Reputation, Contracts and the Dynamics of Cooperation

Theoretical and Experimental Approaches

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Abstract

This article deals with the effects of reputational incentives in the building of cooperative behaviors between contracting partners. We show that bilateral reputation between two partners could act as a way to enhance cooperation. More precisely, our model, based on the framework of Tirole [2008], shows how contracting costs decrease over time thanks to the growing trust given to the contractual partner that has proved to be honest in past transactions. Such a trust leads to increase the degree of contractual incompleteness over time if contracts are renewed, since parties rely much more on informal agreements. By this way, we took another path than recent contributions in relational contracting which only focus on the valorization of future business. In our view, informal practices characterizing relational contracts depend both on future transactions and past experiences. We also propose an empirical assessment of relational contracting and the impact of reputational concern in the dynamics of cooperation by using experimental economics.

JEL Codes : L20, L14, C90

1 Introduction

Reputational incentives are likely to play an important role in markets where moral hazards are pervasive (MacLeod [2007]). In fact, reputation affects the interactions between principals and agents because many relevant situations involve repeated interactions or situations where principals acquire information about agents' past behavior (Fehr et al. [2008]).

The effect of reputational incentives in the building of cooperation is easy to explain: when the behavior of the agent is untrustworthy, he will be considered as an unreliable partner and his reputation will decrease. His chances to keep his partners and to find new ones are lowered. At contrary, if the agent is trustworthy, he will be considered as reliable and his reputation will increase. Moreover, he will improve his possibility to keep his partners and to develop new relationships. In other terms, the threat of a change at next contract renewal is supposed to prevent opportunistic behavior from agents, and to encourage innovations and cooperative behaviors.

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The impact of reputational concern is well-known in economic literature, especially in the relational contract literature. As noted by Baker-Gibbons-Murphy (BGM hereafter, [2001]), "the core of the analysis is therefore checking whether reputation concerns in fact outweigh the temptation to renege on a given relational contract". According to their seminal work, parties respect their informal agreements whenever they obtain greater benefits by cooperating rather than by reneging on their promises. In that way, both of them use new information whenever it becomes available in order to adapt the relationship, because they care about their reputations, and they expect their partner to do the same. Thus, those informal relationships between contractors appear as a way to help circumvent difficulties in formal contracting and to achieve better performance at lower cost.

However reputational incentives are well accepted, two surprising fact are catching our attention in this paper. The first concerned the few attention which has been paid up to now to empirically assess its impact, the second concerned the fact that relational contract theory only focuses on the valorization of future businesses, ignoring the importance of past experiences.
In order to emphasize the importance of past experiences, we bring together relational contracting and transaction costs, in a new original theoretical framework derived from Tirole [2008]. Our goal is to demonstrate how contractual incompleteness and trustworthiness evolve over time. To reflect the emphasis given to trustworthiness in contract renewal, we model relationship agreements as incomplete contracts that may rely on informal commitments. For this reason, we also postulate contractual incompleteness and transaction costs of negotiating deals. Indeed, observations of contracts show that these agreements have various lengths, are more or less detailed about future contingencies, and are then more or less costly to elaborate.

Moreover, parties will generally be confronted with the problem of negotiating new terms over time, notably because "it is impossible to concentrate all of the relevant bargaining action at the ex-ante contracting stage" (Williamson [1985]). To account for negotiating costs and contractual incompleteness, the theoretical approach of Tirole [2008] brings together several strands of the contract literature, in order to narrow the gap between mainstream contract theory[3] and the bounded rationality approach (Simon [1961], Williamson [1975], Williamson [1985])[4]. To briefly introduce this framework, let us note that contrary to the "complete contracts" perspective, gathering and processing information is here supposed to be costly, mainly because of cognitive limitations. Yet, in such a context, "parties are aware that

3 In mainstream contract theory, parties do not suffer from bounded rationality, and are able to design costless contracts that foresee any contingency.
4 As noted by Bolton and Faure-Grimaud [2007], parties' bounded rationality has often been underlined to understand why contracts are incomplete: "In reality, a great deal of contractual incompleteness in undoubtedly linked to the inability of parties not only to contract very carefully about the future, but also to think carefully about the utility consequences of their actions. It would therefore be highly desirable to relax the assumption that parties are unboundedly rational." (Hart [1995], p.81)

they are unaware" (Tirole [2008]), and make rational choices to manage these cognitive limitations. Then, parties to a contract avail themselves of to the best design under existing knowledge, but know that everything is not foreseen. Yet, even if not foreseen, contingencies are foreseeable: parties may exert some ex ante cognitive efforts to find out what may go wrong, and to draft the contract accordingly[5]. Then, parties have to decide the levels of ex-ante efforts to do before contracting.

But since Macaulay [1963] and Goldberg and Erickson [1987], we know that contracts could be intentionally incomplete. Thus we ask a simple question: Why parties would choose incomplete contract by voluntary making few cognitive efforts in order to guess about future contingencies? Our answer is consistent with MacNeil [1978]: because parties implicitly rely on their partner's willingness to respect the "spirit" of the contract, rather than its "letter". In such a perspective, an incomplete contract is then a contract that specifies an available design and is renegotiated whenever this design turns out not to be appropriate. A contract is all the more incomplete than few (cognitive) efforts have been made to foresee implications of future contingencies. In other words, those efforts are ex ante transaction costs that determine contractual completeness. Such an approach is close from "traditional" theories of the firm (Williamson [1975], Williamson [1985], Grossman and Hart [1986], Hart and Moore [1990]) to the extent that contractual choices will impact on ex-post hold-ups. Yet, those theories focus on post-contractual investments, while the emphasis is here laid on pre-contractual ones. Moreover, contrary to the Grossman-Hart-Moore approach that imposes contractual incompleteness from outside, parties themselves choose here to leave the contract more or less complete[6].

To sum up, the originality of our work is to show how relational contracting builds over time and induces less and less costly and complete agreements. In that sense, our contribution also aims to make compatible the concepts of "reputation" and "reputational concern". The former relies on past experiences, while the second has to be interpreted according to the valorization of future. By combining past experiences and concerns for future business, our approach allows us to consider a unique and dynamic vision of reputation and its construction during (past and current) contractual relationships. With such a framework, results of our model

[5] The example given by Tirole [2008] (p.1) may be helpful to understand this idea: the event that the oil price may increase, implying that the contract should be indexed on it, is perfectly foreseeable, but this does not imply that parties will think about this possibility and index the contract price accordingly.

[6] Such an idea is also explored in a paper by Bolton and Faure-Grimaud [2007], where parties write satisfying contracts rather than optimal contracts: when they expect to receive a satisfactory payoff from a deal, they do not waste time writing a detailed contract and instead leave many decisions to be determined later. However, they do not deal with relational contracts, and rather focus on consequences of alignment of parties' objectives on contractual incompleteness. In the opposite, our approach both deals with relational agreements and ex ante efforts to make the contract more or less complete.

show that the degree of contractual incompleteness depends on trust and mutual understandings built by partners over time.

Our approach departs from seminal works of BGM previously mentioned because of cognitive limitations of contractors. In fact, we assume that parties have no perfectly rational anticipations of the gains of cooperation and deviation of parties ; they only try to guess the dominating strategy of their partner. This means that they elaborate some ex ante anticipations about the partner's ability to respect his informal commitment. As parties are bounded rational, they conjecture on their partner's behavior. In order to do that, they can try to learn about the partner's profile (i.e. whether he is patient or not and how he valorizes future) by observing past experiences. Then, while BGM associate informal agreements to concern for future business, we aim to show how trustworthiness is a dynamic process that depends both on future concern and past experiences.

Some other recent contributions have focused on the role of reputation in contractual agreements. Bolton and Faure-Grimaud [2007] model costs of delays to acquire information before contracting to account for bounded rationality, but do not include informal agreements nor contractual dynamics. Barro [1986] and Mathis and Rochet [2008] highlight the role of dynamic reputation in different fields than ours, i.e. in monetary policy and financial market respectively. In experimental economics, Fehr et al. [2004, 2008] propose very interesting studies about the impact of reputational incentives.

The paper is organized as follows. Section 2 develops a model based on a simplified version of the framework of Tirole [2008] applied to contractual relationships between a buyer authority and a seller. The public authority is supposed to support some ex ante transaction costs to make the contract all the more complete. To reduce such costs, he may rely on some informal agreements. But the problem is that he is often unaware of the type of seller, i.e. honoring contractor or not, he faces. He becomes all the more willing to leave room for informal contracting that he has had past successful experiences with the agent. Then, the anticipated probability of trustworthiness is path dependent. In this way, our propositions show that past - and not only future - matters in relational contracting as it determines the degree of contractual (in)formalism. The direct consequence is that the change of partner leads to some additional cognitive costs compared to the situation where the previous contractor is renewed. Hence, there may be some rationale to choose the same candidate at contract renewal to economize on transaction costs. Section 3. proposes an empirical test of our propositions thanks to experiences carried out in laboratory (to be completed).

2 The model

2.1 The framework

2.1.1 Agents

To study the issues at stake, we build a theoretical framework derived from Tirole [2008]. More specifically, let us consider two agents: a buyer (B) and a seller (S).

2.1.2 Contract design

B and S contract on a design of a public service, denoted as design A. With probability 1 − r, design A is the appropriate design and delivers utility K^+ for B and costs the manager c to produce ($K^+ > c > 0$).

With probability r, A delivers only K^-, with $K^- = K^+ - D$ where $D > 0$, and some other, initially uncontractible, design A' delivers utility K^+ to B. Converting A into A' implies contract's modifications, that cost "a" to B, with $a \in [0; D[$. This parameter "a" can be assimilated to some ex-post transaction costs supported by the buyer. Then, net gains from renegotiations are $D - a$[7].

By contrast, if design A' is identified before the contracting stage, parties can contract about it and there is no renegotiation nor adjustment cost to get K^+.

Let us note that we focus here on renegotiations that allow to increase the general surplus. Agents are assumed to be benevolent, and then do not engage in pure opportunistic renegotiations to impose a new sharing of the gains, once sunk investments have been made. Here, they renegotiate because of unappropriate contractual design, such as bad contractual specifications based on the means rather than on the outcomes, vague or inappropriate terms, environmental changes, implementations of (ex ante) non contractible innovations.

2.1.3 Transaction Costs

Before contracting, we assume that B can incur thinking or cognitive costs $T_B(k)$. Through cognitive attention, B may then become aware of implications of the current design, and of an alternative to it. As in Tirole [2008] (p.8), these cognitive costs "have a broad range of interpretations, including the managers' psychic cost of focusing on issues they are unfamiliar with, their opportunity cost of not devoting time to other important activities, or the fees paid to lawyers and consultants for advice on contracting. The magnitude of cognitive costs is also revealed indirectly by the substantial incompleteness of many contracts and by the costs of this incompleteness."

[7] We assume that trade is efficient, even in the absence of cognition, *i.e.* $K^+ - c - \rho a > 0$.

In other words, the contract is said to be more incomplete if fewer resources are expended to identify the appropriate design, i.e. $T_B(.)$ is low. In such a situation, B knows little about implications of future contingencies, and the probability that the design specified in the contract needs to be altered ex post is all the higher. Let us note that transaction costs may be wastefully incurred[8], as it is in the parties' individual interest to know whether they are vulnerable to renegotiation.

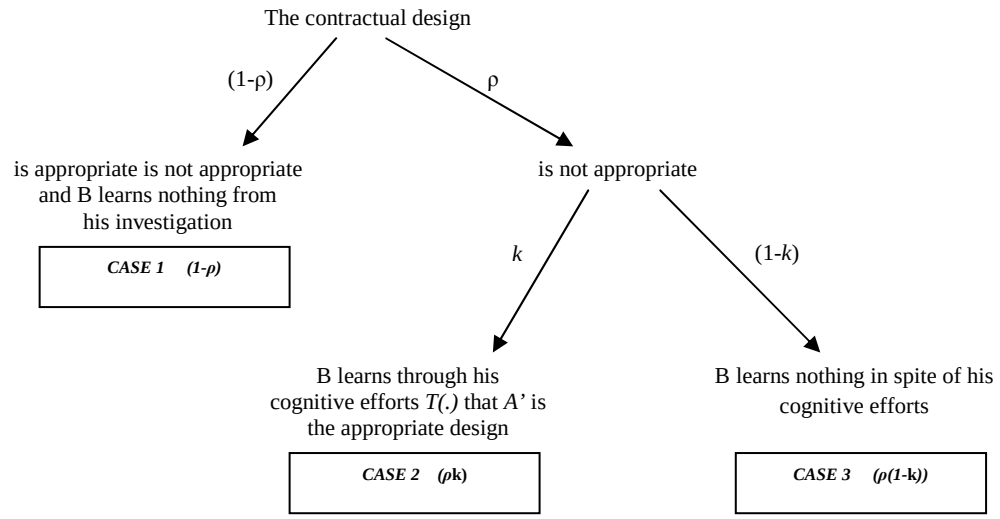
To go back to our model, we assume that if *A* is the appropriate design, B learns nothing from his investigation. If *A'* is the appropriate design, B learns *A'* with probability *k*, and learns nothing with probability 1 − *k*. As a consequence, the correct contractual design is elaborated with a probability (1 − r) + r × *k* [9], while the contract is not appropriate with a probability r (1 − *k*), as shown in the scheme below:

Let us add that the enunciation of A_0 by B fully reveals to M that the proper design is A_0. The choice of b is rational, and not observed by M. The function T_B is smooth, increasing, and convex, so that $T_B(0) = 0$, $T'_B(0)$, and $T'_B(1) = +\infty$.

2.1.4 Contract renewals

We suppose that contracts between B and S are periodically renewed. At each period, B may choose another seller. We denote each contractual period *t, t+1, t+2*….

Figure 1. Contingencies



[8] In this case, contracts are considered as *too* complete.

[9] (1- ρ) represents the probability that *A* is appropriate but B is unaware about it, as he learns nothing from his investigation; and ρ× *k* is the probability that *A* is not appropriate, but because of his ex ante cognitive efforts, B becomes aware of it and is able to propose *A'* before the contract is signed.

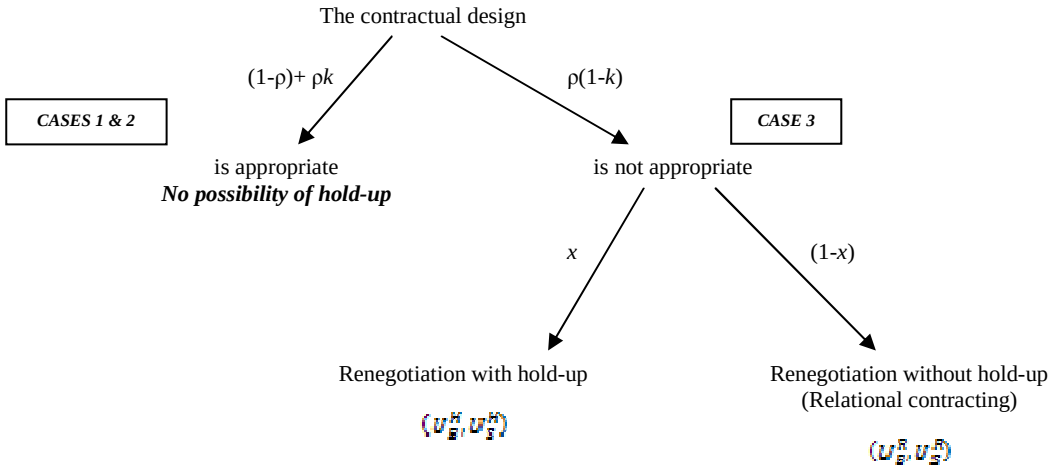
2.1.5 Hold-up and relational contracting

Up to now, the economic literature has shown how parties search for repeated relationships when contracts are (for an exogenous reason) incomplete (Bull [1987], Baker, Gibbons, and Murphy [2002], Baker, Gibbons, and Murphy [2004]). The main idea sustaining such contributions is that parties are willing to informally commit themselves on some actions, when the payoff stream from cooperation is higher than the payoff stream from defection. Such "relational" contracts allow the parties to use their detailed knowledge of their specific situation to adapt to new information as it becomes available. Yet, as these agreements are tacit, they cannot be enforced by third parties and must become self-enforcing, hence the proposition that the value of the relationship must be sufficiently large that neither party wishes to renege. A consequence of informal dealings formulated by Macaulay [1963], is that they allow to economize on the cost of specifying the letter of the contract, as parties are supposed to abide by its spirit. In our model, relational contracting may intervene when A is not appropriate, and B is unaware of it, in spite of his investigation cost k. In such a case, B asks for renegotiation to switch towards A', but during the renegotiation process, S may hold up B. We assume that hold up occurs with probability x. The seller asks for one part of the net gains, i.e. h = s (D − a), where s is the bargaining power of S. In the other case (1−x), S adjusts "by the spirit of the law" and does not hold up B.

Let us note that we explore in this model one-sided opportunism: as the renegotiation may increase the utility of the buyer by allowing to reach K^+ rather than K^-, the fear of opportunism is that of the seller, since he could ask for one part of the gains of the buyer. Symmetrically, we could explore buyers' opportunism by assuming that a renegotiation could increase the surplus of the seller and the buyer could ask one part of the gains. Situations will be reversed, without changing the validity of our main propositions[10].
Figure 2 allows to sum up the various situations:

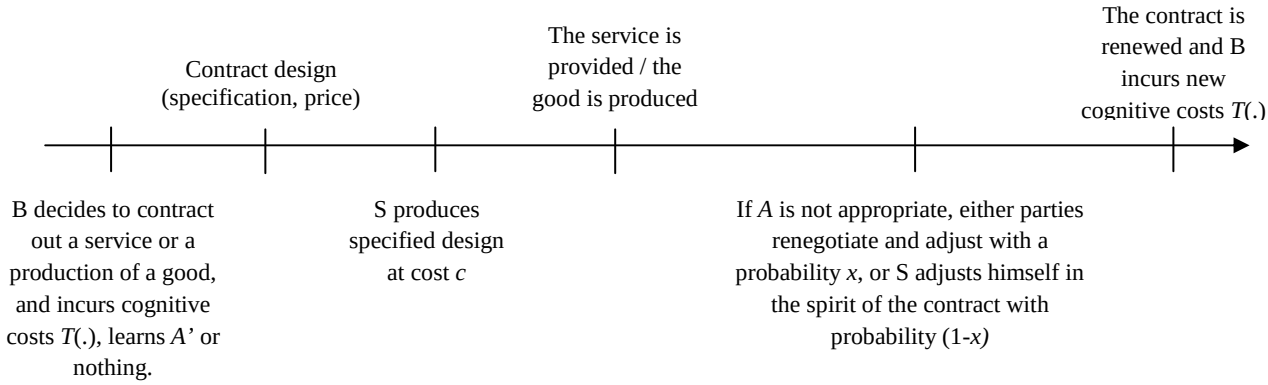
[10] We could introduce the two types of opportunism in the model and allow both agents to support ex ante cognitive costs. This would make the demonstration more complex, without changing anything to our general proposition.

Figure 2. Evolution of contractual design and associated payoffs



The timing is summarized in figure 3.

Figure 3. Timing of a contractual period.



2.1.6 The ex ante bargained price

S has bargaining power s ∈ [0; 1], so that he can secure a proportion s of the gains during a renegotiation. Symmetrically, the bargaining power of the buyer is (1 – s)[11]. Let us first determine the ex-ante bargained price at which trade is contracted.

In a pure equilibrium strategy, we denote k^* the equilibrium probability that B discovers that *A* is not appropriate when it is indeed the case. Suppose that B learns nothing, and decides to contract on design *A*. Two situations may occur: either *A* is the right design or is inappropriate,

[11] For simplicity's sake, we assume that *ex post* and *ex ante* bargaining powers are the same.

which leads to potential hold-up. The posterior probability that *A* is not appropriate conditional on cognitive efforts *k* and unawareness is[12]:

$$\hat{\rho}(k) = \frac{\rho(1-k)}{1-\rho k}$$

On the equilibrium path, $k = k^*$, and the expected hold-up is $\hat{\rho}(k)h$. As a consequence, the bargained ex-ante price p(k^*) is such as the price shares the total expected surplus, i.e.:

$$\sigma(K^+ - c - \hat{\rho}(k)a) = p(k^*) - (c - \hat{\rho}(k)hx) \qquad (1)$$

$$p(k^*) = c + \sigma(K^+ - c - \hat{\rho}(k*)\left(a + \frac{hx}{\sigma}\right))$$

(1) represents the equalization of the seller's profit (on the left-hand side) and the share of the total surplus that he is able to bargain (on the right-hand side), according to his bargaining power σ[13].

2.1.7 The payoffs of the agents

Let us now deduce the (gross) payoffs[14] of the agents in each situation depicted in figure 1:

• First Case: the contractual design *A* is appropriate (1 − ρ). In this case, B learns nothing from his investigation, then trade occurs at price p(k^*), as previously defined. As the design is appropriate, no renegotiation takes place and the buyer's payoff is then $U_B^A = K^+ - p(k^*)$, while the seller's payoff is $U_S^A = p(k^*) - c$.

• Second Case: The contractual design A is not appropriate (ρ) and B becomes aware that *A'* is the appropriate design (with a probability *k*) because of his investigation. He can ex ante contract on *A'*, and does not renegotiate ex post. Since B becomes aware ex ante that *A'* is appropriate, and then that neither renegotiation at cost "a" nor hold-up will occur, and the ex-ante bargained price does not take into account such a risk.

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[12] The probability that is not appropriate and B is unaware about it is ρ(1-*k*) (Case 3). The probability that B is unaware about the contractual design (i.e. the probability that he learns nothing) is (1-ρ+ρ(1-*k*) = 1 – ρ*k* (Cases 1 & 3).

[13] Indeed, the seller's profit depends on his bargaining power s to appropriate a share of the expected total surplus (K^+ - *c* - $\hat{\rho}(k)a$). On the other hand, he receives the *ex ante* bargained price, supports costs *c* and benefits from the hold-up *h* with probability $\hat{\rho}(k)x$.

[14] Net payoffs of B are obtained by deducing ex ante transaction costs T_B.

(1) becomes σ (K⁺ − *c*) = p(*k**) − *c*, i.e. p(*k**) = *c* + σ (K⁺ − *c*). Hence, the total surplus is shared according to the bargaining power of the parties: $U_B^{A'}$ = K⁺ − p(*k**) = (1 − σ)(K⁺− *c*), and $U_S^{A'}$ = σ (K⁺ − *c*).

• Third Case: In case of inappropriate design, with a probability (1-*k*), B does not find that the contractual design is inappropriate, and choose to trade at some price p(*k**) as previously defined in equation (1). Yet, renegotiation occurs to reach K⁺ and B supports adjustment costs *a*. Hold-up occurs with some probability *x*. Then U_B^H = K⁺ – *a* – *xh* − p(*k**) and U_S^H = p(*k**) − *c*+ *xh*.

The various payoffs of the agents are summarized in the following table:

Table 1. Various payoffs of the agents

Contingency	Awareness	Payoffs
A is appropriate (1-ρ)	B learns nothing from T_B	U_B^A = K⁺ − p(*k**) U_S^A = p(*k**) − *c*
A is inappropriate (ρ)	B learns it (*k*)	$U_B^{A'}$ = (1 − σ)(K⁺− *c*) $U_S^{A'}$ = σ (K⁺ − *c*)
	B does not learn it (1-*k*)	U_B^H = K⁺ – *a* – *xh* − p(*k**) U_S^H = p(*k**) − *c*+ *xh*

2.2 Optimal levels of cognitive efforts

2.2.1 Choice of cognitive efforts

Let us now determine the optimal level of the buyer's cognitive efforts supported to foresee future contingencies, *k*. B maximizes his expected payoffs in each situation:

$$\max_k -T_B(k) + \rho(1-k)U_B^H + \rho k U_B^{A'} + (1-\rho)U_B^A$$

$$\Leftrightarrow$$

$$\max_k -T_B(k) + \rho(1-k)(K^+ - a - xh - p(k^*)) + \rho k(1-\sigma)(K^+ - c) + (1-\rho)(K^+ - p(k^*)) \quad (2)$$

By replacing p(*k**) by its value, (2) becomes:

$$\max_k \left(-T_B(k) + \rho(1-k)K^+ - a - xh - (c + \sigma\left(K^+ - c - \beta(k)\left(a + \frac{xh}{\sigma}\right)\right)\right) + \rho k(1-\sigma)(K^+ - c) + (1-\rho)\left(K^+ - (c + \sigma\left(K^+ - c - \beta(k)\left(a + \frac{xh}{\sigma}\right)\right)\right)\right)$$

$\Leftrightarrow$

$$\max_k \left(-T_B(k) + (K^+ - c)(1-\sigma) - \rho(1-k)(a+xh) + \rho(1-k)\left(\hat{p}(k)\left(a+\frac{xh}{\sigma}\right)\right) + (1-\rho)\hat{p}(k)\left(a+\frac{xh}{\sigma}\right)\right)$$

$\Leftrightarrow$

$$\max_k \left(-T_B(k) + (K^+ - c)(1-\sigma) - \rho(1-k)(a+xh) + (1-\rho k)\left(\hat{p}(k)\left(a+\frac{xk}{\sigma}\right)\sigma\right)\right) \qquad (3)$$

Differentiating (3), we obtain:

$$T'_B(k) = \sigma\,[a + xh - \hat{p}(k)\sigma(\alpha + \frac{hx}{\sigma})]$$

$\Leftrightarrow$

$$T'_B(k) = \rho\,[a\,(1 - \hat{p}(k)\sigma) + xh(1 - \hat{p}(k))] \qquad (4)$$

From (4), we can deduce some results about ex-ante transaction costs $T_B(k)$:

• $\frac{\delta T'_B(k)}{\delta a} = \rho(1 - \hat{p}(k)\sigma) \geq 0$, then the higher adjustment costs "*a*" are, the higher ex-ante transaction costs to learn about contingencies are.

• $\frac{\delta T'_B(k)}{\delta x} = \rho h\left(1 - \hat{p}(k)\right) \geq 0$, then *ex ante* transaction costs increase with x, i.e. the higher the probability of hold-up in case of inappropriate design is, the higher transactions costs are to avoid such a situation. The corollary is that the lower the probability of hold-up (i.e. the more relational contracting is applied), the lower transaction costs are. The buyer spends fewer resources on cognitive efforts, as he knows that S will apply the spirit of the contract, and will not take advantage of renegotiation to hold-up him. Given the previous definition of contractual incompleteness, then the more relational contracting is observed, the more incomplete contracts are. This result is consistent with Tirole [2008], and highlights that relational contracting is not only a response to, but generates contractual incompleteness.

• Static comparative on *h* gives $\frac{\delta T'_B(k)}{\delta h} = \rho x\left(1 - \hat{p}(k)\right)$. As *x* and ρ are probabilities ∈ [0; 1], then this implies $\frac{\delta T'_B(k)}{\delta h} \geq 0$. The higher the level of hold-up is, the higher ex ante transaction costs are[15].

[15] Such a result is consistent with the transaction cost framework. Assuming that hold-up is linked to asset's specificity, we note that transaction costs increase with it.

Let us note that these conclusions about ex ante transaction costs $T_B(k)$ remain valid for the total transaction costs (denoted TTC), as $TTC = T_b(k) + \rho(1-k)a$ (with $T_b(k)$ the *ex ante* transactions costs and $\rho(1-k)a$ the *ex post* transaction costs).

Hence the following proposition:

Proposition 1 *Transaction costs to learn about future contingencies increase with ex post adjustment costs (a), the level of potential hold-up (h) and with the probability of hold-up in case of inappropriate contractual design (x). The contracts are all the more incomplete than the seller proves to be ready to respect the spirit of the contract (x → 0), and to adapt without hold-up of the buyer.*

Such a proposition is consistent with Tirole [2008]. Contrary to propositions derived from Baker, Gibbons, and Murphy [2002, 2004], causality about relational contracting can run in both directions: relational contracts generate (and are not only a response to) contractual $\frac{\partial T'_B(k)}{\partial h} =$ exogenous parameter, but as a choice made by contractors. If parties rely on their informal behaviors, they have no interest to support ex ante transaction costs to detail each type of future contingency in the formal contract.

From proposition 1, we can note that the probability x of hold-up determines to a large extent the level of ex ante transaction costs that makes the contract more or less complete. However, *x* is not an exogenous parameter. The seller decides to respect his informal dealing if such a strategy dominates that of deviation. Let us now determine in which case the probability *x* of hold-up is higher or lower, i.e. in which circumstances S abides by the spirit of the contract rather than decide to hold-up the buyer.

2.3 Conditions for sustainable relational contracts

When the agents are in a long term relationship and care about the future, some positive consequences on their incentives to invest can be generated (Baker, Gibbons, and Murphy [2002], Baker, Gibbons, and Murphy [2004]). The value of parties' future relationships determines whether they agree or refuse to respect their informal commitments. Here, we do not focus on the role of relational contracting on seller's incentives to invest, but rather on their ability not to hold-up their partner, as in Bull [1987] or Klein [1988], who suggest that reputation effects can limit hold-up problems. To model this informal agreement, we assume

that B proposes to S an informal dealing, and asks him not to hold-up in case of contractual inappropriateness. If S does not respect his commitment, then B threatens to renew him with a lower probability in the future. For simplicity's sake, we assume that reputation is built in a bilateral relationship[16].

We will use the trigger strategy framework, with Nash reversion to static equilibrium in case of deviation to account for such a situation. A period in our framework is considered as a contract's duration. As a consequence, at each period, the buyer can choose to pursuit or to stop the relationship. The discount factor is denoted $0 \leq \delta \leq 1$. We assume that S respects his informal dealing, whenever payoff stream from cooperation is higher than payoff stream from deviation. At the beginning of the game, relational contracting induces a different bargaining price, as parties do not expect hold-up. Then, the price becomes $k^{*,r}) = c + \sigma a(K^{+} - c - \hat{p}(k^{*}))$, since $h = 0$, and the level of cognitive effort $k^{*,r}$ changes (Proof in Appendix A).

Let us now detail the strategy of the seller:

• Either S decides to abide by the spirit of the contract and respects his informal commitment. He gains $p(k^{*,r}) - c$. Then, whenever the contractual design is inappropriate, he does not hold-up B. In exchange, he is renewed with probability p_c. His future expected payoff derived from relational contracting is denoted $E(U_S^R) = \rho\left[kU_S^{A',R} + (1-k)U_S^{H,R}\right] + (1-\rho)U_S^{A,R}$, where $U_S^{A',R}$ is the utility under relational contracting when the contractual design A' has been learnt, $U_S^{H,R}$ is the utility in case of inappropriate contractual design, and $U_S^{A,R}$ M is the utility when the contractual design A is appropriate (See Appendix A for proof).

• Or S deviates and does not respect his informal commitment. He holds up B, whenever possible (in case 3 described above) and then, has a total gain of $p(k^{*,r}) - c + h$ when he deviates. Since S levies an amount h from B, then at next contract renewals, his probability to be chosen again is $p_h \in [0; 1]$ with $p_h \leq p_c$[17]. In the subsequent periods, B does no longer trust him, and considers that hold-up will occur whenever possible. After having deviated, the expected payoff of S is

[16] The respect or deviation of S has some consequences on the probability to be renewed by B but not by other buyers. Let us note that if we allow for some communications between several buyers, the reneging of S from his informal commitment would increase the sanction, as more buyers will refuse to contract with him in the future. Then, this would strengthen our result. Yet, if we assume a perfect communication between all buyers, that agree to apply the same sanction to a deviating partner, then this would prevent all kind of opportunism.

[17] p_h is not systematically equals to 0. For instance, we can suppose that the market is oligopolistic, and there is no other alternative than this seller, or the costs to change the seller are too high. Moreover, if is not selected at one contractual renewal, reputation effects are still persistent over time, as S will keep his "unfavorable" probability p_h to be selected again in the other future contractual renewals.

denoted $E(U_S^D) = \rho\left[kU_S^{A',D} + (1-k)U_S^{H,D}\right] + (1-\rho)U_S^{A,D}$, where $U_S^{A',D}$ is the utility when the contractual design *A'* has been learnt, $U_S^{H,D}$ is the utility in case of inappropriate contractual design, and $U_S^{A,D}$ is the utility when the contractual design *A* is appropriate (See Appendix B for proof).

In other words, S does not hold up B in case of inappropriate design *A* whenever:

$$p(k^{*,r}) - c + \delta p_c E(U_S^R) + \delta^2 p_c E(U_S^R) + \delta^3 p_c E(U_S^R) + \ldots > p(k^{*,r}) - c + h + \delta p_h E(U_S^D) + \delta^2 p_h E(U_S^D) + \delta^3 p_h E(U_S^D) + \ldots$$

$$\Leftrightarrow$$

$$p(k^{*,r}) - c - \frac{\delta p_c E(U_S^R)}{1-\delta} > p(k^{*,r}) - c + h - \frac{\delta p_h E(U_S^D)}{1-\delta}$$

$$\Leftrightarrow$$

$$\frac{\delta(p_c E(U_S^R) - p_h E(U_S^D))}{1-\delta} > h$$

Let us denote $V = (p_c E(U_S^R) - p_h E(U_S^D))$. We can deduce that relational contracting is sustainable for relatively "low" amount of potential hold-up, inferior to $\tilde{h}$, so that:

$$\tilde{h} = \frac{\delta V}{1-\delta} > h \qquad (5)$$

From (5), we can deduce that S accepts to cooperate and not to hold up B, if the level of hold-up (h) is low enough (inferior to $\tilde{h}$).

Two factors determine $\tilde{h}$:

• The level of discount factor

If $\delta \to 0$, then $\tilde{h} \to 0$ and relational contracting is not sustainable (the hold up h cannot be negative). This situation also means that S is not patient and he attributes a low value to future gains.

If $\delta \to 1$, then $\tilde{h} \to \infty$. This means that even for high levels of hold-up, the relational contract is sustainable. S is very patient and attributes as much importance to present as to future.

• **Value of future business** related to the probability to be chosen again when cooperating rather than deviating (V).

The higher such a value is, i.e. V → ∞, the higher $\tilde{h}$ becomes, and the more sustainable relational contracts become. Future business represents a too strong opportunity to deviate.

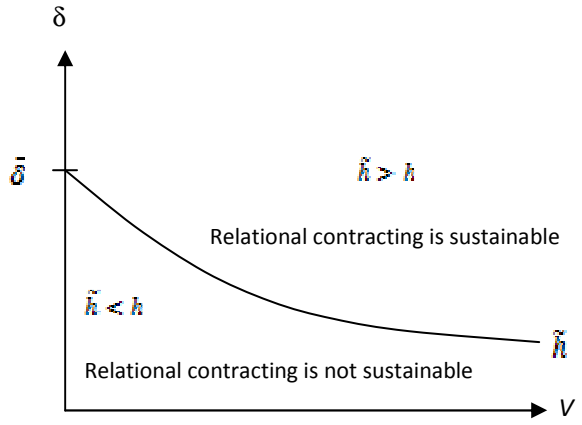
The lower this value is, i.e. V → 0, the less sustainable relational contracting is[18]. Indeed, the amount *h* of hold-up has to become lower and lower to be smaller than $\tilde{h}$. Perspective of future business with B are not strong enough.

As a consequence, the following proposition can be established:

Proposition 2 *Both discount factor* δ *and relative value of future business determine the probability that sellers do not hold-up buyers in case of inappropriate contractual design, so that x = x(δ,V).*

Such a result may be graphically represented as follows:

Figure 4: Sustainable relational contracting as function of δ and V.



• There exists a level $\bar{\delta}$ so that beyond such a level, S proves to be very patient, and relational contracting is sustainable, whatever the value *V* is.

[18] Theoretically, V could even take negative values, which does not change the results: if V is negative, then relational contracting is not sustainable.

• Under $\overline{\delta}$, the cooperation depends on the value of *V*. The higher *V*, the more sustainable relational contracts are. The value of future business becomes so high that S has better not to hold-up to benefit from the more favorable probability p_c to be chosen again in future. Let us note that V depends on the value of future business, but also on competitive pressure. For instance, assume that $p_c = 1$, which means that whenever relational contracting is respected, the seller is certain to be chosen again at next contract renewal. In such a configuration, p_h is a measure of competitive pressure: the higher p_h is, the less competitive pressure is observed, since the buyer has a high probability to choose the same operator even if he cheats. To the contrary, when $p_h \to 0$, the seller is unlikely to be renewed, this means that it is rather easy for B to turn to another partner. The competitive pressure is high when $p_h \to 0$. As a consequence, we observe that *V* grows up when p_h tends to be lower. In other words, the higher competitive pressure, the higher *V*, and the more easily relational contracts are enforced.

Proposition 3 *The higher competitive pressure is, the more sustainable relational contracts become.*

However, because of cognitive limitations, the buyer is unaware of the values of δ and *V*. He may guess *V* but δ is much more difficult to determine. For instance, if B represents a small market share of S's activities, the value V is all the more likely to be low for S, while if S has difficulties to sign new contracts with other buyers, he will be all the more attentive to keep the relationship with B. In the same way, a small local seller will be all the more attentive to the business with B, as it is probably much more difficult for him to diversify his activity, than for a big multi-national firm. Yet, δ represents the degree to which S prefer present gains to future ones, and is not easily foreseeable. Before signing a contract, B has to anticipate S's behavior, i.e. S's values of δ and *V*. The following subsection proposes to detail such a mechanism.

2.4 Role of past experiences between contractors

Before signing an agreement with a seller, the buyer tries to form some conjectures as to the probability of hold-up. To this end, he has to guess how "patient" S is (δ), and how S considers value of future business (*V*).

Let us now introduce two types of sellers:

• Type 1: Sellers of type 1 are very patient and attribute strong value to future, i.e. have a high δ, so that $\delta > \bar{\delta}$. Then whatever the value of *V*, we suppose that they are able of credible commitments and bind themselves to respect the spirit of the contract.

• Type 2: Sellers of type 2 are much more impatient, i.e. have a lower δ. Then, their willingness to cooperate depends on the value of *V*.

Let $\alpha_t \in [0; 1]$ be B's subjective probability at the start of period t that the private operator is of type 1, i.e. the probability that the seller is very patient. As a consequence, at each period t, there is a probability $(1 - \alpha_t)$ that the seller is of type 2, and may choose not to respect his informal agreement, according to the value of *V*. Whenever a new contractual relationship begins with a new seller, for period 0 of the relationship, α_0 is a given value and is common knowledge[19].

We assume that $z \in [0; 1]$ is the proportion of type 2-sellers that attribute a high value to *V*[20]. For instance, they may have few business or some other future contracts, whose attribution is connected to reputation on the contract with B. Or they believe that communication between different buyers is good enough to prevent other contracts to be signed with others buyers in case of holdup, so that they refuse to do so, because p_h will tend towards zero for many other contracts.

Table 2. Summary of anticipations formulated about M by G

Subjective probability of B	**Type of the seller**	**Value of future business**
α_t	Type 1 ($\delta > \bar{\delta}$)	
$1- \alpha_t$	Type 2 ($\delta < \bar{\delta}$)	z *V* is strong enough $(1-z)$ *V* is too low

The probability α_t formulated by B about S's type is revised at each period t, by taking into account "good" (h=0) or "bad" behavior from S ($h \neq 0$) in the previous period, that is whether he has reneged or not in case of inappropriate contractual design. If the contractual design was appropriate at period t, then $\alpha_{t+1} = \alpha_t$, because B has no additional information to revise his

[19] α_0 is the expected fraction of type 1- private managers among the population.

[20] For simplicity's shake, z is common-knowledge: once B knows that S is of type 2, he knows that z% of type 2- sellers have a high value of V. For instance, B knows that his contract represents an important market share for S, so that V is high for S. As a consequence, uncertainty is mainly about how patient S is (α_t).

subjective probability. Yet, if the contractual design was inappropriate, then B revises upward the probability that S is of type 1[21].

The adaptation formula follows from Bayes' law as :

$$\alpha_{t+1} = \text{Prob}(\text{Type1}/h_t, h_{t-1}, \ldots = 0) \qquad (6)$$

$\Leftrightarrow$

$$\alpha_{t+1} = [\ \text{Prob}(\text{Type1}/h_{t-1}, \ldots = 0) \times \text{Prob}(h_t = 0/\text{type1})\ ] \ / \ \text{Prob}(h_t = 0/h_{t-1} = 0, \ldots)$$

$\Leftrightarrow$

$$\alpha_{t+1} = \frac{\alpha_t + 1}{\alpha_t + (1-\alpha_t)z}$$

A $0 \leq \alpha_t \leq 1$, and $0 \leq z \leq 1$, then $\alpha_{t+1} \geq \alpha_t$. In other words, the observation of $h_t = 0$ raises the probability that S respects his informal dealings.

To sum up,

• If the contractual design *A* is appropriate (with probability (1−ρ), then $\alpha_{t+1} = \alpha_t$. B has no information to revise his subjective probability upwards or downwards.
• If the contractual design is inappropriate (with probability ρ), and that S does not hold up B (with probability $(1 - x)$, then $\alpha_{t+1} \geq \alpha_t$.
• If the contractual design is inappropriate (with probability ρ), and that S holds up B (with probability *x*), then $\alpha_{t+1} = \alpha_{t+2} = \ldots = 0$. B knows that S is untrustworthy, and selects him at next contract renewal with probability $p_h \leq p_c$.

2.4.1 Consequences for transaction costs

Remember that from (4):

$$T'_B(k) = \rho\ [a(1 - \hat{\rho}(k)\sigma) + xh(1 - \hat{\rho}(k))]$$

[21] This demonstration is similar to the way adaptative anticipations are modeled in macroeconomic models, as that of Barro [1986] that study reputation in a model of monetary policy with incomplete information.

Where x represents the probability that S holds-up B, when the contractual design is inappropriate. Therefore, x is the probability that S is of type 2 and attributes a low value to V, i.e. $x_t = (1 - \alpha_t)(1 - z)$.

If we denote $T'_{B,t}(k)$ the level of transaction costs supported by G before each contractual period t, then :

$$T'_{B,t}(k) = \rho\,[a(1 - \hat{p}(k)\sigma) + (1 - \alpha_t)(1 - z)h(1 - \hat{p}(k))]$$

and

$$T'_{B,t+1}(k) = \rho\,[a(1 - \hat{p}(k)\sigma) + (1 - \alpha_{t+1})(1 - z)h(1 - \hat{p}(k))]$$

Since $\alpha_{t+1} \geq \alpha_t$, then $(1 - \alpha_{t+1}) \leq (1 - \alpha_t)$ and

$$T'_{B,t+1}(k) \leq T'_{B,t}(k) \qquad (7)$$

By recurrence:

$$T'_{B,t+n}(k) \leq \cdots \leq T'_{B,t+1}(k) \leq T'_{B,t}(k) \qquad (8)$$

This leads to the following proposition:

Proposition 4.a *Suppose that B chooses the same seller during several contractual periods, and that S has not held up him. The level of ex ante transaction costs supported to anticipate future contingencies decreases with time. As a consequence, contracts between the same partners tend to become more and more relational over time.*

2.4.2 Consequence for contract renewal

Let us now focus on contract renewals. We denote t = 0 the first contractual period with a new private manager. Then, if S is honest, (8) gives:

$$T'_{B,t+n}(k) \leq \cdots \leq T'_{B,t+1}(k) \leq T'_{B,t}(k) \leq \cdots \leq T'_{B,0}(k)$$

Because of increasing-convexity of function T, then

$$T_{B,t+n}(k) \leq \cdots T_{B,t+1}(k) \leq T_{B,t}(k) \leq \cdots \leq T_{B,0}(k)$$

For each new potential seller, $T_{B,0}(k)$ is the same at period 0 of the relationship, as α_0 represents the probability of type1-sellers in the population. Then if the seller that is chosen at period t = 0 is honest, at each next contract period, he is all the more likely to be chosen again, as transaction costs supported by B are lower than those that would be supported in case of partner's change. For instance, at period t, if B decides to choose another seller, he bears $T_{B,0}(k)$, while if he continues the contractual relationship with the previous private firm, he supports $T_{B,t}(k) \leq T_{B,0}(k)$. Such a result shows that there may be some rationale to select the same candidate over time, if the production costs proposed by the candidates are similar. Lock-in may thus be justified.

Proposition 4.b *If a seller has proved to be honest on relational contracting in past experiences, then he is more likely to be selected again than similar competitors (ceteris paribus), because buyers will support fewer ex ante transaction costs.*

3. An experimental analysis of reputation and relational contracting

The starting point of our empirical assessment is the model we developed in previous section. We show that reputational concerns enhance sellers to behave honestly in order to promote cooperation. We also show that the growing trust between contractual partner leads to sign contracts intentionally less complete. To catch the effect of reputation on the dynamics of cooperation, we conducted a series of experiments where buyers could choose the level of ex ante transaction cost according to their relationship and to their partners concerned with. The advantage of the experimental economics laboratory comes from the possibility to control the environment. More precisely, we are able to compare differences of behavior due to different environment by simply modifying the experimental design.

3.1. Reputation and relational contract

As Dellarocas (2005) argue, the objective of reputation mechanisms is to enable efficient transactions in social interactions where cooperation is compromised by post-contractual opportunism (moral hazard) or information asymmetries (adverse selection). Thus, those

mechanisms will play distinguished role by acting as a sanctioning device in the former case and as a signaling device in the later case. Thus, reputation incentives are likely to play an important role in such markets where hazard problems are pervasive (MacLeod 2007). One of the main theoretical fields that take into account this interest of reputation incentives is the relational contract theory. According to seminal works (Klein and Leffler 1981; Bull 1987; MacLeod and Malcomson 1989, 1998; Baker, Gibbons and Murphy 1994, 2002), if the same principals (buyers) and agents (sellers) interact repeatedly[22] or if the principal has information about the agent's behavior in previous transactions with other principals, the principal can condition the current contract terms on the agent's past behavior. The valorization of the future by the agent will may motivate him to better perform, because if he satisfies the principal today, his future contract terms will certainly be more attractive.

But in spite of this theoretical argument, empirical evidence on the role of reputation is still scarce. The contribution of Fehr, Brown and Zender (2008) is grounded on this later observation. They argue and empirically find that reputation is a powerful amplifier of the efficiency enhancing effect of reciprocity in situations of contractual incompleteness where principals face a moral hazard problem.

More precisely, they show how reciprocity and reputation interact in the enforcement of contracts. Their results provide evidence on the impact of reputational incentives: the opportunity for reputation formation implies that selfish agents also have an incentive to behave as if they were reciprocal. In other words, the possibility to be selfish is limited by reputational concerns of participants. They also show that while reputation formation enhances efficiency, it also fundamentally alters the nature of interactions in competitive markets with moral hazard. The absence of third party enforcement of contracts, which is a central assumption of the relational contract theory, gives rise to a strong bilateralisation of trades. In their results, bilateral relations prevail even when public information about agents' past behavior would provide adequate information for sustaining reputation incentives outside of such relations.

3.2. The experiments

In a series of experiment, we examine the impact of past interactions and bilateral and multilateral reputation on the dynamics of cooperation and on the contractual design choosing by the principal. According to the model, hold-up occur in cases where the initial contractual design is inappropriate and the principal can choose the level of ex ante investment in order to minimize the risk to be held up by the seller.

[22] Which is usual in real-world markets with moral hazard.

Contractual design. In the theoretical model, hold up could occur in case where the initial contractual design is not appropriate. Incompleteness of contract lead to renegotiate and those renegotiations open rooms for opportunistic behaviors for agents. In our experiments, the necessity to renegotiate is replicate by the existence of adjustment costs beared by principals. In those situations, the final sharing of relationship surplus is decided by agents. They can still to equitably share the surplus or they can choose to grab a larger part. However, in our model, principals can decide or not to anticipate such a possibility by choosing the level of ex ante investment. According to our predictions, this choice of ex ante investment will depend on the past experience between the two partners: principals who trust particular agents will choose to less invest, i.e. to sign an incomplete contract; because they know that no hold up will occur in case of inappropriateness of the contractual design. If they don't trust the seller, they can protect them by investing more or by ending the relationship and start a new relationship with another partner.

Competition. Reputation incentives can only play a role if principals have the possibility to switch of agents for their future relationships. A minimum competition between agents is necessary. Without such competition, principals do not have a way to punish selfish behavior by ending the relationship and start a new relationship with another partner. Of course, principals have the possibility to associate themselves with different agents and agents have the possibility to refuse the association. These possibilities of multiple matching and of change of partner have to purpose to replicate the importance of competitive pressure.

Information, bilateral and multilateral reputation. In order to catch the effect of reputation, is necessary to enable principals and agents to engage in long-term relationships and to allow principal within these relationship to condition their contract offers on the agent's past behavior. It is also essential that relationships took place between principals and agents that could be identified during all the stages. Under these conditions, reputation effects can emerge endogenously (Brown, Falk and Fehr 2004). In our treatments, all principals and agents have fixed identification numbers for the whole duration of the experiment. The experimental design allow us to observe bilateral reputation, principals can directly observe agents' past behavior of the agents with they are currently associated; and multilateral reputation, principals can obtain information about any agent past behavior in all the relationship of the later. Under such conditions, reputation could play the two distinguished role identified previously: signaling device (agents with good reputation will have greater chance to be selected again) and sanctioning device (agents who do not cooperate could be punish by principals. In our case,

punishment takes the form of a non-renewal of the relationship: the principals could discipline the agents in the non-final periods by practicing a contingent renewal policy: if an agent is cooperative in period t, the principal offered him to pursue the relationship in t+1).

The possibility for principals to buy information is a way for us to replicate the theoretical model where buyers (principals) can try to learn about the type of sellers (agents): patient or not patient, cooperative or not cooperative. Thus, we expect in the experiments with access to information to observe more cooperative behavior than in the baseline with no information.

We also conduct an experience where this information is free (i.e. the information is available on simple request) in order to catch the link between reputational concern, cooperation and the level of common knowledge shared between agents. The future results could be compared with results of Fehr, Brown and Zender (2008) which observed a stable bilateralisation of relationships even in the case where the information sharing is institutionalized.

It appears important to note, that in our treatment, agents are only informed of the possibility for principals to buy information. They do not know if principals really buy that information and they neither do know which principals buy it. Furthermore, principals, it they pay the requested price, are informed about the behavior of agents during the last three period and they only have aggregate information: they learn the percentage of cooperative versus non cooperative behavior of agents. Thus we do not distinguish short run reputation (information about the last session) and long-run reputation (information about all sessions)[23].

Experimental design. In our experimental design, there are two categories of players: players A (sellers / agents) and players B (buyers / principals). There are 6 principals and 6 agents. All of them have an initial capital of 0 Experimental Currency Units (ecus hereafter). In a first stage, principals can make an offer of association to agents. The proposition is free. Agents will receive 0 to 6 offers and they can accept at most 4 offers. Once the two players agree, they will face an initial cost of 6 ecus (called *initial investment*). This initial investment is required for all new associations but it fall to 0 in case of association renewal. In order to replicate the risk of inappropriate contractual design, the experiments foresee the case where the association requires an adjustment cost beared by the principals (called *additional cost*). This additional cost can be compared to costs associated with renegotiation. Moreover, such renegotiation opens rooms for opportunistic behavior for agents.

[23] See Keser (2002) for an interesting comparison between the effect of short-run reputation and long-run reputation in trust game.

In the experimental design, we consider the possibility of hold-up by modifying the conditions of surplus attribution. In other words, we will differentiate two situations:

1. The design is appropriate: there is no additional cost and the surplus is fairly shared.
2. The design is inappropriate: there is additional cost and the sharing of surplus is made by the agents. They can choose a fair or an unfair sharing.

The lilkelihood of inappropriateness is arbitrary established to 0,5. According to our model, the principals can do this likelihood varying by modifying the amount of initial investment: if they invest the minimum amount, the probability is equal to 0 but they can decrease this probability if they invest an additional amount (called *additional investment*). Thus we distinguish the two following possibilities:

Table 3. Likelihood of appropriate contractual design and principals' investments

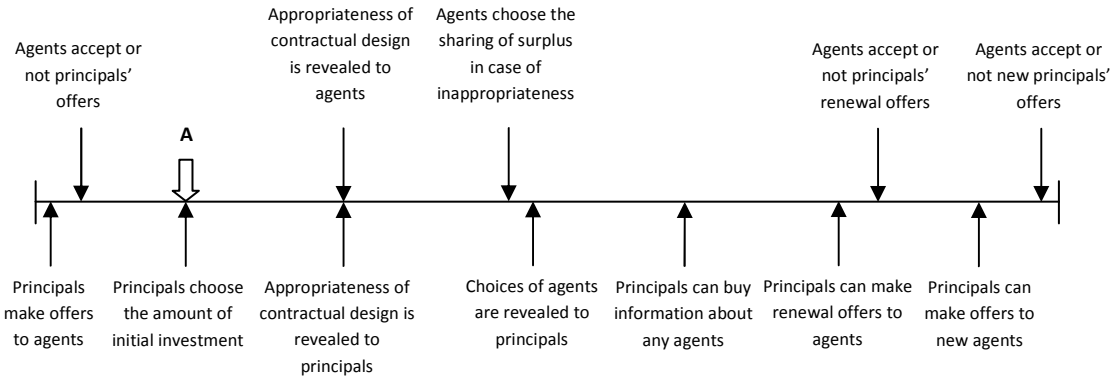
Investment of the principal	Likelihood of appropriateness	Likelihood of inappropriateness
Simple investment	0,5	0,5
Simple investment + Additional investment	0,75	0,25

Note that if the simple investment is beared only once by the principals (and fall to zero in case of association renewal), the risk of inappropriateness is always present. For that reason, the additional investment can be engaged for all periods.

As previous experimental works, we expect to observe reciprocity between partners which interact repeatedly: agents will try to build up a reputation of being cooperative. The objective is obviously to still selected by actual players A in future trade and, maybe, to be selected by new partners A. For our particular case concerning the contractual design, we expect to observe that principals engaged in relation with cooperative agents will go to less invest ex ante: cooperation may have a negative impact on additional investment.

The timing of one period is presented in the figure 1. Each stage is repeated in minimum 10 periods. After the tenth period, the game is pursue period by period according to a probability equal to 0,5. We attempt, by this way, to minimize the end-of-game effect.

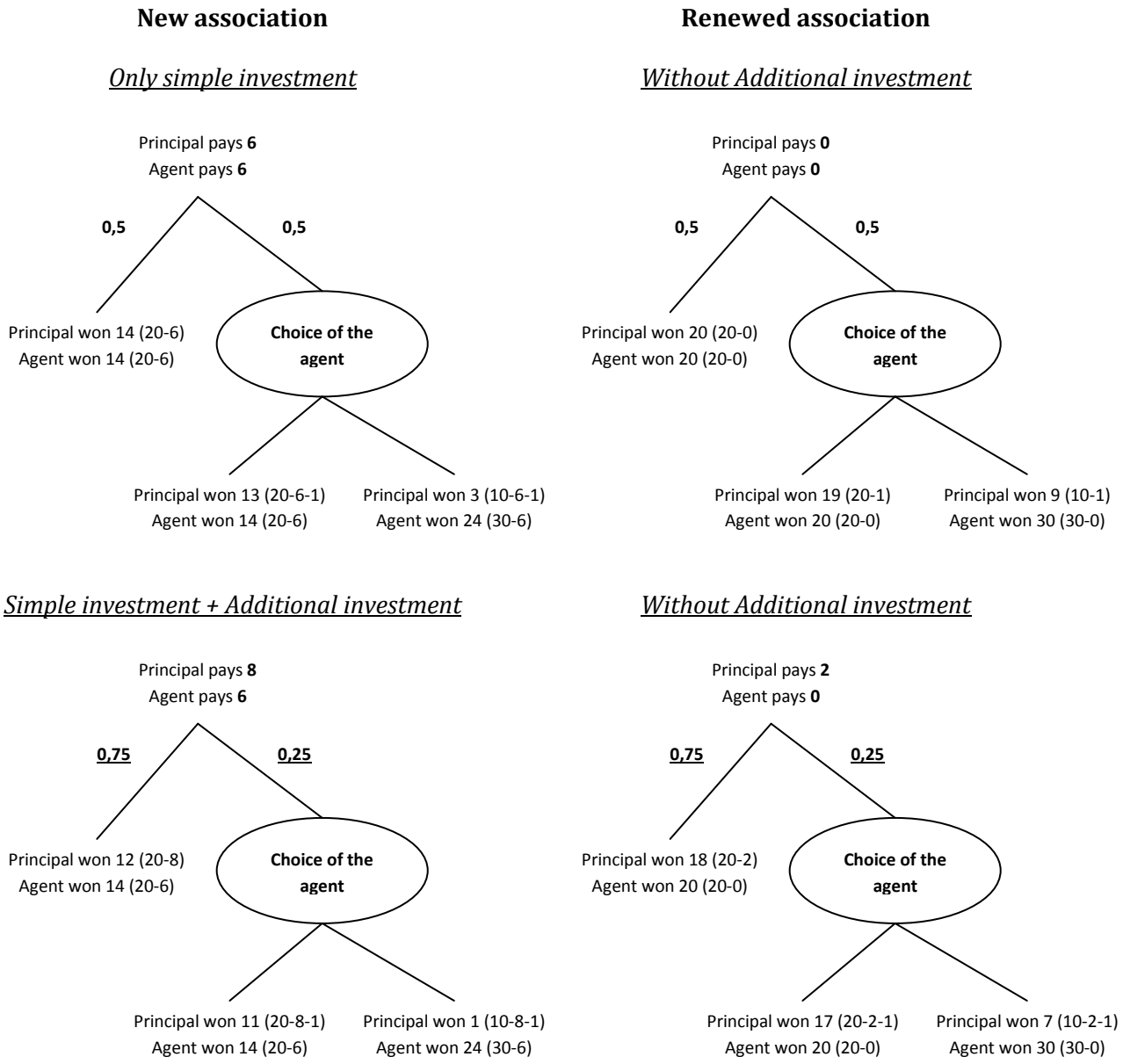
Figure 1. Timing of one period



At the end of the period, the same timing is running again since the point **A** indicates in the above-specified timing.

Concerning the calculation of the surplus, we remain that it will differ according to the characteristics of the relationships and the choices of partners : choice of ex ante investment by the principals, appropriateness of contractual design and choice of ex post sharing surplus by the agents in case of inappropriateness. The calculation corresponding to treatment XX is presented in figure 2.

Figure 2. Calculation of surplus



Our experimental design involves six treatments: a baseline and five variations corresponding to the different hypothesis of our theoretical framework. The different treatments are presented in table 2.

Table 2. Treatments

	Baseline Treatment	Strong Hold-Up Treatment	Light Hold-Up Treatment	Information Treatment	Public Information Treatment	Competition Treatment
Initial investment	6	6	6	6	6	6
Additional investment	2	2	2	2	2	2
Additional cost (in case of inappropriate contractual design)	1	1	3	1	1	1
Principal's payoff in case of appropriateness	20	20	20	20	20	20
Agent's payoff in case of appropriateness	20	20	20	20	20	20
Principal's payoff in case of appropriateness and cooperative behavior of agent	20	20	20	20	20	20
Agent's payoff in case of appropriateness and cooperative behavior	20	20	20	20	20	20
Principal's payoff in case of appropriateness and opportunistic behavior of agent	10	0	10	10	10	10
Agent's payoff in case of appropriateness and opportunistic behavior	30	40	30	30	30	30
Possibility to buy information about agents past behavior	no	no	no	yes	yes	yes
Cost of information (per agents)	-	-	-	2	free	2
Number of principals	12	12	12	12	12	18
Number of agents	12	12	12	12	12	18

3.3. Results

Up to now, we finalize the laboratory experiments and the data collection. This part of the paper have to completed and it will be by May or June.

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Appendix A

In case of relational contracting, S informally commit not to hold-up B in case of inappropriate design (Case 3). In exchange, B promise to select S at next contract renewal with probability p_C. In such a case, the ex-ante bargained price changed as well as the optimal level of cognitive effort $k^{*,r}$.

The ex ante bargained price in case of relational contract

As previously mentioned, we assume that S has bargaining power $\sigma \in [0; 1]$, and the posterior probability that *A* is not appropriate conditional on cognitive efforts band unawareness is:

$$\hat{\rho}(k) = \frac{\rho(1-k)}{1-\rho k}$$

As under the informal dealing between parties, there is no hold-up, and renegotiation occurs at cost *a*, equation (1) defining bargaining on ex-ante price becomes:
σ ($K^+ - c - \hat{\rho}(k)a$) = $p(k^*) - c$ which leads to $p(k^{*,r}) = c + \sigma$ ($K^+ - c - \hat{\rho}(k)a$).

The payoffs of the agents

Let us now deduce the (gross) payoffs of the agents under relational contracting, in each situation depicted in figure 1:

• First Case: the contractual design A is appropriate (1 − ρ): In this case, B learns nothing from his investigation, then trade occurs at price $p(k^{*,r})$, as previously defined. As the design is appropriate, no renegotiation takes place and B's payoff is then $U_B^{A,r} = K^+ - p(k^{*,r})$, while the seller's payoff is $U_S^{A,r} = p(k^{*,r}) - c$.

• Second Case: There is no need of relational contracting and payoffs remain as in the initial case: $U_S^{A',r} = U_S^{A'} = \sigma\,(K^+ - c)$.

• Third Case: In case of inappropriate design, with a probability (1-k), B does not find that the contractual design is inappropriate, and choose to trade at some price p($k^{*,r}$), with the hope that no hold-up will occur. Hence, renegotiation occurs to reach K^+ and B supports adjustment costs a. Payoffs become $U_B^{H,r} = K^+ - a - p(k^{*,r})$, and $U_S^{H,r} = p(k^{*,r}) - c$. There is no hold-up.

As a consequence, in case of relational contracting, the expected payoff of M when he decides to respect his informal dealing is:

$$E(U_S^r) = \rho\left[kU_S^{A',r} + (1-k)U_B^{H,r}\right] + (1-\rho)U_S^{A,r}$$

Optimal cognitive efforts

Let us now determine the optimal level of B's cognitive efforts supported to foresee future contingencies, k^r, in case of relational contracting. B maximizes his expected payoffs in each situation:

$$\max_k -T_B(k^r) + \rho(1-k^r)\left(U_B^{H,r}\right) + \rho k^r\left(U_B^{A',r}\right) + (1-\rho)\,U_B^{A,r}$$

$\Leftrightarrow$

$$\max_k -T_B(k^r) + \rho(1-k^r)(K^+ - a - p(k^{*,r})) + \rho k^r(1-\sigma)(K^+ - c) + (1-\rho)\left(K^+ - p(k^{*,r})\right)$$

By replacing $p(k^{*,r})$ by its value:

$$\max_k -T_B(k^r) + \rho(1-k^r)\left(K^+ - a - \left(c + \sigma(K^+ - c - \hat{p}(k^r)a)\right)\right) + \rho k^r(K^+ - c) + (1-\rho)\left(K^+ - \left(c + \sigma(K^+ - c - \hat{p}(k^r)a)\right)\right)$$

$\Leftrightarrow$

$$\max_k -T_B(k^r) + (K^+ - c)(1-\sigma) - \rho(1-k^r)a + \rho(1-k^r)\left(\hat{p}(k^r)\right)a + (1-\rho)\left(\left(\hat{p}(k^r)\right)a\right)$$

$\Leftrightarrow$

$$\max_{k} -T_B(k^r) + (K^+ - c)(1-\sigma) - \rho(1-k^r)a + (1-\rho k^r)\left(\hat{\rho}(k^r)\right)a \qquad (9)$$

$\Leftrightarrow$

$$\max_{k} -T_B(k^r) + (K^+ - c)(1-\sigma) + \rho a[-1 + k^r a + (1-\hat{\rho}(k^r)a)] \qquad (10)$$

Differentiating (10), we obtain the equation defining $k^{*,r}$:

$$T'_B(k^{*,r}) = \rho a\left(1-\hat{\rho}(k^{*,r})\right)$$

Let us note that this level of transaction cost is lower than that in the absence of relational contract (equation (4)). This is quite intuitive, as it implies that the public authority is less willing to support cognitive costs to avoid inappropriate contractual design, because in this case, there is no hold-up as the contract is expected to be relational.

Appendix B

Suppose that a relational contract has been concluded at price $p(k^{*,r})$. Then, when S deviates from his informal commitment, then B does no longer trust him. If he is still chosen at next contract renewal, then the ex-ante bargained price in next periods takes into account the hold-up action of the seller in the future. In other words, $x = 1$ in (1) that becomes:

$$p\left(k^{*,d}\right) = c + \sigma\left(K - c - \rho(k^*)\left(a + \frac{h}{\sigma}\right)\right)$$

$$p\left(k^{*,d}\right) = c + \sigma(K - c - \rho(k^*)\Delta)$$

Since $h = \sigma(\Delta - a)$, i.e. $\Delta = \left(a + \frac{h}{\sigma}\right)$

• First Case: the contractual design *A* is appropriate $(1-\rho)$. In this case, B learns nothing from his investigation, then trade occurs at price $p\left(k^{*,d}\right)$. As the design is appropriate, no renegotiation takes place and B's payoff is then $U_B^{A,D} = K^+ - p\left(k^{*,d}\right)$, while the seller's payoff is $U_S^{A,D} = p\left(k^{*,d}\right) - c$.

• Second Case: As shown in appendix A, there is no opportunity of hold-up, i.e. $U_S^{A'} = U_S^{A',D} = p\left(k^{*,d}\right) - c$

• Third Case: In case of inappropriate design, with a probability (1-*k*), B does not find that the contractual design is inappropriate. Hence, renegotiation occurs to reach K^+ and B supports adjustment costs *a*. Hold-up occurs as there is no more relational contract once the manager has cheated[24]. Payoffs become $U_B^{H,D} = K^+ - a - h - p\left(k^{*,d}\right)$ and $U_S^{H,D} = p\left(k^{*,d}\right) - c + h$. As a consequence, in case of relational contracting, the expected payoff of S is:

$$E(U_S^D) = \rho\left[k^d U_S^{A',D} + (1-k^d)U_B^{H,D}\right] + (1-\rho)U_S^{A,D}$$

Optimal cognitive efforts

Let us now determine the optimal level of B's cognitive efforts supported to foresee future contingencies, k^d, in case of relational contracting:

$$\max_k -T_B\left(k^d\right) + \rho\left(1-k^d\right)U_B^{H,D} + \rho k^d U_G^{A',D} + (1-\rho)U_B^{A,D}$$

$\Leftrightarrow$

$$\max_k -T_B\left(k^d\right) + \rho(1-k^d)\left(K - a - h - p\left(k^{*,d}\right)\right) + \rho k^d(1-\sigma)(K^+ - c) + (1-\rho)\left(K^+ - p\left(k^{*,d}\right)\right) \quad (12)$$

By replacing $p\left(k^{*,d}\right)$ by its value, the previous inequality becomes:

$$\max_k -T_B(k^d) + \rho(1-k^d)\left(K - a - \left(c + \sigma(K^+ - c - \hat{\rho}(k^d)\Delta)\right)\right) + \rho k^d(1-\sigma)(K^+ - c) + (1-\rho)\left(K^+ - \left(c + \sigma(K^+ - c - \hat{\rho}(k^d)\Delta)\right)\right)$$

$\Leftrightarrow$

$$\max_k -T_B(k^d) + (1-\sigma)(K^+ - c) - \rho(1-k^d)(a+h) + \rho(1-k^d)(\hat{\rho}(k)\Delta\sigma) + (1-\rho)(\hat{\rho}(k)\Delta\sigma)$$

$\Leftrightarrow$

[24] We assume that once a seller has cheated, he always hold-up as he is no longer trusted.

$$\max_{k_t} -T_B(k^d) + (1-\sigma)(K^+ - c) - \rho(1-k^d)(a+h) + (1-\rho k^D)(\hat{\rho}(k^D)\Delta\sigma) \quad (13)$$

$$T'_B\left(k^{*d}\right) = \rho\left(a + h - \hat{\rho}\left(k^{*d}\right)\Delta\sigma\right) \quad (14)$$