resource base* of the entering or departing firm. Specifically, a firm that possesses relatively more resources may be a particularly desirable addition to an alliance or a particularly undesirable withdrawal. There are two reasons why the resource base of an entering or departing member firm is likely to influence the relationship between alliance partner reconfiguration and the risk of project termination.

First, resources are directly tied to the successful coordination and execution of the task of the alliance. They allow sharing costs, generating returns, gaining differentiable product technologies, and creating value (Eisenhardt and Schoonhoven, 1996; Lin, Yang, and Arya, 2009). In the case of mineral exploration projects, the costs of developing an initial mineral resource lie in the USD 10–500 million range (Hartman and Mutmansky, 2002). Firms that have a larger resource base are more likely to be able to contribute to achieving the project goals than firms who have less to bring to the table; hence I would expect such firms would on average be a more valuable addition to an alliance than those with fewer resources. Conversely, the exit of a resource-rich member is likely to be particularly detrimental when this member had provided access to a munificent resource base (Singh and Mitchell, 1996).

Second, resources are related to the balance of power and control. Firms that provide scarce resources, or relatively greater access to them, have more power relative to those that depend on those resources (Hart and Saunders, 1997; Thompson, 1967). Balance of power is crucial in alliances (Chung and Beamish, 2010) and a critical factor in how alliance tasks are coordinated (Gulati *et al.*, 2012). Firms are likely to have power in the alliance in line with their contribution of resources to it, and to the extent that the resources are critical, important, or valued by the other member firms (Salancik and Pfeffer, 1974: 455). The exit of a relatively munificent partner firm would hence upset the balance of power and the pattern of coordination more than that of a resource-poor member, diverting more attention from operating to reorganizing (Chung and Beamish, 2010).

These arguments lead me to expect that the relationships between alliance partner reconfiguration and the hazard of project termination developed in Hypotheses 1 and 2 are moderated by the resource base of a firm entering or exiting relative to those available to the alliance as a whole. More specifically, because the exit of a munificent member upsets coordination to a greater degree, and leaves fewer resources at the disposal of alliance for task coordination and task completion than exit of a relatively less munificent member, I expect that the exit of a relatively resource-rich member increases the hazard of unplanned project termination more than that of a relatively resource-poor one. At the same time, because on average a relatively resource-rich member has more to offer toward the continuation and performance of a project than a resource-poor one, I expect that the entry of a relatively more munificent new member increases the hazard of project termination less than the entry of a resource-poor member firm. More formally, I formulate Hypotheses 3 and 4 as follows:

Hypothesis 3: Firm exit from an alliance increases the hazard rate of unplanned project termination more when the departing firm has a munificent resource base than when it has a nonmunificent resource base.

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Hypothesis 4: Firm entry into an alliance increases the hazard rate of unplanned project termination less when the entering firm has a munificent resource base than when it has a nonmunificent resource base.

As I have mentioned, extant literature has suggested that under certain specific conditions, reconfiguration can be a means of adaptation, rather than a source of disruption. In particular, *dynamism in the external environment of the alliance* may mean that rigid alliance structures function less well (Gulati *et al.*, 2012), as it requires flexible reconfiguration instead (Gulati *et al.*, 2012; Zollo and Reuer, 2010). A highly dynamic environment, therefore, may render alliance partner reconfiguration less damaging, or even beneficial.

Environmental dynamism is likely to erode the value of the initial coordination set-up and configuration of firms established at the time of project formation (Bakker and Knoben, 2015). In addition, partners are less able to commit themselves when the future cannot be foreseen (Poppo, Zhou, and Ryu, 2008) and under highly dynamic environmental conditions, routine solutions continuously become impracticable (Wiersema and Bantel, 1993). Hence dynamism may require change on the part of an alliance—bringing new members on board or replacing ones whose contribution has become obsolete (Beckman *et al.*, 2007). As a result, the functionality or dysfunctionality of alliance partner reconfiguration is likely to be contingent on the degree of dynamic change in the task environment in which a project operates (cf. Chandler, Honig, and Wiklund, 2005). Under highly dynamic conditions, adding a member to the project, or dropping one with a skill or resource that is no longer required, may provide an opportunity to adapt, and ascertain "a better and more appropriate fit with the environment" (Wiersema and Bantel, 1993: 490).

This reasoning suggests that the relationship between alliance partner reconfiguration and unplanned project termination proposed in Hypotheses 1 and 2 is likely to be moderated by the level of dynamism in the alliance environment. Higher levels of dynamism may both make reconfiguration more likely and make it relatively less harmful, as despite its potentially disruptive consequences, partner reconfiguration offers an opportunity to adapt to a changing environment. On the basis of these arguments, I offer Hypotheses 5 and 6 as follows:

Hypothesis 5: Firm exit from an alliance increases the hazard rate of unplanned project termination less when environmental dynamism is high than when it is low.

Hypothesis 6: Firm entry into an alliance increases the hazard rate of unplanned project termination less when environmental dynamism is high than when it is low.

METHODS

Research setting

My empirical study is based on an analysis of the Australian mining industry. Australian mining has a colorful history dating back to the 1850s when droves of early settlers "came with only a swag on the shoulder, bought pick and shovel and pan, and borrowing and contriving managed to live and dig" (Blainey, 1964: 23). Much has changed since. Nowadays mining is a global and sophisticated project-based industry with three main activities: the exploration of mineral deposits, the extraction and trade of minerals, and the provision of services to firms engaged in those two activities (Bakker and Shepherd, in press; Connor, 2010). Mining is Australia's primary export sector accounting for seven to eight percent of GDP.

Alliances have been commonplace in offshore oil and gas exploration, petrochemicals, mineral mining, and metals processing for quite some time (Harrigan, 1986; Stuckey, 1983), but recently have been seen to be increasing in frequency even further. One of the mining executives I interviewed told me that in the past firms often undertook projects independently, but that societal concerns about sustainable environmental practices, combined with the increased complexity and cost of mining operations, has changed that and that today "the trend in the industry is clearly toward multiparty joint ventures". Hence the formation of a mineral exploration project now regularly involves an interfirm alliance between mining companies pooling their resources to explore sites where minerals are believed to be present.

Alliances formed in mineral mining tend to have a number of unique features. For one, they are often production-oriented rather than learning-oriented (Greve *et al.*, 2010), involving high stakes and high

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up-front investment. Also, the scale of investment and resource requirement in this setting are typically much higher than in other kinds of settings (Beamish, 1987). In mining, as in other extractive industries, cost reduction is one of the keys to effective competition. This makes obtaining scale economies at large production volumes imperative (Harrigan, 1986). Related to this notion is the importance of financial assets and commodity prices. When it comes to partner selection and contract negotiation, alliance partners typically rely on market prices as a reference point to ensure relationships are economically justified and equitable (Harrigan, 1986). Important decisions are often made inside the alliance or joint venture between the partners (Stuckey, 1983). Strictly arm's length relationships are avoided, or at least kept to a minimum (Stuckey, 1983).

In Australia and elsewhere, mineral mining is highly concentrated around a core of large mining firms (the "majors"), and a periphery of medium- and smaller-sized firms. Some alliances only involve majors, others only smaller prospecting firms, and sometimes they involve a mix of both. The economies of scale and scope and promise of increased profit margins afforded by strategic alliances (Harrigan, 1986) are obviously attractive to small firms, but they can also be attractive to larger firms, even majors (Stuckey, 1983). As production plants are both costly and geographically fixed, alliances and joint ventures allow adding flexible capacity along the value chain and across locations (Stuckey, 1983). The result is the existence of a large international network of plants and miners (Stuckey, 1983).

Data sources

My empirical study is based on an analysis of 1,025 interfirm mineral exploration projects formed over the 2002–2011 period between companies active in the Australian mining industry. The *Register of Australian Mining* was my primary source for annual data on Australian mining companies, their directors, and all of the mineral exploration projects undertaken in Australia (cf. Bakker and Shepherd, in press, who use the same data source, but who study a different topic and sample). The *Register* data on publicly traded companies is gathered from the Australian Stock Exchange (ASX) and the London Stock Exchange (LSE); business media outlets such as Bloomberg, MiningNews.net, Creamer Media, and Mining Weekly; and a wide range of other sources including Sedars, Morningstar, Read Corporate, Marketwire, and MBendi; as well as from government and company websites and the email alerts and annual and quarterly reports of companies. The *Register* is also a source of private company data. Private companies are periodically contacted directly by telephone and email. Moreover, to ensure that information is complete and current, an internet search is conducted every three months to pick up any new private companies (Register of Australian Mining, 2012; personal communication). In digital form, the archive dates back to 2002. To answer our research questions, it was crucial to have access to longitudinal data because alliance partner reconfiguration is a process that occurs over time. To check the reliability of the data, I tracked companies through their ASX listings, then cross-checked using other databases, specifically Sirca and Morningstar.

I collected monthly price data on minerals traded on the open market, e.g., gold, nickel, uranium, copper, coal, and iron ore—records of which are kept by the Bureau of Resources and Energy Economics (BREE). I identified the mineral or minerals explored by a project and used price data to control for changing market conditions (see below).

Finally, to gain a deeper understanding of Australia's mining industry, I visited mines, interviewed senior executives, and spoke to consultants in the industry. The better understanding of the Australian mining industry I gained helped me to interpret my results.

Sample and measures

The *Register* reports on all mineral exploration projects in Australia on an annual basis. For every year a project is active, the *Register* contains detailed entries on the firms that have an ownership stake in the project. The *Register* contains complete data on 3,269 unique mineral exploration projects started in Australia from 2002 through 2011 (cf. Bakker and Shepherd, in press). Among these newly started mining projects, 1,080 were founded by an alliance of firms rather than an individual firm. Of these, 1,025 existed longer than 12 months, a prerequisite for capturing alliance partner reconfiguration through annual repeated measurements (cf. Chung and Beamish, 2010).

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Hence the final sample consists of 1,025 mineral exploration projects formed in the Australian mining industry between 2002 and 2011 that involve an interfirm alliance. In total, these 1,025 projects represent 3,181 project-year observations.

Dependent variable

Unplanned project termination is an event coded 1 when a given joint exploration project present at time t no longer existed at time $t+1$, and coded 0 otherwise. Recall that I distinguish between firm exit, i.e. the departure of a member firm from the partnership, and the termination of the venture as a whole. I hence recorded the occurrence and timing of an event when an interfirm project was terminated. Of the 1,025 interfirm mineral exploration projects in the sample, 379 experienced such an event during the nine-year period of observation.

It is crucial in alliance research to make a distinction between planned termination and unplanned termination (Bakker and Knoben, 2015; Polidoro *et al.*, 2011). How did I determine that a termination was "unplanned"? I looked at the exploration status of each project. Exploratory mining projects are money pits. They are recorded as "exploratory" in the data as long as they are sites where collaborating companies are undertaking exploratory drilling and feasibility studies (Register of Australian Mining, 2012). They are listed as "mines" when they become operational, meaning that operations to extract resources for profit are underway. Not all exploratory projects become operational mines, although all have that goal. I only coded as an unplanned project termination event, a mineral exploration project that was terminated during the exploration phase; i.e. a venture that was terminated before reaching the planned goal of becoming operational and turning a profit. The exploration phase can be lengthy and already requires substantial investment, but it is important to make clear that it is not necessarily "bad" to terminate a project prior to obtaining the planned goal. In fact, in some instances it can be in the best interest of the project, and of individual members, to terminate sooner rather than later (McGrath, 1999). What can be said with some degree of confidence though, is that project termination prior to exploitation is contrary to what alliance members intended when they started out—hence the termination was "unplanned".

Alliance partner reconfiguration

To capture the various aspects of alliance partner reconfiguration, we drew upon an approach taken in other related research (e.g. Chung and Beamish, 2010) that uses annual observations of the alliance of firms involved with each project in each year to develop patterns of alliance change. I hand-coded all 3,181 project-year observations. I also built detailed profiles on all the companies involved in each project on the basis of their entries in ASX and the *Register,* in order to record and then correct for name changes, takeovers, subsidiaries, and mergers. This was done to avoid mistaking a company name change for a partner reconfiguration event. All explanatory variables are time-varying covariates that were lagged one year.

Firm exit

Firm exit captures for each time t any decrease in the number of firms with an ownership stake in the project compared to time $t-1$. For example, suppose project X is formed in 2003 between three companies A, B, and C. If in 2004 A, B, and C are again listed, there was no decrease in the interfirm alliance in the second year compared to the previous one, hence a score of 0. If in 2005 only A and B are still affiliated with the project, it would mean a score of 1 for 2005 to capture the exit of firm C from the partnership.

Firm entry

Firm entry captures for each time t the increase in the number of firms with an ownership stake in the project compared to time $t-1$. If project Y is formed in 2003 by an alliance between companies A, B, and C and in 2004 membership is A, B, C, and D, this is an increase of 1 compared to 2003 reflecting the entry of firm D into the partnership.

Exit—munificent firm

Mining is an extremely capital-intensive industry. It is not uncommon for the cost of exploratory drilling to run into the tens of millions of dollars (Hartman and Mutmansky, 2002). My interviews indicate that mining executives generally consider raising financial capital to be the most critical bottleneck. Hence one of the most important resources a partner can contribute to a mineral exploration project

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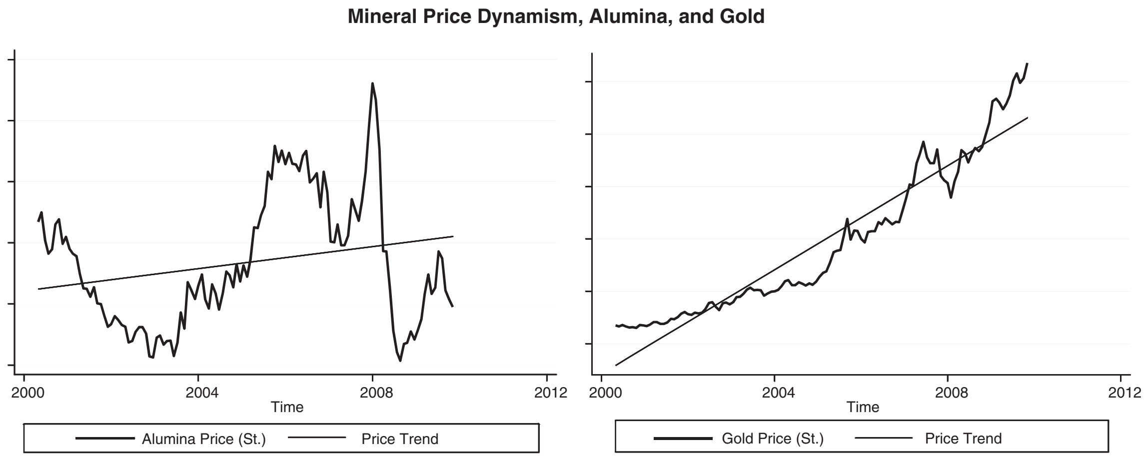

Figure 1. Mineral price dynamism, (a) alumina and (b) gold

is financial capital; it is considered as being most important and valued by the other firms (see Salancik and Pfeffer, 1974). For this reason, I focused on the financial resource base that each firm can bring to the table, relative to that of the other collaborating firms. Rather than relying on an absolute measure of size, which can vary widely between mining firms, I computed a relative measure specific to each alliance: I consider a firm to be "munificent" when it holds more financial assets than the mean of the financial assets of the other collaborating firms combined.[1] The variable Exit—Munificent Firm is a dummy variable that is coded as 1 for exit by a munificent firm, coded as 0 for exit by a nonmunificent firm, and coded as missing otherwise.

Entry—munificent firm

Similar to above, entry by a munificent firm occurs when an entering firm holds more financial assets than the mean of the financial assets of the other partnering firms. The variable Entry—Munificent Firm is a dummy variable coded as 1 for entry by a munificent firm, coded as 0 for entry by a nonmunificent firm, and coded as missing otherwise.

Environmental dynamism

One of the most important factors in the environment of mining firms is the mineral price. For example, when the goal of an exploration project is to extract gold, the gold price is an important and direct indicator of the market for its product. I hence used mineral price data to construct a measure of environmental dynamism. Environmental dynamism is a time-varying covariate that captures price trend variability over the preceding 12 months for each mineral explored by the focal project. Following Dess and Beard (1984) and Boyd (1990) I regressed the monthly price of different minerals against time and took a moving average of the standard error of the coefficient (beta). I took the mean dynamism score for alliances involved in mining more than one mineral.

Figure 1 provides an illustration on the basis of the alumina and the gold price over the years 2001–2010 (i.e., the period of observation for the projects in the sample, one year lagged). It shows how, over time, the alumina price diverges much more from the trend line than the gold price; hence the level of dynamism of the alumina market (0.378) is much higher than that of gold (0.028) over this period.

Control variables

Alliance size

The greater the number of collaborators, the greater the opportunities for change (Chandler *et al.*, 2005). At the same time, partnerships with more collaborators may be more robust against reconfiguration. I controlled for these effects by taking the average number of alliance partners over the life of the project.

[1] I ran additional analyses classifying a firm as munificent when it holds more financial assets than respectively 75, 60, or 40 percent of the financial assets of the other collaborating firms combined and found that all results are robust.

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Alliance importance

Reuer *et al.* (2002) found that partnerships that are more salient for the partners involved are relatively more apt to undergo post-formation governance changes. To control for the alliance importance factor, I measured the sum of the total number of projects held by each collaborating firm and then reversed the resulting measure. The intuition behind this is that firms that are involved in relatively more projects need to spread their attention (Ocasio, 1997) to a greater extent than those firms that have only one. That is, an alliance that is part of a larger alliance portfolio is on average likely to be less salient to the firm than an alliance that represents a firm's sole project.

Project scope

I controlled for project scope because there is likely to be a relationship between the scope of a project and resource needs. Project scope takes a value of 0 when a project is formed to mine one mineral only (e.g. gold) and a value of 1 in the case of two or more (e.g., gold and silver).

Partner asymmetry

As I mentioned, alliances in mineral exploration sometimes involve collaborations between smaller firms and majors. Prior work has linked such partner asymmetry to the ongoing performance and survival of strategic alliances (e.g., Arend and Seale, 2005). To control for this factor, I captured the absolute size difference between the collaborating firms in terms of their financial assets in AUD millions. I then took the log of this variable to account for skewness.

Prior ties

A shared history of collaboration between partner firms is likely to influence project termination (e.g., Greve *et al.*, 2010). This variable captures whether collaborators have previously been in alliances together, coded as 1 if they did and 0 if not.

Competitive overlap

The degree of competitive overlap between alliance partners is an important factor impacting the rate of termination (Baker, Faulkner, and Fisher, 1998; Rogan, 2014). I based this measure on the number of markets in which the partnering firms compete. Specifically, I captured the number of overlapping mineral markets that the alliance partners are active in based on their entire portfolio in a given year, and divided this number by the sum of the total number of mineral markets in which they are active. Hence higher scores represent relatively more competitive overlap.

Financial capital

To ensure I captured the net effect of entry and exit by relatively more or less munificent member firms, I controlled for the financial assets (minus liabilities) available to the project (in AUD millions). This measure is similar to George's (2005) measure of high discretionary slack. I obtained the financial assets of the project by summing the financial assets across all partnering firms. I log-transformed the resultant measure to account for skewness.

Company age

Learning tends to crowd out exploration (Levinthal and March, 1993). As a result, as firms get older they typically explore less (Katila and Chen, 2008). Company age captures the mean age of the collaborating firms involved.

Portfolio orientation

It is important to consider the orientation of the portfolio of each partner firm, as it reflects the skills and tasks of which the firm is capable (Bakker and Shepherd, in press). Portfolio orientation captures the ratio of the total number of projects in the exploration stage to the total number of projects in each of the partner firms' portfolios, and then takes the mean of the exploration-to-all projects ratios across all partner firms.

Board's competence breadth

Diversity along skill and competence-based dimensions among the partner firms' board of directors is a relevant predictor of organizational actions and outcomes (e.g., Golden and Zajac, 2001) and could influence project success (e.g,. Milliken and Martins, 1996). One reason for this importance of this factor is that diversity in the skills and competencies of board members can lead to a greater variety of perspectives being brought to bear on

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decision-making, which increases the likelihood of creative solutions to problems (Milliken and Martins, 1996). Following the suggestions offered by Forbes and Milliken (1999), I computed a composite score of the presence of knowledge in particular skill domains, by summing the number of unique competencies (e.g., experience in geology, business, or human resources) among the individuals on the boards of the collaborating firms involved.

Market trajectory

Market trajectory captures the mineral price trend—up or down—over the preceding 12 months for each mineral of each project. Following Dess and Beard (1984) and Boyd (1990), I divided the coefficient (beta) of a regression of the price of the mineral against time by its mean over the same time period. Hence, the resulting market trajectory score for each project is a time-varying covariate based on a moving window of the mineral price for the 12-month period. Again, I took the mean trajectory score for projects involving more than one mineral. Figure 1 shows how both alumina and gold have a positive market trajectory (i.e., an upward incline in the fitted curve), but the market trajectory for gold is much steeper. Hence the market trajectory score for projects exploring for alumina is lower than that for gold (0.237 versus 0.955).

Interest rate

I control for the interest rate to reduce the risk that macro-economic conditions rather than mineral-specific dynamism drive the results. I used the official "cash rate" set by the Reserve Bank of Australia over the period 2001–2011, lagged by one year.

Year dummies

Previous research (Dussauge, Garrette, and Mitchell, 2000; Lunnan and Haugland, 2008) has linked age and cohort effects to the hazard of alliance termination. To control for such effects, I included dummy variables corresponding to the year of establishment of each project.

Analyses

I used an event history approach to test the hypotheses (Allison, 1984). In event history analysis the dependent variable is the duration that cases spend in a state before experiencing an event (Box-Steffensmeier and Jones, 2004). Mineral exploration projects enter the risk set when started. During their lifetime, they continue to be at risk of termination. As I track cohorts of newly established interfirm projects, there is no left-censoring in the data. Projects that do not experience termination during the observation period are right-censored. This is a data feature that event history can efficiently handle (Allison, 1984).

Since my theoretical framework makes no assumptions about the distribution of the baseline hazard, I used a Cox proportional hazards model to test the hypotheses. I tested the proportional hazards assumption using the stphtest command in Stata13 and found it was not violated.

Estimates from the Cox proportional hazards model give information on the hazard rate. *Positive* coefficients imply a *shorter survival time;* that is, they show a decrease in the time it takes for an event to occur (Box-Steffensmeier and Jones, 2004). Hence positive coefficients indicate that the hazard rate of a particular project experiencing termination is increasing with changes in the covariate (Box-Steffensmeier and Jones, 2004). Negative coefficients indicate the hazard rate of an event is decreasing with changes in the covariate. All the covariates are time-varying, lagged by one year. I estimated robust standard errors through the Lin and Wei method, which I clustered by mineral identifier (e.g., gold, silver, copper), to account for the lack of independence between ventures concerned with mining the same mineral.

RESULTS

Descriptive statistics

Table 1 reports descriptive statistics and pairwise correlations between the explanatory variables. The correlations I find are generally low to moderate, with the obvious exception of the correlation between Member Entry and Entry—Munificent Firm, and that between Member Exit and Exit—Munificent Firm. I did not simultaneously include these variables in any of the regression models.

The average duration of the interfirm projects in the sample was 3.87 years. Alliance partner reconfiguration appeared to occur relatively frequently

Table 1. Descriptive statistics and pairwise correlations[a,b]

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Firm exit	0.12	0.37	–																
2. Firm entry	0.19	0.48	−0.12	–															
3. Exit—munificent firm	0.06	0.24	0.74	−0.09	–														
4. Entry—munificent firm	0.09	0.29	−0.10	0.69	−0.08	–													
5. Environmental dynamism	−0.06	1.46	0.00	−0.02	0.00	−0.03	–												
6. Alliance size[c]	1.77	0.49	−0.02	0.08	−0.03	0.05	−0.04	–											
7. Alliance importance[c]	6.02	0.61	0.04	−0.13	0.03	−0.02	−0.01	0.05	–										
8. Project scope	0.10	0.30	−0.01	−0.01	−0.01	0.00	−0.08	0.00	−0.02	–									
9. Partner asymmetry[c]	2.18	2.63	−0.16	0.14	−0.13	0.11	−0.08	0.39	−0.01	0.01	–								
10. Prior ties	0.16	0.36	−0.12	0.02	−0.10	−0.01	−0.05	0.18	0.00	0.00	0.24	–							
11. Competitive overlap	0.20	0.18	−0.22	0.09	−0.18	0.11	−0.05	0.29	0.06	−0.01	0.45	0.28	–						
12. Financial capital[c]	5.06	0.95	−0.02	−0.05	0.00	−0.03	−0.14	0.15	0.02	−0.06	0.49	0.07	0.10	–					
13. Company age	6.79	7.76	0.04	−0.07	−0.02	−0.06	0.02	0.10	0.01	0.01	0.18	0.05	0.10	0.18	–				
14. Portfolio orientation	0.83	0.21	0.02	0.02	0.04	0.01	0.00	−0.03	0.30	0.02	−0.11	−0.03	−0.12	−0.12	−0.15	–			
15. Board's competence Breadth	0.32	0.37	−0.05	0.17	−0.02	0.13	0.00	0.18	0.11	0.00	0.07	−0.08	0.05	−0.05	−0.03	0.39	–		
16. Market trajectory	1.47	3.91	−0.06	−0.04	−0.04	−0.02	0.16	−0.01	0.00	−0.04	−0.01	−0.04	−0.05	−0.02	0.00	0.02	0.03	–	
17. Interest rate	5.03	1.06	−0.11	−0.03	−0.06	0.00	0.03	0.02	0.09	−0.02	−0.07	−0.08	−0.09	−0.07	−0.02	0.02	0.04	0.43	–

[a] N = 1,025 interfirm mineral exploration projects over the period 2002–2011 (3,181 project-year obs.). Correlations greater than |0.03| are significant at $p < 0.05$.
[b] Excludes year dummies.
[c] Log-transformed.

among the partnerships formed in mineral exploration, with firm entry more common (a mean of 0.19), than firm exit (0.12). While technically entry and exit are count variables, 98.8 percent of values were 0 or 1, thus despite the fact that over their lifetime alliances regularly did see change, more than one change in a given year was extremely rare.

Hypothesis tests and effect size analyses

Table 2 reports on a Cox proportional hazards model of unplanned project termination in which the estimates are nonexponentiated regression coefficients. Model 1 shows the effects of control variables only. I used Models 2–7, in which I add one predictor at a time, to test the set of hypotheses. Effect sizes are calculated as:

$$\%\Delta h(t) = \left[\frac{e^{\beta(x_i=X_1)} - e^{\beta(x_i=X_2)}}{e^{\beta(x_i=X_2)}}\right] * 100,$$

which is the percentage change in the hazard rate of termination as a function of increases or decreases in distinct values (X_1 and X_2) for a given covariate x_i on the basis of its Beta coefficient (Box-Steffensmeier and Jones, 2004: 60).

Hypothesis 1 proposed that firm exit from an alliance increases the hazard rate of unplanned project termination. Model 2 enters the effect of Firm exit, reporting a statistically significant coefficient of 0.16 ($p < 0.05$) for its effect on the hazard of project termination. Analysis of the effect size indicates that exit by one member firm increases the hazard rate of termination by 17.3 percent. This finding provides support for the claim that firm exit increases the hazard of unplanned project termination. Thus Hypothesis 1 is supported.

Hypothesis 2 stated that firm entry into an alliance increases the hazard rate of unplanned project termination, but the effect is smaller than that of firm exit. Model 3 shows that Firm entry has a positive and statistically significant coefficient of 0.14 ($p < 0.01$), thus the first part of Hypothesis 2 is supported. Regarding the second part of Hypothesis 2, I find that the effect size of the coefficient for Firm entry indicates that entry by one additional member firm increases the hazard rate of project termination by 15.0 percent, which is indeed smaller than in the case of Firm exit—although the absolute difference is relatively small.

According to Hypothesis 3, firm exit from an alliance increases the hazard rate of unplanned project termination more when the departing firm has a munificent resource base than when it has a nonmunificent resource base. The coefficient for Exit—munificent firm in Model 4 is positive and statistically significant ($p < 0.05$), and at 0.35 indicates that exit by a munificent firm has a greater impact on the hazard of project termination. The size of the effect is such that exit by a munificent firm increases the hazard of project termination by 41.9 percent. These findings support Hypothesis 3.

Hypothesis 4 stated that firm entry into an alliance increases the hazard of unplanned project termination less when the entering firm has a munificent resource base than when it has a nonmunificent resource base. Model 5 shows that the coefficient of Entry—munificent firm is 0.17, which is statistically nonsignificant. Furthermore, its sign is in the opposite direction than hypothesized, hence provides no support for Hypothesis 4.

I evaluated the moderation effects of environmental dynamism (Hypotheses 5 and 6) through partial Models 6 and 7. I stated in Hypothesis 5 that firm exit from an alliance increases the hazard rate of unplanned project termination less when environmental dynamism is high than when it is low. Model 6 reports a coefficient of 0.03 for the Exit × dynamism interaction, which is small and not statistically significant, providing no support for Hypothesis 5. Hypothesis 6 stated that firm entry into an alliance increases the hazard rate of unplanned project termination less when environmental dynamism is high than when it is low. The coefficient of the Entry × dynamism interaction is small and not statistically significant (−0.01), providing no support for Hypothesis 6. Hence, to my surprise, I find no support for the contingent effect of dynamism on the reconfiguration—project termination relationship. I discuss the implications of these findings in the final sections of the paper.

ADDRESSING ENDOGENEITY AND POSSIBLE ALTERNATIVE MECHANISMS

I performed additional analyses to test the robustness of my findings. First, I performed a Heckman correction to assess whether endogeneity influenced the effects of alliance partner reconfiguration on unplanned termination, using the two-step procedure suggested by Shaver (1998) and Hamilton and Nickerson (2003). Specifically, I first ran two

Table 2. Cox proportional hazards model of unplanned project termination[a,b]

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Firm exit		**0.16* (0.08)**				**0.17* (0.08)**	
Firm entry			**0.14** (0.05)**				**0.14** (0.05)**
Exit—munificent firm				**0.35* (0.15)**			
Entry—munificent firm					0.17(0.27)		
Exit × dynamism						0.03 (0.05)	
Entry × dynamism							−0.01 (0.03)
Environmental dynamism	−0.06*** (0.01)	−0.06*** (0.01)	−0.06*** (0.01)	−0.05*** (0.01)	−0.08* (0.04)	−0.06*** (0.01)	−0.05*** (0.01)
Alliance size[c]	0.50*** (0.07)	0.48*** (0.07)	0.49*** (0.08)	0.48*** (0.07)	0.29 † (0.15)	0.48*** (0.07)	0.48*** (0.08)
Alliance importance[c]	−0.10 † (0.06)	−0.10 † (0.06)	−0.08 † (0.06)	−0.10 † (0.06)	−0.15 (0.12)	−0.10 † (0.06)	−0.08 (0.06)
Project scope	−0.23 (0.18)	−0.22 (0.18)	−0.21 (0.17)	−0.21 (0.18)	−0.10 (0.16)	−0.21 (0.18)	−0.21 (0.17)
Partner asymmetry[c]	−0.01 (0.02)	−0.00 (0.02)	−0.01 (0.02)	0.00 (0.02)	−0.05 (0.03)	0.00 (0.02)	−0.01 (0.02)
Prior ties	0.23 (0.17)	0.25 (0.17)	0.24 (0.16)	0.25 (0.17)	−0.17 (0.27)	0.25 (0.17)	0.24 (0.16)
Competitive overlap	0.07 (0.21)	0.17 (0.25)	0.10 (0.22)	0.18 (0.24)	0.11 (0.45)	0.18 (0.25)	0.10 (0.22)
Financial capital[c]	0.04 (0.05)	0.04 (0.05)	0.05 (0.05)	0.04 (0.05)	0.07 (0.18)	0.03 (0.05)	0.06 (0.06)
Company age	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.02* (0.01)	−0.01 (0.01)	−0.01 (0.01)
Portfolio orientation	0.02 (0.24)	0.00 (0.24)	0.02 (0.24)	0.01 (0.24)	0.72 (0.65)	0.00 (0.24)	0.02 (0.24)
Board's competence breadth	−0.44*** (0.11)	−0.42*** (0.11)	−0.48*** (0.09)	−0.42*** (0.11)	−0.48*** (0.11)	−0.42*** (0.11)	−0.48*** (0.09)
Market trajectory	0.04 † (0.02)	0.04 † (0.02)	0.04 † (0.02)	0.04 † (0.02)	0.03 (0.03)	0.04 † (0.02)	0.04 † (0.02)
Interest rate	−0.34*** (0.03)	−0.35*** (0.03)	−0.34*** (0.03)	−0.34*** (0.03)	−0.45*** (0.07)	−0.34*** (0.03)	−0.35*** (0.03)
2003	0.66** (0.21)	0.70** (0.22)	0.64** (0.22)	0.70** (0.21)	0.96 † (0.56)	0.70** (0.22)	0.65** (0.22)
2004	0.41* (0.20)	0.44* (0.20)	0.39 † (0.21)	0.45* (0.19)	0.14 (0.34)	0.44* (0.20)	0.39 † (0.21)
2005	0.21 (0.19)	0.25 (0.18)	0.18 (0.19)	0.26 (0.18)	0.32 (0.42)	0.24 (0.18)	0.19 (0.20)
2006	0.36 (0.27)	0.38 (0.26)	0.33 (0.27)	0.38 (0.26)	0.37 (0.74)	0.37 (0.26)	0.34 (0.28)
2007	0.33* (0.13)	0.35** (0.13)	0.29* (0.13)	0.36** (0.13)	0.34 (0.35)	0.34** (0.13)	0.29* (0.14)
2008	0.08 (0.21)	0.09 (0.21)	0.08 (0.22)	0.11 (0.20)	0.10 (0.45)	0.08 (0.21)	0.08 (0.22)
Log pseudolikelihood	−2,289.0	−2,288.1	−2,287.7	−2,287.1	−2,288.2	−2,288.0	−2,287.6

[a] N = 1,025 interfirm mineral exploration projects formed over the period 2002–2011 (3,181 project-year obs.). N = 379 projects experience termination event.
[b] Estimates are regression coefficients (not hazard ratios); robust standard errors (clustered by mineral) in parentheses.
[c] Log-transformed.
†$p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

regressions in which partner reconfiguration (firm exit and firm entry, respectively) is the dependent variable (the selection model) and obtained the inverse Mills ratio from those equations; then I added these to a probit regression of unplanned project termination (the outcome model). In the outcome model I excluded two instrumental variables that were found to be unrelated to project termination and that were used to calculate the inverse Mill's ratio (Bascle, 2008; Shaver, 1998); namely Financial Capital and Project Scope. I found that the results for the effect of firm exit and firm entry on project termination are robust.[2]

Second, because strategic alliances span firm boundaries and often lack a higher authority to ensure compliance, they are fertile ground for *opportunistic behavior* by partners (Das, 2006; Gulati, 1995; Parkhe, 1993). The possibility, or actual occurrence, of opportunistic behavior can trigger membership changes and also project termination and hence can be an alternative explanation for my findings. *Prior ties* among alliance partners (i.e. this having collaborated before) can engender trust (Gulati, 1995), which can lower the expected hazard of opportunism (Das, 2006). It flows from this argument that if problems with the level of cooperation in the alliance explain the findings, the effect of partner reconfiguration on termination should be different for alliances between partners with prior ties and for those without (likely representing higher and lower risks of opportunism, respectively). In addition, as Oxley (1997) has suggested, the larger the number of partners in an alliance, the higher the costs of *monitoring* both the contributions of other partners and the performance of the project as a whole. Consequently, if difficulty monitoring ongoing project performance explains the findings, the effect of partner reconfiguration on unplanned project termination should be different for smaller versus larger alliances. I ran additional analyses to test for these possible alternative explanations but found no evidence to support either.[3]

A third robustness test pertains to measurement. Alliance partner reconfiguration occurs in continuous time. I modelled this using a Cox proportional hazards model. However, I technically measured changes in alliance membership annually, which amounts to a discrete measurement of the change process. Hence, I checked the robustness of the findings with a discrete Logit model. The results, which are not reported due to space constraints, were basically unchanged. Given that the Cox model is more flexible and very robust (Allison, 1984), I report the Cox model in the main analysis.

Fourth, I performed a robustness test on the data using additional information on a small number of mineral exploration projects that were not terminated, but rather became mines during the period of observation (cf. Bakker and Shepherd, in press). Specifically, I reran the analyses specifying these cases as experiencing a competing event, rather than as being censored. Perhaps not surprisingly given the small number of cases, the results did not change.

Finally, I checked different time lags for the dynamism measures. In the main analysis I used a one-year time lag. A longer time lag might provide projects with more time to respond to a changing environment. I experimented with longer time lags but still found no support for a moderation effect.

DISCUSSION

Recent research suggests that the need for flexibility sometimes prevails over long-term commitments (Bakker and Knoben, 2015). In accordance with this view, I found in this study of mineral exploration projects that mining firms over time "step in" and "step out" of interfirm alliances. Such movement out of old alliances and into new ones, "can be seen as steps in a firm's alliance career, just as job moves are seen as steps in the careers of individual workers" (Greve *et al.*, 2013: 93). In this paper, I have sought to show the relevance of studying and understanding the consequences of post-formation partner reconfiguration.

In my study of mineral exploration alliances, partner reconfiguration appears to be a common element of alliance evolution. This study shows why that is of considerable importance: partner reconfiguration influences project survival. Prior studies have shown that project failure is prevalent (e.g. Shepherd, Patzelt, and Wolfe, 2011) and that alliance dissolution rates range from 50 to 80 percent depending on the industry (Bleeke and Ernst, 1991; Kale and Singh, 2009). In addition, an understanding of alliance partner reconfiguration is

[2] The detailed results of this analysis are available from the author upon request.

[3] The detailed results of this analysis are available from the author upon request.

important to develop realistic models of network dynamics (Greve *et al.*, 2010; Kogut, 1989; Rowley *et al.*, 2005). I explored two alternative theoretical perspectives on partner reconfiguration, one revolving around disruption, the other around adaptation, and assessed each's predictions in the context of mineral exploration projects in the Australian mining industry.

I found that alliance partner reconfiguration of a mining project on average increases the hazard of unplanned project termination. My findings imply that partner reconfiguration disrupts alliance coordination (Gulati *et al.*, 2012), diverts attention (Chung and Beamish, 2010), and hence increases the relative risk of mining project termination. In line with my expectations, I found support for the proposition that firm exit is even more deleterious than firm entry, because exits typically are unilateral decisions whereas entries need to be endorsed by an alliance as a whole. One area where these findings contribute is to the literature on strategic alliance dynamics (e.g., Ariňo and De la Torre, 1998; Das and Teng, 2002; Doz, 1996; Khanna *et al.*, 1998; Levinthal and Fichman, 1988; Reuer and Ariño, 2002; Reuer *et al.*, 2002; Ring and Van de Ven, 1994), which has not previously considered the consequences of partner reconfiguration. Extending our understanding of how alliances shape outcomes (Lunnan and Haugland, 2008; Rogan, 2014; Rowley *et al.*, 2005), I showed that alliance performance research that only considers the initial composition of strategic alliances and ignores membership change runs the risk of misattributing termination effects.

While the basic number of entries and exits is an important factor, I found that more precise insights could be gained by taking into account the resources held by an entering or exiting mining firm. I found that exit by a relatively more munificent mining firm increases the hazard of unplanned project termination to a greater extent. Yet, while I found alliance partner reconfiguration in the context of mineral exploration projects to be quite prevalent, I found no support for an adaptive effect of alliance partner reconfiguration through the moderation analysis with environmental dynamism. Hence my overall pattern of findings supports a disruptive rather than an adaptive perspective on alliance partner reconfiguration.

This leads to the puzzle I foreshadowed in earlier sections of this paper: *If alliance partner reconfiguration is indeed mostly disruptive, then why do I observe it occurring so frequently?* Let me first acknowledge that despite the initial set of findings reported here, there might be situations in which alliance partner reconfiguration *is* beneficial. I looked at the very specific context of mineral mining. Without empirical data, there is no way of knowing a priori whether these findings hold for other types of settings, particularly the more learning-oriented or R&D alliances found in, for example, biotech (Baum *et al.*, 2000) and pharmaceuticals (Hoang and Rothaermel, 2005). Also, I focused on mineral market dynamism, a type of "general performance cue" (Zhelyazkov, 2012). Beckman, Haunschild, and Phillips (2004), suggested that market cues (market uncertainties) should be distinguished from firm-specific uncertainties. In the context of strategic alliances, Zhelyazkov (2012) refers to the latter as collaboration-specific performance cues. Where general performance cues impact all firms in a market (Beckman *et al.*, 2004), collaboration-specific performance cues could potentially make for a stronger trigger of alliance reconfiguration than general performance cues, and partner reconfiguration would perhaps also be more effective when undertaken in response to collaboration-specific performance cues. In other words, while I did not find support for the claim that alliance partner reconfiguration would be less detrimental, or even beneficial, for project survival in a dynamic market, this does not mean that partner reconfiguration could never be beneficial for project survival per se. In fact, I would very much like to see future research identify situations in which alliance partner reconfiguration is beneficial. Building on this initial framework by including alliance-specific performance cues would be one promising way to of doing so.

A second explanation for the above puzzle pertains to the more general issue of levels of analysis. Many alliance changes may be brought about by firms instrumentally acting in their own best interest rather than in the best interest of the alliance as a whole (Greve *et al.*, 2013; Khanna *et al.*, 1998). Hence while partner reconfiguration may not necessarily benefit an alliance as a whole, it may benefit an individual firm; and since firms are generally in control of their own actions, they may choose to trigger an alliance reconfiguration when it is in their own best interest even if it imperils the alliance. Especially for firm exit, a purely unilateral decision, this explanation makes sense. The other alliance partners may simply have no choice but to let a firm leave. This is why, in contrast with many previous studies that have used relationship survival as a measure of success (e.g., Barkema *et al.*, 1997; Harrigan, 1986), I deliberately distinguished between the departure of a firm from an alliance and the termination of a project as a whole.

A third possibility is that in some cases, especially those in which both alliance performance and firm performance suffer in the long run due to alliance partner reconfiguration, firms do not behave fully rationally. In fact, this explanation is not without precedent in the alliance literature. Chung and Beamish (2010) observed a high occurrence of ownership changes in international joint ventures despite their having negative long-term consequences; even if they were undertaken in response to poor performance, the change process itself was so disruptive that it offset any benefits. This is an interesting point, given that I found that new partner entry, which is typically a multilateral decision, also increases the hazard of project termination. Most previous work on alliance dynamics has emphasized the positive impact of changes in alliances. The more negative implications offered in this paper and in the work of Chung and Beamish (2010) offers a counterbalance to this. My findings are also significant because their flip side suggest that maintaining the stability of an alliance, and the relational capital that can be accumulated by doing so (Kale, Singh, and Perlmutter, 2000) are extremely valuable (Dyer and Singh, 1998).

Let us now turn to the implications of the other findings. One interesting finding that was contrary to my expectations is the lack of support for a moderating effect of the resource base of an entering firm. I took this unexpected finding to industry experts to try to make sense of it. One mining executive I talked to spoke at length about the importance of balance for mineral exploration ventures. Recalling an anecdote from his days as a portfolio manager for a major Australian mining firm, he said, "balance is crucial. When they [a very large mining firm] entered the alliance, the balance of power was disrupted, and it led to a collapse. When the balance of power, the balance of control, when that's disrupted, it's a recipe for disaster." This and a number of the other things my informants shared when I revisited them led me to rethink the importance of the balance of power and how it relates to entry and exit differently in the context of the high-stakes, high-investment alliances formed in mineral mining. Specifically, I interpret the nonstatistically significant coefficient for the effect of entry by a munificent firm, the sign of which was positive (i.e., hinting in the direction that entry by a munificent firm increases the risk of unplanned termination more), as indicating that entry by a munificent new member may disrupt the power balance of the alliance to such a degree that it offsets the beneficial effect of contributing more resources. When a firm joins an alliance it disrupts the group process and it may distract alliance members from their core duties while the newcomer is being socialized (Beckman *et al.*, 2007; Ring and Van de Ven, 1994). If the entrant is comparatively large, it may upset the group process more than in the case of a smaller firm, which would serve to offset the potential benefits of such a new partner (cf. Beckman *et al.*, 2007). This would explain why I do not find the expected result for firm entry, but indeed for firm exit. I must note that this finding, to a degree, may be specific to my sample of high-investment production-oriented alliances, as the scale of investment and resource requirement is typically much higher in this setting than in other kinds of settings (Beamish, 1994), while at the same time these alliances often involve a mix of smaller and larger firms.

Finally, the overall pattern of findings presented here tie into a nascent debate in the strategic alliance literature (Greve *et al.*, 2010; Zhelyazkov, 2012), between economic/instrumental perspectives on alliance dynamics—in which the decision to continue investing toward an uncertain outcome versus exercising the exit option is treated as a strategic decision (e.g., Greve *et al.*, 2013)—and more sociological approaches that emphasise embeddedness and the constraints it imposes on alliance withdrawals (e.g., Uzzi, 1999). Some (e.g., Greve *et al.*, 2013) have claimed that prior work has disproportionally stressed the latter perspective, leading to an over-socialized view of strategic alliances that stresses the inertia that results from alliance network embeddedness. This view has discouraged research into post-formation changes in alliances (Greve *et al.*, 2010, 2013; Reuer *et al.*, 2002; Rogan, 2014). This is an important limitation because, unless we assume that alliance dynamics occur randomly (Bakker and Knoben, 2015; Rogan, 2014), theories of network evolution should take into account alliance formations, dissolutions, and structural changes in order to provide realistic representations (Greve *et al.*, 2013). I have attempted to contribute to this stream of research by opening up the black box of alliance partner reconfiguration and its potential consequences.

Limitations and an agenda for future research on strategic alliance reconfiguration

This study has a number of limitations. An obvious one is that I studied only one industry, which suggests caution in making generalizations. As I mentioned, alliances formed in the context of mineral exploration projects are production-oriented (i.e., they are joint projects formed to share risk and achieve economies of scale and scope) and the scale of investment and resource requirement in this setting is typically much higher than in other kinds of settings (Beamish, 1994). In other industries, for example biotech (Baum *et al.*, 2000) and pharmaceuticals (Hoang and Rothaermel, 2005), projects may be more learning-oriented (Greve *et al.*, 2010), more iterative, and more short-lived (Bakker *et al.*, 2013). While I see no direct reason why the findings of this study would not hold in such settings, there is no way of knowing a priori whether alliance partner reconfiguration is as frequent, or as relevant, in other industries as they are in mineral exploration.

I stated earlier that unplanned project termination is not a bad thing per se. In fact, it may be in the best interest of all partners involved if a poorly functioning project is terminated sooner rather than later (McGrath, 1999). A limitation of my research is that I did not consider the performance implications of project termination for the partner firms involved. Hence a useful extension of this work would be to consider the performance implications of a member withdrawing from an alliance, or entering one, not only for the alliance as a whole, but also for both the partner entering or exiting and for the partner or partners remaining—and to ascertain if these differ. Studying partner-level performance effects would be a worthwhile extension of this work, in particular because it could factor in the important distinction between private benefits (that is, those that only benefit a specific member) and common benefits, those that benefit the alliance as a whole (Khanna *et al.*, 1998).

A third limitation is that I assumed a fairly simple set of reconfiguration patterns for each alliance. While the approach to record membership changes annually is a clear step forward from cross-sectional work that has focused solely on initial configurations, a more refined way of tracking alliance partner reconfiguration would be to do so with a smaller interval between observations, perhaps quarterly or even monthly, better still in real time. This could potentially uncover more complex patterns of partner reconfiguration and allow for studying their particular temporal sequences. Doing so could also open the door to using GARCH models (e.g., Folta and O'Brien, 2004; O'Brien and Folta, 2009; O'Brien, Folta, and Johnson, 2003) to capture environmental uncertainty, and I would stimulate future research to do so.

Fourth, while I have started to explore the role played by the resources of entering and exiting firms compared to those of the alliance as a whole, I only looked at financial resources. This, in my view, was warranted given the crucial role of financial resources in mineral exploration. Future research, however, would do well to consider also other resources such as human or social capital.

Finally, I have focused on the consequences of alliance partner reconfiguration, not its antecedents, nor its potential role as a moderator. In one of the secondary analyses performed in the context of this paper, I found interesting mirror effects of partner asymmetry and board's competence breadth on the probability of firm entry and exit, respectively. I believe that there is an opportunity here for research to explore further the antecedents to entry and exit to develop a fuller understanding of the various patterns of alliance partner reconfiguration.

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