Competition, Formal Governance and Trust in Alliances: An Experimental Study

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We study the role of alliance governance in the behavior of partners in alliances with different degrees of competition. Using data from a lab experiment on 1,009 alliances and 31,662 partners' choices, we explore whether and how alliances succeed in different competitive scenarios, contingent on the use of formal governance mechanisms (termination clauses) and the number of partners in the alliance. We find that trust, an informal governance mechanism, emerges as a complement to formal governance in order to establish success in our experimental alliances, especially when competition is

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1 Introduction

While partner selection and alliance design are important strategic decisions, managing, or governing, "the alliance relationship over time is often considered more important"(Doz and Hamel 1998: p. XV) for alliance success. Managing alliances implies dealing with partners' opportunistic behavior, frictions in the organization of shared tasks, and partners' organization design that may affect the alliance set-up (Bakker 2016; Greve et al. 2010).

How and when do alliances persist and thrive? Prior work discusses the role of cooperation and incentive alignment to share the joint value created (Gulati et al. 2012; Salvato et al. 2017). Formal and informal governance mechanisms (Cao and Lumineau 2015) help solve the tension inherent in alliances—an alliance needs contributions to succeed, and partners cannot be excluded from the benefits regardless of their extent of cooperation. Further, alliance governance matters especially in multi-sided alliances, where there is more scope for partners' opportunism (Fonti et al. 2017).

However, the level of competition within the alliance may affect how these mechanisms work. Alliances between competitors are common (Gulati and Singh 1998; Hoffmann et al. 2018; Kale et al. 2002; Lavie 2007), but exacerbate tensions within the alliance. Even the potential benefits of promoting learning (Hamel 1991; Inkpen and Tsang 2007) and access to strategic knowledge (Arora et al. 2020) cannot fully resolve the tension of contributing to the common good versus safeguarding one's interests (Das and Teng 2000).

Aligning incentives within more competitive alliances (Adegbesan and Higgins 2010; Bourreau and Doğan 2010; Dawid et al. 2013) with increased scope for opportunistic behavior (Panico 2017; Martinez-Vaquero et al. 2017) can be difficult. This has two consequences: first, formal governance mechanisms, like contractual clauses specifying the rights and obligations of alliance partners (Li et al. 2010; Reuer and Ariño 2007; Schepker et al. 2014) may work differently depending on the level of competition within the alliance. Second, informal mechanisms based on shared values and

mutual trust (Lui and Ngo 2004; Lumineau 2017; Malhotra and Lumineau 2011) can be affected by the diverging incentives of alliance partners. We study the *post-formation* phase of alliances and focus on the level of competition within the alliance, which may depend on technological, cultural or economic factors on top of the degree of product market competition among partners. Hence, we ask *if and how formal and informal governance mechanisms affect behavior and success in alliances, and if their effect is contingent on the level of competition within an alliance.*

We analyze partners' behavior over time contributing to alliance success in a lab experiment. We observe 1,009 partnerships with 31,662 individual moves by alliance partners and study different payoff structures to assess randomly allocated partners' behavior contingent on within-alliance competition. We focus on termination clauses with breakup fees as a specific formal governance mechanism (Comino et al. 2010; Lerner and Merges 1998) and vary the number of alliance partners (Fonti et al. 2017). We observe repeated interactions in our experiment, which lets us study whether trust emerges for different levels of competition.

A key finding of our study is that termination clauses matter most for success in high competition alliances. However, our central contribution is to investigate empirically how informal governance, i.e., trust, matters. To do this, we decompose trust in two components, *trust-building* and *trust repair*. Each component can mitigate opportunistic behavior at different points in time. First-round trust is partners' cooperative behavior at the start of the relationship (trust-building). Forgiveness is collaborating after being exploited by alliance partner(s) later in the alliance (trust repair). Both contribute to alliance success, especially in settings with high competition and in combination with termination clauses.

We add to the literature in two ways. First, we extend work on alliance design (Panico 2017; Poppo 1995; Poppo and Zenger 2002; Fonti et al. 2017) by studying the effectiveness of formal alliance governance contingent on the level of competition within the alliance. Second, we unpack

the notion of trust in alliances by highlighting trust-building and trust repair to either consolidate or recover partnerships. Moreover, we show how trust in alliances is affected by formal alliance governance, thus expanding on the "formal governance-trust" nexus in strategic alliances (Faems et al. 2008; Li et al. 2012) and in inter-organizational relationships in general (IORs) (Lumineau et al. 2015; Lumineau 2017; Mellewigt et al. 2007; Vanneste et al. 2014; Weibel 2007) by focusing on trust dynamics.

This has three main implications. First, we provide evidence on the role of trust over time, its complementarity with formal governance, and its impact on alliances with different levels of competition. This adds to work on the boundary conditions of contractual and relational governance between organizations (Cao and Lumineau 2015; Long and Sitkin 2018) and the interplay between competition and cooperation (Hoffmann et al. 2018; Kale et al. 2000).

Our study has also implications for research on the complementarity between contract design and trust (Cao and Lumineau 2015; Poppo and Zenger 2002) but differs from previous studies in two ways. In our experiment, contractual clauses are exogenous to parties' choices, emphasizing the pure effect of formal governance. In our setting, contractual clauses increase partners' costs if the alliance turns unsuccessful and influence partners' actions only indirectly, limiting their controlling function. These features highlight how the complementary between contractual clauses and trust relies on solidarity and flexibility (Poppo and Zenger 2002), but without the norms of information exchange (Malhotra and Murnighan 2002; Fehr and List 2004) and controlling (Lumineau 2017).

Second, we study forgiveness as a way to restore cooperation and trust when the alliance faces a breakdown. Forgiveness can restore collaboration especially for relationships highly prone to exploitative behavior. This sheds light on alternative informal governance forms when traditional instruments are ineffective (Lumineau 2017). Finally, we add evidence on the unconditional nature of forgiveness (Fudenberg et al. 2012) since it is not preceded by an apology, compensation, or

communication. This adds to work on pro-social motivations in inter-firm cooperation (Adobor 2005; Fehr and Gelfand 2012; Salvato et al. 2017).

2 Alliance Dynamics and Competition

How partners behave in the post-formation phase is crucial for alliance success (Bakker 2016; Doz and Hamel 1998; Gulati et al. 2012). After establishing the general parameters of the alliance in the design phase, partners need to make ongoing contributions to the alliance (Greve et al. 2010). Formal (contractual features) and informal (trust) governance mechanisms contribute to the running of an alliance, as does the level of competition among alliance partners. The interplay of *formal governance, trust mechanisms, and competition* affects partner behavior and ultimately alliance success over time. We discuss each of them in turn.

2.1 Addressing Cooperation Challenges in Alliances

Cooperation requires that parties pursue a common goal and share an understanding about contributions and gains (Gulati et al. 2012; Salvato et al. 2017). How, then, can partners maintain their engagement and contributions if contributions may not be reciprocated? Maintaining cooperation requires addressing a tension between the individual and collective (alliance) interest (Martinez-Vaquero et al. 2015; Zeng and Chen 2003). This tension pits cooperation—behavior maximizing collective payoffs—against self-interested behavior—defecting in contributions, retaining essential resources, under-staffing joint teams etc.

The tension between individual and collective interests is stronger with more alliance partners (García-Canal et al. 2003; Van de Ven 1976) that bring interaction complexity (Gong et al. 2007; Park and Russo 1996) and exacerbate concerns about opportunism (Doz and Hamel 1998), making multi-partner alliances inherently less stable than dyadic ones (Heidl et al. 2014; Gong et al. 2007).

Fonti et al. (2017) find that free-riding hinders multi-party alliances' effectiveness if partners have either a very high or low perception of the other parties' contributions. Contribution rates decline when partners feel the other collaborators over- or under-contribute in research consortia.

Prior work on cooperation in alliances cites two factors as essential to maintaining cooperation: formal governance and trust (Cao and Lumineau 2015; Faems et al. 2008; Li et al. 2010; Lumineau 2017; Poppo and Zenger 2002).

Formal Governance. Formal governance comprises official and written agreements to regulate partners' duties and responsibilities, reduce opportunism, and control risk (Higgins 2007; Lui and Ngo 2004; McCannon et al. 2018; Reuer and Ariño 2007; Williamson 1991).[1] Most formal governance mechanisms are captured in contracts. *Inter alia*, contracts specify appropriate responses to possible collaboration breakdowns (Helm and Kloyer 2004; Weber and Mayer 2011). Contracts are legally binding and assign control rights, specify the expected effort through milestones, and formalize the division of rent, penalties, and remedies in case of opportunistic behavior (Adegbesan and Higgins 2010; Higgins 2007).

Formal agreements also specify partners' commitment and expected contribution to the partnership as well as their rights to a share of the value created (Panico 2017; Poppo 1995; Reuer and Ariño 2007). Specifically, termination rights for the alliance partners (Lerner and Merges 1998; Sampson 2004) and their economic significance (Comino et al. 2010) can deter opportunistic behavior and enforce collaboration. Specifically, one party can threaten to dissolve the alliance if a particular contribution level is not met. Their economic significance in the form of breakup fees can increase commitment in the alliance as higher cost from divestment and exit penalties imply lower profits outside the alliance, which discourages partners from terminating it.

[1] The literature refers to formal governance as "formal contract", "legal contract", and "legal safeguards" (Cullen et al. 2000; Schermerhorn 1975).

However, contracts and legal clauses may leave gaps in the formal agreement that the partners may opportunistically leverage (Crocker and Reynolds 1993). Hence, formal governance is often combined with informal instruments such as trust (Das and Teng 1998; Gulati 1995; Lui and Ngo 2004; Parkhe 1998).

Informal Governance and Trust. Informal governance encompasses social relations, shared norms, and trust that reinforce positive interactions between partners (Dyer and Singh 1998; Krishnan et al. 2006; Poppo et al. 2008; Vanneste et al. 2014).[2] Partners can link mechanisms reinforcing altruistic and pro-social attitudes to encourage behavior in the spirit of the alliance (Bakker 2016; Das and Teng 1998; Das and Teng 2000; Lui and Ngo 2004). Particularly, trust can shape alliance dynamics and long-term interactions (Cullen et al. 2000; Fehr and List 2004; Krishnan et al. 2006; Poppo et al. 2008; Vanneste et al. 2014).

Trust is the confidence in partners' goodwill and the belief that they will contribute to the shared goal (Das and Teng 1998; Salvato et al. 2017). It triggers pro-social behavior, enhances interdependence and collaboration (Kretschmer and Vanneste 2017) and reduces cultural conflicts (Adobor 2005; Das and Teng 2001; Parkhe 1998). The effectiveness of trust as a collaborative mechanism often relies on the credibility of threats and promises to contribute (for example, in tit-for-tat strategies). Contributions may fall short because of a lack of trust caused by poor inter-organizational knowledge and inadequate clarity on the shared goals (Oliveira and Lumineau 2019). Standard rules and social ties among partners (Gulati 1995) can also drive trust. Trust can further be self-reinforcing (Adobor 2005; Faems et al. 2008) and establish confidence in partner contributions (Das and Teng 1998; Mellewigt et al. 2007), which supports a willingness to share information and make relationship-specific investments (Gulati 1995; Lui and Ngo 2004).

[2] Scholars have also called this "relational governance", "relational mechanisms", and "social control mechanisms" (Cao and Lumineau 2015; Long and Sitkin 2018).

However, just as trust can emerge through repeated interactions (Das and Teng 1998), it can also be destroyed in the course of an alliance (Dyer and Singh 1998). Trust often already declines in the partnership's early stages when inter-organizational performance is low and partners develop distrust (Vlaar et al. 2007; Zaheer et al. 1998). Hence, early-period trust is key to build momentum when uncertainty about the partners' actions is high (Krishnan et al. 2006). Contractual governance can support collaboration once trust has declined (Connelly et al. 2012; Das and Teng 2001; Sitkin and Roth 1993). Formalizing tasks contractually can shape beliefs about partners' goodwill and ability to cooperate (Long and Sitkin 2018; Weibel 2007; Williamson 1991).

To repair damaged trust, collaborators can implement solutions that involve the partners' cognitive process, the restoration of social dynamics, and structural remedies (Dirks et al. 2009). Trust repair relies on the transgressor's pro-active engagement in the exchange and the offended party's willingness to forego retaliation to re-install cooperation. This can revert a trust-damaged relationship through forgiveness—the willingness of a party to cooperate after a partner's exploitative behavior (Laifa et al. 2018; McCullough et al. 1997; McCullough et al. 2011; Wieselquist 2009).

Forgiveness has been studied in social psychology (Leunissen et al. 2012; Wallace et al. 2008), repeated game theory (Fudenberg et al. 2012; Gibson et al. 1999), and evolutionary game theory (Martinez-Vaquero et al. 2015; Okamoto and Matsumura 2001), where it is a means to reinstate cooperation after partners' defection in repeated games. Work in social psychology has analyzed the behavioral antecedents of forgiveness such as apologies, empathy, rumination, and existing relationship quality (Wieselquist 2009; Bottom et al. 2002) and its psychological and behavioral consequences, such as repentance and recidivism. Research in repeated and evolutionary game theory has also studied (costly) apology (Martinez-Vaquero et al. 2015; Okamoto and Matsumura 2001). However, it has centered on the fitness and stability of forgiving strategies, the usefulness of forgiveness when partners' actions are imperfectly observed, and the use of forgiving strategies by

participants in experiments (Fudenberg et al. 2012; Okamoto and Matsumura 2001). However, we know little about the use of forgiveness to restore trust in alliances.

Trust allows for relational alliance governance that can complement formal governance (Das and Teng 1998; Lui and Ngo 2004; Parkhe 1998; Poppo and Zenger 2002). Indeed, formal or relational governance are not independent choices. Formal governance can affect relational governance, hampering or enhancing trust (Fehr and List 2004; Malhotra and Murnighan 2002; Lumineau 2017; Gulati and Nickerson n.d.). Conversely, existing informal ties between alliance partners can shape the formal agreements put in place for the alliance (Cao and Lumineau 2015; Gulati 1995).

2.2 Example

As an illustrative example, consider the electric vehicle (EV) industry. Alliance rates have risen dramatically to complement incumbent know-how and assets with non-competing partners' competencies and technologies. For example, GM and LG signed a collaboration agreement in 2019 worth $2.3 billion to share expertise and investment costs for developing the electric and autonomous vehicle segments. Agreements to collaborate can also involve rival automakers. In 2009, Tesla and Daimler signed an agreement to cooperate. The partnership formalized their long-term commitment to integrating Daimler's lithium-ion pouch-cell battery technology in Tesla's S-Model and Tesla's battery pack and charging electronics into Daimler's "Smart ForTwo" project. Similarly, in 2019 Ford and Volkswagen signed a wide-ranging partnership including shared capital investments into a platform initially developed by Volkswagen. Some partnerships also extend to multiple partners. An example is the Corporate Electric Vehicle Alliance (CEVA), where companies such as Amazon, Hertz, Siemens, DHL, Uber, and Ikea collaborate to accelerate the transition to EV technologies and infrastructure. Commitments to align incentives often take the form of investments in joint facilities or partner's equity stakes and contractual clauses that specify rights and duties as well as

fees in case of a breach of the agreement (i.e., formal governance). The logic of these mechanisms is to foster long-term collaboration by making it costly to break up the alliance.

The Ford-Volkswagen alliance is likely more competitive than the LG-GM partnership in the post-formation stage, which creates a different climate for incentive alignment (Lavie 2007). Among close rivals, knowledge generated within the alliance may have immediate applicability for the individual firms, and staffing engineers to work for the alliance goals directly implies that they are not available for similar tasks within the contributing firm. Thus, cooperating has higher opportunity costs and free-riding is more beneficial in alliances among close competitors. At the same time, rivals may have a shared understanding of what a successful alliance looks like and may have a history of shared interactions (Gulati 1995). Therefore, both the nature of alliance and the way in which the formal and informal governance mechanisms work may differ between the Ford-Volkswagen and the LG-GM alliances.[3]

Among rivals, the co-existence of both competitive and cooperative intentions makes interaction more complex and the tensions between individual versus collective interests are amplified (Lavie 2007). This degree of competition within an alliance can significantly shape partners' strategies (Brandenburger and Nalebuff 2011; Park and Ungson 2001), and the extent to which one partner's payoffs in an alliance come at the expense of others will affect both rent generation and division (Bourreau and Doğan 2010; Dawid et al. 2013). As a case in point, repeated interactions among rivals may trigger a race to out-learn each other (Hamel 1991; Arora et al. 2020). Frequent exchanges make sharing strategic (and proprietary) knowledge with rivals more likely (Inkpen and Tsang 2007; Russo and Vurro 2019). The extent to which this knowledge can be appropriated by rivals depends

[3]Note that the *nature* of an alliance (high or low competition) may depend on other factors too. In the Appendix we offer a simple model linking *within-alliance* competition to *product market* competition, but this link is not material to our interest in within-alliance behavior conditional on within-alliance competition, which is what we explore in our experiment.

on the complexity of the organizational process, bargaining power, and alliance stability (Doz 1996).

Clearly, there is wide heterogeneity in alliance membership, design and the level of competition within the alliance. To address our main questions of how alliance governance mechanisms affect alliance behavior and success across different levels of competition, we create two scenarios, high and low competition within the alliance (with different payoff structures), and run a lab experiment that captures, in stylized form, some key parameters in these alliances: (1) How easy is it to leave the alliance, and (2) how many partners are there in an alliance? Given our experimental setup, we can study these different alliance designs without issues of self-selection, and we can observe nuanced behavior by alliance partners over time.

3 Experiment

Our experimental setting captures some key dimensions of the reality of the post-alliance formation phase. We assume that day-to-day decisions regarding one firm's alliance behavior are taken by an alliance manager who responds to economic incentives.[4] The alliance manager needs to understand the agreement's economic and financial implications, consider potential undesired effects from competition, and the legal consequences from termination. When interacting with alliance partners, the alliance manager chooses whether to contribute to the partnership as planned in the budget, reduce the investments, or terminate the agreement, for example if the operations and production units raise concerns on the project advancement. Clearly, while our experiment abstracts from the real world, it reproduces essential traits and key decisions in repeated interactions within our scenarios.

[4]Interviews with two managers responsible for alliances and business development in large organizations confirm this notion (more details and qualitative evidence are in the Appendix). Moreover, we consulted numerous job ads for alliance managers describing the main general assignments and tasks of the role.

3.1 Alliance Game

Our general setup has the following elements:

- Every round, each partner can either contribute resources to the alliance (C) to increase demand for their products, not contribute (nC), or unilaterally break up the alliance (B). C implies contributing to the alliance in 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 formal terms of the contract.

- The per-period payoff to a partner is composed of four elements:

  - Profits, $\pi(\tilde{a}, m)$, which depend on demand, $\tilde{a} > 0$, and the per-unit price-cost margin, $m > 0$. Both partners' decisions determine overall demand. Market conditions determine the price-cost margin. From a baseline demand, a, in the absence of an alliance or in the event of breakup, demand increases to $a + g \cdot k/N$ if g out of N partners contribute ($g < N$), and to $a + k + s$ if all N partners contribute. Parameter s indicates synergies from full collaboration, and they only materialize when all alliance partners contribute (Agarwal et al. 2010).

  - A baseline cost, F, of keeping the alliance going. Unless breakup is chosen, this cost is borne by all partners regardless of their choice.

  - A cost of contributing resources to the alliance, e, if C is chosen. Alliance partners control their own resource contributions, and the decision to contribute resources carries a private cost of e monetary units.

- A per-period breakup cost, $b \geq 0$. In the experiment, we use a one-off cost that reflects the discounted per-period cost of b.

- Decisions in each round 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 hard to observe and specify ex ante.[5] Action interdependencies make it even more difficult to measure separate contributions immediately (Gulati and Singh 1998; Kretschmer and Puranam 2008).

- All value created in alliances is shared by all alliance partners. 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."

Table 1 summarizes per-period decisions. Choices and payoffs given in the table are symmetric across partners. See the Appendix for a full exposition of our model.

[Table 1 about here.]

The competitive nature of the alliance depends on the payoff structure, which *inter alia* can depend on the degree of product market competition between alliance partners. As we show in the model in the Appendix, alliances can either be stag hunt-type games (with multiple equilibria) or prisoner's dilemma-type games (where the one-shot dominant strategy is to choose nC), depending purely on the degree of competition in the product market and the corresponding payoffs. Accordingly, we label stag hunt games as facing *low competition* and prisoner's dilemma games as facing *high competition*. While the degree of product market competition can translate directly into a more or less competitive alliance (see Appendix), the level of competition *within the alliance* can

[5] Some 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.

also be driven by other aspects, like the process of generating synergies, cultural issues or the alliance partners' objective functions. What matters for us is that in one setting, payoffs within the alliance can be gained at the expense of others (high competition), while in the other, there is no incentive to unilaterally deviate (low competition). Importantly, this does not matter if all partners cooperate (where full synergies are realized) or none do (where no synergies are realized). Indeed, both games give identical payoffs for full and no cooperation.

The one-period interaction, or *stage game*, is repeated an ex-ante unknown number of times. The process of repetition is eventually stopped by chance.[6] Once partners have made their choices and received their payoff for the period, a random number between 1 and 10 is picked and the alliance game is terminated if the realized number is 10, while it continues otherwise. This termination is definite: the alliance is dissolved, partners receive no further payoff from the alliance, and participants are re-matched to start a new alliance game if there is time remaining in the experimental session. This is different from endogenous breakup B, where partners continue to receive (outside) payoffs until the alliance is terminated randomly.

Formal governance and termination. Participants can choose B to unilaterally terminate the alliance in each period. This is irreversible and partners "go it alone" for the rest of the game. After terminating, players do not take any further decisions.

Choice B may be cost-free or may carry a positive one-off cost for all partners. We label the latter the *termination clause* setup. This cost captures, for example, the need to dismantle alliance-

[6]This random termination corresponds to a future that is uncertain and always has the potential of seeing *one more interaction* with partners. This gives the theoretical possibility that partners cooperate in the repeated game even if they would not cooperate in the stage game. If we assume agents in the game to be expected utility maximizers, random termination is equivalent to assuming that agents who discount the future are involved in an infinite interaction.

related infrastructure or organizations and is formalized by termination clauses (Comino et al. 2010; Reuer and Ariño 2007). All partners bear this cost when a termination clause is in place. In the experiment, we reduce the payoff from choice B by an amount b that delivers the contractual one-off cost in expectation. Once partners choose B, their profits do not include the synergistic benefits from the alliance anymore.[7]

Bilateral alliances. Table 2, Panel (a) shows the implementation of the one-period interaction of two alliance partners facing high competition. This game is analogous to the representation of alliances used in Arend (2009) and, without the breakup option, resembles a prisoner's dilemma. This game has characteristics representing an alliance interaction (Agarwal et al. 2010). The game with *no termination clause* is shown in the left matrix, and the game with a termination clause is on the right.[8]

[Table 2 about here.]

Multilateral alliances. In multilateral alliances, partners must coordinate on any punishing action to non-cooperative partners, introducing a further barrier to alliance success. We thus expect the effect of formal governance with termination clauses on alliance success and dynamics to be different in bilateral than in the three partner alliances described in Figure 3, panel (a).[9]

[7] The Appendix gives the instructions about termination and the relative payoffs.

[8] The parameters that generate this setup are $a = 2.5, k = 6, s = 4$, and $m = 2/3$. The chosen per-period cost of breakup of 1 corresponds, in expectation, to a one-off cost of breakup of 10.

[9] Conceptually, in a dynamic interaction where partners may behave "conditionally", responding to past behavior of others, multilateralism introduces a coordination problem. After a partner misbehaves in a given period, the other partners who wish to punish such behavior must tacitly decide who is to bear the cost of such punishment. The change from two to three partners captures the gist of this difference between bilateral and multilateral alliances.

Level of competition. Based on our formalization, we have two different stage games with different strategic properties. Table 2, Panel (a) reflects high competition alliances, and Panel (b) of Table 2 shows the stage game for our low competition bilateral treatments without (left) or with (right) termination clause. Under low competition, partners have stronger incentives to contribute resources to the alliance. The low competition setups for multilateral alliances are in Table 3, Panel (b).

[Table 3 about here.]

3.2 Sampling and Framing

Given the above baseline setup and the variations, we have eight different scenarios ($2 \times 2 \times 2$): Two levels of termination costs, two values of the number of alliance partners, and two levels of competition. We ran two sessions for each setup-treatment combination, giving a total of 16 experimental sessions. All sessions were run at Melessa, the Experimental Social Sciences Laboratory at LMU Munich. Experiments were programmed and conducted with zTree (Fischbacher 2007) and the participant recruitment software used was Orsee (Greiner 2015).[10]

We recruited participants from a general subject pool, including non-students. However, only 1.04% of participants were non-students, and 6.23% did not declare a field of study.[11] Assignment of participants to setups and treatments was random; we split our sample for each treatment into two sessions to minimize weekday and time biases in our sampling. The fraction of female participants

[10] All zTree scripts are on the Cern public knowledge repository, Zenodo, and are available for download at `https://doi.org/10.5281/zenodo.5067689`.

[11] Among those who declared a field of study, 31.4% were in Economics and Management, 14.9% in Engineering, Computer Science, and Technology, 10.9% in Sciences, 8.1% in Sociology and Psychology, 7.8% in History and International Studies (languages, philology, geography), 6.8% in health-related studies, 6.7% in Law, 5.6% in Education and Pedagogy, and 7.3% in other humanities.

was 58.2% overall, average age was 24.8 and median age was 23.

Our approach is methodologically close to other experimental work on alliances, rooted in the experimental economics tradition, and thus based on the principle of *induced value*. We induce value by paying participants according to their decisions and those of other participants (their alliance partners), thus attaching real monetary consequences and risks to their choices (Smith 1976). Lab experiments do not intend to acquire data *in the wild* but to isolate certain characteristics of a problem and understand their functioning. This logic underlies the principle of induced value, and the importance of having a participant pool truly affected by the within-experiment consequences of their actions.[12]

We framed the experiment with the language pertinent to our application. Hence, in the instructions we told participants that they were playing the role of firm managers involved in an alliance where resource contribution decisions need to be made in every period of an interaction with unknown duration. The framed situation and payoffs followed the alliance configurations given in section 3.1.

3.3 Other Experimental Details

Alliances, interactions, and partner matching. In a single experimental session, a single subject partakes in several consecutive alliances. The duration of each alliance and the total number of alliances a subject participates in is unknown ex-ante. When an alliance ends, time permitting, a new alliance starts with randomly-chosen partners among all subjects in the session. To enable random matching and re-matching of subjects in consecutive alliances, all subjects in a session

[12]Induced value relies on the assumption that the change in *utility* due to a change in choices made in the experiment follows the same direction as the changes in *payoff*. There is no guarantee that this will be the case, especially in the presence of pro-social or altruistic participants. However, if the changes in payoff are significant to the participants, there is a higher chance of this happening.

experience the same number and length of alliances, in the same order. We call each realization of an alliance length for all subjects in the lab an *interaction*.[13]

Random duration. To maintain credibility regarding the randomness of interaction duration, participants were given a time limit (45 minutes) after which no new interactions were initiated. They were further told that if the last initiated interaction went on beyond a *reasonable* time, the experiment would be continued at a later time convenient for all participants. The random duration of interactions was determined in the first two sessions we ran. This gave us two *interaction draws*, (a) and (b), that we replicated in all future sessions to enhance comparability of our data. Each setup and treatment was run under both interaction draws.

Instructions. Participants in our sessions were given print-out instructions plus abridged instructions via the interface each time they were prompted to make a decision. We kept instructions short and used interactive examples to enhance understanding. In each period of a session the experimental interface reminded participants about key aspects of the strategic situation: the payoffs corresponding to each combination of partner and own choices; whether partners were the same as before or new; that the current period had a 0.1 chance of being the last; and that a breakup choice would be irreversible.

Entry test and exit questionnaire. To test participants' understanding of the instructions, we started the computerized part of each session with three examples containing questions. Participants' answers were immediately checked and they received feedback via the computerized interface stating whether their answers were correct or not and giving a brief explanation. After each ses-

[13]Consider an example with 24 subjects. They can be initially matched into 12 bilateral or 8 multilateral *alliances*. If these initial alliances terminate after 5 periods, we say the first *interaction* of this session had 5 periods. If the session ends up having 7 interactions, data will be collected on 84 (if bilateral) or 56 (if multilateral) alliances.

sion participants took an exit questionnaire with demographic characteristics (gender, age, and field of study) and questions about the decisions made during the session. Descriptive analysis of questionnaire responses (in the Appendix) did not generate any further insights.

4 Results

We recruited 376 subjects and ran 16 experimental sessions. Table B.1 in the Appendix summarizes subject characteristics and payoff information for each session. Overall, including the €4 show-up fee, median subject payoff was €20.55, with payoff variation across sessions driven by treatment effects. We start by looking at the aggregate success of alliances, with a focus on *if* and *how* partner contributions are affected by treatment variables (termination clauses and number of partners) in our two competitive settings. Cooperation challenges exist in all alliance setups, but we expect that in high competition alliances, alliances will find it harder to achieve good outcomes. Our unit of analysis in most of this section is the *alliance*. However, to analyze trust, we study individual and joint choices over time in Sections 4.2.1 and 4.2.2.[14]

4.1 Collaboration and Competition

To study overall alliance success, we measure resource contributions by all partners: *collaboration*, the share of alliance periods in which all partners contribute. Another view on alliance performance, linked to our formal governance treatment, is whether partners break up the alliance prematurely. We measure this with *breakup*, a dummy equal to 1 if partners choose premature breakup, and 0 otherwise.

Table 4 shows collaboration in low and high competition alliances across our four different

[14]The basic datasets of per-alliance and per-partner data, from which all results are generated, are available on Zenodo at `https://doi.org/10.5281/zenodo.5067695`.

alliance designs. Clearly, alliances where participants face low competition levels perform better than those where competition is high. Average collaboration in low competition alliances ranges between 75% (in the multilateral-no termination clause design, hereafter MnT) and more than 95% (in the bilateral-no termination clause and bilateral-termination clause designs, hereafter BnT and BT). For high competition alliances, average collaboration is substantially lower and its range much wider: starting from 12% (MnT), reaching 27% (multilateral-termination clause design, hereafter MT), then 63% (BnT), and finally almost 87% (BT).

Alliance design matters differently for the two levels of competition. Panel (a) of Table 4 shows that for low competition alliances mean collaboration does not differ across termination clauses, as indicated by the insignificant differences and small effect sizes reported in the far right columns. The same columns of Panel (b) show that for high competition alliances termination clauses lead to significantly more collaboration. For both levels of competition and differences in termination clauses, multilateral alliances collaborate significantly less (t tests in Table 4), and effect sizes are substantial.[15]

[Table 4 about here.]

Panels (a) and (b) of Table 5 show a similar pattern for the frequency of breakups: for low competition alliances, termination clauses make no significant difference, whereas a higher number

[15] Alternatively, one can compare the entire distribution of collaboration across treatments. While this can be done with Mann-Whitney Wilcoxon or Kolmogorov-Smirnov tests (both corroborate t-test results), the approach presented in online Appendix D is better adapted to the characteristics of our data. Collaboration is almost binomially distributed: 419 out of 501 low competition alliances always contribute (collaboration = 1) and 42 never contribute (coll.= 0); 239 out of 508 high competition alliances always contribute (coll.= 1) and 211 never contribute (coll.= 0). We thus alternatively measure alliance success with *continued collaboration*, a dummy equal to 1 if partners contribute to the alliance in every period, and 0 otherwise. In Appendix D we present descriptive statistics and treatment effect tests for this measure.

of partners leads to more frequent breakups (see χ^2 tests in the rightmost column and bottom row of panel (a)). For high competition alliances, termination clauses lead to significantly less breakup. Indeed, the breakup frequency drops from almost 35% in BnT alliances to about 5% in BT alliances and from almost 85% in MnT alliances to less than 30% in MT 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 5 about here.]

In sum, formal governance through termination clauses is a key factor in improving the performance of high competition alliances whereas it makes no difference in the performance level of low competition alliances. Comparing bilateral and multilateral alliances, we find that multilateral alliances are significantly less successful than bilateral ones.

Table 6 summarizes these results in a regression format, which lets us include control variables and consider potential serial correlation within sessions. Since experience may matter for partner behavior in our experiment, we control for the type of experience (interaction draw) and the level of experience (interaction number) from which each alliance in the sample is drawn. Standard errors are clustered by session since matching and re-matching lead, ex-post, to randomization of treatments at the session level (Abadie et al. 2017). The first two columns of Table 6 show how our two measures of performance—collaboration and probability of breakup—are driven by alliance design and level of competition. For collaboration we use OLS, and we estimate the breakup probability via a logistic regression.[16] The baseline is a low competition BnT alliance and coefficients should be measured against the success of this competitive environment and alliance design.

[Table 6 about here.]

[16] Coefficients of the logistic regression are expressed as odds ratios: a coefficient > 1 means that odds increase and a coefficient < 1 means that the odds of breakup decrease.

In the first column of Table 6, we see that termination clauses increase the frequency of success by 11%, having more partners in the alliance decreases it by almost 37% and being in a high competition alliance decreases it by 35%. The second column shows that termination clauses reduce the odds of breakup by about 87%, while being in a multiparty alliance increases the odds seven-fold, and operating a high competition alliance by a factor of 12. All coefficients are significant at the 1% level.

Including interaction effects (columns 3 and 4 of Table 6), we see that governance through termination clauses only influences performance in high competition alliances. The main effect of termination clauses disappears, but the interaction of termination clauses and high competition is significant, and the effect size (0.232, third column) is larger than the effect of termination clauses without interaction (0.11, first column). There is an additional negative effect on collaboration of multiple partners in high competition alliances (-0.316 in column 3, significant at the 1% level), but not on breakups. Other interaction effects are not significant.

We also address the concern that termination clauses may lead to "zombie alliances", i.e., essentially failed alliances that continue to exist despite participants not cooperating. We do so by looking at the frequency of failure—the fraction of all interaction periods where all partners of an alliance choose nC. Both for bilateral and multilateral alliances, termination clauses increase the frequency with which alliances fail, but the difference is significant only for multilateral alliances.[17] This means that the effect of governance through termination clauses for multilateral alliances is ambiguous in that it increases collaborative behavior among alliance partners, but it also increases the likelihood of a "zombie alliance" in which participants have given up on collaborating, but do

[17] In bilateral alliances, the average frequency across all alliances increases from 0.05 to 0.07 with termination clauses. In multilateral alliances, the increase is from an average 0.05 to 0.28. Mann-Whitney Wilcoxon tests of equality across treatments of the distribution of frequency of failure rejects the null at a significance level of 0.01 for multilateral but not bilateral alliances.

not terminate the alliance.

4.2 Trust

Our experimental setup lets us establish a causal effect of the relationship between cooperation and competition on alliance performance (section 4.1). We explore possible explanations for these effects by looking at the effects of trust-building and trust repair.[18] To do so, we disaggregate data to study *individual behavior* in *time*. Note that we define trust as a behavioral outcome, not a theoretical attitude. Hence, trust in our study is *enacted*, i.e., manifested in behavior that makes the trusting party vulnerable to exploitative behavior of others.

Trust-building emerges at the outset of an alliance (i.e., without any behavioral cues or experience about the partners' behavior), and we analyze it by measuring *first-period trust*—cooperative behavior from the onset of the relationship. First-period trust reflects the focal (cooperating) player's positive expectation that their partner(s) will cooperate in a particular context (Sitkin and Roth 1993; Vlaar et al. 2007). We expect that alliance design will affect expectations about partners' behavior, own behavior, and, consequently, first-period trust.

Trust repair emerges in subsequent and unstable periods (i.e., when one or more alliance partners do not cooperate), and we operationalize it by measuring *forgiveness*—cooperation after a partner's exploitative behavior (Laifa et al. 2018; Wieselquist 2009). *Exploitation* in our setting occurs when one partner (the exploited party) chooses C while at least one other partner chooses nC. Exploitation precedes *forgiveness*, which is the deliberate choice to cooperate after having been exploited. We expect alliance design to affect how partners react to other partners' past misbehavior. Termination clauses, for example, may increase partners' willingness to forgive to avoid breakup and attempt to restore long-term cooperation.

[18] A complementary analysis on the dynamic behavior of alliances is in Appendix E.

While trust-building is forward-looking and helps establish a positive alliance climate from the start, trust repair indicates a return to collaboration after a (temporary) breakdown in cooperation. We first explore whether alliance design affects these two features and then whether this behavior carries over to alliance success.

4.2.1 Trust-Building - First Period Contribution

There are no significant differences in first period behavior across different settings of formal governance for low competition alliances (panel (a) of Table 7). However, panel (b) of Table 7 shows that termination clauses significantly affect first period behavior of single partners in high competition alliances. Indeed, the distribution of actions has more C, less nC and less B when there is a termination clause (χ^2 tests in last column). These differences are strongest for bilateral alliances. Comparing bilateral and multilateral alliances, both panels (a) and (b) show significant differences, with bilateral alliances having more collaboration (choice C) in the first period. In sum, the average effects identified earlier are reflected in first-period behavior.

Joint first period behavior also significantly differs across treatments.[19] Our findings provide an empirical characterization of Connelly et al. (2012), who study the context-specific trade-off between trust and formal governance. The effects of termination clauses and trust-building depend especially on the degree of competition.

[Table 7 about here.]

[19] The odds of joint choice of C by all partners in the first period of the alliance fall by 75% when low competition alliances are multilateral instead of bilateral. Here, termination clauses have no significant effect. For high competition alliances, having multiple partners reduces the odds of joint first-period contribution by over 90%, while termination clauses triple the odds.

4.2.2 Trust Repair - Forgiveness.

We now look at *forgiveness*, which occurs when a party that has been offended or exploited foregoes retaliation and responds cooperatively towards the offender (McCullough et al. 1997; McCullough et al. 2011; Wieselquist 2009).

To observe forgiveness, we must first observe non-contribution. Non-contribution is infrequent in low competition alliances, hence the sample is small, reducing statistical power. Panel (a) of Table 8 shows that the difference in forgiveness in low competition alliances across alliance designs is small in magnitude and statistically insignificant. Conversely, panel (b) of Table 8 indicates significant differences in forgiveness across alliance designs in high competition alliances, where specifically multilateral alliances with a termination clause perform best (and differences with other settings are statistically significant).

Forgiveness thus emerges as a trust repair mechanism in unstable alliances. This is consistent with research in social psychology and evolutionary game theory, where although forgiveness can cause short-term loss, restoring cooperation can lead to long-term gain (Zagorsky et al. 2013).

[Table 8 about here.]

In sum, both first-period behavior and forgiveness are similar across different designs of low competition alliances, while alliance design in high competition alliances triggers significant differences in both types of trusting behavior.

4.3 Mediation Effects on Trust-Building and Trust Repair

In Section 4.2 we studied how alliance design affects first-period trust and forgiveness. We now link these behaviors back to the ultimate objective, *alliance success*. Mediation analysis (Imai and Yamamoto 2013) is a useful tool for this as it lets us break down the *total effect* of alliance design

on alliance performance into a *mediated effect* carried by the proposed mechanisms (e.g., alliance design affects first-period trust, and first-period trust in turn affects cooperation), 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 performance (cooperation) on alliance design (dummies for termination clause and multilateral alliance), the mediator (either first-period trust or forgiveness), and control variables (competition level, interaction draw, and interaction) with the results of separate regressions of each mediator on alliance design and control variables. The latter regressions show the effect of alliance design on each of our proposed mediator variables. The former uncovers the effect of the mediator on alliance success. Tables 9a and 9b show the mediating role of first-period trust and forgiveness, respectively.

We modify the variable for alliance success—collaboration—to exclude first-period behavior, since this is one of the mediators we study. To account for the possibility that in the full sample forgiveness is highly correlated with non-contribution (forgiveness can only occur if previously a partner cheated), we study this mediator in a reduced sample including only alliances with at least one instance of non-contribution. While our analysis so far shows that finding meaningful treatment effects depends on whether we consider low or high competition alliances, there is no conceptual or statistical reason to believe the role of mediators to differ across competition levels. In fact, instances where the treatment has no effect will be ignored in mediation analysis. We thus merge high and low competition alliances for mediation analysis, but control for competition in all regressions.

[Table 9 about here.]

First period trust is a significant mediator of both the effect of termination clauses and the number of partners. Governance through termination clauses significantly increases collaboration, while adding a third partner significantly decreases it. Over 70% of these effects is mediated by the

effect of termination clauses and number of partners on first period trust.[20]

Conversely, forgiveness is a significant mediator of the effect of termination clauses only, for which it mediates 40% of the total effect. Importantly, the mediation analysis of forgiveness, restricted to alliances with at least one case of non-contribution, captures alliance design effects on the success of *imperfect* alliances. This is different from the analysis of first period trust, which mainly captures the effect of design on the emergence of *perfect* alliances. Formal governance has a positive effect in both cases, first by changing attitudes toward the alliance from the onset and second by increasing forgiveness when partners are opportunistic.

Having an alliance with more than two partners changes behavior at the alliance onset and consequently leads to an increase in non-collaborative alliances. However, it does not reduce partners' willingness to forgive, so that forgiveness is not a mediator of the negative effect of the number of partners on alliance success.[21]

5 Discussion and Conclusion

Prior work has discussed the conditions for maintaining cooperation once an alliance has been established (Gulati et al. 2012). Contractual features and trust help partners avoid frictions (Lumineau

[20] We also run separate analyses for high and low competition. The effect of termination clauses is approximately 68% mediated by first period trust in high competition environments, and cannot be identified in low competition since there termination clauses have no effect on alliance success. The effect of a third partner is approximately 78% mediated by first period trust in high competition environments, and 55% in low competition environments.

[21] This is supported by the (unreported) finding that forgiveness positively affects collaboration among imperfect alliances, but forgiveness is not significantly affected by the number of partners. A robustness check of mediation analysis using one level of competition at a time corroborates this: For high competition, forgiveness mediates 36% of the effect of termination clauses and none of the effect of the number of partners. For low competition, forgiveness mediates none of the effect of number of partners and the mediation role for commitment cannot be established, since commitment has no effect on alliance performance in this case.

2017; Poppo and Zenger 2002). Formal and informal governance instruments are potentially more needed in multi-sided partnerships, where the risk of partner opportunism is higher (Fonti et al. 2017).

We explore how these mechanisms work for different levels of competition within an alliance. Higher competition between partners weakens alliance stability because of the increased odds of opportunistic behavior. Shared values and trust may also be more uncertain when partners are rivals (Cao and Lumineau 2015). Considering only the incentive alignment among partners—that is, how they cooperate through formal and informal governance—without its connection to rent sharing may offer just a partial understanding of the conditions for alliance success, but existing research has often considered these themes in isolation (Cao and Lumineau 2015; Hoffmann et al. 2018; Lavie 2007; Salvato et al. 2017).

In a lab experiment, we consider formal governance in the form of termination clauses and the number of alliance partners as different alliance design features. We let participants interact repeatedly to study trust as an informal mechanism to manage cooperation. Our effects are contingent on the level of competition. In our experiment, competition between alliance partners takes two forms, each with different payoff structures. Our low competition alliances resemble a stag hunt game, while high competition alliances resemble a prisoner's dilemma.

We find that formal governance in the form of costly termination clauses increases the odds of collaboration for high competition alliances. Low competition alliances respond less to this form of incentive alignment. This relates to the few studies that have considered partner rivalry in tandem with other features as determinants of alliance success (Kale et al. 2000). Our finding aligns with Panico (2017) in highlighting the role of both design mechanisms and rent division between partners as drivers of alliance persistence. For high competition alliances, the positive effect of formal governance is stronger in bilateral than multilateral alliances. This adds to work on multiparty

alliances (Fonti et al. 2017) and suggests that aligning incentives through formal governance may be ineffective when multiple partners need to collaborate. Hence, alternative organizational forms and even alternative ways of managing firms in social networks rather than dyads (Gulati 1998) may be more promising than classical alliances with many partners. This is particularly relevant for research on alliances in ecosystems (Eisenhardt and Hannah 2018) and standard-setting organizations (Ranganathan et al. 2018), where value creation depends on many actors (Kretschmer et al. 2020).

As for (enacted) trust as an informal governance mechanism when competition defines the inter-organizational relationships, we document the significance of trust-building and trust repair in alliance dynamics. This is a novel contribution to the alliance literature, which has often considered trust to be a single concept. Trust-building in our setting is first-period trust that reflects the willingness to cooperate at the relationship's inception. This resembles Doz (1996) and Ariño and De la Torre (1998), who document a self-reinforcing process of alliance success and failure that consequently puts high weight on first-period behavior. Further, our results empirically complement Connelly et al. (2012)'s model of contextual trust-building, since trust building in our experiment is stronger in alliances with low competition, between a small number of partners, and being bound by strong formal governance (termination clauses).

We further analyze trust repair as a means to revert to collaboration when not contributing has disrupted cooperation. While research has mainly analyzed trust repair mechanisms in intra-organizational relations (Fehr and Gelfand 2012; Petriglieri 2015), studies on inter-organizational dynamics are scarce (Dirks et al. 2009; Zaheer et al. 1998). Trust repair in alliances emerges through forgiveness, i.e. cooperative behavior following non-contribution by the other party (Laifa et al. 2018; Wieselquist 2009). Forgiveness often occurs in the later stages of multilateral, high-competition partnerships. Here, it can help realign incentives to contribute. An important implication is that

parties do not play tit-for-tat strategies when non-contribution occurs (Zagorsky et al. 2013). Our results relate to Okamoto and Matsumura (2001) and explain how cooperation can remain due to forgiveness despite occasional opportunism.

Our work also offers a novel view of forgiveness. While there is ample evidence on forgiveness following apologies and compensations (Leunissen et al. 2012; McCullough et al. 1997) or communication (Gibson et al. 1999; Wallace et al. 2008), we define and observe it as an unconditional collaborative response to exploitation. Two features may trigger forgiveness: the path-dependency in contributions and the complementary presence of formal governance in the alliance design. Both mechanisms help decrease the focal partner's uncertainty about the collaborators' expected behavior. The path-dependency in contributions conveys information on the partners' historical cooperative attitude (Fudenberg et al. 2012), while formal governance readjusts the payoffs to increase commitment to the alliance (Das and Teng 2001; Williamson 1991). We expand on the role of the latter, offering a contribution on how these mechanisms improve the likelihood of trust repair in alliances. This adds to work on cooperation in alliances (Bakker 2016; Greve et al. 2010; Kale et al. 2000; Reuer and Ariño 2007) and in inter-organizational relationships (Salvato et al. 2017) as we show that trust repair is especially useful in unstable alliances with multiple partners. Our findings on forgiveness as trust repair mechanism can inspire work on the evolutionary and social-psychology traits of alliances, such as beliefs by looking at partners' behavior after being forgiven. Another line of inquiry originating from our study is the evolution of partners' intentions before and after forgiving behavior, and their effect on future exploitation events.

Our analysis of the effect of termination clauses on trust contributes to the debate on whether formal and relational forms of governance are complements or substitutes (Cao and Lumineau 2015; Das and Teng 1998; Gulati 1995; Poppo and Zenger 2002). We are not the first to use experiments to study causal relations along the lines of this debate, but we differ from existing studies in two

ways. First, in our setup formal governance is an exogenous manipulation, while in Malhotra and Murnighan 2002 and Fehr and List 2004, among others, it is a choice made by participants. When contractual clauses are voluntarily offered by one of the partners, they can be interpreted as signals of mistrust that can lead to a *dampening* of pre-existing relational governance (Cao and Lumineau 2015). Our experimental design shuts down this signaling channel and focuses instead on the pure effect of the contractual clauses. Second, in previous experiments, formal governance was imposed on contribution amounts, exerting control on partners' actions. The termination clauses manipulated in our work act only indirectly on partners' actions, regulating them by attaching a higher cost to an alliance being unsuccessful and terminated (shadow of the future). Differently from studies with stricter contractual terms, we find a positive effect of formal governance on trust, providing suggestive evidence for the theoretical treatment of control in Lumineau 2017.

Note some limitations of our study. In addition to the simplification and partial abstraction from real-world alliances in the experiment, we also rule out some alliance design features that may drive alliance performance and behavior. First, we do not consider communication as mechanism supporting collaboration and alliance survival. Furthermore, reputation buildup across alliances might act as a disciplining device, especially for early phases of alliances among newly matched partners. Finally, varying the extent of resource contributions and the option of dynamic investment patterns would bring added realism, especially for R&D alliances. Nevertheless, our experimental design randomly assigns partners to competitive scenarios and overcomes the selection biases that typically affect studies based on observational data. Further, by focusing on a narrowly defined 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. Future work could use simulations or vector autoregressive models to explore how changes in product market competition in alliances endogenously drive rent division and thus cooperation among parties.

Our managerial implications revolve around two themes: First, pro-social behavior within an alliance improves through formal governance. Hence, the ex-ante design of contractual mechanisms can help managers raise contributions. Second, the *design* of incentive mechanisms depends on the degree of competition between alliance partners. We suggest that high competition alliances should be more restrictive, i.e., involve fewer partners, and feature built-in formal devices to discipline partner behavior. That is, more due diligence should be exercised in such cases, because design choices will likely have a stronger impact on eventual alliance performance.

We take a first step towards a deeper understanding of the effect of formal governance, trust-building, and trust repair mechanisms on the success of alliances. We hope that our work will inspire more researchers to follow this path.

Table 1: General Alliance Game: Payoffs.

		Total number of partners choosing C: N	$g < N$	Some partner chooses B
Focal	C	$\pi(a+k+s,m)-e-F$	$\pi\left(a+\frac{g \cdot k}{N},m\right)-e-F$	$\pi(a,m)-b$
Partner's	nC	$-$	$\pi\left(a+\frac{g \cdot k}{N},m\right)-F$	$\pi(a,m)-b$
choice:	B	$\pi(a,m)-b$	$\pi(a,m)-b$	$\pi(a,m)-b$

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 2: Experimental Design. Bilateral alliances.

(a) High competition setup, without (left) and with (right) termination clause.

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

Partner 1 \ *Partner 2*	*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

(b) Low competition setup, with low (left) and high (right) termination clause.

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

Partner 1 \ *Partner 2*	*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

Notes: The matrices present the payoffs of partners 1 and 2, as a function of their choices.

Table 3: Experimental Design. Multilateral alliances.

(a) High competition setup without (left) and with (right) termination clause.

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

(b) Low competition setup, with no termination clause (left) and termination clause (right).

	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	6.5	0.5	-1.5
nC	6	4	2
B	1.5	1.5	1.5

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 4: Differences between designs: Collaboration.

(a) Low competition alliances.

		No term. clause	N	Term. clause	N	Diff. of means	Cohen's d
Bilateral	Mean	0.953	156	0.952	149	0.001	0.004
	Std. Dev.	0.197		0.184			
Multilateral	Mean	0.752	104	0.810	92	−0.058	−0.147
	Std. Dev.	0.415		0.369			
Difference of means		0.201**		0.142**			
Cohen's d		0.664		0.530			

(b) High competition alliances.

		No term. clause	N	Term. clause	N	Diff. of means	Cohen's d
Bilateral	Mean	0.634	144	0.869	156	−0.235**	−0.597
	Std. Dev	0.467		0.316			
Multilateral	Mean	0.121	104	0.267	104	−0.146**	−0.408
	Std. Dev.	0.307		0.406			
Difference of means		0.513**		0.602**			
Cohen's d		1.259		1.705			

Notes: Collaboration is defined as the proportion of periods of an alliance where $[C, C]$ or $[C, C, C]$ is played. The table reports estimated mean and standard deviation of collaboration, and sample sizes (number of alliances). Mean differences across alliance designs are reported and tested with $t-$tests. Effect sizes (Cohen's d) are also reported. * significant at the 5% level; ** significant at the 1% level.

Table 5: Differences between designs, Breakup.

(a) Low competition alliances.

	No termination clause		Termination clause		Difference test (χ^2)
	Freq.	N	Freq.	N	
Bilateral	0.038	156	0.020	149	0.89
Multilateral	0.183	104	0.098	92	2.87
Difference test (χ^2)	14.9**		7.3**		

(b) High competition alliances.

	No termination clause		Termination clause		Difference test (χ^2)
	Freq.	N	Freq.	N	
Bilateral	0.347	144	0.051	156	42.0**
Multilateral	0.846	104	0.288	104	65.9**
Difference test (χ^2)	60.9**		28.1**		

Notes: Breakup is measured as the proportion of all alliances where this choice (breakup) is made. For the Pearson χ^2 test, * indicates significance at the 5% level; ** significance at the 1% level.

Table 6: Regression analysis of success measures.

	Success Measure			
Independent Variable	Collaboration	Breakup	Collaboration	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)
Termination clause	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. × Termination clause			0.232**	0.193**
			(0.050)	(0.117)
Multilateral × Termination clause			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
N	1009	1009	1009	1009

Notes: OLS regressions of Collaboration 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 7: First Period - Trust-Building

(a) Low competition alliances.

	No termination clause				Termination clause				Difference
	C	nC	B	N	C	nC	B	N	test (χ^2)
Bilateral	0.965	0.035	0.000	312	0.973	0.023	0.004	298	1.773
Multilateral	0.917	0.080	0.003	312	0.938	0.062	0.000	276	1.664
Difference test (χ^2)		6.828*				6.083*			

(b) High competition alliances.

	No termination clause				Termination clause				Difference
	C	nC	B	N	C	nC	B	N	test (χ^2)
Bilateral	0.809	0.184	0.007	288	0.942	0.054	0.004	312	24.98**
Multilateral	0.519	0.465	0.016	312	0.615	0.378	0.007	312	6.600*
Difference test (χ^2)		55.92**				97.30**			

Notes: Relative frequencies of each choice are reported. Sample sizes correspond to the number of interactions times the number of partners per interaction (2 or 3) and are reported in columns N. Pearson's χ^2 test of difference between the distribution of first period choices for low and high formal governance alliances as well as bilateral and multilateral alliances; * significant at the 5% level; **significant at the 1% level.

Table 8: Trust Repair - Forgiveness

(a) Low competition alliances.

	No termination clause		Termination clause		Difference
	Freq.	N	Freq.	N	test (χ^2)
Bilateral	0.600	25	0.667	39	0.07
Multilateral	0.584	125	0.593	123	0.00
Difference test (χ^2)	0.00		0.39		

(b) High competition alliances.

	No termination clause		Termination clause		Difference
	Freq.	N	Freq.	N	test (χ^2)
Bilateral	0.222	72	0.286	56	0.38
Multilateral	0.258	155	0.465	297	17.35**
Difference test (χ^2)	0.17		5.43*		

Notes: Relative frequency of choice C after choosing C in the preceding period while at least one partner chose nC. Sample size corresponds to the number of periods across all interactions in each type of alliance, in which a subject chose C while at least one partner chose nC. Pearson's χ^2 test of difference of this *forgiveness* frequency; * significant at the 5% level; **significant at the 1% level.

Table 9: Causal mediated effects of alliance design on alliance collaboration.

(a) Mediator: First period Trust-Building

	Treatment variable	
	Termination clause (treatment = yes)	Number of partners (treatment = multilateral)
Total effect	0.109^{**}	-0.371^{**}
Direct effect	0.027	-0.101^{**}
Mediated effect	0.082^{**}	-0.271^{**}
Proportion mediated	$75.51\%^{**}$	$72.90\%^{**}$
Adjusted R^2 of outcome regression	0.759	
Sample size	1009	

(b) Mediator: Trust Repair - Forgiveness

	Treatment variable	
	Termination clause (treatment = yes)	Number of partners (treatment = multilateral)
Total effect	0.093^{**}	-0.165^{**}
Direct effect	0.055	-0.179^{**}
Mediated effect	0.038^{**}	0.014
Proportion mediated	$40.93\%^{**}$	-8.53%
Adjusted R^2 of outcome regression	0.192	
Sample size	315	

Notes: First period trust 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 in the alliance. 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 collaboration (excluding first period) on alliance environment and design, and on the mediator. Mediator regressions: linear regressions of mediator on alliance environment and design. We control for the level of competition, interaction draw and interaction; * significant at the 5% level; ** significant at the 1% level.

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Competition, Formal Governance and Trust in Alliances: An Experimental Study

Online Appendix

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Appendix A Mathematical Model

A.1 Basic Setup

We first describe in general the per-period actions and payoffs of two symmetric alliance partners. 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

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in 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 formal terms of the contract.

Synergies and full partnership value are only realized when both alliance 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 carries 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 specify in sufficient

Table A.1: Payoff Matrices.

(a) Basic Setup.

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

(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 A.1b) we set $m = 1$, and to reflect high competition (panel A.1c) we set $m = 2/3$.

detail ex ante.[1] Action interdependencies make it even more difficult to measure separate contributions immediately (Gulati et al. 1998; Mesquita et al. 2008; Kretschmer et al. 2008).

Table A.1a summarizes the payoffs of each firm as a function of both firms' choices within the alliance.

We assume that all value created in alliances is shared by all alliance partners. We follow Dyer et al. (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." Using the simple formalization above, it is possible to show that the nature of the alliance depends on the payoff structure, which reflects the competitive intensity in

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

the product market. We give a formal proof below, but the key insight is that alliances can either be stag hunt-type games (having multiple equilibria) or prisoner's dilemma-type games (with a typical focus on cooperation problems) depending purely on the degree of competition in the product market and the associated payoffs, with all other model and alliance design parameters the same.[2] Specifically, if competitive intensity is high, the firms are in a prisoner's dilemma-type alliance where the (one-shot) equilibrium is for no one to contribute, but this equilibrium is Pareto-dominated by all partners contributing. If competitive intensity is lower, there are two (one-shot) equilibria; all players contributing or no one contributing. Again, the former dominates the latter equilibrium.

This illustrates that the intensity of cooperation problems can significantly vary, originating from the same fundamental parameters and that the stability of alliances can change over time simply because product market competition increases or decreases and alters the payoffs. Moreover, it illustrates an interesting, but subtle point: competition will affect firm profits not only directly through profit margins (modeled as an exogenous parameter here), but also indirectly through alliance partners' optimal resource contributions to the alliance.

Table A.1 (panels (b) and (c)) gives the parameterizations we use in our experimental analysis. In Table A.1c, we show a case of high competition and low margins (case (i)), $m = 2/3$, whereas Table A.1b gives a case of low competition and high margins (case (ii)), $m = 1$. These two levels of competition will lead to opportunistic behavior.[3] In both cases, the Pareto-optimal outcome is the one in which both partners contribute.

[2]Note that product market competition is simply modeled as a price-cost margin common to all firms in the market. It does not change endogeneously with two or more firms deciding to enter an alliance agreement.

[3]Naturally, these two parameterizations are just two possible ones. They have not been chosen to yield the same expected payoffs, but rather to exemplify the different alliance types that generate different static equilibria.

These alliance types and corresponding parameterizations are the stage game for our experiment, i.e. the subjects play one of these games (or their modifications) repeatedly. In the experiment, we introduce several modifications to reflect the dynamics of real-world alliances more closely. Specifically, we allow for a randomly determined number of repetitions, an option to break up the alliance at each point of the game, and variations in how costly a break up is and in the number of alliance participants.

Our mathematical model, which offers predictions on whether each of the two firms will contribute resources, proceeds in two steps. We first compare firms' payoffs across all possible pairs of actions. Based on this comparison, we determine the firms' optimal behavior and the equilibrium outcomes. The key parameter in this proposition is the price-cost margin m, our proxy for the intensity of competition. For notational simplicity, we denote by $\Pi_i(\cdot,\cdot)$ the payoff to partner i $(=1,2)$ for each combination of actions of partners 1 and 2. For example, $\Pi_1(C,nC)$ represents the payoff to partner 1 when partner 1 contributes resources while partner 2 does not. As described in Figure A.1, $\Pi_1(C,nC)=\pi\left(a+k/2,m\right)-e$. As actions and payoffs are symmetric across partners, we can concentrate on the behavior of just one of the two partners, say partner 1.

As shown in Figure A.1, contributing resources, while the other does not do so, is optimal, i.e., $\Pi_1(C,nC)>\Pi_1(nC,nC)$, as long as $\pi\left(a+k/2,m\right)-\pi\left(a,m\right)>e$. Rearranging it, given that $\pi\left(a+k/2,m\right)-\pi\left(a,m\right)=k/2\cdot m$, we have that contributing resources is optimal as long as the intensity of competition is high enough, $m>e/(k/2)$. Defining it as a threshold, $m_3^*\equiv e/(k/2)$, we have that $\Pi_1(C,nC)>\Pi_1(nC,nC)$ as long as $m>m_3^*$.

Following the same procedure, we have that contributing resources, while the other does so, is optimal, i.e., $\Pi_1(C,C)>\Pi_1(nC,C)$, as long as $\pi\left(a+k+s,m\right)-\pi\left(a+k/2,m\right)=$

$(k/2+s)\cdot m > e$. Rearranging it, we have that $\Pi_1(C,C) > \Pi_1(nC,C)$ as long as $m > m_2^* \equiv e/(k/2+s)$. The two thresholds can be ordered. As $k/2+s > k/2$, we have that a partner is more likely to contribute resources while the other does so, i.e., $m_2^* < m_3^*$.

Comparing the two symmetric outcomes, we can also show that both contributing resources is better than neither contributing, i.e. $\Pi_1(C,C) > \Pi_1(nC,nC)$, as long as $\pi(a+k+s,m) - \pi(a,m) = (k+s)\cdot m > e$. Rearranging it, we have that $\Pi_1(C,C) > \Pi_1(nC,C)$ as long as $m > m_1^* \equiv e/(k+s)$. As $k+s > k/2+s$, we also have that $m_1^* < m_2^*$, and therefore the three thresholds are ordered as follows: $m_1^* < m_2^* < m_3^*$.

We now analyze firm behavior in each of the scenarios determined by these thresholds. First, suppose that $m > m_3^*$ and therefore $\Pi_1(C,nC) > \Pi_1(nC,nC)$. Since $m > m_3^* > m_2^*$, we also have that $\Pi_1(C,C) > \Pi_1(nC,C)$. Thus, choosing C is a dominant strategy, i.e., it is optimal for any possible action of the other partner, and $[C,C]$ is the unique equilibrium. In addition, since $m > m_3^* > m_1^*$, we also have that $\Pi_1(C,C) > \Pi_1(nC,nC)$ and therefore the equilibrium outcome, $[C,C]$, "Pareto-dominates", i.e. it is better for both players, than the outcome in which none of them were contributing, $[nC,nC]$.

Second, suppose that $m_2^* < m < m_3^*$ and thus $\Pi_1(C,C) > \Pi_1(nC,C)$ but $\Pi_1(C,nC) < \Pi_1(nC,nC)$. In this case, the optimal action depends on the action of the other partner, C is optimal if the other chooses C but nC is optimal if the other chooses nC. We have two pure-strategy Nash equilibria, $[C,C]$ and $[nC,nC]$. In addition, since $m_1^* < m_2^* < m$, we have that $\Pi_1(C,C) > \Pi_1(nC,nC)$ and therefore the first equilibrium Pareto-dominates the second.

Third, suppose that $m_1^* < m < m_2^*$ and therefore $\Pi_1(C,C) < \Pi_1(nC,C)$ and, since $m < m_2^* < m_3^*$, $\Pi_1(C,nC) < \Pi_1(nC,nC)$. Thus, choosing nC is a dominant strategy. But,

since $m_1^* < m$, we have that $\Pi_1(C, C) > \Pi_1(nC, nC)$. Thus the equilibrium outcome of neither contributing, $[nC, nC]$, is Pareto-dominated by both of them contributing, $[C, C]$.

Fourth, if $m < m_1^*$, the equilibrium is the same as in the third scenario but the equilibrium non-contributing outcome $[nC, nC]$ now Pareto-dominates both contributing $[C, C]$.

Appendix B Experimental Details

B.1 Experimental Sessions

Table B.1 describes the characteristics of each of the sixteen sessions run. It specifies the session identifier with the date and time at which it was run and indicates the treatment run: whether it was a low or high level of competition, bilateral or multilateral, and with either a low or a high level of formal governance. Finally, also the interaction draw – either (a) or (b) – specifying the number and duration of interactions played in any given session, is specified.

B.2 Experimental Instructions

Full instructions are given below. Instructions are compartmentalized indicating the parts used in all treatments' instructions and – inside boxes – the parts used only in either bilateral or multilateral treatments. Differences between low and high competition alliances are indicated as bracketed numbers in the text, the slanted brackets corresponding to high competition alliances. Additional text used only in high commitment alliance treatments, is appropriately indicated.

Table B.1: Summary of sessions, treatments, and subjects.

Date_Time	Competition	2 or 3 partners	Comm. level	Subjects	Interaction draw	Fem.	Med. age	Med. pay (€)
041816_0930	Low	2	L	24	(a): 7 interactions, lasting 5, 14, 5, 11, 6, 12, 37 periods each.	62.5%	23.5	24.6
041816_1145	High	2	L	24	(b): 6 interactions, lasting 19, 4, 2, 15, 20, 21 periods each.	62.5%	24.5	15.1
041916_0930	Low	3	L	24	(a)	62.5%	25.5	23.7
041916_1145	High	3	L	24	(b)	75.0%	21.5	15.0
042016_0930	High	2	L	24	(a)	37.5%	23.5	22.3
042016_1145	Low	2	H	22	(a)	50%	24.0	24.6
042016_1430	High	2	H	24	(b)	83.3%	21.5	20.1
042116_0930	High	3	L	24	(a)	37.5%	23.0	16.0
042116_1145	Low	2	L	24	(b)	37.5%	22.5	22.5
042116_1430	Low	3	L	24	(b)	70.8%	22.0	19.4
042216_0930	Low	2	H	24	(b)	62.5%	24.0	22.2
042216_1145	High	2	H	24	(a)	70.8%	22.5	23.4
062416_0930	Low	3	H	24	(a)	58.3%	24.5	21.5
062416_1145	High	3	H	24	(b)	58.3%	24.5	13.9
062416_1430	Low	3	H	18	(b)	44.4%	24.0	22.5
062816_1430	High	3	H	24	(a)	54.2%	25.0	11.8

Notes: Each date_time combination identifies a session. Each session consists of a number of interactions. Each treatment is characterized by the level of competition and the alliance configuration. In session 041816_1145, participants hit the specified time constraint for starting new interactions, so only 5 of the 6 type (b) interactions were run.

All treatments:

Alliance Experiment

Welcome to this experimental session. Please read all instructions carefully. They are identical for all participants. You and the other participants will be asked to make decisions. At the end of the experiment you will be paid according to your own decisions and the other participants' decisions. Additionally, you will receive 4 Euros for showing up on time.

During the entire experiment it is prohibited to communicate with the other participants, to use mobile phones, and to start other programs on the computers. If you break these rules, we will have to exclude you from the experiment without payment. If you have a question, please raise your hand. An experimenter will come to your place to answer your question. If the question is relevant to all participants, we will repeat and answer it out loud.

During the experiment we do not talk about Euros. Instead we use points. Your payoff will first be calculated in points. At the end of the experiment, the total number of points you accumulated will be converted to Euros at the following rate:

1 point = [0.035€] *[0.09€]*

(you need approximately [30] *[11]* points to make 1€)

The final payment of the experiment will be rounded up in 10-cent increments.

Box 1: Bilateral treatments only

Alliance Experiment: The Situation

You are the manager of a firm. Your firm will collaborate in alliances with other firms, whose managers are also participants in this session. In principle, your firm and the other firms are

competitors, but you try to join forces in an alliance in order to increase joint sales. When an alliance is formed, an *interaction* between you and another specific manager is initiated, and has the following elements:

Beginning of an interaction

At the beginning of an interaction you are assigned a *partner*. Your partner is also a manager of a firm and is randomly chosen among all other participants of the experiment. He or she is your partner for the entire duration of the interaction. The duration of the interaction is measured in *periods*.

End of an interaction

In every period, there will be a 10% chance that the interaction with the current partner ends (based on a randomly chosen number).

You and your partner's choices and profits in the alliance

An interaction starts out as an *alliance* but the alliance may be broken up by either you or your partner. Running the alliance costs 1 point per period, due to for example administrative costs. Assuming that both firms split this cost evenly, this would amount to 0.5 points for each firm. Of course you save this cost if you choose to terminate the alliance.

In every period, as long as the alliance is maintained, you can choose to contribute resources to the alliance – which costs you 5.5 points – or not. Your partner has the same choices. While contributing resources to the alliance is costly, these resources lead to an increase in sales for all products. This increase is **equally split** amongst both partners of the alliance.

More specifically, without any contribution of resources to the alliance, total sales equal [5] *[3]* points. When one firm contributes resources it adds [6] *[4]* points to these sales. When both firms contribute, total sales increase by [6+6] *[4+4]* points, plus there is an additional increase

of [8] *[6]* points due to synergies. These synergies exist because you and your partner possess complementary skills in the alliance.

Therefore, total sales vary from [5] *[3]* points when nobody contributes resources, to [11] *[7]* points when only one of the two firms contributes resources, to [25] *[17]* points if both firms contribute resources.

Your *profit* equals your share of the total sales, minus your share of the administrative cost and minus your individual cost of contributing resources in case you decide to contribute. The same holds for your partner. This means that your profit as well as your partner?s profit depends on the choices of both firms as follows:

- Neither firm contributes resources to the alliance: You and your partner each have a profit of [2] *[1]* points (sales of [5] *[3]* minus 1 of admin cost, divided by 2).

- Both firms contribute resources to the alliance: You and your partner each have a profit of [6.5] *[2.5]* points (sales of [25] *[17]* minus 1 of admin cost, divided by 2, minus a cost of 5.5 for each).

- You contribute resources to the alliance but your partner doesn't: Your profit is [-0.5] *[-2.5]* points and your partner's profit is [5] *[3]* points (sales of [11] *[7]* minus 1 of admin cost, divided by 2, minus a cost of 5.5 for you but not for your partner).

- You don't contribute resources to the alliance but your partner does: Your profit is [5] *[3]* points and your partner's profit is [-0.5] *[-2.5]* points (sales of [11] *[7]* minus 1 of admin cost, divided by 2, minus a cost of 5.5 for your partner but not for you).

You will be reminded of the link between the two managers' choices and your profit each time you are prompted to make a choice.

Alliance termination option and "going it alone"

In every period you and your partner both have the option to unilaterally terminate the alliance. This option is irreversible and means that you will both effectively "go it alone" for the remainder of the interaction. [HIGH COMMITMENT: *Terminating the alliance is costly. When you or your partner terminates the alliance, each of you pays a one-off termination cost of 10 points.*] When you go it alone, neither you nor your partner need to make any decisions regarding the alliance and you each receive a profit of [2.5] *[1.5]* in every remaining period of the interaction. This profit equals your share of the sales when neither firm contributes to the alliance, [5/2] *[3/2]* , since in this case you no longer pay the administrative cost of running the alliance, but neither do you benefit from collaboration.

[HIGH COMMITMENT: *In the period when the alliance is terminated you additionally pay the termination cost. Thus, in that period only, your profit is -7.5: a profit of 2.5 points from going it alone minus the termination cost of 10 points.*]

Box 2: Multilateral treatments only

Alliance Experiment: The Situation

You are the manager of a firm. Your firm will collaborate in alliances with other firms, whose managers are also participants in this session. In principle, your firm and the other firms are competitors, but you try to join forces in an alliance in order to increase joint sales. When an alliance is formed, an *interaction* between you and two other specific managers is initiated, and has the following elements:

Beginning of an interaction

At the beginning of an interaction you are assigned two *partners* identified as Partner 1 and Partner 2. Your partners are also managers of a firm and are randomly chosen among all

other participants of the experiment. Partner 1 and Partner 2 are your partners for the entire duration of the interaction. The duration of the interaction is measured in *periods*.

End of an interaction

In every period, there will be a 10% chance that the interaction with the current partners ends (based on a randomly chosen number).

You and your partners' choices and profits in the alliance

An interaction starts out as an *alliance* but the alliance may be broken up by either you or your partners. Running the alliance costs 1.5 points per period, due to for example administrative costs. Assuming that the three firms split this cost evenly, this would amount to 0.5 points for each firm. Of course you save this cost if you choose to terminate the alliance.

In every period, as long as the alliance is maintained, you can choose to contribute resources to the alliance – which costs you 5.5 points – or not. Your partners have the same choices. While contributing resources to the alliance is costly, these resources lead to an increase in sales for all products. This increase is **equally split** amongst the three partners of the alliance.

More specifically, without any contribution of resources to the alliance, total sales equal [7.5] *[4.5]* points. When one firm contributes resources it adds [6] *[4.5]* points to these sales. When two firms contribute, total sales increase by [6+6] *[4.5+4.5]* points. When all three firms contribute, total sales increase by [6+6+6] *[4.5+4.5+4.5]* points, plus there is an additional increase of [12] *[7.5]* points due to synergies. These synergies exist because you and your partners possess complementary skills in the alliance.

Your *profit* equals your share of the total sales, minus your share of the administrative cost and minus your individual cost of contributing resources in case you decide to contribute. The same holds for your partners. This means that your profit as well as your partners' profit depend on

the choices of all three firms as follows:

- None of the firms contributes resources to the alliance: You and your partners each have a profit of [2] *[1]* points (sales of [7.5] *[4.5]* minus 1.5 of admin cost, divided by 3).
- All three firms contribute resources to the alliance: You and your partners each have a profit of [6.5] *[2.5]* points (sales of [37.5] *[25.5]* minus 1.5 of admin cost, divided by 3, minus a cost of 5.5 for each).
- Two firms contribute resources and one firm doesn't: The contributing firms' profit is [0.5] *[-1.5]* each and the non-contributing firm's profit is [6] *[4]* (sales of [19.5] *[13.5]* minus 1.5 of admin cost, divided by 3, minus 5.5 for the contributing partners but not for the non-contributing partner).
- One firm contributes resources and two firms don't: The contributing firm's profit is [-1.5] *[-3]* and the non-contributing firms' profit is [4] *[2.5]* each (sales of [13.5] *[9]* minus 1.5 of admin cost, divided by 3, minus a cost of 5.5. for the contributing partner but not for the non-contributing partners).

You will be reminded of the link between the three managers' choices and your profit each time you are prompted to make a choice.

Alliance termination option and "going it alone"

In every period you and your partners have the option to unilaterally terminate the alliance. This option is irreversible and means that you will effectively "go it alone" for the remainder of the interaction. [HIGH COMMITMENT: *Terminating the alliance is costly. When you or one of your partners terminates the alliance, each of you pays a one-off termination cost of 10 points.*] When you go it alone, none of you needs to make any decisions regarding the

alliance and you each receive a profit of [2.5] *[1.5]* in every remaining period of the interaction. This profit equals your share of the sales when neither firm contributes to the alliance, [7.5/3] *[4.5/3]* , since in this case you no longer pay the administrative cost of running the alliance, but neither do you benefit from collaboration.

[HIGH COMMITMENT: *In the period when the alliance is terminated you additionally pay the termination cost. Thus, in that period only, your profit is [-7.5] [-8.5]: a profit of [2.5] [1.5] points from going it alone minus the termination cost of 10 points.*]

All treatments:

Next interaction

When an interaction ends (randomly), we will check how much time has passed since the beginning of the very first interaction. If less than 45 minutes have passed, we will start a new interaction, otherwise we will end the experiment.

In the next interaction your {partner is} {partners are} newly chosen, randomly, among all participants of the experiment.

If the last interaction we started continues for an unreasonable amount of time, we may choose to postpone the continuation of the experiment to a later date convenient for all participants.

End of the Experiment and Payoff

Your payoff for the experiment, in "points", is the sum of the points you make in every period of every interaction. Points are converted to Euros at a rate of [3.5] *[9]* Euro cents for each point.

Your show-up fee of 4 Euros ([115] *[44]* points) is deposited in an account with which you start the experiment and which will act as a bumper if you make negative payoffs in any given period.

When the last interaction ends you will be asked to answer a brief questionnaire. In order to protect your privacy, instead of asking for your name, we ask you to enter your seat number. We need this

information in order to pay you.

We will now start the computerized interface of the experiment and ask you to go over a few examples, in order to test your understanding of these instructions. When all participants are done with the examples, we will begin the first interaction.

Your answers to the example and questionnaire questions do not count toward your payoff.

B.3 Exit Questionnaire

All subjects filled out an exit questionnaire at the end of the session they participated in. The questionnaire had four parts: personal information, questions about the subject's partner in the last alliance, questions about the experiment in general, and report of payoff (the subject was told her payoff for the session). Each section occupied separate *pages* on the screen. Different alliance designs differed slightly (for example, in multilateral alliances we asked about each partner separately). We indicate differences in brackets, preceded by a bold **M** for multilateral alliances, and a bold **C** for high commitment. The contents of all questionnaire screens was the following:

Please enter your seat number. This will maintain anonymity.

Personal Data

- Please enter your age
- What is your gender?
  - Male
  - Female
- If you are a student, what is your field of study?

Tell us about your partner [M: partners]

In the following questions, you are asked to choose your level of **agreement** with the given statements. You can choose a level between 0 (completely disagree) and 5 (completely agree).

All questions are asked about your partner [M: partners] in the *LAST* interaction.

1. I think my partner was cooperative [M: I think Partner 1 was cooperative]
2. [M: I think Partner 2 was cooperative]
3. My partner [M: partners] and I managed to reach an implicit agreement on how to play in every period
4. I tried to reach a certain outcome, but my partner [M: partners] never understood my intentions. He/she [M: They] persisted in playing something else
5. [M: Partner 1 and I had a good understanding on how to behave. Partner 2 insisted in doing something else]
6. [M: Partner 2 and I had a good understanding on how to behave. Partner 1 insisted in doing something else]
7. I think my partner [M: partners] tried to push me to play in a certain way, but I didn't quite understand what way
8. [M: My partners were completely unpredictable to me. I don't know what their intentions were]
9. I wish I had had a different partner [M: I wish I had had different partners]

Tell us about the experiment

In the following questions, you are asked to choose your level of **agreement** with the given statements. You can choose a level between 0 (completely disagree) and 5 (completely agree)

1. Instructions were clear and easy to understand
2. The experiment was too long

3. I clearly understood that the duration of each interaction was random and not chosen by the experimenter
4. The experiment was boring
5. [**C**: The termination option was too expensive]
6. [**C**: I could use the termination option to punish my partner]
7. [**C**: It was not reasonable to ever choose to terminate the alliance]
8. Knowing that I was involved in a long-term relationship was very important for my choices
9. I wish that before the beginning of the experiment I had been given the opportunity to practice the experimental task without affecting my payoff.
10. Comment why you think it mattered that you had the same partner during the entire interaction each time [**M**: partners during any given alliance].
11. Please enter further comments about the experiment.

Your earnings

Including the show-up fee of 4 Euros, you will receive a total of {blank} Euros.

Thank you for participating.

We report summary statistics for questionnaire answers numbered between 0 and 5 in Table B.2 and Figures B.1 to B.4. Questions 1-4, and 9, of section "Tell us about the experiment", are about understanding of the experiment. We report averages and medians across all respondents in Table B.2. The value of answers to questions 1-3 of section "Tell us about your partner" is increasing in trust and cooperation. We average individual answers for the three (or two, if bilateral) to construct a single trust indicator whose distribution across competition levels and alliance designs are reported in Figure B.1, panel (a). The value of answers to questions 4-8 of "Tell us about your partner" are decreasing in ability to coordinate. We average answers to these questions and report their distribution for each

Table B.2: Answer to questions 1-4 and 9 about the experiment.

	Question				
	Q1—*Instr.*	Q2—*Long*	Q3—*Length*	Q4—*Boring*	Q9—*Practice*
Mean	4.49	1.92	4.54	3.17	1.08
Median	5	1	5	4	0

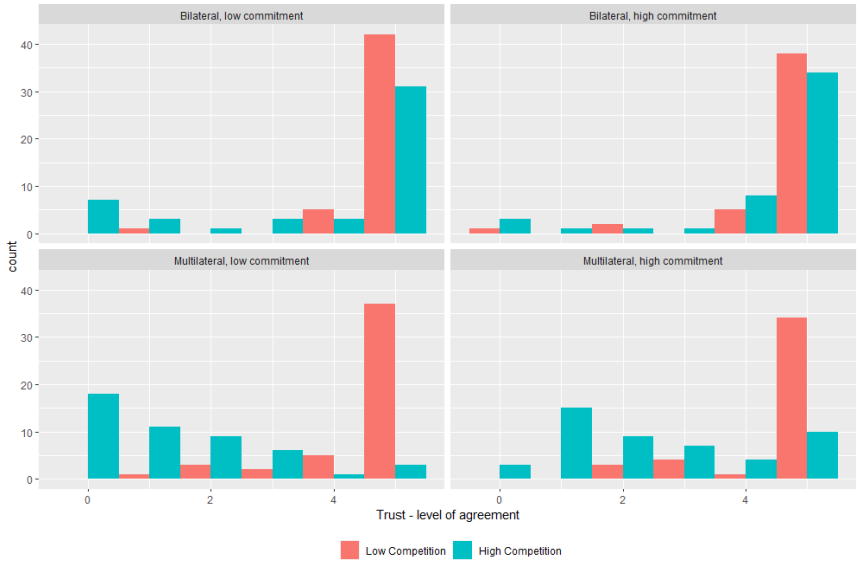
level of competition and alliance design, in Figure B.1, panel (b). The distribution of values of questions about breakup cost is summarized for each level of competition and number of partners in Figure B.2. Question 9 about partners—"I wish I had different partner(s)"—and question 8 about the experiment—long-term mattered for choice—are separately reported in Figure B.3. Finally, two word clouds in Figure B.4 illustrate open answers to questions 10 and 11 about the experiment.

We can see that, in general, the experiment was considered long and boring, but also easy to understand. From figure B.1, we see that trust and ability to coordinate both differ substantially between low and high competitive intensity scenario and across number of partners. In high competitive intensity scenario, trust is lower, more so if the alliance is multilateral. In terms of coordination, multilateral alliances in a highly competitive environment are clearly less satisfied than other categories.

Termination costs are perceived as more expensive but also more useful as punishment for partner misbehavior by multilateral alliances in both competitive intensity scenario (Figure B.2. In both designs and competition levels termination is perceived as unreasonable, but less so in high competition multilateral alliances. A clear pattern is visible for the desire to change partners: it is high only when the environment is highly competitive and the alliance is multilateral (Figure B.3, panel (a)). Instead, the perception that repetition is important for choices is higher when commitment is high, regardless of the environment and number

Figure B.1: Trust and Mis-coordination from questionnaire answers.

(a) Questions 1-3 about partners—*Trust*.



(b) Questions 4-8 about partners—*Mis-coordination*.

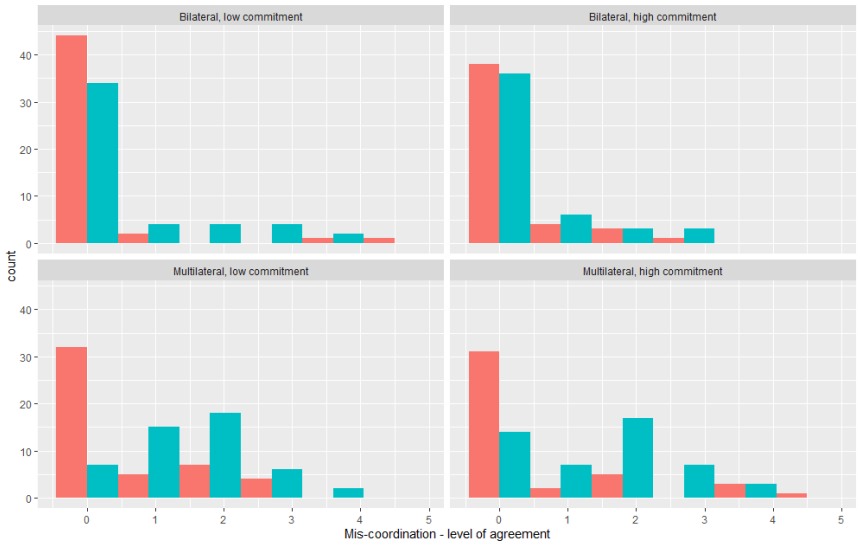
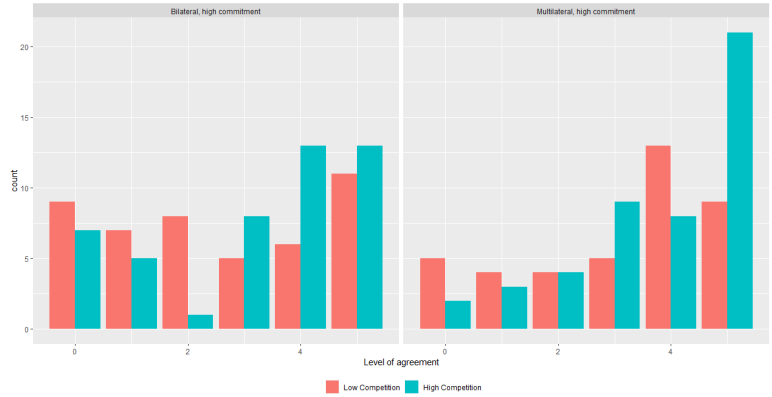
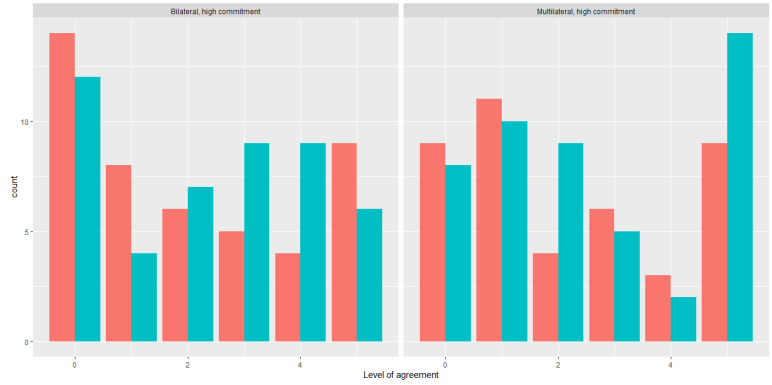


Figure B.2: High formal governance alliances. Questions on termination.

(a) "Termination was too expensive."



(b) "Termination as punishment."



(c) "Termination was unreasonable."

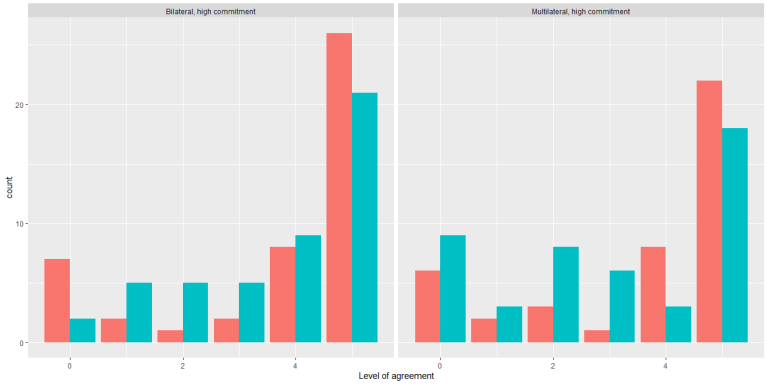
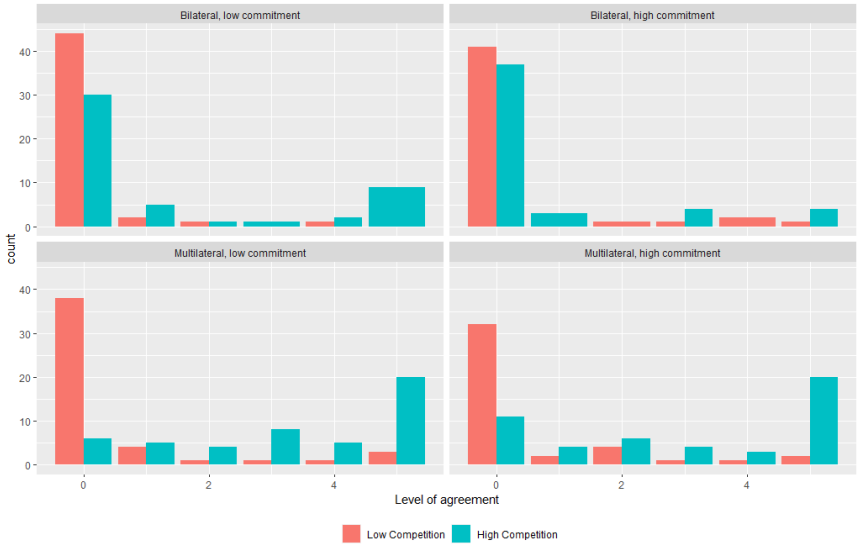


Figure B.3: Question 9 on partners and 8 on experiment.

(a) "I wish I had had different partner(s)."



(b) "...long term relationship was important for my choices."

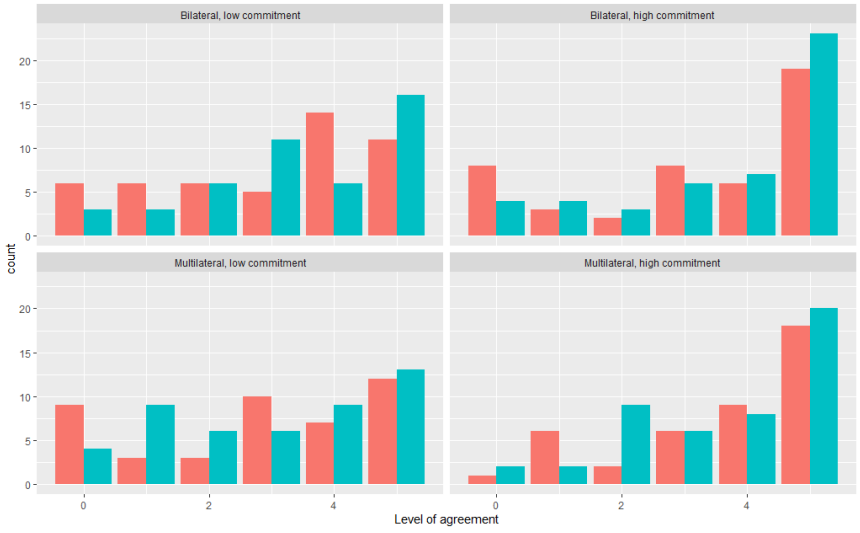


Figure B.4: Most frequently-used words in open questionnaire questions.

(a) Open question on having the same partner(s).

(b) Open question on the experiment.

of partners (Figure B.3, panel (b)).

Appendix C Qualitative evidence in support of the experimental design

Preliminary to setting the experimental protocol, we followed two complementary routes to familiarize ourselves with the alliance manager's tasks and decision-making process for the existing partnership portfolio.

First, we consulted several job posts targeting alliance managers. With this step, we acquainted with the general skills, competencies, and tasks that those agents should cover – see, for example, the ad in the picture here below. For instance, ads consistently reported that alliance managers should reckon and extend business opportunities from partnerships, organize existing agreements, enact a plan to monetize from the collaborations, and cooperate with the other organization's departments.

To reconstruct the alliance decision-making process, we interviewed two alliance and business development managers of two large firms – that is, firms with more than 1,000 employees. One firm operates in the robotics and automated storage industry, the other one in the pharmaceutical sector. Each interviews lasted about 40 minutes and focused on the organization of alliances' decision-making and the strategic management of alliance portfolio. We recorded and transcribed one of the two, while for the second, we took detailed notes.

Both managers pictured very similar tasks' chain structured into three core phases based on staging gates. In the first phase, the alliance manager determines the economic significance of each existing partnership. To assess the economic margin, the manager refers to several indexes such as the return on investments and equity. The controlling function and the CFO provide support to generate the economic benchmark and the indexes. This stage

is crucial; Values below the expected threshold may trigger the alliance termination.

Second and conditional on phase one providing positive evidence, the manager considers the financial results – that is, the cash flow resulting from the partnership. Again, the CFO and the controlling support the task and provide the relevant financial data.

Last, the alliance manager liaises with the sales and operations managers. For example, the alliance manager may need information from the operations department about the project's development. She may also need to collect details from the business units about the market response to the product or service underlying the partnership. For example, one interviewee mentioned that *"If there is oncology deal, every single oncology deal will go through this person. Then that person has a network within the organization, and we have a network with the business side. Still, we also have a network with the research side, and they then contact the respective head of commercial research of whatever, so any research or commercial person knows the deal that is on-going in his or her area. "*

The alliance manager usually disposes of decision power for each stage granted through delegation. Full delegation is conditional on the economic and strategic importance of the partnership. The alliance manager can decide up to certain budget thresholds, above which the decision moves to higher levels in the organizational hierarchy. In this latter case, the alliance manager is responsible for collecting the relevant information for each stage and passing it on to the hierarchy's upper level. For example, one manager commented *"We got the template and then obviously...you know it is all boxes and it is project assessed, you set up a project and then you decide to have people possible and why, even I am part of these teams, I am a responsible and if it is a big deal it goes to the board and I need to comment on the board and I've dedicated a person to those teams."*

We constructed the laboratory experimental setting with this qualitative evidence in mind.

Appendix D Additional Results: Continued Collaboration

Table D.3 shows measure *continued collaboration*—a dummy equal to 1 if partners contribute resources to the alliance in every period, and equal to 0 otherwise—in low and high competition alliances across our four different alliance designs. As can be seen, continued collaboration shares almost perfectly match average values of *collaboration* presented in Section 4.1 in each design (panel (a) of Table D.3). This is unsurprising given that of 501 low competition alliances, 419 had partners that always contributed to the alliance (both measures, collaboration and continued collaboration, equal 1) and 42 had 0 periods where all partners contributed (both measures equal 0), leaving only 50 alliances with intermediate values of collaboration.

Also in high competition alliances continued collaboration frequencies closely match average collaboration values (panel (b) of Table D.3). Again, this is driven by alliances clustering into two main types: always contribute or never contribute (respectively, 239 and 211 out of 508 high competition alliances).

Pearson χ^2 tests of proportions for continued collaboration are reported in Table D.3 and corroborate the treatment effects found for collaboration and reported in the main article.

Table D.3: Differences between designs: Proportion of Continued Collaboration.

(a) Low competition alliances.

	No termination clause	Termination clause	Difference test (χ^2)
Bilateral	0.917	0.899	0.275
Multilateral	0.683	0.772	1.939
Difference test (χ^2)	23.458**	7.287**	

(b) High competition alliances.

	No termination clause	Termination clause	Difference test (χ^2)
Bilateral	0.590	0.821	19.278**
Multilateral	0.096	0.154	1.582
Difference test (χ^2)	62.389**	112.235**	

Notes: Continued collaboration is defined as 1 for an alliance that plays $[C, C]$ or $[C, C, C]$ in every period and 0 for other alliances. The table reports the proportion of alliances in each design that engages in continued collaboration. Differences across alliance designs are tested with Pearson's χ^2 tests. * significant at the 5% level; ** significant at the 1% level.

Appendix E Additional Results: Alliance Dynamics

Our analyses in the main text highlight two phenomena. First, partners of an alliance anticipate post-formation interaction, as behavior across designs and environments in our experiment differs from the first period on. Second, alliance partners, especially in multilateral alliances and high competition environments, do not always behave the same throughout the lifetime of the alliance. We now ask when and why alliance partners choose differently throughout the alliance.

We take the *alliance* as the relevant unit of analysis, and in Figure **??** we consider all alliances, period by period. Panel (a) displays per period joint behavior of all partners in percentages. Partners can all contribute, none contribute, choose (unilaterally) to break up the alliance, or be stagnant due to breakup in the past. Asymmetric contributions take

only one form in bilateral alliances (one chooses C, the other nC), but two in multilateral alliances (one chooses C, two choose nC, or two choose C, one nC). We thus have 5 categories for bilateral and 6 categories for multilateral alliances. We combine low and high competition alliances as the distribution of choices in time does not significantly differ by the degree of competition. Clearly, later periods have much fewer alliances, but representation in percentages implies bar lengths are normalized across periods. Panel (b) restricts the sample to alliances that do not contribute in all periods (collaboration less than one), since these are the only alliances that potentially change behavior over time. We do keep alliances who broke up in a prior period, since they illustrate treatment effects.

First, as the figures suggest, most instances of *non-contribution*—one partner chooses C while one or two other partners choose nC—occur early on, and this is more accentuated when formal governance is low. In fact, the first period of the alliance is the modal period for non-contribution in all designs and levels of competition. With a termination clause, much non-contribution takes place also in later periods, implying an effect of termination clauses on the distribution of non-contribution in time (one-tailed Mann-Whitney Wilcoxon tests, both levels of competition, bilateral and multilateral alliances).

With low commitment, instances of alliance failure—all partners choose nC—are also restricted to early periods, but with high commitment, these instances remain common even after long relationships. Also breakup, as expected, occurs sooner and more often when commitment is low.

The effect of termination clauses as formal governance mechanism is more accentuated on the timing of failure, the choice of nC by all partners. The modal period for failure without termination clause is the second, and with termination clause it is the third or

fourth. With termination clause, the distribution across periods is almost uniform over the first 20 periods. This suggests a reluctance of partners to exit even from failed alliances when breakup is costly ("zombie alliances"). Mann-Whitney-Wilcoxon tests reveal that the effect of formal governance on the timing of failure is significant only with high competition—with low competition, failure is too infrequent to disentangle treatment effects. Finally, although with termination clause breakup is much less frequent, the timing of breakup is only different for multilateral alliances in highly competitive environments. In this case, without termination clause almost all breakups occur in the second or third period, while with such a clause the breakup choice is more uniformly distributed in time.

With termination clause, the number of partners has no effect on the timing of choices. Without termination clause and with high competition, failure, breakup, and the bulk of cooperative choices, all occur sooner in multilateral than in bilateral alliances. In high competition multilateral alliances, termination clauses significantly shift cooperative behavior to later periods. This suggests contractual features may solve some of the cooperation problems encountered early on in multilateral alliances, and further illustrates the multilayered effect of formal governance in this case.

Figure E.7 and E.8 show the distribution of joint partner choices across different periods of all alliances in our experiment. There are always fewer choices in total in later periods because not all alliances are long lived. The plotted categories are (i) all partners contribute, (ii) none of the partners contributes, (iii) at least one partner contributes and at least one partner does not contribute, and (iv) at least one partner chooses breakup. The figures display smoothed distributions of each one of these choices across alliance periods, for each level of competition and each alliance design. Because of attrition in later periods, these

figures should be compared across treatments, not time within-treatment. In particular, they show that commitment introduces important shifts in the timing of unilateral lack of cooperation ("non-contribution"), mutual lack of cooperation ("failure"), and breakup, and the number of partners affects the timing of mutual contribution.

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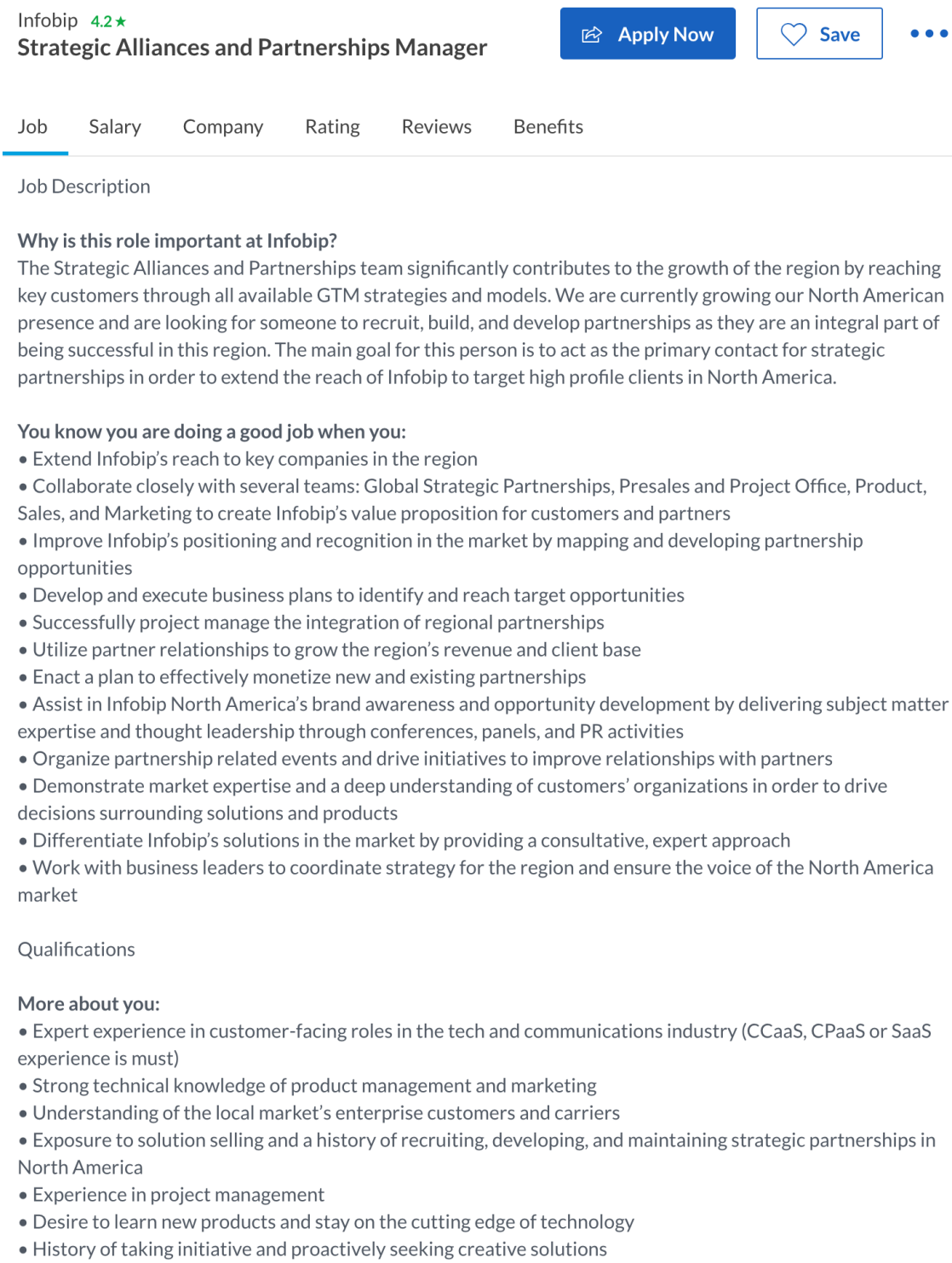
Figure C.5: Example of job ad for alliance managers



Infobip 4.2★

Strategic Alliances and Partnerships Manager

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Job | Salary | Company | Rating | Reviews | Benefits

Job Description

Why is this role important at Infobip?
The Strategic Alliances and Partnerships team significantly contributes to the growth of the region by reaching key customers through all available GTM strategies and models. We are currently growing our North American presence and are looking for someone to recruit, build, and develop partnerships as they are an integral part of being successful in this region. The main goal for this person is to act as the primary contact for strategic partnerships in order to extend the reach of Infobip to target high profile clients in North America.

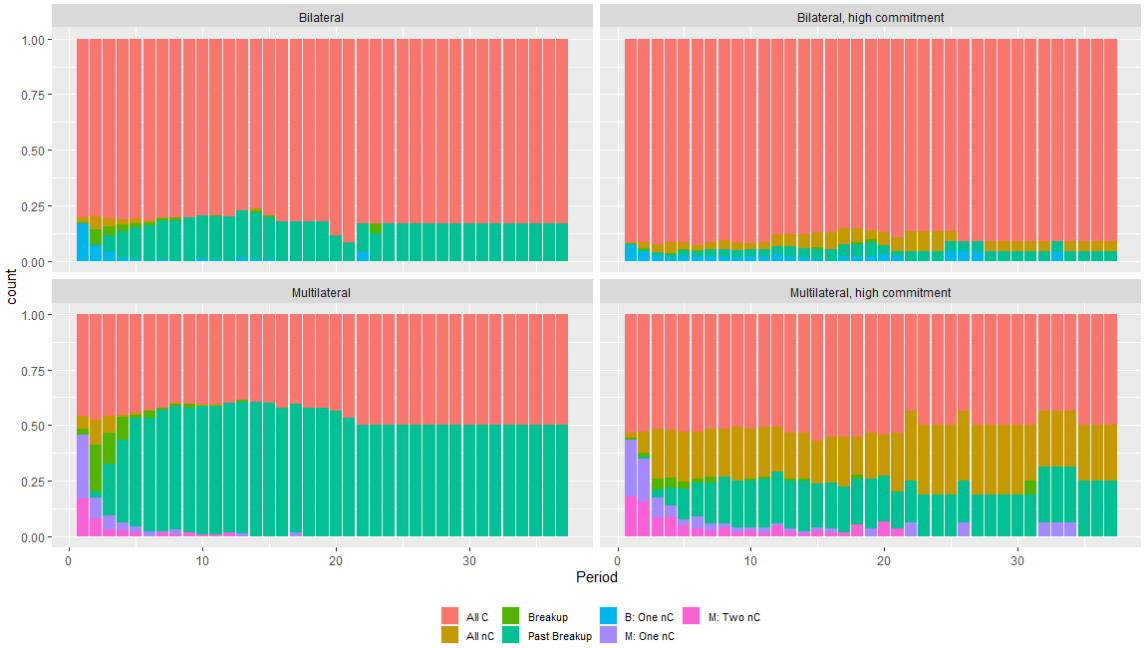
You know you are doing a good job when you:
• Extend Infobip's reach to key companies in the region
• Collaborate closely with several teams: Global Strategic Partnerships, Presales and Project Office, Product, Sales, and Marketing to create Infobip's value proposition for customers and partners
• Improve Infobip's positioning and recognition in the market by mapping and developing partnership opportunities
• Develop and execute business plans to identify and reach target opportunities
• Successfully project manage the integration of regional partnerships
• Utilize partner relationships to grow the region's revenue and client base
• Enact a plan to effectively monetize new and existing partnerships
• Assist in Infobip North America's brand awareness and opportunity development by delivering subject matter expertise and thought leadership through conferences, panels, and PR activities
• Organize partnership related events and drive initiatives to improve relationships with partners
• Demonstrate market expertise and a deep understanding of customers' organizations in order to drive decisions surrounding solutions and products
• Differentiate Infobip's solutions in the market by providing a consultative, expert approach
• Work with business leaders to coordinate strategy for the region and ensure the voice of the North America market

Qualifications

More about you:
• Expert experience in customer-facing roles in the tech and communications industry (CCaaS, CPaaS or SaaS experience is must)
• Strong technical knowledge of product management and marketing
• Understanding of the local market's enterprise customers and carriers
• Exposure to solution selling and a history of recruiting, developing, and maintaining strategic partnerships in North America
• Experience in project management
• Desire to learn new products and stay on the cutting edge of technology
• History of taking initiative and proactively seeking creative solutions

Figure E.6: Joint partner choices per period.

(a) All alliances.



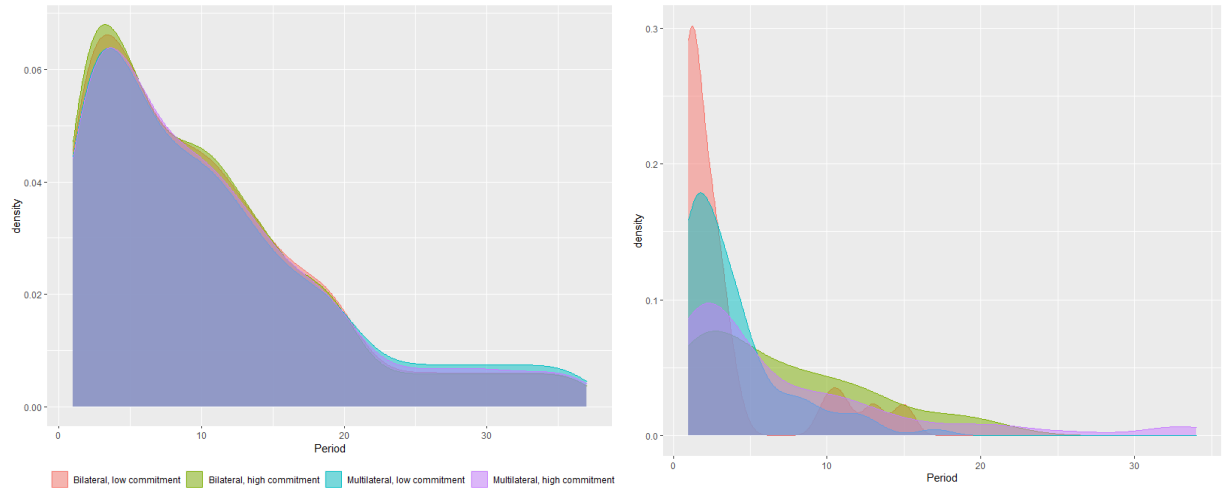
(b) Alliances where partners do not always choose C.

In every period, percentage of all alliances that have not yet been randomly terminated, that makes a given combined choice (all C, all nC, at least one B, B in a preceding period, or asymmetric contribution: at least one C and at least one nC). We distinguish between bilateral and multilateral alliances for asymmetric contribution, and identify each case with an initial B (bilateral) or M (multilateral) in the legend. Panel (a) includes all alliances, panel (b) includes only alliances with imperfect cooperation (less than 1). Panel (a) displays the behavior of 1009 alliances, and Panel (b) that of 351 alliances who do not always contribute.

Figure E.7: Joint partner choice per period. Low competition alliances.

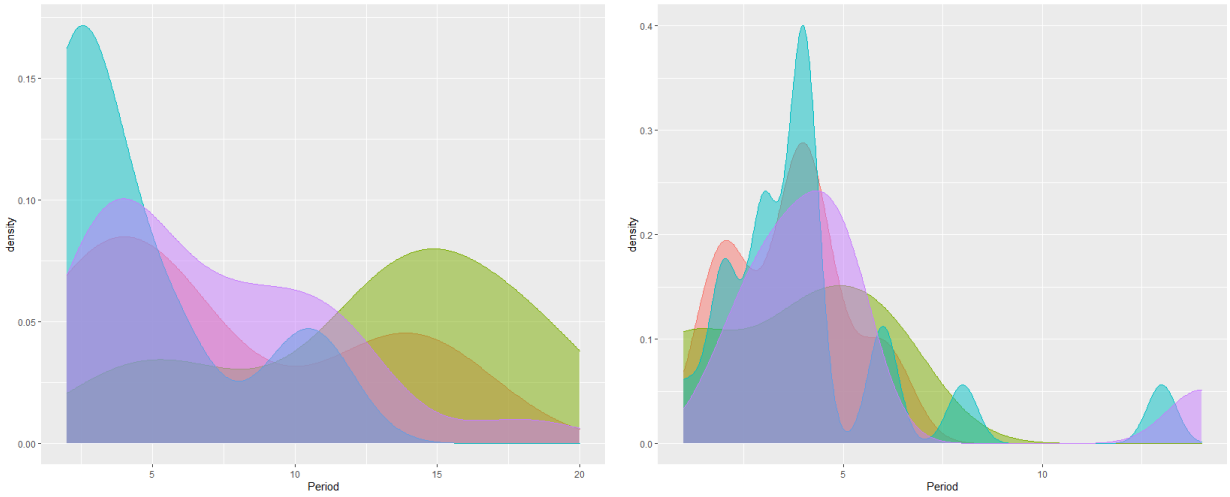
(a) Cooperation.

(b) Non-contribution.



(c) Failure

(d) Breakup

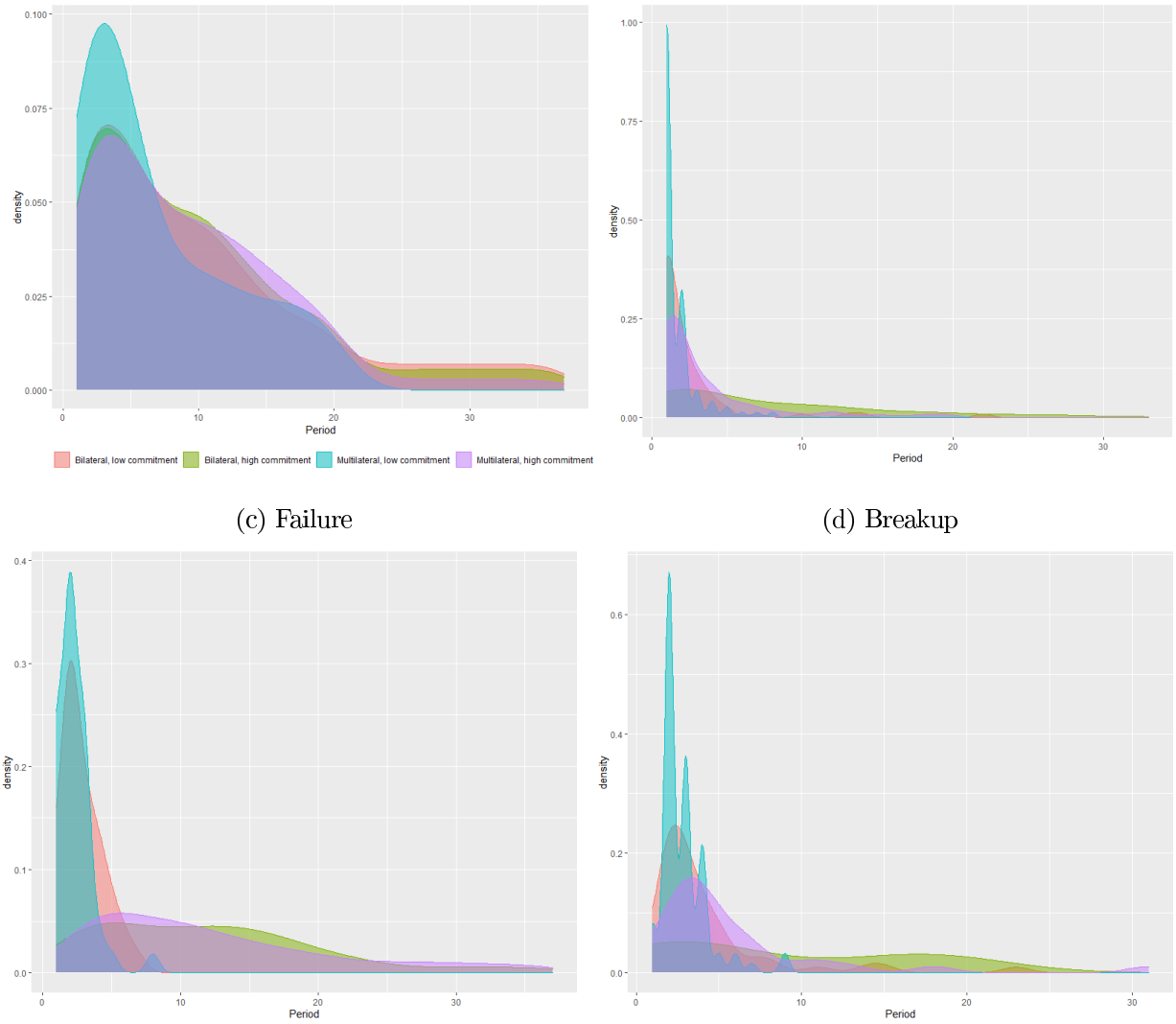


Smoothed empirical density of joint partner choices over alliance periods. Number of alliances per period varies over periods, no adjustment made for this. Cooperation means all partners choose C, non-contribution means at least one partner chooses C and at least one partner chooses nC. Failure means all partners choose nC. Breakup means at least one partner chooses B.

Figure E.8: Joint partner choice per period. High competition alliances.

(a) Cooperation.

(b) non-contribution.



(c) Failure

(d) Breakup

Smoothed empirical density of joint partner choices over alliance periods. Number of alliances per period varies over periods, no adjustment made for this. Cooperation means all partners choose C, non-contribution means at least one partner chooses C and at least one partner chooses nC. Failure means all partners choose nC. Breakup means at least one partner chooses B.