

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

Appendix

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Appendix A Proof of Proposition 1

The proof of the proposition, 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 1, $\Pi_1(C, nC) = \pi(a + k/2, m) - e$. 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 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 $\pi(a + k/2, m) - \pi(a, m) > e$. Rearranging it, given that $\pi(a + k/2, m) - \pi(a, m) = k/2 \cdot m$, 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 $\pi(a + k + s, m) - \pi(a + k/2, m) = (k/2 + s) \cdot m > e$. 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 $\Pi_1(C, C) > \Pi_1(nC, nC)$ 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 Strategy, Sessions and Instructions

B.1 Experimental Strategy

We discuss a number of methodological choices for our experiment below.

Framing. For the instructions and interface we chose a framed language: participants were told that they were playing the role of firm managers involved in an alliance where resource contribution decisions would need to be made in every period of an interaction with unknown duration. The framed situation and payoffs followed exactly the alliance configurations given in section 3.4.

Induced value and subject pool. We induce value by paying our 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; Friedman and Sunder 1994). The purpose of lab experiments is not to acquire data *in the wild* but to isolate certain characteristics of a problem and understand their functioning. This logic inspires the principle of induced value: it is important to have a participant pool that is truly affected by the within-experiment consequences of their actions.¹ Ideally one also wants to have a participant pool with the traits and expertise of the population studied by the theory, but the added cost or reduced statistical power from such an approach sometimes makes this an unattractive choice (Fréchette 2011; Dyer, Kagel, and Levin 1989; Fehr and List 2004).

Interactions and matching. One interaction refers to one realization of the dynamic situation described in section 3.4. We run several interactions in one session,

¹Induced 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 involved, there is a higher chance that this be the case. Therefore, especially in experiments permitting cooperation between players, it is important that payoffs be significant for participants.

each having a random number of periods. To keep the strategic games in the lab close to those described in section 3.4 and to maximize independence across interactions, we match and rematch partners in each new interaction anonymously and randomly.

Random duration. To maintain credibility regarding the randomness of interaction duration, participants were given a time limit (45 minutes) after which no new interactions would be initiated. They were further told that if the last initiated interaction went on beyond a *reasonable* time, the continuation of the experiment would be rescheduled for 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) (see table B.1), that we replicated in all remaining sessions in order to enhance comparability of our data. Each treatment was run under both interaction draws.

Instructions. Participants in our sessions were given print-out instructions plus abridged instructions via the experimental interface, each time they were prompted to make a decision. Following Bigoni and Dragone (2011), we kept instructions short and used interactive examples to enhance understanding (see below). 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 our participants' understanding of the print-out 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. At the end of each session participants took part of an exit questionnaire where they were asked for demographic characteristics –gender, age, and field of study– and a series of closed and open opinions about the decisions made during the session; we provide a short explanation on

these in the next section. We make limited use of the information collected in the exit questionnaire since it adds little to our analysis.

B.2 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 commitment. Finally, also the interaction draw – either (a) or (b) – specifying the number and duration of interactions played in any given session, is specified.

B.3 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.

<i>Date_Time</i>	<i>Competition</i>	<i>Partner No.</i>	<i>Commit</i>	<i>Subject No.</i>	<i>Interaction draw</i>
041816_0930	Low	2	L	24	(a): 7 interactions, lasting 5, 14, 5, 11, 6, 12, 37 periods each.
041816_1145	High	2	L	24	(b): 6 interactions, lasting 19, 4, 2, 15, 20, 21 periods each.
041916_0930	Low	3	L	24	(a)
041916_1145	High	3	L	24	(b)
042016_0930	High	2	L	24	(a)
042016_1145	Low	2	H	22	(a)
042016_1430	High	2	H	24	(b)
042116_0930	High	3	L	24	(a)
042116_1145	Low	2	L	24	(b)
042116_1430	Low	3	L	24	(b)
042216_0930	Low	2	H	24	(b)
042216_1145	High	2	H	24	(a)
062416_0930	Low	3	H	24	(a)
062416_1145	High	3	H	24	(b)
062416_1430	Low	3	H	18	(b)
062816_1430	High	3	H	24	(a)

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:

$$1 \text{ point} = [0.035\text{€}] [0.09\text{€}]$$

(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 experi-

ment. 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.

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