Relational Contract and Endogenous Contractual Incompleteness. Experimental Evidences.

Preliminary version

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Abstract

This paper empirically investigates the interaction between relational contracting and endogenous contractual incompleteness. We design an infinitely repeated games experiment between identifiable players, where the probability of continuation and the level of shared information vary, and the level of contractual completeness is decided by participants. Our results allow us to show that relational contract can be regarded as a determinant of contractual incompleteness.

Keywords: Contractual Incompleteness, Relational Contract, Reputation, Repeated Games, Experiment.

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1 Introduction

Observed contracts are rarely complete in the Arrow Debreu sense, and a large part of the economic literature takes contractual incompleteness for granted. However, little has been done to understand the evolution of contractual incompleteness over time, when parties have concern for future business. In this paper, we use experimental data to analyze the interplay between relational contracts and the dynamics of endogenous contractual incompleteness. We show that the sustainability of relational contracts can explain the decision to leave contracts incomplete, and how trust building over time leads to more and more contractual incompleteness.

To justify our interest on such a determinant of contractual incompleteness, let us first recall why this notion has drawn so much attention up to now, and why we still need to make progress to better understand it. Two visions of contractual incompleteness have progressively emerged in the literature.[1] In the first perspective, incompleteness is exogenous to the contract. The parties may be unable to condition performance on future states that they cannot observe or make verifiable for the courts. The reasons may be the bounded rationality of the agents (Simon [1981]) or the cost to make all details verifiable (Hart [1995]).

The second perspective considers that contracts are "deliberately" incomplete in the sense that parties decline to condition performance on available, verifiable measures that could be specified in the contract. The main argument is to show that the *ex ante* cost of crafting more complete agreements has to be compared to the *ex post* inefficiencies associated with less exhaustive arrangements. Crockers and Reynolds [1993] provide some empirical support to this argument, by examining panel data of Air Force engine procurement contracts. For the theoretical approach, Anderlini and Felli [1994] have also explored how contractual incompleteness could be explained by the *ex ante* costs of describing events. More recently, Bolton and Faure-Grimaud [2005] propose a model of bounded rationality based on time-costs of deliberating current and future decisions. Incomplete contracts are accepted because individuals prioritize their thinking and decide on less important decisions *ex post*, once the precise contingencies occur. All these contributions provide some explanations about why parties voluntarily accept incomplete contracts, and they mainly explain contractual incompleteness by a trade-off between costs and benefits. However, surprisingly, incomplete agreements may also be accepted, even if the cost of specification is relatively low. Contractual incompleteness becomes a strategic decision. For instance, Spier [1992] shows that some individuals had better propose an incomplete contract when the information is asymmetric, to avoid to send signals that would be badly interpreted. Spier illustrates such a strategy by the example of an athlete's agent that may advise the athlete to refrain from asking for an injury clause, because the team manager could infer from such a request that the athlete is more accident prone. Strategic considerations of contractual incompleteness are also explored by Bernheim and Whinston [1998]. They show that when some aspects of behavior are observable but not verifiable, parties may prefer incomplete contracts that increase the set of outcomes that can be supported by a subgame perfect equilibria. More precisely, they suggest that contractual incompleteness may allow relational contracts to become sustainable. Relational contracts are informal commitments sustained by the value of future transactions (Baker et al. [2002]). They imply that the parties are themselves able to punish deviation in future interactions. Contractual incompleteness may make some punishment strategies avail-

[1] A very good review of the literature dealing with contractual incompleteness is proposed by Kornhauser and MacLeod [2010]. We partly inspire from it here.

able, which would not be the case if the contractual agreement describes precisely the behavior of the agents. This result has been somewhat challenged by Tirole [2009]. Instead of thinking contractual incompleteness as a way to allow for relational contracts, he suggests that relational agreements could be the reason for accepting incomplete contracts. As shown in a companion paper (Desrieux and Beuve [2011]), this implies that relational contracts would be a cause and not a consequence of contractual incompleteness, contrary to what Bernheim and Whinston [1998] suggest.

However, there is no empirical work (to our knowledge) that investigates the links between relational contracts and contractual incompleteness. In this paper, we propose to fill this gap by providing some support to the vision of contractual incompleteness as a result of sustainable relational contracts. We conduct an experiment to see whether parties are willing to sign more incomplete contracts as trust builds over time. Such a reverse of causality (compared to Bernheim and Whinston [1998]) may explain the reluctance of business traders to change of providers they trust and know each other for years, even if a challenger propose lower production costs. Our methodology based on experimental economics proved to be particularly relevant for our purpose. This allows us to overcome several limits of empirical papers testing contractual incompleteness. Compared to the study of Crocker and Reynolds [1993], the experimental approach allows us to observe the entire story of relationships. History between parties start at the first period and the observed behaviors cannot be related to unobservable past events. Moreover, the empirical works as that of Crocker and Reynolds [1993] focus on relationships between one buyer and one or two sellers, while we can create in lab an environment where buyers and sellers are numerous and identically distributed in the population. Compared to experimental studies, our paper is closed to Fehr et al. [2000] and Brown et al. [2004]. In their paper, Fehr et al. [2000] study the impact of reciprocity on the voluntary choice of incomplete contract in a one-shot game setting. They find that reciprocity effect enhances the preference for incomplete contract and allows better performances. For their part, Brown et al. [2004] study relational contract in a repeated game setting which compares complete contract, incomplete contract with fixed identities and incomplete contract with random identities. They find that reputational effect allows to improve performances of incomplete contract when identities are fixed. In this paper, we do not focus on contract performance but we aim to link up relational contract and endogenous contractual incompleteness. Hence, as we will see, our original experimental design allows us to jointly analyze the existence of relational contracting and the subsequent contractual choices.

The following section provides a very simple theoretical framework to support our view of relational contracts as a factor of endogenous contractual incompleteness. Section 3 describes our experimental design, and section 4 describes the different treatments we study to put our propositions to the test. Section 5 comments our results and section 6 concludes.

2 The theoretical framework

In this section, we propose a very simple model to provide some structure on *(i)* why agents decide to cooperate in a relational contract, and (*ii*) how investments in contractual completeness evolve over time in such a situation. We intend this framework to be source of testable implications that we will take to our experimental data in the following sections.

2.1 Introduction of the Model

Let us consider a repeated bilateral contractual relationship between two agents, a buyer (B, whom we refer as "he") and a seller (S, whom we refer as "she"). The buyer wishes a project or a service, and asks the seller to perform the work according to the buyer's specifications, *i.e.* according to the contractual design. An illustration could be the public procurement sector, where the buyer (a public authority) asks a contractor to build an infrastructure, following some contractual specifications. As in Bajari and Tadelis [2001], we focus here on problems of *ex post* adaptations in a context where the level of contractual incompleteness is endogenously determined. We consider that both parties share uncertainty about contingencies that may arise once the contract is signed, and the production begins.[2]

When all contingencies are foreseen in the contract, the buyer gets a value U^+ of the project. However, some *ex post* unforeseen contingencies may also occur, in which case the contractual design is inappropriate. Before the beginning of each new period, the buyer can make an *ex ante* non-observable investment, say $I \in [0,1]$, to determine the level of contractual completeness of the agreement he signs with the seller. The more complete the design is, the lower the probability that unforeseen contingencies occur. Then, with probability $\rho(I) \in [0,1]$ ($\rho' > 0, \rho'' < 0$), the contract foresees all the contingencies, and delivers a value U^+ for the buyer. Yet, with probability $1-\rho(I)$, some unforeseen contingencies occur. In this case, the seller has to decide whether to cooperate or not. If she cooperates, the buyer still gets a value U^+ from the project, but if she decides not to cooperate and to act in her self-interest, the buyer only gets a utility $U^D < U^+$.

At the end of each period, the buyer decides to continue the relationship with the seller, or to stop and to use his outside option. We denote U^P the gain of the buyer when he uses his outside option, with $U^+ > U^P > U^D$. In other words, the buyer has always interest that the seller cooperates in the relationship but prefers to stop than to be cheated. In such a context, the relational contract is the threat of the buyer not to renew the seller if she decides not to cooperate in case of unforeseen contingencies.

The payoff of the seller is C when all contingencies have been foreseen, and when she cooperates under unforeseen contingencies. If she deviates, she gains D.[3] Her expected payoff when she does not trade with the buyer (her outside option) is P, with $D > C > P$.[4]

Last, we consider an infinitely repeated game. The buyer discounts his payoffs at rate $\delta_B \in [0,1]$, while the discount rate of the seller is $\delta_S \in [0,1]$. For analytical simplicity, we will consider trigger strategy in this infinitely repeated game: if the seller does not cooperate at any time, then the buyer stops the relationship forever.

The timing of the game is as follows:

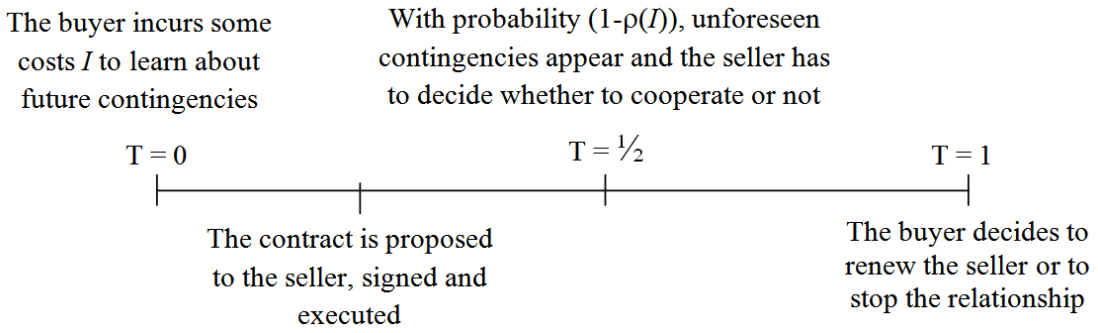
We propose to solve the model by backward induction: we determine whether the seller respects or not her informal commitment, and then analyze the level of investment in contractual completeness made by the buyer at the beginning of each period.

[2] To justify and illustrate this theoretical concern on *ex post* adaptations, the paper of Bajari and Tadelis [2001] (p.388) provides useful information about the public procurement, and show why the procurement problem is mainly about *ex post* adaptations rather than *ex ante* screening.

[3] The decision of the seller we describe is inspired from Gibbons [1997].

[4] In other words, when unforeseen contingencies occur, the situation is similar to a prisoneer's dilemma. In a static framework, by backward induction, the buyer anticipates that the seller will deviate, and there is no trade, since the buyer prefers his outside option U^P rather than U^D.

Figure 1: Timing of the game for one contractual period



2.2 The seller's decision to cooperate

When unforeseen contingencies occur at date $T = \frac{1}{2}$, the seller has to choose whether to cooperate or not. We determine here the self-enforcement condition of the seller. She cooperates whenever her discounted payoff stream from cooperation is higher than that of deviation, i.e. :

$$\frac{C}{1-\delta_S} > D + \frac{P\delta_S}{1-\delta_S} \qquad \text{(SEC)}$$

$$\Leftrightarrow \delta_S > \frac{C-D}{P-D}$$

As traditional in the literature on relational contracting, cooperation is all the more likely to occur than:

Result 1. The outside option (P) is all the lower (*ceteris paribus*).

Result 2. The discount rate of the seller (δ_S) is high (*ceteris paribus*).

2.3 The buyer's investment in contractual incompleteness

At the beginning of each new period, in $T = 0$, the buyer chooses his investment in contractual completeness so as to maximize his own payoff. Under symmetric information, the buyer knows whether (SEC) is respected or not, *i.e.* he knows whether the seller will cooperate or not in case of unforeseen events.

- If the seller cooperates, then the buyer expects a gain U^+ in case of *ex post* adaptations. Then, his expected per-period payoff is

  $$\rho(I)U^+ + (1-\rho(I))U^+ - I = U^+ - I$$

  Then, the payoff of the buyer is maximized when $I = 0$, which means that the buyer does not invest in contractual completeness. He prefers to *leave the contract intentionally incomplete*, because the relational contract is sustainable and the seller always cooperates.

- If the seller deviates, then the buyer expects a gain U^D in case of unforeseen events. His payoff becomes:

$$U^+\rho(I) + (1-\rho(I))U^D - I$$

The buyer chooses the investment level that maximizes his own payoff, *i.e.*:

$$I^B = \arg\max\{U^+\rho(I) + (1-\rho(I))U^D - I\} \Leftrightarrow \rho'(I^B)(U^+ - U^D) = 1$$

This means that the buyer invests in contractual completeness until the marginal benefit of the investment equals its marginal cost.

In other words, the contract is left intentionally incomplete when the buyer knows that the relational contract is sustainable. Otherwise, the buyer prefers to invest *ex ante* to make a contract more complete, in order to avoid the occurrence of *ex post* adaptations that will lead to the deviation of the seller. While relational contracts are traditionally considered as a solution to contractual completeness, we show here that they can also be viewed as a factor explaining endogenous contractual incompleteness.
Let us also add that this result can be related to that of Crocker and Reynolds [1993]: the buyer compares the *ex ante* costs of contractual completeness to *ex post* risk of opportunism. However, we show here that such a risk depends on the sustainability of relational contracts.

Result 3. The contract is left intentionally incomplete when the buyer knows that the relational contract is sustainable.

2.4 Testable implications

This short model above contains several testable predictions:

- Parties are all the more likely to respect a relational contract than:
  - (*Result 1:*) the rate at which they discount their future payoffs is high (*ceteris paribus*).
  - (*Result 2:*) their outside option is low (*ceteris paribus*).
- The contract is left intentionally incomplete when parties anticipate that the relational contract governing unforeseen contingencies is sustainable (*Result 3*).

To give these results some empirical content, we discuss below each of them:

2.4.1 The discount rate

As recalled by Fudenberg and Tirole [1991], there are two interpretations of the discount rate: it represents both the rate of time preference and the probability of continuation of the game.[5]

[5]More formally, $\delta = e^{-r\Delta}$ where r is the rate of time preference and Δ is the length of the period. However, if we add a probability μ of continuation from one period to the next, then with probability $(1-\mu)$ there is no gain, and with probability μ, the gain is discounted at rate $\delta = e^{-r\Delta}$. Then, the expected discounted value of the gain is $\delta' = \mu\delta = \mu e^{-r\Delta}$. Thus, the situation is the same as if $\mu = 1$ and $r' = r - \frac{ln(\Delta)}{\mu}$, hence the dual interpretation of the discount rate.

As a consequence, when parties anticipate that the duration of the game is longer, they discount future payoff at a higher rate, *all other things being equal*. Then, (SEC) is all the more likely to be satisfied, *i.e.* the relational contract is all the more sustainable. Then, we obtain our first testable implication:

Proposition 1. *The longer the duration of the game, the higher the incentives of the parties to respect their informal commitment.*

2.4.2 The outside option

In our model, the incentives of the seller to cooperate are all the higher than P (her gain outside the relationship) is low. Several determinants of the outside option can be established. Among them, the level of asset specificity included in the relationship makes the outside option all the lower, because those assets have no more value outside the relationship, and the partner supporting such investments may prefer to stay (even if he has been cheated) than to stop the relationship and to loose his specific investments. In the same way, the market structure is not neutral, since it determines whether alternative partners (outside the initial relationship) may be found in the market or not.

Last, public information also determines the value of the outside option. In the context of multilateral relationships, Greif [2006] and Bernstein [1992] show that the punishment of a cheater is effective only if it is applied by all the members of the community, so that the outside option of the cheater becomes low. One of the many difficulties of a collective punishment is that the information and communication channels need to be very efficient so that everyone may identify a cheater (Li [2003]; Dixit [2004, 2009]), and may apply the punishment. Then, public information would allow to identify the cheater more easily, and makes the punishment more efficient in case of deviation. With a different approach, Tadelis [2008] and Frestre and Garrouste [2011] also suggests that individuals are more willing to cooperate when they know that others observe their behaviors (i.e. in case of public information) because of the player's aversion to being thought of as acting in an inadequate way. In our paper, the goal is not to discriminate between these different explanations but to verify whether public information leads to more cooperation or not.

Then, we propose here to focus on the impact of public information on the level of the outside option, for a given level of asset specificity and in a given market structure. When information is public, the level of the outside option should be all the lower, and then makes cooperation all the more sustainable, since the alternative payoff (*i.e.* the outside option) is low:

Proposition 2. *Cooperation is more sustainable when information about the behavior of the participants is public rather than private.*

2.4.3 Endogenous contractual incompleteness

Our model shows that parties voluntarily sign incomplete contracts, when they know that a relational contract governing unforeseen contingencies is sustainable. Since information is symmetric and parties are rational, then the buyer knows *ex ante* whether he needs to invest in contractual completeness or not. However, in many situations, the buyer suffers from asymmetric information about the ability of the seller to respect her informal commitment, so the possibility to use backward induction disappears. He may be ignorant of the value of the outside

option (Halac [2010]) or of the discount rate of the seller (Desrieux and Beuve [2011]). These recent models of bayesian learning show that when there is no possibility to implement menus of contracts, the buyer has some prior about the ability of the seller to cooperate, and revises his prior over time. Past behavior of the partner delivers some information about the seller, and is the main factor allowing the revision of beliefs. If we apply such an intuition to our model, we could expect that the information collected in past interactions allows to influence the level of investment in contractual completeness made by the buyer at the beginning of each new period.[6] When there is no public information about the behavior of the agents, then the buyer can only focus on the information he collects on his own, through past experiences with a given seller. However, when the information about past interactions is public, each buyer can observe the behavior of a seller with all the different buyers. His information comes from his own past experiences and the past experiences of all the other buyers, since he can observe these interactions. Then, our last testable implications are:

Proposition 3. *Under private information, the more cooperative the past interactions between the parties are, the more incomplete the contracts proposed by the buyer become.*

Proposition 4. *Under public information, the more cooperative the seller was in all her past interactions, the more incomplete the contracts proposed by the buyers to this seller are.*

3 Experimental design

The experiment was designed to study the interplay between relational contract and contractual incompleteness. It corresponds to a buyer-seller game where gains will be determined by the decisions of players. In the instructions and during the experiment, we only refer to players A (i.e. buyers) and players B (i.e. sellers) in order to obtain as a neutral context as possible. Nevertheless, for a better understanding of the results, we will refer in the paper to buyers and sellers.

3.1 Subjects

The experiment was conducted in the Experimental Economic Laboratory of Paris at University of Sorbonne. One hundred and ninety-two subjects, predominantly undergraduate students of various fields, participated in the experiment. For each of the next described treatments we conducted four separate sessions, each with one group of twelve different students (every subject only participated in one session). Subjects were randomly assigned to a workstation and received written instructions. Those instructions have also been exposed in lab and subjects answered a control questionnaire before the start of the experiments to ensure they had a complete understanding of the rules.[7] Finally, all payoffs in the game were in ECUs and at the end of each session, the ECUs earned by each subject were converted into Euros (at the exchange

[6] Desrieux and Beuve [2011] show in a more detailed model that the more cooperation is observed in past interactions, the more incomplete contracts become. This paper takes into account strategic behaviors of the seller, *i.e.* their interest to commit temporarily to their informal promise, to cheat later on. This makes the reduction of completeness more progressive, but cooperative behaviors still induce less completeness.

[7] An example of game instructions is provided in appendix 2. The results of the test give a mean mark of 9,2/10 for a standard deviation equal to 1,1.

rate of 1 ECU = 0,025 Euros) and paid privately in cash. This exchange rate between ECUs and euros ensured that subjects had significant incentives to try to maximize their earnings.[8]

3.2 Matching procedure and identifiable players

In each session, subjects were divided into two groups: six players A (buyers) and six players B (sellers). At the beginning of each session, players receive a fixed identification number (from A_1 to A_6 for buyers and from B_1 to B_6 for sellers) for the whole duration of the experiment. As a result, all relationships took place between players that could be identified during all stages. Under these conditions, players are able to engage in long term relationships and, as we will see, buyers will be able to condition their choices on the seller's past behavior, so that reputation effects can emerge endogenously (Fehr et al. [2009]).
Furthermore, the matching between players was not random but autonomous. Technically, buyers can propose relationships to any seller and sellers can decide to accept or reject those offers. In the repeated game framework described after, buyers can decide to stop or to propose to pursue their relationships with current partners and to propose new relationship to other sellers at the end of each round. As for sellers, they can decide to accept or reject offers of relationships' renewal and offers of new relationships. To maintain a minimum level of competitive pressure and allow the threat of relationship termination to be effective, all players were limited to three different relationships per period.

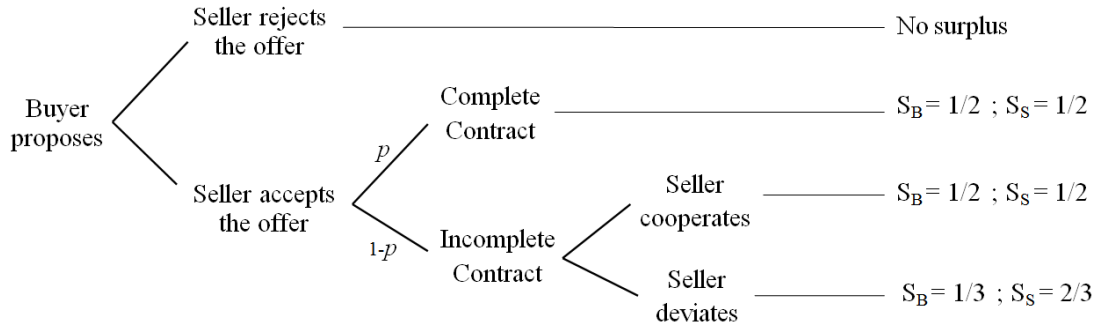
3.3 Incomplete contract and cooperation

In our experimental design, the surplus of the relationship is automatically and equitably shared between parties with a probability p; and, with a probability $1-p$ the sharing of the surplus is decided by the seller. According to the theoretical model we provide in section 2, the first case correspond to a complete contract where contingencies are well foreseen and there is no need for *ex post* adaptation, while the second case corresponds to an incomplete contract where unanticipated contingencies arise and parties have to find a new agreement. This incomplete contract situation opens rooms for opportunistic behaviors. Hence the sellers decide if they want to cooperate (i.e. to maintain an equitable sharing of the surplus) or to hold-up buyers (i.e. to have two-thirds of the surplus and leave one-third to the buyer).
Figure 2 summarizes those first elements of the experimental design.

$(S_B = \frac{1}{2}; S_S = \frac{1}{2})$ means that the surplus is shared equally between parties, while $(S_B = \frac{1}{3}; S_S = \frac{2}{3})$ means that the buyer gets one-third and the seller gets two-thirds of the surplus. The seller makes the decision only when contracts are incomplete, so that the game becomes similar to a dictator game in this case.

[8] Earnings in ECUs : m = 583 , σ = 182. Earnings in Euros : m = 14,6 , σ = 4,6.

Figure 2: Matching, contractual completeness and surplus sharing



3.4 Additional investment and endogenous contractual incompleteness

The experimental design considered two different types of investment associated with contracting. On the one hand, both players have to bear an initial investment at the beginning of each new relationship (*i.e.* when they first play with a new partner). This initial investment can be compared to specific investment due to the implementation of the relationship. On the other hand, the buyers can decide to periodically incur an additional investment which allows them to minimize the risk of incomplete contract and, *de facto*, the risk to be held up. Such an additional investment could be compared to efforts to make the contract more complete. Contrary to the initial investment, those efforts can be made at the beginning of each new period (*i.e.* whether the partner is new or not).

In our experiment, when they start a new relationship, a buyer and a seller both invest 6 ECUs (which is then the amount of initial investment). Thereafter, at the beginning of each round, buyer can decide to invest 2 ECUs in order to limit the risk of incomplete contract in the current round. If the buyer does not make this additional investment, the probability $1 - p$ to face an incomplete contract is equal to 0,5. This probability falls to 0.25 when the buyer makes the additionnal investment.[9] Here we can notice that informations about additional investment and associated probabilities are known by all players. Nevertheless, during the experiment, the sellers do not know if the buyers decide or not to make this additional investment. As a consequence, the choice of cooperation in case of incomplete contract cannot be analyzed as a reciprocal answer to the trust expressed by the buyers when they choose not to make the additional investment. The reciprocity effect comes after in the timing: the sellers who decide to cooperate might hope offers of relationships' renewal. In other words, the reciprocity is not due to the buyers' choices of contractual completeness (invisible to sellers) but relies on the repeated interactions (buyers can discipline the sellers by practicing a contingent renewal policy).

[9] All the values assigned to the parameter of the experimental design are discretely determined by the authors. Nevertheless, values are established in order to ensure enough incentives to players and to hold specific conditions described in the subsection 3.5 Payoffs.

Table 1: Buyer's investment and likelihood of incomplete contract

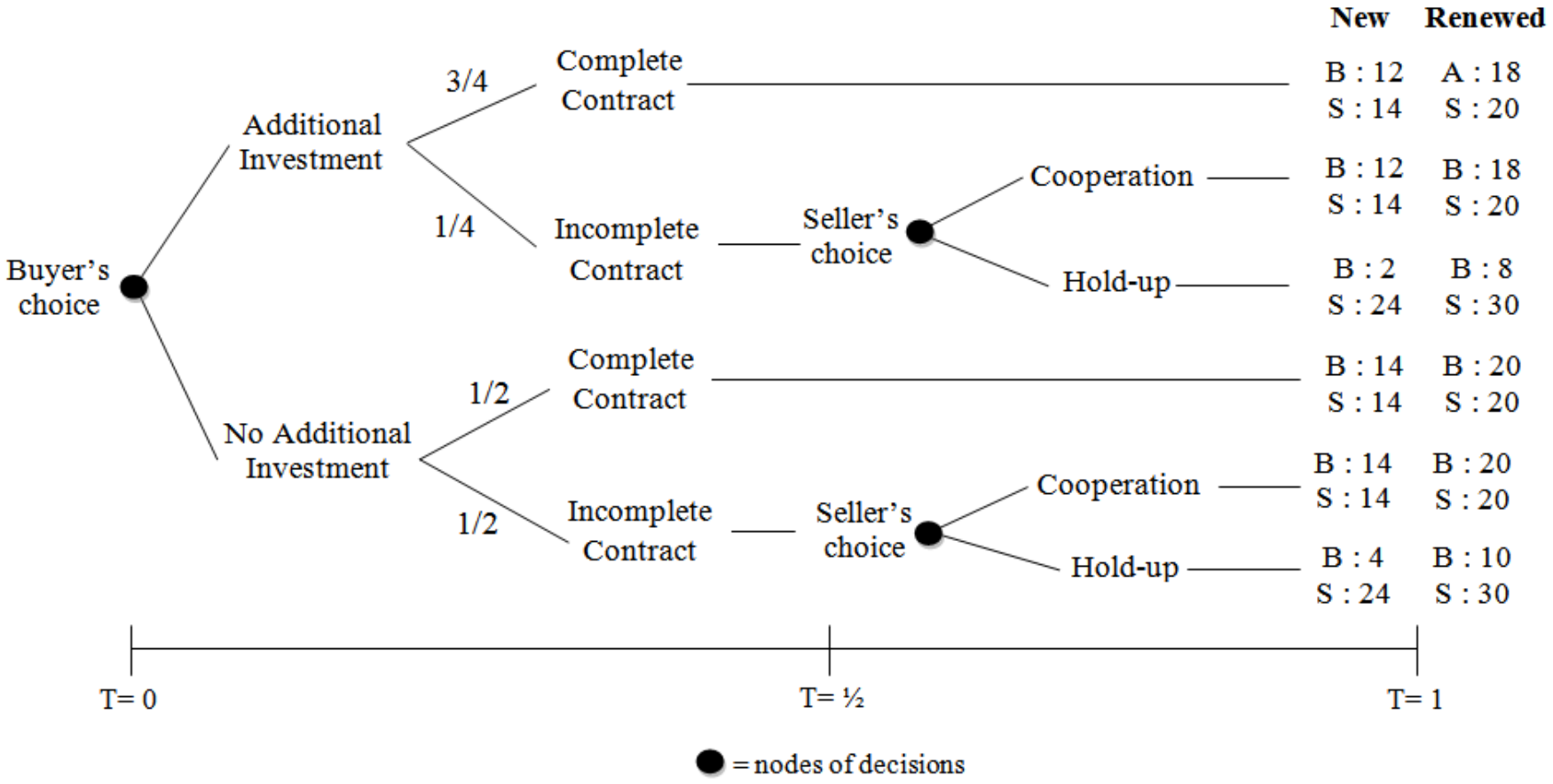
Additional Investment	0 ECU	2 ECUs
Likelihood of complete contract (p)	0,5	0,75
Likelihood of incomplete contract (1-p)	0,5	0,25

3.5 Payoffs

At the beginning of the experiment, all players have an initial capital of 0 ECUs. In the end, payoffs of players will be determined by the nature of the relationship (new or renewed) and their actions (additional investment or not of buyers and cooperative or opportunistic behaviors of sellers). Figure 3 displays the payoffs tree (in ECUs) of players for all different situations. It is important to note that gains associated with the different actions are the same in all treatments. They were specifically designed to fulfill the following conditions:

- It is always profitable to have a relationship for players.
- In one shot-game, it is always profitable for sellers to deviate.
- In one shot-game, it is always profitable for buyers to protect themselves against risk of hold-up by making the additional investment.
- In infinitely repeated games, it is always profitable for buyers to make the additional investment if they know with certainty that sellers will deviate.
- In infinitely repeated games, it is never profitable for buyers to make the additional investment if they know with certainty that sellers will cooperate.

Figure 3: Payoffs



4 Treatments

In the previous section, we present the experimental design that holds for all treatments. In this section, we now focus on the parameters that will be modified between treatments in order to put to the test our propositions of section 2.

4.1 The duration of the game

When they come to the lab, the players were informed that they would play two different games without knowing what would be those two games. They discover it successively.

4.1.1 One shot game

The first game was a one shot game where players only interact during one period. There was only one matching procedure. According to the design, buyers decide the level of investment they want and sellers decide to cooperate or deviate in case of incomplete contract. Afterwhile, gains are announced to players and the game stops. Then the first game ended and players received instructions for the second game.

4.1.2 Infinetely repeated games

The second game was a repeated version of the one shot game. Obviously, identification numbers were redistributed among players in a manner that no information could be extracted from the first game. We run experiment in two different infinitely repeated games contexts by using a random continuation rule. In long-run repeated game (LR), players interact during at least six periods, thereafter they play successive additional periods with a probability of continuation δ = 0,8. In short-run repeated game (SR), players interact during at least six periods, thereafter they play successive additional periods with a probability of continuation $\delta = 0{,}2$.[10] In infinitely repeated games with a continuation probability δ, the expected number of rounds is equal to $1/(1\text{-}\delta)$. Therefore, the expected numbers of rounds in our treatments are equal to 7 for $\delta = 0{,}2$ and 11 when $\delta = 0{,}8$.
According to our proposition 1 and according to previous experimental studies (Murninghan and Roth [1983], Dal Bo [2005]), we expect to observe a higher level of sellers' cooperation when the time horizon is longer (i.e. when the probability of continuation is equal to 0,8).

4.2 The nature of information

4.2.1 Private information

When information is private, buyers can only observe behaviors of sellers they are currently associated with. Nevertheless, they have no possibility to obtain information neither on the

[10] The probability of game continuation is common knowledge for all players at the beginning at the experiment.

behaviors of their partners in other relationships nor about other sellers they are not associated with.
According to our proposition 3, we expect to observe less buyers' additional investment in contractual completeness when their sellers cooperated in the previous periods.

4.2.2 Public information

When information is public, buyers still have information about sellers they are currently associated with but also about past behaviors of all sellers present in the lab. More precisely, at the end of each period, buyers learn the percentage of cooperative versus non cooperative behavior of sellers in all their relationships and in all previous periods.[11] As a result, the nature of information could modify the behavior of both players.
According to our proposition 2, public information acts as an incentive to create and maintain a reputation of reliability and we expect to observe more sellers' cooperation in treatments with public information.
According to our proposition 4, reputation (of cooperative behaviors) can be used by buyers as a proxy for seller's willingness to cooperate, so we expect to observe less additional investment on contractual completeness when reputation built during previous periods is high.

4.3 Summary

Thus we have five different treatments of the experiment. A one shot game treatment (OSG) and four different infinitely repeated game treatments. The second and the third are treatments with a game discount $\delta = 0{,}2$ after the fifth round. However, information is private in the treatment denoted SR (Short Run) and is public in the treatment denoted SRP (Short Run with Public information). The fourth and the fifth are treatments with a game discount $\delta = 0{,}8$ after the fifth round. Similarly, information is private in the treatment denoted LR (Long Run) and is public in the treatment denoted LRP (Long Run with Public information).Table 2 summarizes the different treatments.

Table 2: Treatments

Name	**OSG**	**SR**	**SRP**	**LR**	**LRP**
Type of the game	One shot game	Infinitely repeated game	Infinitely repeated game	Infinitely repeated game	Infinitely repeated game
Probability of continuation	0	0.2	0.2	0.8	0.8
Nature of information	-	Private	Public	Private	Public

[11] As soon as we have an incremental measure of sellers' reputation, we do not distinguish short run reputation (information about the last session) and long-run reputation (information about all sessions). See Keser (2002) for an interesting comparison between the effect of short-run reputation and long-run reputation in trust game.

5 Results

To test our four propositions described in subsection 2.4, we draw our attention on the determinants of seller's cooperation and the interaction between sustainable relational contract and contractual incompleteness. Nevertheless, before analyzing results coming from descriptive statistics and the econometrical analysis, we have to control that we can compare observations from our different treatments. Consequently, the first question is whether there is enough evidence to reject the proposition that samples of observations of our main variables (i.e. *Cooperation* and *Additional Investment*) are generated by the same stochastical process. As suggested by many studies, this is evaluated by using non parametric testing methods (Hackett 1993). The nonparametric Wilcoxon test reports are presented in Table 3 (in Appendix) where "Z" is the Wilcoxon score and "P>Z" is the significance level at which the null proposition of no difference in distribution is rejected. Most of the time, tests reject the null proposition of no difference in distribution of our variables between samples. Particularly, the null proposition is rejected at 1 percent level when we compare short run versus long run treatment on the one hand and private versus public information treatment on the other hand.

5.1 The determinants of cooperation

Our goal in this subsection is to study whether our experimental data are consistent with propositions 1 and 2 about the determinants of seller's cooperation.

5.1.1 Descriptive statistics

We begin our analysis with an overview of the frequency of cooperative behaviors of sellers[12] in case of incomplete contracts observed in the treatments described in the previous section (see Figure 4). We distinguish six settings of observations corresponding to different segments of experiments length. Then, we focus on the percentage of cooperative behaviors of sellers in:

- All rounds compiled.
- Rounds 1 (*i.e.* the first round of each session). Since we have a one shot game treatment, we can compare the impact of the probability of continuation and public information on the level of cooperation reached in the only first round of each session.[13]
- Rounds 1 to 5. It corresponds to the first five rounds of each session where the probability of continuation is equal to 1
- Rounds 6 to 19. It corresponds to rounds where the probability of continuation becomes lower than 1 (i.e. 0,2 for SR and SRP treatments and 0,8 for LR and LRP treatments).[14]

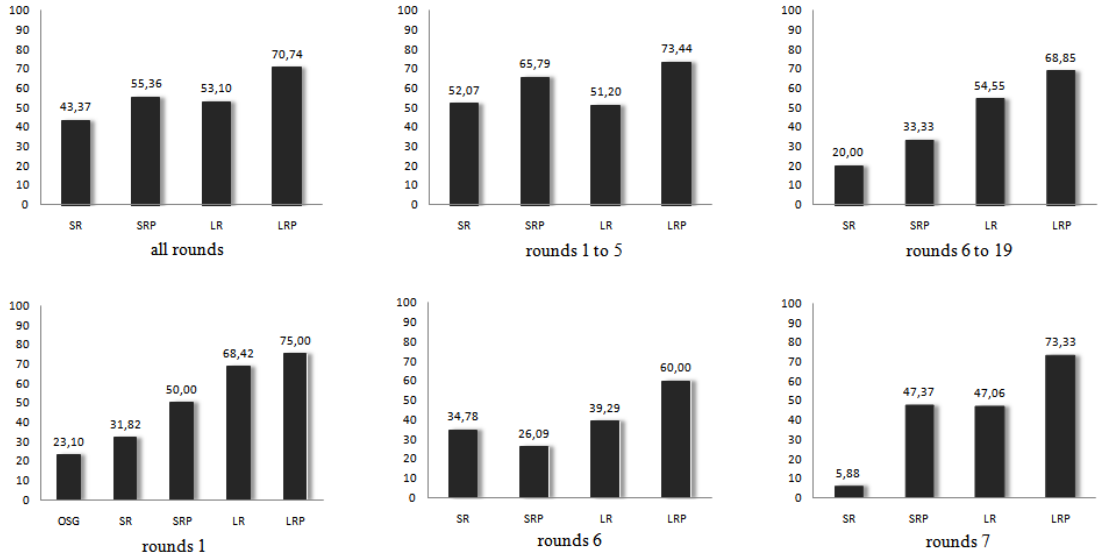
[12] This frequency means here the percentage of cooperative behaviors among all the observed behaviors.

[13] Most of the time, experimental papers do not take into account first periods in order to avoid considering actions that are taken with little understanding of the game. They consider that learning happens in the first matches. In our paper, since participants played the one shot game before the repeated game and since we observe very high rates of rules understanding, we do not exclude first periods in the analysis of the results.

[14] 19 corresponds to the highest number of rounds reached during a session (LR treatment).

- Rounds 6 and Rounds 7. It corresponds to the two first rounds of each session where buyers and sellers interact in an uncertain context.[15]

Figure 4: Frequency of *Cooperation* by rounds and by treatments



Comparisons of the behaviors during the first round of each session confirm that cooperation is higher in repeated game than in one shot game from the very beginning of the game. Beyond the enhancing power of repeated game on cooperation, those comparisons also highlight the impact of probability of continuation and information sharing. In fact, we observe that a higher probability of continuation and public information lead to higher level of cooperation, already in the first round. It is consistent with the view that many subjects understand the logic of reputational incentives (Fehr et al. [2009]). This effect is then confirmed by the comparisons of cooperation on larger segments of the sample, as shown in Figure 4. For instance, the comparison between the two treatments SR and LRP which allow us to jointly assess the impact of probability of continuation and public information is very instructive. Whatever the chosen segment, cooperation is always higher in repeated game with a high probability of continuation and with public information than in repeated game with low probability of continuation and with private information. This is confirmed by the observation of all rounds but also by the more relevant observation of rounds superior than 5 where the probability of continuation differs accross SR and LR treatment.

Thus, in accordance with proposition 1, a longer duration of the game enhances sellers to sustain informal cooperation. The higher probability of continuation makes the cooperation strategy more chosen compared to the deviation one. Indeed, the opportunity cost associated with a punishment by buyers increases with the likelihood of longer relationship.[16] Our statistics are also consistent with our proposition 2 as we observe that sellers are conduced to behave cooperatively when they know that information about their past behaviors is made public. Our

[15]Rounds 6 were played in all sessions. Rounds 7 were played in almost all sessions (13/16).

[16]Those observations are consistent with previous findings of experimental studies in different repeated games framework (Murninghan and Roth [1983], Engle-Warnick and Slonim [2006], Duffy and Ochs [2009], Dal Bo [2005]).

interpretation is that the risk of deviation strategy to be punished by non renewal becomes higher since it is extended to all sellers' relationships.[17] As expected, the combination of these two factors (in the LRP treatment) leads to the highest level of cooperation.

5.1.2 Econometric analysis

Our experiment allows us to obtain panel data where panel variables are all the different relationships between buyers and sellers and where time variables are successive rounds. Thus we can test econometrically our propositions 1 and 2. In order to do this, we run the following logit estimation:

$$C_{ijk} = \alpha.PC + \beta.PI + \gamma.SE_i + \eta.Z + \varepsilon_{ijk} \quad (1)$$

Where C_{ijk} (*Cooperation*) is a dummy variable indicating whether seller i cooperates or not in round j in its relationship with buyer k; PC (*Probability of Continuation*) is a dummy variable equal to 1 if the probability of continuation is high ($\delta = 0{,}8$) and 0 if the probability of continuation is low ($\delta = 0{,}2$); PI (*Public Information*) is a dummy variable that takes value 1 when information is public and 0 when information is private; SE_i (*Specific Effect*) is a variable capturing fixed effect associated with each seller i. More precisely, we cluster on sellers' level in order to take into account fixed-effects associated with sellers engaged in different relationships with different buyers. Z is a vector of control variables encompassing the following dimensions: the number of previous interactions between seller i and buyer k (*Past Experiences*); the number of ongoing relationships of seller i in round j (*Ongoing Relationships*); the "level" of altruism identified in each particular session (*Altruism*[18]), the age (*Age*) and the sex (*Sex*) of the seller i as well as his status (*Status*) and the discipline (*Discipline*) he studies. Lastly, ε_{it} is a potentially heteroskedastic regression error term. We assume that $\varepsilon_{it} \rightsquigarrow (0, \Sigma)$.

Results of the logit estimation (1) confirm the observations coming from descriptive statistics. As observed in Table 6, coefficients associated with the variables *probability of continuation* (proposition 1) and *Public Information* (proposition 2) are positive and significant at the 1% level. It means that cooperative behaviors are more likely to emerge in situations where the expected length of the relationship is long and the information about cooperative or uncooperative sellers' past behaviors is public. Econometrical investigation thus confirms that relational contracts are easier to sustain when potential duration is longer and when information is public. In the following subsection, we now study the impact sustainable relational contracts have on endogenous contractual incompleteness.

[17] Hereagain, this observation is consistent with previous experiments findings on the positive impact of reputational concerns on cooperative behaviors (Fehr et al. [2009], Bolton et al. [2005]).

[18] As previously said, participants first played a one shot game without knowing that they would played a repeated game after. Since there is any incentives to cooperate in the one shot game, we use the level of cooperation observed during the one shot game as a measure of the proportion of altruistic players present in the lab

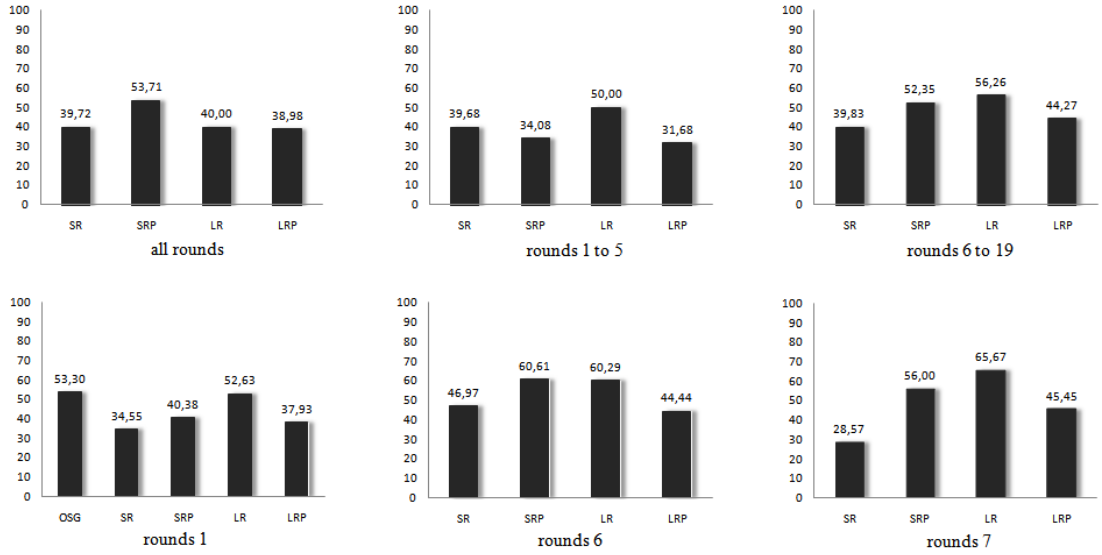
5.2 Sustainable relational contract and contractual incompleteness

Our goal in this subsection is to study whether our experimental data are consistent with propositions 3 and 4 about subsequent choices of buyers in terms of contractual completeness regarding to sellers' past behaviors and reputation.

5.2.1 Descriptive statistics

We have to statistically determine if the sellers' cooperation influences the level of contractual completeness decided by buyers in our framework. Indeed, in our experiment, the risk to face an unforeseen contingencies opening rooms for sellers' opportunism decreases with the level of buyer's periodic efforts to complete the contract. In other words, buyers have to invest more (*Additional Investment*) in order to lower the risk of incomplete contract in which case sellers make the decision of surplus sharing.
Thus we observe in Figure 5 the *Additional Investment* rates in the same six different settings described above.

Figure 5: Frequency of *Additional Investment* by rounds and by treatments



As observed, the treatment where we observe higher levels of *Additional Investment* is the LR treatment. This could appear as a surprising observation. Indeed, we previously verify that a higher probability of continuation is an enhancing factors of sellers' cooperation. As a consequence, buyers should anticipate this incentive to cooperate and react accordingly by choosing a lower level of additional investment. In other words, although reputational concerns provide incentives for sellers to behave cooperatively, buyers do not seem to consider those incentives are effective and they do not invest accordingly by choosing to invest less in contractual completeness. Thus, it seems that we cannot make conclusions about the direct effect of probability of continuation and public information about behaviors of sellers on the level of *Additional Investment* chosen by buyers.
However, in subsection 2.4.3, we recall that under asymmetric information, buyers may learn

over time and adapt their behaviors. Consequently, we analyze the choices of buyers in terms of *Additional Investment* by taking into account their past experiences with each particular seller over time.

On this regard, Figures 6 and 7 are very instructive. Figure 6 shows the frequency of *Additional Investment* of buyers according to the cooperative behaviors of sellers during the last three periods. For instance, the first column means that when the seller had cooperated in the last three rounds, only 9,1 % of the buyers made an additional investment. The fifth column means that when the seller had cooperated to the previous period (T-1), but that the contract was complete during the two anterior periods (T-2 and T-3), then 20,3 % of the buyers made an additional investment.

As we can notice, buyers are less likely to invest more *ex ante* when sellers were cooperative during previous rounds. In fact, the lowest four rates of *Additional Investment* (i.e. 9,1%; 9,5%; 13,9% and 16%) correspond to situations where buyers only observe cooperative behaviors during the last three rounds. On the opposite, the highest four rates (i.e. 73,3%; 75%; 75,2% and 80%) correspond to situations where buyers only observe opportunistic behaviors during the last three rounds. Moreover, we also observe a gap in buyers' behaviors: as soon as there is at least one opportunistic behavior during the last three periods, the *Additional Investment* rate of buyers switch from 26,4% to 50%. Such an observation, corroborating that opportunistic behaviors of sellers in the past make buyers more wary, is consistent with (relational contract theory based on) trigger strategy which assume cooperative choices so long as no party has defected from the implicit agreement in past interactions.

A same effect is observed in Figure 7 when we look at the impact of sellers' reputation. This figure shows the frequency of *Additional Investment* of buyers according to the reputation of sellers observed in the last period. We range the frequencies of cooperative behaviors of sellers by decile in treatments where information is public: For instance, the first colum means that 174 sellers had cooperated in less than 10% of the cases of contractual incompleteness, and 67,24 % of the buyers chose to make additional investments when they played with those sellers. We observe that the lowest rate of *Additional Investment* is reached when sellers are known to be cooperative (frequency of additional investment of buyers is equal to 16,67% when they observed that seller's reputation is higher than 90%[19]) and high rate of *Additional Investment* is reached when sellers are known to be opportunistic (frequency of additional investment of buyers is equal to 67,24% when they observed that seller's reputation is lower than 10%).

Those descriptive statistics highlight a clear and strong interaction between past cooperative behaviors of sellers and choices of buyers in terms of contractual completeness. Observations are consistent with our propositions 3 and 4 arguing that the more cooperative the past interactions between the parties are, the more incomplete the contracts proposed by buyer are under private information and the more cooperative the seller has been in all her past interaction, the more incomplete the contracts proposed by the buyers to this seller are under public information.

[19]It means that the seller had chosen to cooperate in 90% of incomplete contract situations she faced since the beginning of the experiment.

Figure 6: Buyer's *Additional Investment* depending on sellers' past *Cooperation*

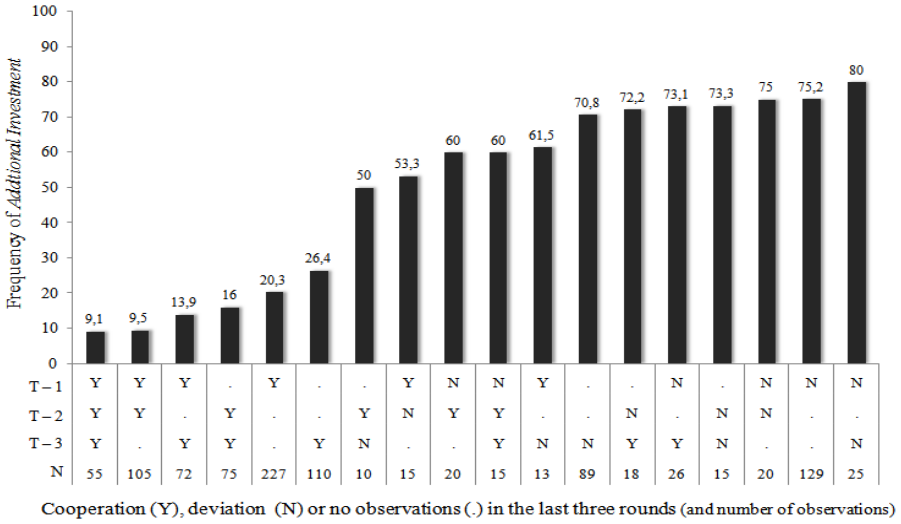
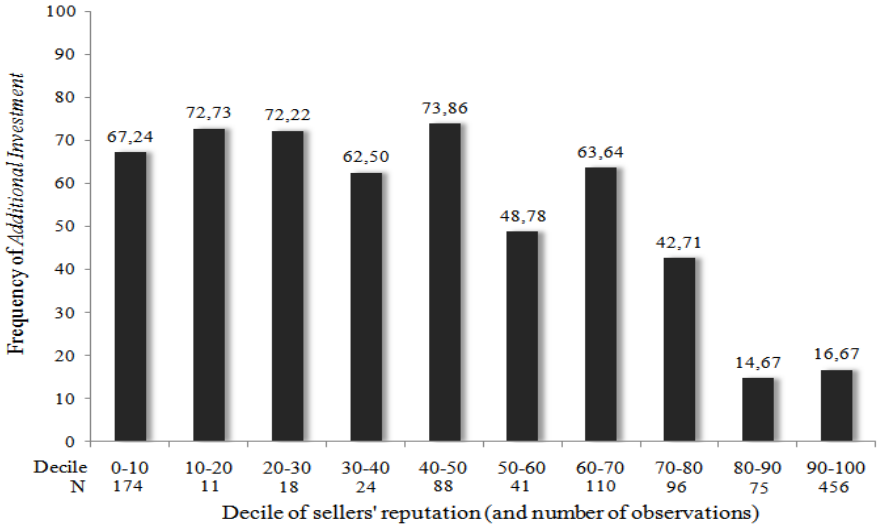


Figure 7: Frequency of buyer's *Additional Investment* depending on sellers' *Reputation* (in SRP and LRP treatments)



5.2.2 Econometric analysis

In order to corroborate those observations and to put to the test our propositions 3 and 4, we run the following logit estimations:

$$AI_{kji} = \alpha.PC + \beta.PI + \gamma.SE_k + \eta.L.C_{ijk} + \theta.L.R_{ij} + \kappa.Z + \varepsilon_{ijk} \quad (2)$$

$$AI_{kji} = \alpha.PC + \beta.PI + \gamma.SE_k + \eta.L.CC_{ijk} + \theta.L.R_{ij} + \kappa.Z + \varepsilon_{ijk} \quad (3)$$

$$AI_{kji} = \alpha.PC + \beta.PI + \gamma.SE_k + \theta.L.R_{ij} + \kappa.Z + \varepsilon_{ijk} \quad (4)$$

Where AI_{kji} (*Additional Investment*) is a dummy variable indicating whether the buyer k

chooses to incur additional investment or not in round j in its relationship with seller i; the next variables are exactly the same than in the specification of seller's cooperation (i.e. *Probability of Continuation*, *Public Information*, *Specific Effect* of each buyer and Z is the same vector of control variables. Moreover, in order to study the effect of past history on *Additional Investment*, we also include a set of lagged variables: $L.R_{ij}$ (*Lagged Reputation*) is the frequency of cooperative behaviors of seller i in all its different relationships and all the previous periods, $L.C_{ijk}$ (*Lagged Cooperation*) is a dummy variable indicating whether the seller i cooperate or not in its relationship with buyer k in the previous period and $L.CC_{ijk}$ (*Lagged Cumulative Cooperation*) is the frequency of cooperative behaviors of seller i in its relationship with buyer k in all previous periods from the beginning of their relationship. Lastly, ε_{it} is a potentially heteroskedastic regression error term. We assume that $\varepsilon_{it} \rightsquigarrow (0, \Sigma)$.

In estimations (2) and (3), we analyze the impact of sellers' cooperation during the previous period and during all periods since the beginning of the relationships on the choices of buyers in terms of additional investment. Results are provided in Tables 7 and 8. They provide strong support to our proposition 3. Indeed, we observe a negative and significant sign (at the 1% level) associated with our lagged variables *L.Cooperation* and *L.Cumul Cooperation*. Such results indicate that buyers are less likely to incur additional investment when their partners behaved cooperatively in (the) previous period(s). The importance of sellers' past behaviors to determine buyers' investments is also illustrated by the positive and significant sign associated with our lagged variable *L.Cooperation*. It indicates that buyers not only take into account their personal interactions with each particular seller but they also also care about the behavior of the seller outside of their relationship.

Nevertheless, a more rigourous investigation of our proposition 4 requires to look at the choices made by buyers in terms of contractual incompleteness when they start a new relationship with a seller they were never associated with. That is precisely what we do in estimation (4). For this purpose, we only observe new relationships in treatments where the buyers have access to information on sellers' past behaviors (i.e. in case of SRP and LRP treatments where *Public Information*= 1). In such a situation, and in accordance with our proposition 4, we observe a negative and significant (at the 1% level) sign associated with our variable *L.Reputation* (see Table 9). It indicates that, under public information, the more cooperative the sellers were in all their past interactions, the more incomplete the contracts proposed by the buyers to them are.

Let uss add that our variable *L.Reputation* is significant in all our estimations. We interpret this result by the key role played by past reputation. Indeed, sellers' reputation helps buyers in their decisions in two ways: on the one hand, it could reinforce or moderate information obtained by buyers through direct interactions; on the other hand, it could be used by buyers as a proxy for willingness to cooperate when they do not have any past interactions with particular sellers.

A surprising result also appears in Tables 7 and 8 with the positive and significant sign sometimes associated with the probability of continuation. Such a result might indicate that buyers are more likely to invest in contractual completeness in long run treatments than in short run treatments. A possible explanation of this result comes from the existence of strategic behaviors of sellers. Indeed, although long duration of the game facilitates cooperation, it does not imply that sellers always cooperate. As observed in the data, and as confirmed by informal discussions with participants at the end of experiments, sellers in repeated game are more willing to imagine strategies than to follow a specific behavior. Such strategies generally take two forms : cooper-

ate most of the time and hold-up occasionally in order to increase their earnings while avoiding the risk of being punished by buyers or always cooperate at the beginning of the game hold-up more and more frequently when the game were extended periods by periods. Consequently, buyers also have to periodically revise their beliefs and to protect themselves by investing more in contractual completeness. Since those kind of strategies are easier to implement on the long run, it could explain why we have this positive and significant sign associated with our variable *probability of continuation* in the econometric analysis of *Additional Investment*.
Nevertheless, our results corroborate that less complete contracts correspond to highest cooperative relationships (proposition 3) and highest reliable sellers (proposition 4). As a consequence, we can affirm that the implementation of sustainable relational contract encourage buyers to reduce the level of contractual completeness.

6 Conclusion

The primary purpose of this study was to examine the interplay between sustainable relational contract and endogenous contractual incompleteness. The series of experiments shed new lights on this topic. Indeed, evidences suggest that reputational concerns - through higher probability of continuation and public information - are enhancing factors of sustainable relational contract but also that the more or less cooperative behaviors of sellers have a strong consequence in the subsequent choices made by buyers in terms of contractual completeness. Indeed, buyers clearly appear less prone to protect themselves (by investing more in the contractual design) when they are associated with cooperative sellers than uncooperative ones. It means that buyers adapt their investment in contractual completeness according to what they learned in previous periods and they decide themselves to incur lower costs in contractual safeguard mechanisms only when they really observe cooperative behaviors. Those results are a step forward on the path to improve our understanding of the dynamics of contractual incompleteness. For instance, it might be used to explain many situations of "lock-in" effect where a firm (or a public authority) prefers to keep its actual partner (or operator) despite of the presence of other potential and cheaper partners. Indeed, the learning process allow parties to know each other and to build contractual design accordingly, making the change of partners potentially risky and more expensive than the cost reduction proposed by the alternative option. This way, it also highlights the importance of considering past experiences in the choice of partner and level of safeguard mechanisms foreseen by the contract.
Our study leaves open many directions for future extensions. The first concern is about the extent to which the results in this study are robust to changes in the payoffs parameters. In the experiment, the level of payoffs does not vary since we are firstly interested in the enhancing factors of cooperation and their implications on the level of contractual completeness. Nevertheless, one can expect that the level of payoffs may impact on the behaviors of buyers and sellers. For instance, a case where the hold-up is high for sellers (i.e. possibility to grab all the surplus) and strongly dangerous for buyers (*i.e.* negative payoffs) may modify their respective behaviors in terms of cooperation and investment in contractual completeness. A second concern is that we only focus in this paper on one-side opportunism (only sellers have the possibility to deviate). Obviously, in classical buyer-seller relationship, buyers can also deviate (payment default for instance) and sellers could want to learn their partner's type. Then, an interesting

extension will be to enrich the experimental design in order to allow both players to choose between cooperation or deviation in the surplus sharing and to define the level of contractual completeness they want. Such an experiment can provide us a finest analysis of the interplay between cooperative relationships and subsequent choices in terms of contractual completeness.
Our third concern is about outside option. While we remind that incentives provided by the outside option depend on the levels of competitive pressure, specific investments and information sharing; only the nature of information varies in our experiments. As a consequence, we actually notice few cases of relationships' failures in our experiment (24,24% of relationships are ended when buyers observe opportunistic behaviors). Most of the time, the buyers prefer to increase the level of contractual completeness rather than to start a new relationship. Thus, it could be explained by the level of initial investment (i.e. specific investment) but also by the fact that the maximum authorized numbers of different relationships by rounds was established to three while there is six potential partners on the lab. It might be worthwhile to compare our actual results with sessions including more potential partners and/or with different levels of initial investment to observe the subsequent choices of buyers and sellers. An interesting extension has to be found in Brown et al. [2008]. In this paper, the authors study the performance of relational contract with variations in the market structure: they refer to *high-demand* market when there is more principals than agents and, inversely, to *low-demand* market when there is less principals than agents.
Finally, another extension that could be worthwhile to investigate would be to allow players to have more or less profitable relationships (or similarly to specify more or less important payoffs for different relationships). Such a design would help us to observe how the causality between relational contract and endogenous contractual incompleteness could also be influenced by the profitability of relationships. All those possible extensions are as many alleys for future researches in this exciting topic.

7 Appendix

7.1 Tables

Table 3: Samples, non-parametric test results (Wilcoxon scores)

Variables	Samples	Z	Probability >Z
Cooperation	SR vs SRP	-2.187	0.0287
	SR vs LR	-0.963	0.3358
	SR vs LRP	-5.555	0.0000
	SRP vs LR	1.309	0.1905
	SRP vs LRP	-3.301	0.0010
	LR vs LRP	-5.555	0.0000
	Short Run vs Long Run	**-3.046**	**0.0023**
	Private vs Public information	**-5.021**	**0.0000**
Additional Investment	SR vs SRP	-0.085	0.9321
	SR vs LR	-4.562	0.0000
	SR vs LRP	0.530	0.5959
	SRP vs LR	-4.565	0.0000
	SRP vs LRP	0.630	0.5287
	LR vs LRP	0.530	0.5959
	Short Run vs Long Run	**-2.870**	**0.0041**
	Private vs Public information	**3.966**	**0.0001**

Table 4: List of variables and summary statistics

Variable	**Description**	**Obs.**	**Mean**	**St. Dev.**	**Min.**	**Max.**
Cooperation	Dummy variables indicating whether the seller decide to cooperate (1) or not (0).	935	0.58	0.49	0	1
Additional Investment	Dummy variables indicating whether the buyer decide to make an additional investment at the beginning of the round (1) or not (0).	2450	0.44	0.50	0	1
Probability of continuation	Dummy variables indicating whether the probability of continuation is high (1) or low (0).	5400	0.63	0.48	0	1
Public Information	Dummy variables indicating whether the information about sellers' past behaviors is public (1) or not (0).	5400	0.51	0.50	0	1
Past Experiences	Number of past interactions between the seller and the buyer during previous rounds.	5400	7.2	3.6	0	19
Ongoing Relationships (Buyer)	Number of ongoing relationships of the buyer in the current round.	5400	2.72	0.57	0	3
Ongoing Relationships (Seller)	Number of ongoing relationships of the seller in the current round.	5400	2.72	0.58	0	3
Reputation	Percentage of cooperative decisions made by each seller in all the previous periods and in all its relationships.	2308	56.75	42.77	0	100
Cumul Cooperation	Percentage of cooperative behaviors of seller in all the previous periods of their relationship.	2322	0.53	0.45	0	1
Altruism	Percentage of "altruistic players" identified during the one shot game.	5400	50.73	30.88	0	66.6

Table 5: Correlations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Cooperation	1.0000								
(2) Additional Investment	-0.2331	1.0000							
(3) Probability of Continuation	0.1244	0.0672	1.0000						
(4) Public Information	0.1597	-0.1089	0.0139	1.0000					
(5) Past Experiences	0.0500	0.0400	0.3156	-0.0711	1.0000				
(6) Reputation	0.7647	-0.2879	0.1084	0.2161	0.1204	1.0000			
(7) Ongoing Relationships (Buyers)	0.0632	-0.0271	0.0290	-0.0329	0.1470	0.0805	1.0000		
(8) Ongoing Relationships (Sellers)	0.1172	-0.0519	0.0744	-0.0391	0.2211	0.2612	0.0935	1.0000	
(9) Altruism	0.0890	-0.0529	0.2685	-0.1822	0.3974	0.1111	0.1195	0.1236	1.0000

Table 6: Logit analysis of *Cooperation*

Cooperation	Rounds 1-19	Rounds 1	Rounds 1-5	Rounds 6-19	Rounds 6	Rounds 7
Probability of Continuation	0.395*	2.372***	0.040	1.310***	0.936*	1.290*
	(0.184)	(0.692)	(0.222)	(0.365)	(0.443)	(0.583)
Public Information	0.789***	0.890	0.884***	0.919**	0.380	2.484***
	(0.189)	(0.749)	(0.230)	(0.322)	(0.571)	(0.631)
Past Experiences	-0.035	-	0.018	0.056	0.448^{+}	0.184
	(0.025)	-	(0.093)	(0.042)	(0.240)	(0.223)
Ongoing Relationships	0.301	1.717**	0.119	0.660^{+}	0.789	-0.337
	(0.224)	(0.651)	(0.237)	(0.341)	(0.711)	(0.754)
Altruism	0.012**	0.041*	0.011*	0.012*	0.008	0.039*
	(0.004)	(0.017)	(0.006)	(0.005)	(0.010)	(0.015)
Sex	0.156	0.270	0.506*	-0.004	0.131	0.713
	(0.199)	(0.867)	(0.229)	(0.313)	(0.606)	(0.743)
Age	-0.033	-0.472**	-0.055^{+}	0.030	0.062	-0.015
	(0.030)	(0.177)	(0.032)	(0.055)	(0.061)	(0.059)
Discipline	Yes	Yes	Yes	Yes	Yes	Yes
Status	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-1.186	1.192	-0.330	-5.003**	-8.048*	-3.724
	(0.909)	(4.258)	(0.928)	(1.532)	(3.584)	(2.812)
R^2	0,11	0,41	0,1	0,23	0,21	0,33
Predict	64,5	80	69,5	71,4	72,7	79,2
N	931	70	482	441	99	77

Level of significance: $^{+}$:p<0,1 ; *:p<0,05 ; **:p<0,01 ; ***:p<0,001

Table 7: Logit analysis of *Additional Investment*-I

Additional Investment	Rounds 1-19	Rounds 1	Rounds 1-5	Rounds 6-19	Rounds 6	Rounds 7
Probability of Continuation	0.637**	0.396	0.509	0.682*	-0.170	1.822
	(0.233)	(0.316)	(0.377)	(0.344)	(0.491)	(0.963)
Public Information	0.111	-0.217	-0.333	0.081	-0.051	-0.302
	(0.228)	(0.308)	(0.361)	(0.326)	(0.542)	(0.863)
L.Reputation	-0.007+	-	-0.013^{+}	-0.002	0.000	0.015
	(0.004)	-	(0.008)	(0.006)	(0.011)	(0.016)
L.Cooperation	-2.058***	-	-1.534*	-2.073***	-1.177+	-4.211***
	(0.276)	-	(0.612)	(0.334)	(0.647)	(1.151)
Past Experiences	-0.036	-	-0.075	-0.118**	-0.359	-0.355
	(0.030)	-	(0.163)	(0.042)	(0.222)	(0.254)
Ongoing Relationships	-0.659+	0.512	-1.223**	-0.320	-0.862	0.823
	(0.340)	(0.274)	(0.448)	(0.557)	(0.892)	(1.257)
Altruism	-0.000	-0.004	-0.003	0.005	-0.008	0.008
	(0.004)	(0.007)	(0.008)	(0.005)	(0.014)	(0.015)
Sex	-0.313	-0.609^{+}	-0.513	-0.334	-0.300	-0.223
	(0.212)	(0.325)	(0.385)	(0.264)	(0.492)	(0.880)
Age	-0.052+	-0.032	-0.093*	-0.053	-0.057	0.188
	(0.031)	(0.034)	(0.037)	(0.049)	(0.116)	(0.120)
Discipline	Yes	Yes	Yes	Yes	Yes	Yes
Status	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	4.424***	-0.723	7.247***	3.817	7.151	-4.623
	(1.328)	(1.105)	(1.880)	(2.081)	(4.271)	(5.133)
R^2	0,27	0,05	0,3	0,27	0,22	0,31
Predict	79,1	61,7	81,6	76,9	72,5	75,7
N	731	217	293	433	102	70

Level of significance: $^{+}$:p<0,1 ; *:p<0,05 ; **:p<0,01 ; ***:p<0,001

Table 8: Logit analysis of *Additional Investment*-II

Additional Investment	Rounds 1-19	Rounds 1	Rounds 1-5	Rounds 6-19	Rounds 6	Rounds 7
Probability of Continuation	0.455***	0.396	0.515**	0.442*	0.016	0.843*
	(0.124)	(0.316)	(0.183)	(0.189)	(0.320)	(0.372)
Public Information	-0.086	-0.217	-0.508**	0.146	0.309	0.106
	(0.124)	(0.308)	(0.182)	(0.182)	(0.348)	(0.399)
L.Reputation	-0.012***	-	-0.011***	-0.008*	-0.009^{+}	-0.021*
	(0.002)	-	(0.002)	(0.003)	(0.006)	(0.009)
L.Cooperation	-0.648***	-	-1.021***	-0.646***	-0.820***	-0.907***
	(0.065)	-	(0.154)	(0.073)	(0.222)	(0.231)
Past Experiences	0.205***	-	0.156^{+}	0.137***	0.221	0.239
	(0.027)	-	(0.085)	(0.032)	(0.139)	(0.140)
Ongoing Relationships	-0.081	0.512	-0.209	0.007	0.538	1.565*
	(0.178)	(0.274)	(0.248)	(0.289)	(0.478)	(0.700)
Altruism	-0.015***	-0.004	-0.017***	-0.012***	-0.022**	-0.015
	(0.003)	(0.007)	(0.005)	(0.003)	(0.008)	(0.009)
Sex	-0.099	-0.609+	-0.361^{+}	0.016	-0.393	0.241
	(0.116)	(0.325)	(0.192)	(0.152)	(0.326)	(0.355)
Age	-0.014	-0.032	-0.009	-0.035	-0.022	0.034
	(0.014)	(0.034)	(0.021)	(0.024)	(0.035)	(0.046)
Discipline	Yes	Yes	Yes	Yes	Yes	Yes
Status	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.198	-0.723	1.808*	1.517	0.414	-4.482
	(0.647)	(1.105)	(0.909)	(1.105)	(1.816)	(2.576)
R^2	0,24	0,05	0,22	0,28	0,2	0,27
Predict	75,3	61,7	74,5	76,6	72,4	77,2
N	1963	217	807	1140	246	206

Level of significance: $^{+}$:p<0,1 ; *:p<0,05 ; **:p<0,01 ; ***:p<0,001

Table 9: Logit analysis of *Additional Investment*-III

Additional Investment	Rounds 2-19	Rounds 2	Rounds 2-5	Rounds 6-19	Rounds 6
Probability of Continuation	-0.322	-1.081	-0.351	0.892	1.631
	(0.345)	(0.914)	(0.419)	(0.865)	(1.375)
Public Information	0.305	1.152	0.389	0.764	0.226
	(0.363)	(0.889)	(0.447)	(0.511)	(0.685)
L.Reputation	-0.024***	0.001	-0.016**	-0.063***	-0.059*
	(0.006)	(0.013)	(0.006)	(0.016)	(0.023)
Ongoing Relationships	0.048	-0.329	0.235	0.437	-0.033
	(0.318)	(0.648)	(0.469)	(0.559)	(1.079)
Altruism	-0.018	-0.014	-0.007	-0.026	0.002
	(0.009)	(0.028)	(0.013)	(0.015)	(0.019)
Sex	0.093	-0.759	0.081	0.392	0.753
	(0.316)	(0.750)	(0.419)	(0.607)	(1.316)
Age	0.033	-0.113	0.042	0.003	-0.085
	(0.034)	(0.119)	(0.042)	(0.080)	(0.084)
Discipline	Yes	Yes	Yes	Yes	Yes
Status	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Constant	-3.090*	2.667	-3.577*	-5.133	-2.251
	(1.302)	(3.389)	(1.677)	(2.855)	(5.274)
R^2	0,13	0,17	0,1	0,26	0,26
Predict	97,2	90	96	98,1	95,7
N	2078	110	895	1119	208

Level of significance: $^{+}$:p<0,1 ; *:p<0,05 ; **:p<0,01 ; ***:p<0,001

7.2 Experimental instructions

*The following instructions were handed out to the participants in the **LRP tretament***

Instructions

You participate in an economic experiment which takes place in a computer room. We inform you that during this experiment it is purely forbidden to have talks. If you follow carefully the instructions, you will make gains and you will be paid in cash at the end of the experiment.
Please note that the following guidelines are applicable to all candidates.
The currency used during the experiment is the ECU (Experimental Currency Unit), and all the transactions will only be denominated in ecus. At the end of this session, your gains will be paid in euro according to the following exchange rate: 40 ecus for 1 EURO.

Parts of the experiment
The participants of the experiment are assigned to two different groups:

- Group A: 6 participants: from A_1 to A_6.
- Group B: 6 participants: from B_1 to B_6.

The participants have to assume the role of their group (A or B) and number (from 1 to 6) until the end of the experiment. This way, you can identify the other participants with who you are going to interact throughout the experiment. You start the experiment with 0 ecus.
The experiment is composed of an undetermined number of periods.

The relationship
In order to improve your decision-making and to optimize your understanding of the decisions made by the other participants, there is some information about the relationships' functioning.
During this experiment, you are going to make other participants your partners in. These partnerships allow your partner and you to make some profits.
Players A will suggest partnerships to Players B. Players B will have the choice to accept or refuse the partnerships' suggestions made by Players A.
You will be able to make at the most three different partnerships by periods. It is also possible that according to the other participants' choices you will have 0 partnerships sometimes.

Investment
When you create a partnership for the first time, both of the participants (A and B) will have to invest 6 ecus. This investment has to be made only once. This way, if you repeat the partnership during the following period, the two participants will not have to invest 6 ecus again. Yet, if two participants who were already in a partnership before decide to get into a partnership again, both of them will have to invest again 6 ecus because they did not repeat the partnership during the following period.

"Situations" and "choices"
When a partnership is created, two types of situations can happen (according to the probabilities given between parentheses) :

- Situation 1 (probability : 50%) : the partnership yields 40 ecus which are automatically spitted up into two equals part. Both participants receive 20 ecus.

- Situation 2 (probability : 50%) : the partnership yields 40 ecus but in this case, the distribution of the profits depends of the choice of the B participant. B will choose between:
  - Choice 1 : A wins 20 ecus and B wins 20 ecus
  - Choice 2 : A wins 10 ecus and B wins 30 ecus

Additional Investment

At the beginning of each period, players A can decide to make an additional investment of 2 ecus in order to change the probabilities assigned to the situations 1 and 2. This additional investment allows players A to obtain the situation 1 with a probability of 75% and the situation 2 with a probability of 25% (to compare with the 50%-50% probability when there is not additional investment) for the current period.

Information

At the end of each period, players A are informed about the choices made by all players B during the past periods. This way, players A can notice the distribution (in percentage) of the choices made by players B between the choice 1 and the 2 during all the past periods.

The sequence of one period

- Step 1. Players A suggest partnerships to players B. (At most 6 propositions)
- Step 2. Players B accept or reject partnership offers from players A. (At most 3 accepted partnerships)
- Step 3. Players A choose at most 3 players B among positive answers.
- Step 4. Players A choose the level of their investment. (Players B do not know the investment level chose by players A)
- Step 5. All participants learn the repartition of their partnerships between situations 1 and 2.
- Step 6. Players B choose surplus sharing in case of situations 2.
- Step 7. All participants learn their gains for the current period, then their cumulative gains for the whole experiment.
- Step 8. Players A learn the choice made by all players B in their partnerships since the beginning of the experiment.
- Step 9. Players A can decide to stop some of their partnerships (or all of them) or to suggest to players B to pursue some of their partnerships (or all of them).
- Step 10. Players B accept or reject partnership's renewals' offers from players A.
- Step 11. Players A can suggest partnerships to players B with who they were not associated within the current period.
- $\rightarrow$ Go back to Step 2.

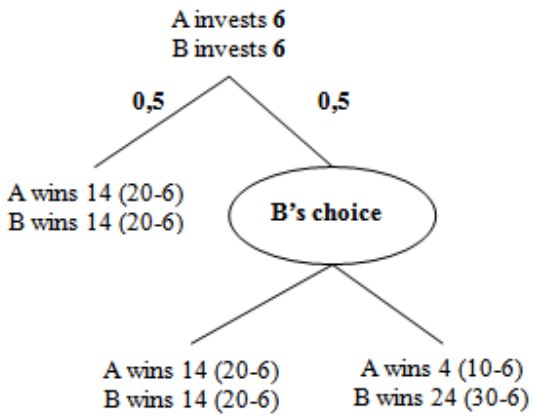
Length of the experiment

The experiment entails at least 6 periods. After which, the experiment continues period by period with a probability 0,8. In other words, at the end of the sixth period, there are 8 in 10 chances to play an extra seventh round. At the end of this seventh period, there are 8 in 10 chances to play an extra eighth. And so on ...

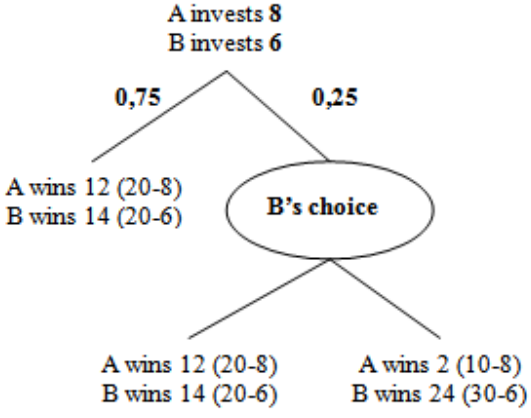
Payoffs

The figure below summarizes gains associated with different situations and actions of players.

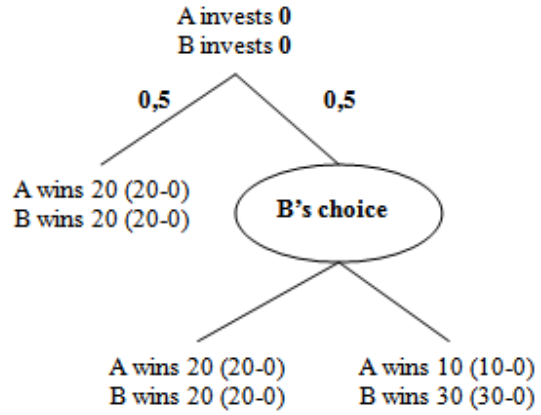
New partnership, without additional investment



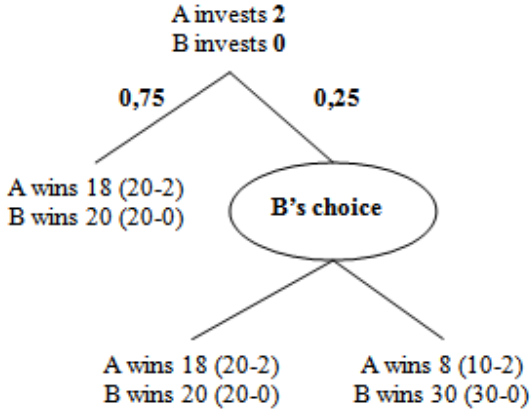
New partnership, with additional investment



Renewed partnership, without additional investment



Renewed partnership, with additional investment



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