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Abstract

A core question in alliance research is how alliance design influences alliance success. Two underexplored aspects of this question are whether the effect of alliance design is contingent on the external competitive environment and how alliance design affects the behavioral dynamics in an alliance. We address these aspects by studying two core dimensions of alliance design, the level of commitment in an alliance and the number of alliance partners. We match two competitive environments, high and low competition, with different alliance designs and vary the number of alliance partners and the level of commitment and experimentally study the aggregate performance and behavioral dynamics of the different alliance designs. We find that with low competition, alliance design does not affect performance much, while with high competition, alliance performance depends heavily on alliance design. Regarding dynamics, we find that aggregate performance is most strongly affected by first-period behavior, while the willingness to forgive a partner's non-cooperative behavior has a more muted effect on alliance performance.

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The Contingent Effect of Alliance Design on Alliance Dynamics and Performance: An Experimental Study

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1 Introduction

Firms extensively engage in strategic alliances, i.e. voluntary inter-firm agreements that require input by multiple partners. For an alliance to be successful, each partner needs to contribute resources to create mutually beneficial economic value (Gulati and Singh 1998; Agarwal, Croson, and Mahoney 2010; Gulati, Wohlgezogen, and Zhelyazkov 2012; Garrette, Castañer, and Dussauge 2009). However, despite their popularity, more than 50% of alliances fail to achieve their goals (Kale, Dyer, and Singh 2002; Lunnan and Haugland 2008), which has led to extensive research into the drivers of success and failure of strategic alliances (Kale and Singh 2009; Kogut 1989; Park and Ungson 1997; Park and Russo 1996; Reuer and Zollo 2005).

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A core question in this context is how alliance design influences alliance success. Alliance designs differ in many characteristics but, as we discuss below, two core dimensions of heterogeneity in observed arrangements are the level of commitment in an alliance[1] and the number of alliance partners (Gulati 1995; Heidl, Steensma, and Phelps 2014; Gong, Shenkar, Luo, and Nyaw 2007). We study these two design parameters and their interaction in an experimental setup. Our baseline results are directionally intuitive: simple alliances (with fewer partners) work better than complex ones, and higher commitment can make alliance partners behave more cooperatively. Our first main contribution, however, is to show that the effects are often contingent on the competitive environment, and how.

Indeed, optimal alliance design may depend on contextual factors. Existing research suggests that the effect of design parameters on alliance performance is conditional on exogenous factors: what works for an alliance among unrelated firms may not be optimal for an alliance among close competitors (Gulati 1995; Baker, Gibbons, and Murphy 2008). Hence, we experimentally study the boundary conditions of our alliance design parameters by modelling the competitive environment and the resulting key alliance challenges (Gulati 1995; Baker et al. 2008). We find that alliance design matters most in high-competition alliances, i.e., when partners are strong rivals in product markets. In low-competition alliances, different designs have a much less pronounced impact.

Our experimental setup also lets us study the dynamic properties of partnerships, i.e. the alliance "behavior" over time – our second main contribution. There, we find that differences in performance are largely mediated through behavior in the beginning of the alliance. That is, differences in first-period behavior explain a large portion of aggregate performance. Conversely, forgiveness, i.e. cooperating after a partner has not, has a more muted impact on aggregate performance. This corresponds to the findings by Doz (1996) and Ariño and De la Torre (1998), who document a self-reinforcing process of alliance success and failure that puts a high

[1] For example, partners having formed a formal joint venture will face the cost of dissolving if the benefits from the alliance are not satisfactory, while an informal alliance can be abandoned easily, leaving only the pre-dissolution efforts as sunk costs.

weight on first-period behavior. Thus, initial differences are likely to persist over the duration of an alliance.

We contribute to the alliance literature by studying the aggregate performance and dynamic behavior under different alliance designs and different competitive environments. Our work adds to a small, but emerging experimental literature on strategic alliances (Agarwal et al. 2010; Amaldoss, Meyer, Raju, and Rapoport 2000; Amaldoss and Rapoport 2005; Arend 2009; Fonti, Maoret, and Whitbred 2016). Experimental work overcomes two key issues often present in empirical work: First, managers choose an alliance design based on their expected performance, which means empirical work faces issues of endogeneity (Hamilton, Nickerson, and Owan 2003). Our controlled setup, on the other hand, lets us separate the alliance design choice from its expected performance implications – that is, in our experiment, we exogenously assign alliance designs to different states of the competitive environment (Agarwal et al. 2010). Second, real-life alliance designs and behavior are complex and idiosyncratic, which often renders empirical work highly context-specific (Newbert 2007; Poppo 1995; Walker and Poppo 1991). We instead have detailed information on a large number of identical (experimental) alliances. This lets us isolate the impact of key alliance characteristics on different performance and behavioral metrics (Lunnan and Haugland 2008). Moreover, we can dig deeper into within-alliance dynamics, which typically requires detailed process data on individual alliances (Segrestin 2005; Ariño and De la Torre 1998). Finally, our setting lets us control all parameters, such as the extent of benefits available to each partner, which allows us to precisely trace the behavioral aspects of partners' actions over time.

2 Alliances and Alliance Design

Most of the vast literature on strategic alliances studies at least one of three key questions: *What are common problems alliances face?*, *How does alliance design affect alliance performance?*, and *Which dynamic aspects of partner behavior affect alliance performance most?* We discuss each of them in turn.

2.1 Coordination Problems and Opportunistic Behavior

The key challenges in strategic alliances identified by practitioners and academic literature are the potential for opportunistic behavior and coordination problems (Gulati 1998). Early work on strategic alliances has emphasized alliance partners' concerns that their counterpart might appropriate much of the value (or knowledge) from an alliance through opportunistic behavior (Balakrishnan and Koza 1993; Pisano, Russo, and Teece 1988; Williamson 1991). This logic is reflected in work on mechanisms to overcome the threat of opportunistic behavior through repetition (Arend and Seale 2005) or trust (Das and Teng 1998).

An alternative stream of research has focused on coordination issues as a challenge to alliance success (Gulati 1995). Recently, these two views have been integrated and there is a consensus that both problems and the corresponding solutions tend to be present in strategic alliances to varying degrees (Gulati and Singh 1998; Agarwal et al. 2010; Kumar 2010a; Kretschmer and Vanneste 2016). Khanna, Gulati, and Nohria (1998) and Kumar (2010b) propose that it is the ratio of public to private benefits that determines the balance, a view formalized by Kretschmer and Vanneste (2016) and Arslan (2016). Importantly, the literature agrees that opportunistic behavior and coordination problems can arise within the same setting and that their relative weight is a matter of degree rather than of strict separation.

2.2 Alliance Design and Alliance Performance

Another stream studies drivers of alliance performance. A broad classification of those drivers is into exogenous factors, like the extent to which alliance partners are competitors or macroeconomic indicators, and endogenous factors, i.e. elements that alliance partners themselves choose. Work on alliances among competitors has found that alliances among close competitors often perform worse as shown by greater rates of alliance dissolution (Greve, Baum, Mitsuhashi, and Rowley 2010) or lower resource contributions (Amaldoss et al. 2000; Amaldoss and Rapoport 2005).

Firms design safeguards to reduce the detrimental effects of allying with close competitors (Ariño and De la Torre 1998; Dussauge, Garrette, and Mitchell 2000).

Two design elements affecting the likelihood and cost of non-cooperative behavior of competitors-cum-alliance partners are the arrangements among alliance partners that increase their commitment and the number of partners.[2]

Commitment. Many alliance design choices aim to increase the commitment of partners to alleviate issues of coordination and opportunism such as (i) contracts which create economic bonds or hostages (Anderson and Weitz 1992; Srinivasan and Brush 2006) and (ii) equity investments or stand-alone alliance entities such as joint ventures (Helm and Kloyer 2004; Barringer and Harrison 2000) to decrease opportunistic behavior (Das and Teng 2000). Prior work examines the performance of alliance design choices that affect commitment (Macher and Richman 2008).

Design choices that increase formal commitment will affect subsequent alliance processes and behavior, and relational contracts among alliance partners. Formal commitments and relational contracts can be substitutes or complements (Schepker, Oh, Martynov, and Poppo 2014; Faems, Janssens, Madhok, and Van Looy 2008). If trust allows for less formally specified commitment devices, the two are substitutes, while they are complements if the combined use of formal design choices and relational governance promotes cooperation (Poppo and Zenger 2002). For example, if contractual or equity safeguards signal that partners intend to behave cooperatively, they facilitate the development of relational norms (Poppo and Zenger 2002). Das and Teng (2000) argue that contracts are linked to alliance performance through their effect on the level of inter-partner conflict during the alliance (Lumineau, Eckerd, and Handley 2015), suggesting the two are complements. They address questions of how (which mechanisms) and when (which contingencies) contracts matter to alliance performance (Hoetker and Mellewigt 2009; Weber and Mayer 2011). Recent work has found support for the complementary view (Brown, Dev, and Lee 2000; Dyer and Chu 2003; Mellewigt, Madhok, and Weibel 2007; Hoetker and Mellewigt 2009; Li, Poppo, and Zhou 2010; Luo 2002).

[2]Many other elements will plausibly affect alliance performance, for example the extent of synergies arising from the alliance or the amount of investment required from each party. Likewise, uncertainty about synergies will affect partners' willingness to invest in the alliance. We consider these factors as exogenous parameters that cannot be affected by alliance design choices.

Number of Alliance Partners. Conceptually, it is often assumed that alliances involve two partners, while empirically we frequently observe at least three (García-Canal, Valdés-Llaneza, and Ariño 2003; Hennart and Zeng 2002; Li, Eden, Hitt, Ireland, and Garrett 2012; Gulati 1995; Gulati and Singh 1998; Makino and Beamish 1998). Multilateral alliances have been studied rarely (Zeng and Chen 2003; Lavie, Lechner, and Singh 2007; Siegel 2003; Gong et al. 2007) until recently (Li et al. 2012; Mishra, Chandrasekaran, and MacCormack 2015; Heidl et al. 2014; Gong et al. 2007).

A higher number of alliance partners increases managerial complexity and coordination costs (Van de Ven 1976; Hu and Chen 1996; García-Canal et al. 2003; Gong et al. 2007; Hennart and Zeng 2002; Park and Russo 1996) and can lead to dysfunctional behavior within the group (Gong et al. 2007; Hackman 1987; Steiner 1972). Managing multi-partner cooperation exacerbates concerns about opportunism and coordination (Doz and Hamel 1998; Hwang and Burgers 1997), suggesting that multi-partner alliances perform worse and are inherently less stable than two-partner alliances (García-Canal et al. 2003; Beamish and Kachra 2004), which has been supported empirically (Dussauge et al. 2000; Heidl et al. 2014; Gong et al. 2007).

2.3 Alliance Process

Another line of research studies the dynamic properties, i.e. the alliance "behavior" rather than aggregate success. Much of this literature stream has focused on individual cases (Majchrzak, Jarvenpaa, and Bagherzadeh 2015) (and/or on the dissolution of alliances. Ariño and De la Torre (1998) study the dynamics of a (failed) horizontal market-making alliance and find that there is constant adjustment following alliance partners' actions and beliefs that contribute to reinforcing feedback loops – either positively or negatively. Further, there are some large-sample studies identifying the determinants of alliance dissolution in general and joint ventures in particular (Park and Russo 1996; Park and Ungson 1997; Lokshin, Hagedoorn, and Letterie 2011; Lunnan and Haugland 2008). Conceptually, Doz (1996) separates alliance behavior into two phases – the initial conditions and a learning phase. Doz (1996) illustrates how the two mutually affect each other, suggesting that competitive environment and alliance design (i.e. the initial exogenous and endogenous conditions) impact alliance dynamics. An emerging stream of research in this vein is experimental work studying repeated alliance games, often capturing a game-theoretic logic (Arend 2009). Fonti et al. (2016) study multi-party alliances, while Amaldoss and Staelin (2010) and Amaldoss et al. (2000) and Agarwal et al. (2010) study two-player alliances.

2.4 Roadmap

We take existing research on alliances as a starting point for our approach. Indeed, our experimental framework as well as our experimental treatments and payoffs are based on a formal model of a strategic alliance and integrate each of these three strands of the literature. We do not propose formal hypotheses as the baseline effects of alliance context and design are intuitive (for example that low competition alliances outperform high competition alliances) and we are predominantly interested in an empirical exploration of more nuanced dynamic behavior as well as contingent effects of alliance design on performance.

First, to recognize the concurrent existence of problems of coordination and opportunism, we demonstrate theoretically that their relative importance can shift with a single parameter of our formal model, the extent of competition between alliance partners (i.e., the extent to which they are rivals in product markets). For high levels of competition, opportunistic behavior is the dominant concern and strategic alliances will resemble a prisoner's dilemma. For low levels of competition, coordination considerations dominate and strategic alliances will resemble a stag hunt game. Experimentally, we use two representative levels of competition (high/low competition) leading, respectively, to opportunistic behavior and coordination problems.

To study some key differences across alliance designs, we allow for varying levels of commitment and numbers of alliance partners. While there are multiple aspects in which alliances differ in terms of commitment, our setup captures the essence of an important dimension, namely how easy it is to abandon an alliance. We proxy for this with a breakup cost that is either zero (low commitment) or positive (high commitment). The number of partners creates differences in the level of collaboration needed to achieve the anticipated benefits. We vary the number of alliance partners from two (bilateral) to three (multilateral) to capture these differences.

Finally, to reproduce and study dynamic interaction, we allow alliance partners to change decisions over time and react to past choices. We use a $2 \times 2 \times 2$ setup (high/low competition, high/low commitment, bilateral/multilateral), capturing both competition and alliance design, and study both alliance dynamics and overall alliance performance. Observing behavior during an alliance – conditional on alliance design – tells us about the causal effect of alliance design on alliance partners' behavior, and the aggregate outcomes of exogenously assigned alliance designs inform us about the effects of two key alliance parameters.

3 Framework

We now present a model of an alliance between firms interacting and competing in the same product market over time. Our aim is twofold. This model serves as a framework – and as a way to directly derive treatments and payoffs – for our experimental analysis. We also use it to show that the intensity of product market competition may affect the type of strategic interaction firms face within alliances. Indeed, in our framework, opportunistic behavior and coordination problems arise for "relatively high" and "relatively low" intensities of competition, respectively.

3.1 Basic Setup

We first describe the per-period actions and payoffs of the two symmetric alliance partners of our dynamic model. Each of the two firms decides whether to "contribute resources" to the alliance (C) or not (nC) to increase demand for their products. C implies contributing to the alliance in the letter and spirit of the contractual agreement, nC means contributing to the alliance in the letter of the contractual agreement but not its spirit. For example, when contributing, a partner would staff its best personnel to the alliance, would actively promote the common brand, or would share up-to-date information with its partner. When not contributing, a partner would do none of this while still fulfilling the terms of the contract.

Synergies and full partnership value are only realized when both partners contribute resources (Hagedoorn 1993; Agarwal et al. 2010). Formally, product market profits of each partner are given by $\pi(\widetilde{a}, m) = \widetilde{a} \cdot m$, where $\widetilde{a} > 0$ is firm demand and $m > 0$ the per-unit price-cost margin, which decreases with the intensity of competition in the product market. Demand for each of the two partners is as follows:

$$\widetilde{a} = \begin{cases} a & \text{if none contributes} \\ a + k/2 & \text{if one contributes} \\ a + k + s & \text{if both contribute,} \end{cases}$$

where $a > 0$ is the baseline individual demand, $k/2 > 0$ are the (per-partner) gains of the individual contributions and $s > 0$ the (per-partner) "synergy" gains in excess of the individual contributions.

Alliance partners control their own resource contributions, and the decision to contribute resources requires a private cost of e monetary units. Decisions at each point in time are taken simultaneously. Our model thus reflects the uncertainties resulting from difficulties in monitoring the behavior of alliance partners (Agarwal et al. 2010; Arend 2009). Indeed, many of the required "contributing" actions are difficult to observe and describe in sufficient detail.[3] Action interdependencies make it even more difficult to measure separate contributions immediately (Gulati and Singh 1998; Mesquita, Anand, and Brush 2008).

Table 1a summarizes the payoffs of each firm as a function of both firms' choices within the alliance. As shown in the table, payoffs of a given partner depend not only on its own actions but also on its partner's actions.

[Table 1 about here.]

We assume that the economic value created in alliances is shared, and alliance

[3] Some of these resource contributions may be contracted upon, but enforcing (near-)complete contracts is prohibitively expensive (Crocker and Reynolds 1993). For simplicity therefore, we assume resource contributions to be fully non-contractible.

partners cannot be excluded from benefiting. We follow Dyer and Singh (1998: 666)'s concept of "complementary resource endowments" that "collectively generate greater rents than the sum of those obtained from the individual endowments of each partner."

3.2 Theoretical Results

We now show that the *degree of product market competition* affects the type of strategic interaction firms face within the alliance, and the resulting equilibrium actions (proof in Appendix A). Thus, competition will not only affect profits directly through margins, but also indirectly through partners' optimal resource contributions.

Proposition 1. There exist critical degrees of product market competition, represented by margins $\bar{m}_1$, $\bar{m}_2$ and , $\bar{m}_3$, such that alliances result in the following types of strategic interaction and equilibria:
(i) "*High competition alliance*" for $\bar{m}_1 < m < \bar{m}_2$: no one contributing is an equilibrium, but it is Pareto-dominated by both contributing.
(ii) "*Low competition alliance*" for $\bar{m}_2 < m < \bar{m}_3$: there are two equilibria; both or no one contributing resources. The former Pareto-dominates the latter.[4]

If competition is intense and thus margins small (case (i)), there may be opportunistic behavior within the alliance, as in a prisoner's dilemma.

If competition is weak and thus margins high (case (ii)), contributing is better than not contributing whenever the other partner contributes as well, which describes a classical stag hunt game. Alliances may as a result face coordination problems (Gibbons 1992; Gulati 1995). Although there is no real conflict of interest, partners may not be able to coordinate on the outcome where both contribute.[5]

Table 1 (panels (b) and (c)) gives the two parameterizations for our experimental analysis. In Table 1c, we show a case of high competition and low margins (case (i)),

[4] An outcome *Pareto dominates* another outcome if it makes each and every partner better off.

[5] If $m < \bar{m}_1$, partners would not contribute resources nor would this be efficient. Conversely, if $m > \bar{m}_3$, firms find it optimal to contribute resources independently of their partners actions, and it is efficient to do so. As both these situations pose no strategic challenges, we do not investigate these cases further.

$m = 2/3$, whereas Table 1b gives a case of low competition and high margins (case (ii)), $m = 1$. As the resulting threshold margins of Proposition 1 are $\bar{m}_1 = 0.55$, $\bar{m}_2 = 0.79$ and $\bar{m}_3 = 1.83$, these two levels of competition will lead to opportunistic behavior and coordination problems, respectively. In both cases, the outcome giving the highest sum of payoffs is the one in which both partners contribute.

3.3 Alliance dynamics and alliance design

We extend our basic setup to allow for dynamics, which involve repeated interaction between partners and the option to break up the alliance. The two levers of alliance design we deal with – commitment and number of partners – are embedded in this extended setup. In real-life alliances, alliance partners interact repeatedly, can change their decisions over time and react to partners' past choices. For example, a partner might start contributing resources but decide to stop doing so if its partner does not do so, or even decide to break up the alliance. Thus, we allow for repeated interaction and a breakup option.[6]

Breakup option. We introduce breakup in our baseline specification as a unilateral choice, B, that leads all partners to obtain an outside option from then onwards. We assume that breaking up the alliance is better than maintaining it if partners do not contribute resources. Specifically, we assume that the outside option of breaking up the alliance is equal to the profits of no resource contribution, $\pi(a, m)$. Maintaining the alliance, however, involves a fixed cost F to each partner, attributable to, e.g. buildings, machines, administration and other overhead needed to keep the alliance in place. Taking into account the breakup option, the modified payoffs as a function of both firms' choices are summarized in Table 2.

[Table 2 about here.]

[6] A breakup option makes it easier to compare our results with empirical papers; indeed, most of the empirical literature identifies an alliance's performance through its duration, as other measures are often unavailable. Perhaps surprisingly, we are aware of only one other theoretical/experimental paper on alliances that allows for firms to decide to be in or out of the alliance (Arend 2009).

Repeated interaction. We model dynamics by considering an indefinite repetition of the decisions and payoffs described above. Alliance behavior then aims at maximizing the discounted sum of profits, given an exogenous discount factor, δ. We modify this indefinitely repeated setup such that if at least one partner breaks up the alliance in a given repetition (chooses B), the alliance ends and cannot be restarted later and both partners obtain the profits of the outside option from there on.[7]

Commitment. Some alliances involve greater degrees of commitment between alliance partners than others. Equity joint ventures, for example, are harder to break up and it is more difficult to step away than in unstructured alliances. We model the degree of commitment in the alliance through a one-off cost of dissolving the alliance that all partners must pay if any of them decides to break up the alliance.

Multilateral alliances. We capture bilateral and multilateral alliances by analyzing alliances with two and three partners.[8] Synergies are only realized when all partners contribute resources. Demand for each of the three partners is as follows:

$$\widetilde{a} = \begin{cases} a & \text{if the alliance is terminated} \\ a + g \cdot k/3 & \text{if } 0 \leq g < 3 \text{ partners contribute} \\ a + k + s & \text{if the three partners contribute.} \end{cases}$$

3.4 Experimental Setup

To incorporate alliance dynamics and implement the treatments corresponding to each alliance design, we pick specific parameter values that extend the tables in Table 1 in accordance with the extended setup presented in Section 3.3.

[7]We also implicitly assume that per-period profits cannot be increased through cooperation in the product market. We do this to focus on the effects of repeated interaction within the alliance and not in the product market.

[8]To make the bilateral and multilateral treatments comparable, we augment each of the demand parameters at the aggregate level (baseline demand, gains of individual contributions and synergies), such that the individual demands for each combination of actions are comparable.

Dynamics in the laboratory. Each alliance interaction considered in our experiment involves an indefinite number of *periods*. We assume $F = 0.5$ and use the payoff specifications of Table 2 to construct the per-period payoff matrices used in our experiment (Tables 3, 4, and 5). If none of the partners has yet chosen to break up the alliance, partners face three choices per period, C, nC, and B. If at least one partner chooses breakup, partners face no further choices and payoffs in all future periods equal the outside option (payoff of option B in the tables). An alliance interaction has an indefinite duration with a probability 0.1 of ending in any given period. This allows us to realistically create *indefinite* duration in the laboratory and it induces a discount factor of $\delta = 0.9$.[9]

[Table 3 about here.]

Commitment in the laboratory. In our experimental "low commitment" treatment, the one-off cost of breakup is 0, and in the "high commitment" treatment, this cost is 10. Given the discount factor of $\delta = 0.9$ a one-off breakup cost of 10 units is equivalent to an expected per-period breakup cost of 1 unit. Table 4 gives per-period expected payoffs of the "high-commitment" alliance for low and high competition.

[Table 4 about here.]

Multilateral alliances in the laboratory. Using the same values as for two partners, Table 5 gives per-period expected payoffs for multilateral alliances with low and high commitment and in low and high competition environments.

[Table 5 about here.]

Experimental Implementation. The experimental setup outlined above gives us two degrees of competition (high and low) and the four alliance designs (combinations of commitment and number of partners) outlined in Figure 1. We label an

[9] A discount factor of 0.9 means that any payoff, p, is worth only $0.9 \times p$ if it is delayed by one period. In an expected utility context, a probability 0.1 that the interaction ends this period means that any payoff delayed by one period is weighed by the probability that this period occur, which is 0.9. Thus, the valuation given to future payoffs in these two scenarios is the same.

alliance as *BL* when it is a *b*ilateral *l*ow commitment alliance. Similarly, we use the labels *BH* (*b*ilateral *h*igh commitment), *ML* (*m*ultilateral *l*ow commitment) and *MH* (*m*ultilateral *h*igh commitment).

[Figure 1 about here.]

Each of the eight treatments ($2 \times 2 \times 2$) was run in two different experimental sessions, thus giving a total of sixteen sessions run with between eighteen and twenty-four participants in each. In each session, we run several "interactions" of the same treatment, where an interaction refers to the realization of the random number of periods in the dynamic framework. The random duration of interactions was determined in the first two sessions we ran. This gave us two interaction draws that we replicated in all remaining sessions to enhance comparability of our data. Each treatment was run under both interaction draws. All sessions were run at Melessa, the Experimental Social Sciences Laboratory at LMU Munich. Experiments were programmed and conducted with the software zTree (Fischbacher 2007) and the participant recruitment software at Melessa is Orsee (Greiner 2015). Details are in Appendix B.

4 Results

We start by looking at the aggregate success of alliances, with a focus on *if* and *how* alliance designs, i.e. levels of commitment and the number of partners, make a difference. We investigate whether these have a differential impact depending on whether alliances are in low or high competition settings. Subsequently, we study which dynamic decisions by partners are affected by different environmental (competition) and design elements. Accordingly, in the first part of the results, the unit of analysis is an interaction between two (or three) alliance partners, an "alliance", whereas in the second part, we study the individual choices in the alliances.

4.1 Alliance success

We consider two measures of aggregate alliance success across alliance designs and competitive environments. First, we compute for each alliance the proportion of periods where all partners contribute. We refer to this measure as *cooperation*. Second, we create a dummy variable (*breakup*) indicating if the alliance broke up prematurely or if it continued until the end of an interaction. Both dimensions are important in assessing alliance performance and are common in empirical studies of strategic alliances.

Table 6 shows levels of cooperation in low and high competition alliances across our four different alliance designs. It is clear that in general alliances where participants face low competition levels perform better than those where competition in product markets is high. The frequencies of cooperation in low competition alliances range between 75% (in the ML design) and more than 95% (in the BL and BH designs). On the other hand, the fraction of cooperating high competition alliances is substantially lower and its range much wider: it goes from 12% (ML design), over 27% (MH design) and 63% (BL design), to reach almost 87% (BH design).

We now focus on how the different alliance designs perform in each competitive environment. Panel (a) of Table 6 shows that for low competition alliances mean cooperation does not differ across different commitment levels, as indicated by the significance of t tests reported in the right-most column. The same column of Panel (b) shows that for high competition alliances high commitment leads to significantly more cooperation. For both levels of competition and commitment, multilateral alliances cooperate significantly less (t tests in the bottom row of either panel of Table 6).[10]

[Table 6 about here.]

Panels (a) and (b) of Table 7 show a similar pattern for the frequency of breakups:

[10]We can go beyond comparing mean cooperation using a t test and, instead, compare the entire distribution of cooperation values across alliance designs. Kolmogorov-Smirnov tests (non-parametric tests which, instead of assuming a probability distribution, compare the empirical distributions constructed from data) of differences in cooperation levels across alliance designs corroborate the findings for differences in means (t tests) reported in Table 6.

for low competition alliances commitment makes no significant difference, whereas a higher number of partners leads to more frequent breakups (see χ^2 tests in the rightmost column and bottom row of panel (a)).[11] For high competition alliances, higher commitment leads to significantly less breakup. Indeed, the breakup frequency drops from almost 35% in BL alliances to about 5% in BH alliances and from almost 85% in ML alliances to less than 30% in MH alliances. The increase in breakups when going from two to more partners is equally pronounced and all differences are significant at the 1% level.

[Table 7 about here.]

In sum, commitment is a key factor in improving the performance of high competition alliances whereas commitment makes no difference in the performance level of low competition alliances. When comparing bilateral and multiparty alliances – the other alliance design element in our analysis – we find that, by all measures, multiparty alliances are significantly less successful than bilateral alliances.

Table 8 summarizes these results in a regression format, which allows us to include control variables and take into account potential serial correlation within sessions. The first two columns of Table 8 show how our two measures of success – cooperation and probability of breakup – are determined by alliance design and level of competition. For cooperation we employ a simple OLS regression, whereas we estimate the probability of breakup via a logistic regression.[12] The baseline is a low competition BL alliance and coefficients should be measured against the success of this competitive environment and alliance design.

[Table 8 about here.]

As can be seen from the first column of Table 8, higher commitment increases the frequency of success by 11%, having more partners in the alliance decreases it by

[11] Breakups are measured as frequencies across all interactions and, hence, comparisons are made using Pearson's χ^2 test.

[12] Coefficients of the logistic regression are expressed as odds ratios: a coefficient larger than 1 means that odds increase and a coefficient smaller than 1 means that the odds of breakup decrease.

almost 37% and being in a high competition alliance decreases it by 35%. Likewise, the second column shows that high commitment reduces the odds of breakup by about 87%, while being in a multiparty alliance increases the odds sevenfold, and operating a high competition alliance even by a factor of 12. All coefficients are significant at the 1% level.

When we include interaction effects (columns 3 and 4 of Table 8), we see that commitment only influences performance in high competition alliances. The main effect of higher commitment disappears, but the interaction of high commitment and high competition is significant and the size of the effect (0.232, third column) is larger than the effect of commitment in the absence of interaction (0.11, first column). There is an additional negative effect on cooperation of adding members in high competition alliances (coefficient -0.316 in column 3, significant at the 1% level), but not on breakups. Other interaction effects are not significant.

4.2 Alliance Dynamics

Our experimental setup lets us establish a causal effect of alliance design on alliance performance (section 4.1). However, we also explore possible explanations for these effects by looking at dynamics. We advance two (not mutually exclusive) explanations. Our analysis of first period behavior is based on the intuition that alliance design will crucially affect partners' trust in their partners' good behavior. Partners that enter an alliance with a trusting attitude will create a cooperative environment from the beginning of the alliance (first period) to sustain future alliance success. Our analysis of forgiveness is based on the belief that alliance design will affect the way in which partners react to other partners' past misbehavior; e.g., higher commitment may increase partners' willingness to forgive each other to avoid the costs of breakup. This may in turn lead to more successful alliances since it encourages partners to coordinate and avoids both breakup and the "bad" equilibrium.

We first explore whether alliance design affects these two behavioral features and then (Section 4.3) whether this behavioral effect carries over into alliance success. As we now look at reactions, we naturally make individual choices the focus (as opposed to aggregate outcomes in the previous subsection).

4.2.1 First Period

As can be seen from panel (b) of Table 9, commitment significantly affects first period behavior in high competition alliances. Indeed, the distribution of actions has more C, less nC and less B (χ^2 tests in last column). These differences are strongest for bilateral alliances. On the other hand, there are no significant differences in the first period across different levels of commitment for low competition alliances (see frequencies of actions and χ^2 tests in panel (a)). The same holds when comparing bilateral and multiparty alliances. As visible in the bottom rows of both panel (a) and (b), bilateral alliances perform better than multiparty alliances in the first period. This difference is more pronounced for high competition alliances; differences are significant at the 1% level whereas they are only significant at the 5% level for low competition alliances. In sum, the average effects identified in the previous section show up again very strongly in first-period behavior.

[Table 9 about here.]

4.2.2 Forgiveness

We now look at *forgiveness*, the willingness to contribute after non-contributing (cheating) behavior by a partner. This may be necessary to get cooperation working again, which ultimately contributes to alliance performance. To capture forgiveness, we consider how likely the focal partner is to contribute whenever one or more partners did not contribute in the previous period (but the focal partner did).[13]

In panel (a) of Table 10, we see that the difference in forgiveness behavior in low competition alliances across alliance designs are small in magnitude and statistically insignificant. In low competition alliances, all alliance designs show the same tendency to forgive non-cooperative behavior. Thus, differences in aggregate performance across alliance designs in low competition environments cannot be put down to differences in forgiveness. Conversely, panel (b) of Table 10 shows that there are

[13] The frequencies of choices after all possible outcomes are available from the authors.

significant differences in forgiveness frequencies across alliance designs in high competition alliances. Specifically, in high competition alliances, forgiveness is higher for multilateral high commitment alliances than for the other three designs, and the differences to bilateral high commitment alliances (at the 5% level) and multilateral low commitment alliances (at the 1% level) are statistically significant.

[Table 10 about here.]

4.3 Mediation Effects

In Section 4.2 we studied how alliance design affects two aspects of dynamic alliance behavior: first-period behavior and forgiveness. We now link back this study of dynamics to the ultimate objective, *alliance success*. Mediation analysis (Imai and Yamamoto 2013) is a useful tool for this as it allows us to to break down the *total effect* of alliance design on alliance success into a *mediated effect* carried by the proposed mechanisms (e.g., alliance design affects first-period behavior, and first-period behavior in turn affects success), and a *direct effect*, where *direct* refers to any mechanism other than our proposed ones.

Formally, our mediation analysis combines the results of a regression of alliance success (cooperation) on alliance design (dummies for high commitment and multiparty alliance), first-period behavior (a dummy equal to 1 if all partners choose C in the first period), and forgiveness (a dummy that equals 1 if C is ever chosen after nC by another partner) with the results of separate regressions of each mediator, first-period behavior and forgiveness, on alliance design. The latter regressions uncover the effect that alliance design has on each of our proposed mediator variables. The former regression uncovers the effect of the mediator on alliance success. The two effects are combined to determine the mediated effect of alliance design on alliance success. Table 11 summarizes the results, directly reporting the total, mediated (by each proposed mediator), and direct effect of alliance design on alliance success.

We first consider high competition alliances (panel (b)), where alliance design always has a significant total effect on alliance success. The table reveals that an increase in commitment significantly increases the frequency of cooperation by 0.197.

Of this change, 71.07% (14 percentage points) is driven by the increase in first-period cooperativeness that occurs when the level of commitment is increased, while no part is significantly driven by a change in forgiveness.[14] Analogously, having three instead of two partners decreases the frequency of cooperation in an alliance by 0.56 (total effect), 80.35% of which is driven by a change in first period behavior caused by the increase in the number of partners, and the remainder is a direct effect.

For low competition alliances (panel (a) of Table 11), success is not significantly affected by alliance commitment, so mediation analysis is moot for this design parameter. On the other hand, an increase in the number of partners significantly reduces the frequency of cooperation by 0.173, and both mediators play an important role in driving this change. An effect on first period behavior that in turn affects alliance success, carries 44.5% of the total effect of the number of partners on alliance success, while forgiveness drives 19.07% of the total effect.

To summarize, Table 11 shows that, where significant, a sizeable proportion of the effects of commitment and the number of alliance partners on overall success is mediated by first period behavior, while forgiveness is a significant mediator only for the effect of the number of partners for low competition alliances.

[Table 11 about here.]

5 Discussion and conclusion

We show formally that the relative importance of the two key challenges of strategic alliances, namely problems of coordination and opportunistic behavior, can shift with a single parameter, the intensity of product market competition between alliance partners. Low competition alliances resemble a stag hunt game in which contributing to the alliance is in the partners' interests. High competition alliances are akin to a prisoner's dilemma in which alliance partners have an interest in withholding effort.

[14]The unreported regressions underlying the results reported in Table 11 show that forgiveness is slightly but significantly (at the 5% level) affected by alliance commitment, but that the effect of forgiveness on alliance cooperation is not significant. The product of these two effects is the *mediated effect*, whose significance is determined via a bootstrapping simulation technique.

We match these two competitive environments with different alliance designs and vary the number of alliance partners and the level of commitment. We experimentally study the ability of different alliance designs to overcome these two main challenges of strategic alliances.

None of our baseline results are directionally unexpected: simple alliances (between two players) work better than complex ones, low competition alliances outperform high competition ones, and commitment can make alliance partners behave more cooperatively. However, what is interesting and novel is the fact that the expected effects are often contingent on the competitive environment from the outset. Specifically, we found that low competition alliances react much less to changes in alliance design, while the performance of high competition alliances is strongly contingent on their design. This relates to the few studies that have considered competition or partner rivalry in tandem with other environmental features as determinants of alliance success. Park and Ungson (1997) find that rivalry is a stronger predictor of alliance success than organizational factors, a view we confirm partially for low competition alliances, while we find that in high competition alliances aspects like safeguarding or mutual commitment may be needed to keep opportunistic behavior in check (Kale, Singh, and Perlmutter 2000).

Another noteworthy finding is that across the different performance and behavioral metrics, first-period behavior corresponds most closely with overall performance, a result we confirm through a mediation analysis. That is, while there are some differences across our treatments in forgiveness after an episode of non-cooperation, the key differences in overall performance of alliance designs stem from differences in first-period behavior. This corresponds to the findings by Doz (1996) and Ariño and De la Torre (1998), who document a self-reinforcing process of alliance success and failure that consequently puts a high weight on first-period behavior. In other words, given the high stability of cooperation and comparably minor differences (and lower occurrence) of forgiveness behavior across alliance designs, initial differences are likely to persist over the duration of an alliance.

A useful feature of our controlled experimental setting is that we can rule out a number of possible explanations such as gradual learning about alliance benefits, or the changing shape of alliances over time. However, one possible and plausible mechanism is the development of within-alliance trust among alliance partners. Our results support a view where trust is built at the start of an alliance, not over time. However, contrary to Gulati (1995), who posits that trust is built through repeating alliances with the same partners, we find that even in our simple setting without repeating alliances with the same partners, the level of trust is established at the beginning of a particular interaction and persists through that interaction without a discernible trend up- or downwards (Vanneste, Puranam, and Kretschmer 2014). Our result is also in line with the finding that when the shadow of the future looms largest (i.e. in the early phases of an alliance), trust is most likely to be created (Poppo, Zhou, and Ryu 2008) .

Finally, we also offer insights for the emerging literature on multiparty alliances (Fonti et al. 2016). We find that adding more firms to an alliance exacerbates cooperation problems independent of the level of competition. This informs emerging research on alliances in ecosystems (Eisenhardt and Hannah 2016) and standard-setting organizations (Ranganathan, Ghosh, and Rosenkopf 2016), where creating the full value depends on the behavior of many independent actors. Our results suggest a significant decrease in cooperative behavior as more actors are involved, and this may call for alternative organizational forms and even alternative ways of managing firms moving in social networks rather than dyads (Gulati 1998).

Our model and experimental implementation carry a number of limitations. In addition to the simplifications needed to generate a tractable model (two or three players, three actions, known payoffs) and the abstraction from real-world alliances to get the necessary statistical power and subjects' comprehension in the experiment, we also ruled out a number of alliance design features that could affect the performance of an alliance and its dynamic behavior. For example, pre- and within-alliance communication may help resolve coordination problems in low competition alliances more easily than opportunistic behavior in high competition alliances. Reputation buildup across alliances through a public behavioral history might serve as a powerful disciplining device, especially for early phases of alliances among newly matched partners. Finally, varying the extent of resource contribution and the option of dynamic investment patterns so that today's investment affects tomorrow's baseline cost or demand would bring some added realism, especially for R&D alliances. Nevertheless, we feel that by focusing on a narrowly defined strategic alliance and a small set of design variables and behaviors, we uncover some interesting and relevant dynamics that will be at play in more complex settings too.

The managerial implications revolve around two main themes: First, behavior within an alliance is disproportionately affected by early-stage behavior. This suggests that even absent other, extraneous reasons to behave cooperatively early on like learning or cumulative investments, early cooperative behavior is likely to perpetuate throughout the alliance. Hence, managers should only enter an alliance when they are confident that they will be sufficiently knowledgeable and incentivized to cooperate in letter *and* spirit of the alliance from the outset. Otherwise, they can expect a downward spiral of lacking trust and non-cooperative behavior, leading to a breakup of the alliance. The second set of managerial implications revolves around the *choice* of alliance design features depending on the product market in question. Our findings suggest here that alliances in highly competitive markets should be more restrictive, i.e. involve less partners, and feature built-in commitment devices to discipline alliance partners' behavior. That is, more due diligence should be exercised in highly competitive situations, not least because the incentives may be less aligned than in less competitive situations, but also because design choices are likely to have a much bigger impact on the eventual performance of the alliances.

Our research is a step towards a deeper understanding of dynamic alliance behavior and the contingent impact of alliance design on alliance dynamics. Of course, it would be interesting to study additional features of alliance design in an experimental setting that allows for a controlled variation of specific design parameters. Further, it seems especially promising to study some of our observations on dynamic alliance behavior in the field. For example, the importance of getting an alliance off to a good start or the link between commitment and forgiveness would be interesting to study with field data. We hope our work will inspire research along these lines.

Table 1: Payoff Matrices.

(a) Basic Setup.

Partner 1 \ *Partner 2*	***C***	***nC***
C	$\pi(a+k+s,m)-e$ $\pi(a+k+s,m)-e$	$\pi(a+k/2,m)$ $\pi(a+k/2,m)-e$
nC	$\pi(a+k/2,m)-e$ $\pi(a+k/2,m)$	$\pi(a,m)$ $\pi(a,m)$

(b) Basic setup, *low competition*.

Partner 1 \ *Partner 2*	C	nC
C	7 7	5.5 0
nC	0 5.5	2.5 2.5

(c) Basic setup, *high competition*.

Partner 1 \ *Partner 2*	C	nC
C	3 3	3.5 -2
nC	-2 3.5	1.5 1.5

Notes: Panels (b) and (c) are examples constructed with specific parameter values: a baseline demand of $a = 2.5$, gains of the individual contributions of $k/2 = 3$, synergy gains of $s = 4$, and private costs of contributing resources of $e = 5.5$ monetary units. To reflect low competition (panel 1b) we set $m = 1$, and to reflect high competition (panel 1c) we set $m = 2/3$.

Table 2: Payoff Matrices with Breakup Option.

Partner 1 \ *Partner 2*	C	nC	B
C	$\pi\left(a+k+s,m\right)-e-F$ $\pi\left(a+k+s,m\right)-e-F$	$\pi\left(a+\frac{k}{2},m\right)-F$ $\pi\left(a+\frac{k}{2},m\right)-e-F$	$\pi\left(a,m\right)$ $\pi\left(a,m\right)$
nC	$\pi\left(a+\frac{k}{2},m\right)-e-F$ $\pi\left(a+\frac{k}{2},m\right)-F$	$\pi\left(a,m\right)-F$ $\pi\left(a,m\right)-F$	$\pi\left(a,m\right)$ $\pi\left(a,m\right)$
B	$\pi\left(a,m\right)$ $\pi\left(a,m\right)$	$\pi\left(a,m\right)$ $\pi\left(a,m\right)$	$\pi\left(a,m\right)$ $\pi\left(a,m\right)$

Table 3: Experimental Design. Bilateral, low commitment (BL).

(a) Experiment: Low Competition

Partner 1 \ *Partner 2*	C	nC	B
C	6.5, 6.5	-0.5, 5	2.5, 2.5
nC	5, -0.5	2, 2	2.5, 2.5
B	2.5, 2.5	2.5, 2.5	2.5, 2.5

(b) Experiment: High Competition

Partner 1 \ *Partner 2*	C	nC	B
C	2.5, 2.5	-2.5, 3	1.5, 1.5
nC	3, -2.5	1, 1	1.5, 1.5
B	1.5, 1.5	1.5, 1.5	1.5, 1.5

Table 4: Experimental Design. Bilateral, high commitment (BH)

(a) Low Competition

	Partner 2		
Partner 1	C	nC	B
C	6.5 6.5	5 -0.5	1.5 1.5
nC	-0.5 5	2 2	1.5 1.5
B	1.5 1.5	1.5 1.5	1.5 1.5

(b) High Competition

	Partner 2		
Partner 1	C	nC	B
C	2.5 2.5	3 -2.5	0.5 0.5
nC	-2.5 3	1 1	0.5 0.5
B	0.5 0.5	0.5 0.5	0.5 0.5

Table 5: Experimental Design. Multilateral.

(a) Low Commitment (ML). Low (left) and high (right) competition.

	2 cont.	*1 cont.*	*0 cont.*
C	6.5	0.5	-1.5
nC	6	4	2
B	2.5	2.5	2.5

	2 cont.	*1 cont.*	*0 cont.*
C	2.5	-1.5	-3
nC	4	2.5	1
B	1.5	1.5	1.5

(b) High Commitment (MH). Low (left) and high (right) competition.

	2 cont.	*1 cont.*	*0 cont.*
C	6.5	0.5	-1.5
nC	6	4	2
B	1.5	1.5	1.5

	2 cont.	*1 cont.*	*0 cont.*
C	2.5	-1.5	-3
nC	4	2.5	1
B	0.5	0.5	0.5

Notes: The matrices present the payoffs of partner i as a function of own choices and the number of other partners contributing resources to the alliance.

Table 6: Differences between designs, Cooperation.

(a) Low competition alliances.

	Low commitment	High commitment	Difference
Bilateral	0.953	0.952	0.001
Multilateral	0.752	0.810	-0.058
Difference	0.201**	0.142**	

(b) High competition alliances.

	Low commitment	High commitment	Difference
Bilateral	0.634	0.869	0.235**
Multilateral	0.121	0.267	0.146**
Difference	0.513**	0.602**	

Notes: Cooperation is defined as the proportion of periods where [C, C] or [C,C,C] is played. The estimated mean cooperation across all interactions is displayed and the significance of the differences is assessed with a t test; * significant at the 5% level; ** significant at the 1% level.

Table 7: Differences between designs, Breakup.

(a) Low competition alliances.

	Low commitment	High commitment	Difference test (χ^2)
Bilateral	0.038	0.020	0.89
Multilateral	0.183	0.098	2.87
Difference test (χ^2)	14.9**	7.3**	

(b) High competition alliances.

	Low commitment	High commitment	Difference test (χ^2)
Bilateral	0.347	0.051	42.0**
Multilateral	0.846	0.288	65.9**
Difference test (χ^2)	60.9**	28.1**	

Notes: Breakup is measured as a proportion across interactions; * significant at the 5% level; ** significant at the 1% level.

Table 8: Regression analysis of success measures.

	Success Measure			
Independent Variable	Cooperation	Breakup	Cooperation	Breakup
Intercept	0.883**	0.075**	0.857**	0.069**
	(0.035)	(0.036)	(0.039)	(0.034)
Main Effects				
High competition	−0.354**	12.007**	−0.315**	13.651**
	(0.022)	(4.662)	(0.042)	(5.958)
Multilateral	−0.369**	7.562**	−0.200*	5.702**
	(0.023)	(1.853)	(0.070)	(3.074)
High commitment	0.110**	0.131**	−0.001	0.513
	(0.022)	(0.042)	(0.029)	(0.266)
Interaction Effects				
High comp. × Multilateral			−0.316**	2.028
			(0.080)	(1.237)
High comp. × High comm.			0.232**	0.193**
			(0.050)	(0.117)
Multilateral × High comm.			0.058	0.927
			(0.120)	(0.699)
Three-way interaction			−0.144	0.724
			(0.138)	(0.634)
R^2 (pseudo)	0.352	0.327	0.422	0.342
Sample size	1009	1009	1009	1009

Notes: OLS regressions of Cooperation in each interaction on alliance environment and design, and odds ratios of logistic regression of Breakup on alliance type and design. We control for the interaction draw and interaction. All standard errors are robust for within-cluster covariance, clustered by session; * significant at the 5% level; ** significant at the 1% level.

Table 9: First period behavior.

(a) Low competition alliances.

	Low Commitment			High Commitment			
	C	nC	B	C	nC	B	Difference test (χ^2)
Bilateral	96.5	3.5	0	97.3	2.3	0.4	1.773
Multilateral	91.7	8.0	0.3	93.8	6.2	0	1.664
Difference test (χ^2)	6.828*			6.083*			

(b) High competition alliances.

	Low Commitment			High Commitment			
	C	nC	B	C	nC	B	Difference test (χ^2)
Bilateral	80.9	18.4	0.7	94.2	5.4	0.4	24.98**
Multilateral	51.9	46.5	1.6	61.5	37.8	0.7	6.600*
Difference test (χ^2)	55.92**			97.30**			

Notes: Choice values are in percentages. Pearson's χ^2 test of difference between the distribution of first period choices for low and high commitment alliances as well as bilateral and multilateral alliances; * significant at the 5% level; **significant at the 1% level.

Table 10: Forgiveness.

(a) Low competition alliances.

	Low Commitment	High Commitment	Difference test (χ^2)
Bilateral	60.0	66.7	0.07
Multilateral	58.4	59.3	0.00
Difference test (χ^2)	0.00	0.39	

(b) High competition alliances.

	Low Commitment	High Commitment	Difference test (χ^2)
Bilateral	22.2	28.6	0.38
Multilateral	25.8	46.46	17.35**
Difference test (χ^2)	0.17	5.43*	

Notes: Choice values are in percentages. Pearson's χ^2 test of difference of forgiveness frequency. We measure *forgiveness frequency* as the frequency with which C, as opposed to other actions, is chosen by a subject after an outcome where she chose C while at least one of her partners chose nC; * significant at the 5% level; **significant at the 1% level.

Table 11: Causal mediated effects of alliance design on alliance cooperation. Mediators: first-period behavior and forgiveness.

(a) Low competition alliances.

	Treatment variable	
	Commitment (treatment = high)	Number of partners (treatment = multilateral)
Total effect	0.022	-0.173^{**}
Direct effect	-0.005	-0.063^{**}
Effect mediated by:		
First period outcome	0.022	-0.077^{**}
Forgiveness	0.005	-0.033^{**}
Proportion mediated by:		
First period outcome	–	$44.50\%^{**}$
Forgiveness		$19.07\%^{**}$

(b) High competition alliances.

	Treatment variable	
	Commitment (treatment = high)	Number of partners (treatment = multilateral)
Total effect	0.197^{**}	-0.56^{**}
Direct effect	0.060^{**}	-0.101^{**}
Effect mediated by:		
First period outcome	0.140^{**}	-0.450^{**}
Forgiveness	-0.003	-0.009
Proportion mediated by:		
First period outcome	$71.07\%^{**}$	$80.35\%^{**}$
Forgiveness	-1.52%	1.6%

Notes: First period outcome is measured as a dummy variable with value 1 if all partners choose C in the first period. Forgiveness is measured as a dummy with value 1 if C is chosen after nC by another partner at least once during the interaction. Effects are computed from *outcome regression* and *mediator regressions*, and inference is based on the bootstrapped distribution of effects. Outcome regression: linear regression of alliance cooperation on alliance environment and configuration, first period outcome, and forgiveness. Mediator regressions: linear regressions of first period outcome and of forgiveness on alliance environment and configuration. We control for the interaction draw and interaction; * significant at the 5% level; ** significant at the 1% level.

Figure 1: Alliance designs.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Commitment</td></tr>
<tr><td>Low</td><td>High</td></tr>
<tr><td rowspan="2"># partners</td><td>Two</td><td>BL (Bilateral,
low commitment)</td><td>BH (Bilateral,
high commitment)</td></tr>
<tr><td>Three</td><td>ML (Multilateral,
low commitment)</td><td>MH (Multilateral,
high commitment)</td></tr>
</table>

References

Agarwal, R., R. Croson, and J. Mahoney (2010). “The role of incentives and communication in strategic alliances: an experimental investigation.” *Strategic Management Journal* 31, pp. 413–437.

Amaldoss, W., R. J. Meyer, J. S. Raju, and A. Rapoport (2000). “Collaborating to Compete.” *Marketing Science* 19.2, pp. 105–126.

Amaldoss, W. and A. Rapoport (2005). “Collaborative Product and Market Development: Theoretical Implications and Experimental Evidence.” *Marketing Science* 24.3, pp. 396–414.

Amaldoss, W. and R. Staelin (2010). “Cross-function and same-function alliances: how does alliance structure affect the behavior of partnering firms?” *Management Science* 56.2, pp. 302–317.

Anderson, E. and B. Weitz (1992). “The Use of Pledges to Build and Sustain Commitment in Distribution Channels.” *Journal of Marketing Research*, pp. 18–34.

Arend, R. (2009). “Reputation for cooperation: contingent benefits in alliance activity.” *Strategic Management Journal* 30, pp. 371–385.

Arend, R. and D. Seale (2005). “Modeling Alliance Activity: An Iterated Prisoners’ Dilemma with Exit Option.” *Strategic Management Journal* 26, pp. 1057–1074.

Ariño, A. and J. De la Torre (1998). “Learning from Failure: Towards an Evolutionary Model of Collaborative Ventures.” *Organization Science* 3.9, pp. 306–325.

Arslan, B. (2016). “Private Benefits, Competitive Tensions, and Differential Gains in Strategic Alliances.” Working Paper, Koc University.

Baker, G., R. Gibbons, and K. Murphy (2008). “Strategic Alliances: Bridges Between “Islands of Conscious Power.” *Journal of the Japanese and International Economies* 22.2, pp. 146–163.

Balakrishnan, S. and M. P. Koza (1993). “Information asymmetry, adverse selection and joint-ventures.” *Journal of Economic Behavior and Organization* 20, pp. 99–117.

Barringer, B. R. and J. S. Harrison (2000). "Walking a Tightrope: Creating Value Through Interorganizational Relationships." *Journal of Management* 26.3, pp. 367–403.

Beamish, P. W. and A. Kachra (2004). "Number of Partners and JV Performance." *Journal of World Business* 39.2, pp. 107–120.

Brown, J. R., C. S. Dev, and D.-J. Lee (2000). "Managing Marketing Channel Opportunism: The Efficacy of Alternative Governance Mechanisms." *Journal of Marketing* 64.2, pp. 51–65.

Crocker, K. and K. Reynolds (1993). "The Efficiency of Incomplete Contracts: An Empirical Analysis of Air Force Engine Procurement." *The RAND Journal of Economics* 24.1, pp. 126–146.

Das, T. K. and B.-S. Teng (1998). "Between Trust and Control: Developing Confidence in Partner Cooperation in Alliances." *The Academy of Management Review* 23.3, pp. 491–512.

— (2000). "A Resource-Based Theory of Strategic Alliances." *Journal of Management* 26.1, p. 3.

Doz, Y. (1996). "The Evolution of Cooperation in Strategic Alliances: Initial Conditions or Learning Processes?" *Strategic Management Journal* 17, pp. 55–83.

Doz, Y. and G. Hamel (1998). *Alliance Advantage: The Art of Creating Value Through Partnering*. Harvard Business Press.

Dussauge, P., B. Garrette, and W. Mitchell (2000). "Learning from Competing Partners: Outcomes and Durations of Scale and Link Alliances in Europe, North America and Asia." *Strategic Management Journal* 21, pp. 99–126.

Dyer, J. H. and W. Chu (2003). "The role of trustworthiness in reducing transaction costs and improving performance: Empirical evidence from the United States, Japan, and Korea." *Organization Science* 14.1, pp. 57–68.

Dyer, J. H. and H. Singh (1998). "The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage." *Academy of Management Review* 23.4, pp. 660–679.

Eisenhardt, K. and D. Hannah (2016). “Origins and Outcomes of Cooperation and Competition in Nascent Ecosystems.” Working Paper UT Austin.

Faems, D., M. Janssens, A. Madhok, and B. Van Looy (2008). “Toward an integrative perspective on alliance governance: Connecting contract design, trust dynamics, and contract application.” *Academy of Management Journal* 51.6, pp. 1053–1078.

Fischbacher, U. (2007). “z-Tree: Zurich Toolbox for Ready-made Economic Experiments.” *Experimental Economics* 10, pp. 171–178.

Fonti, F., M. Maoret, and R. Whitbred (2016). “Free-riding in multi-party alliances: The role of perceived alliance effectiveness and peers’ collaboration in a research consortium.” *Strategic Management Journal* 10, pp. 2470–2514.

García-Canal, E., A. Valdés-Llaneza, and A. Ariño (2003). “Effectiveness of dyadic and multi-party joint ventures.” *Organization Science* 24.5, pp. 743–770.

Garrette, B., X. Castañer, and P. Dussauge (2009). “Horizontal Alliances as an Alternative to Autonomous Production: Product Expansion Mode in the Worldwide Aircraft Industry 1945-2000.” *Strategic Management Journal* 30.885-894.

Gibbons, R. (1992). *Game Theory for Applied Economists*. Princeton University Press.

Gong, Y., O. Shenkar, Y. Luo, and M.-K. Nyaw (2007). “Do multiple parents help or hinder international joint venture performance? The mediating roles of contract completeness and partner cooperation.” *Strategic Management Journal* 28.10, pp. 1021–1034.

Greiner, B. (2015). “Subject Pool Recruitment Procedures: Organizing Experiments with ORSEE.” *Journal of the Economic Science Association* 1.1, pp. 114–125.

Greve, H. R., J. Baum, H. Mitsuhashi, and T. Rowley (2010). “Built to Last but Falling Apart: Cohesion, Friction and Withdrawal from Interfirm Alliances.” *Academy of Management Journal* 53.2, pp. 302–322.

Gulati, R. (1995). “Does Familiarity Breed Trust? The Implications of Repeated Ties for Contractual Choice in Alliances.” *Academy of Management Journal* 38.1, pp. 85–112.

Gulati, R. (1998). "Alliances and Networks." *Strategic Management Journal* 19.4, pp. 293–317.

Gulati, R. and H. Singh (1998). "The Architecture of Cooperation: Managing Coordination Costs and Appropriation Concerns in Strategic Alliances." *Administrative Science Quarterly* 43.4, pp. 781–814.

Gulati, R., F. Wohlgezogen, and P. Zhelyazkov (2012). "The Two Facets of Collaboration: Cooperation and Coordination in Strategic Alliances." *Academy of Management Annals* 6.1, pp. 531–583.

Hackman, J. R. (1987). "The Design of Work Teams." *Handbook of Organizational Behavior*. Ed. by J. W. Lorsch. Englewood Cliffs, NJ: Prentice-Hall.

Hagedoorn, J. (1993). "Understanding the Rationale of Strategic Technology Partnering: Interorganizational Modes of Cooperation and Sectoral Differences." *Strategic Management Journal* 14.5, pp. 371–385.

Hamilton, B. H., J. A. Nickerson, and H. Owan (2003). "Team incentives and worker heterogeneity: An empirical analysis of the impact of teams on productivity and participation." *Journal of Political Economy* 111.3, pp. 465–497.

Heidl, R. A., H. K. Steensma, and C. Phelps (2014). "Divisive faultlines and the unplanned dissolutions of multipartner alliances." *Organization Science* 25.5, pp. 1351–1371.

Helm, R. and M. Kloyer (2004). "Controlling Contractual Exchange Risks in R&D Interfirm Cooperation: An Empirical Study." *Research Policy* 33.8, pp. 1103–1122.

Hennart, J.-F. and M. Zeng (2002). "Cross-cultural differences and joint venture longevity." *Journal of International Business Studies* 33.4, pp. 699–716.

Hoetker, G. and T. Mellewigt (2009). "Choice and Performance of Governance Mechanisms: Matching Alliance Governance to Asset Type." *Strategic Management Journal* 30.10, pp. 1025–1044.

Hu, M. Y. and H. Chen (1996). "An empirical analysis of factors explaining foreign joint venture performance in China." *Journal of Business Research* 35.2, pp. 165–173.

Hwang, P. and W. P. Burgers (1997). "The many faces of multi-firm alliances: Lessons for managers." *California Management Review* 39.3, pp. 101–117.

Imai, K. and T. Yamamoto (2013). "Identification and Sensitivity Analysis for Multiple Causal Mechanisms: Evidence from Framing Experiments." *Political Analysis* 21.2, pp. 141–171.

Kale, P., J. H. Dyer, and H. Singh (2002). "Alliance Capability, Stock Market Response, and Long-Term Alliance Success: The Role of the Alliance Function." *Strategic Management Journal* 23.8, pp. 747–767.

Kale, P. and H. Singh (2009). "Managing Strategic Alliances: What Do We Know Now, and Where Do We Go From Here?" *Academy of Management Perspectives* 23.3, pp. 45–62.

Kale, P., H. Singh, and H. Perlmutter (2000). "Learning and Protection of Proprietary Assets in Strategic Alliances: Building Relational Capital." *Strategic Management Journal* 21.3, pp. 217–237.

Khanna, T., R. Gulati, and N. Nohria (1998). "The Dynamics of Learning Alliances: Competition, Cooperation, and Relative Scope." *Strategic Management Journal* 19.3, pp. 193–210.

Kogut, B. (1989). "The Stability of Joint Ventures: Reciprocity and Competitive Rivalry." *Journal of Industrial Economics* 38.2, pp. 183–198.

Kretschmer, T. and B. Vanneste (2016). "Collaboration in Strategic Alliances: Cooperation and Coordination." *Collaborative Strategy: A Guide to Strategic Alliances.* Ed. by L. Mesquita, R. Ragozzino, and J. J. Reuer. Edward Elgar Publishing.

Kumar, M. V. (2010a). "Are Joint Ventures Positive Sum Games? The Relative Effects of Cooperative and Noncooperative Behavior." *Strategic Management Journal* 32.1, pp. 32–54.

— (2010b). "Differential Gains Between Partners in Joint Ventures: Role of Resource Appropriation and Private Benefits." *Organization Science* 21.1, pp. 232–248.

Lavie, D., C. Lechner, and H. Singh (2007). "The performance implications of timing of entry and involvement in multipartner alliances." *Academy of Management Journal* 50.3, pp. 578–604.

Li, D., L. Eden, M. A. Hitt, R. D. Ireland, and R. P. Garrett (2012). “Governance in multilateral R&D alliances.” *Organization Science* 23.4, pp. 1191–1210.

Li, J. J., L. Poppo, and K. Z. Zhou (2010). “Relational Mechanisms, Formal Contracts, and Local Knowledge Acquisition by International Subsidiaries.” *Strategic Management Journal* 31.4, pp. 349–370.

Lokshin, B., J. Hagedoorn, and W. Letterie (2011). “The bumpy road of technology partnerships: Understanding causes and consequences of partnership malfunctioning.” *Research Policy* 40, pp. 297–308.

Lumineau, F., S. Eckerd, and S. Handley (2015). “Inter-organizational Conflicts: Research Overview, Challenges, and Opportunities.” *Journal of Strategic Contracting and Negotiation* 1.1, pp. 42–64.

Lunnan, R. and S. Haugland (2008). “Predicting and Measuring Alliance Performance: A Multidimensional Analysis.” *Strategic Management Journal* 29.5, pp. 545–556.

Luo, Y. (2002). “Building trust in cross-cultural collaborations: Toward a contingency perspective.” *Journal of Management* 28.5, pp. 669–694.

Macher, J. T. and B. D. Richman (2008). “Transaction Cost Economics: An Assessment of Empirical Research in the Social Sciences.” *Business and Politics* 10.1, pp. 1–63.

Majchrzak, A., S. Jarvenpaa, and M. Bagherzadeh (2015). “A Review of Interorganizational Collaboration Dynamics.” *Journal of Management* 41.5, pp. 1338–1360.

Makino, S. and P. W. Beamish (1998). “Performance and survival of joint ventures with non-conventional ownership structures.” *Journal of International Business Studies* 29.4, pp. 797–818.

Mellewigt, T., A. Madhok, and A. Weibel (2007). “Trust and formal contracts in interorganizational relationships – substitutes and complements.” *Managerial and Decision Economics* 28.8, pp. 833–847.

Mesquita, L., J. Anand, and T. Brush (2008). "Comparing the Resource-Based and Relational Views: Knowledge Transfer and Spillover in Vertical Alliances." *Strategic Management Journal* 29.9, pp. 913–941.

Mishra, A., A. Chandrasekaran, and A. MacCormack (2015). "Collaboration in Multi-Partner R&D projects: The impact of partnering scale and scope." *Journal of Operations Management* 33, pp. 1–14.

Newbert, S. L. (2007). "Empirical research on the resource-based view of the firm: an assessment and suggestions for future research." *Strategic Management Journal* 28.2, pp. 121–146.

Park, S. H. and M. Russo (1996). "When Competition Eclipses Cooperation: An Event-history Analysis of Joint Venture Failure." *Management Science* 42.6, pp. 875–890.

Park, S. H. and G. Ungson (1997). "The Effect of National Culture, Organizational Complementarity, and Economic Motivation on Joint Venture Dissolution." *Academy of Management Journal* 40.2, pp. 279–307.

Pisano, G., M. Russo, and D. Teece (1988). "Joint Ventures and Collaborative Arrangement in the Telecommunications Equipment Industry." *International Collaborative Ventures in U.S. Manufacturing*. Ed. by D. Mowery. Ballinger, pp. 23–70.

Poppo, L. (1995). "Influence activities and strategic coordination: Two distinctions of internal and external markets." *Management Science* 41.12, pp. 1845–1859.

Poppo, L. and T. Zenger (2002). "Do Formal Contracts and Relational Governance Function as Substitutes or Complements?" *Strategic Management Journal* 23.8, pp. 707–725.

Poppo, L., K. Z. Zhou, and S. Ryu (2008). "Alternative Origins to Interorganizational Trust: An Interdependence Perspective on the Shadow of the Past and the Shadow of the Future." *Organization Science* 19.1, pp. 39–55.

Ranganathan, R., A. Ghosh, and L. Rosenkopf (2016). "Conflict, Cooperation and Consensus in Multipartner Alliances: An Empirical Study in a Standard Setting Organization." Working Paper UT Austin.

Reuer, J. J. and M. Zollo (2005). “Termination Outcomes of Research Alliances.” *Research Policy* 34, pp. 101–115.

Schepker, D. J., W.-J. Oh, A. Martynov, and L. Poppo (2014). “The many futures of contracts: Moving beyond structure and safeguarding to coordination and adaptation.” *Journal of Management* 40.1, pp. 193–225.

Segrestin, B. (2005). “Partnering to explore: The Renault–Nissan Alliance as a forerunner of new cooperative patterns.” *Research Policy* 34, pp. 657–672.

Siegel, D. (2003). “Data requirements for assessing private and social returns to strategic research partnerships: Analysis and recommendations.” *Technology Analysis and Strategic Management* 15.2, pp. 207–225.

Srinivasan, R. and T. Brush (2006). “Supplier Performance in Vertical Alliances: The Effects Of Self-Enforcing Agreements and Enforceable Contracts.” *Organization Science* 17.4, pp. 436–452.

Steiner, I. D. (1972). *Group Process and Productivity*. New York: Academic Press.

Van de Ven, A. (1976). “On the nature, formation, and maintenance of relations among organizations.” *Academy of Management Review* 1.4, pp. 24–36.

Vanneste, B., P. Puranam, and T. Kretschmer (2014). “Trust Over Time in Exchange Relationships: Meta-Analysis and Theory.” *Strategic Management Journal* 35.12, pp. 1891–1902.

Walker, G. and L. Poppo (1991). “Profit centers, single-source suppliers, and transaction costs.” *Administrative Science Quarterly*, pp. 66–87.

Weber, L. and K. J. Mayer (2011). “Designing Effective Contracts: Exploring The Influence of Framing and Expectations.” *Academy of Management Review* 36.1, pp. 53–75.

Williamson, O. (1991). “Comparative Economic Organization: The Analysis of Discrete Structural Alternatives.” *Administrative Science Quarterly* 36.2, pp. 269–296.

Zeng, M. and X.-P. Chen (2003). “Achieving cooperation in multiparty alliances: A social dilemma approach to partnership management.” *Academy of Management Review* 28.4, pp. 587–605.