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Enforceable vs. Non-Enforceable Contracts: A Theoretical Appraisal with Fair Players

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Abstract

In this paper we provide a simple model examining the choice between enforceable and non-enforceable contracts when, on the one hand, drafting an enforceable contract is costly and, on the other hand, fulfilling a non-enforceable contract is left to parties' fairness. According to the previous literature we find that *(1)* the choice between the two contract settings in equilibrium depends on fairness and enfocement costs, and *(2)* whenever a non-enforceable contract is chosen in equilibrium it turns out welfare-improving. However, we are able to measure efficiency and make punctual predictions of how distant the decentralized solution is from first-best. Precisely, we find that efficiency is strongly conditioned by the stake of the transaction, so that both contracts allow for very high levels of efficency in the presence of low-stake transactions, whereas efficiency always collapses to very low levels for high-stake transactions. It implies that a social planner should intervene only in the last case, even in the presence of high levels of fairness. Our results are robust and hold in a repeated game, proving that reputation is not welfare improving unless the number of interactions exceeds a given threshold.

1 Introduction

As it is usually found written in contract law textbooks, if parties are gentlemen then contracts could be simply finalized by handshake. However, according to a well known saying recalled by Grosheide (2004: 41) "honor does not belong to the province of civil law", so that other legal devices have been introduced in order to solve the crucial problem of contract enforcement.

Although honor does not belong either to the province of the traditional economic theory, the theoretical and experimental investigations carried out by several influential economists during the last decades drew attention to the role of emotional and reciprocal behavior as important driving forces that may

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lead agents to deal with contract complexity in a different fashion than mere self-oriented behavior.[1] This is in particular the case of fairness. On the one hand, fairness may work as a strong contract enforcement device giving rise to or expanding some markets that otherwise would be severely constrained.[2] On the other hand, by allowing the introduction of Pareto-superior contracts in the form of incomplete contracts, fairness reduces the negative effects of the uncooperative outcome (e.g., prisoners' dilemma) and improves overall welfare.[3] These investigations are giving rise to an emerging behavioral contract theory attempting to improve the predictive power and, at times, to change the normative conclusions of traditional contract theory.[4]

We move from this literature claiming that further advancements in behavioral contract theory can be obtained if the focus on fairness includes some other important elements that influence the beneficial effects of fairness in trading and parties' welfare. Precisely, we agree that under certain circumstances fairness serves as a contract enforcement device and improves social welfare, however we claim that its welfare enhancing features depend on the value at stake in the trade between parties.

The experimental literature shows that the magnitude of parties' revenues does not change people's behavior, that is high stakes do not induce to behave selfishly, bringing about the prediction that final outcomes should not be affected.[5] Our results encompass these findings in the sense that the value of transaction does not affect the final choice upon which contract should be implemented. Nevertheless, in our findings the value of transaction is crucial in terms of parties' welfare and efficiency of the final equilibrium also in the presence of fairness: petty transactions are characterized by high efficiency levels and the role of fairness appears marginal, whereas important transactions - stemming from value-enhancing technologies - may show very low levels of efficiency, which can be improved only by means of a fair and trustworthy contractual environment.

Our results are robust and hold both in one shot-games and in finitely repeated games. About the latter case, efficiency loss can be resolved by allowing parties to trade repeatedly so as to acquire reputation,[6] which should induce parties to behave fairly especially in the presence of important transactions. This observation is partially correct, it depends on the levels of fairness triggering informal agreements and on the numerosity of interactions. We are able to measure *i)* in which circumstances informal agreements could give rise to some

[1] Just to cite a few authors, see Akerlof 1982; Geanakoplos *et al.* 1989; Rabin 1993; Fehr *et al.* 1997.

[2] See Fehr *et al.* (1997).

[3] See Fehr *et al.* (1997), Fehr *et al.* (2007).

[4] For an extensive overview on the topic, see Fehr and Schmidt (2002).

[5] High monetary revenues do not affect the final outcome in games like the ultimatum game (Hoffman *et al.* 1996; Slonim and Roth 1998; Cameron 1999) or the gift exchange game (Fehr *et al.* 2002).

[6] Fehr and Schmidt (2004) argue that informal agreements based on fairness are much easier to sustain if the game is repeated. Sobel (2005), and Fehr and Gintis (2007) share the same result.

reputational effects, and *ii)* how much strategic reputation can be truly effective as a substitute for increasing levels of fairness when high stakes come into play.

To achieve these results we propose a principal-agent model involving both fair and selfish individuals trading into a competitive market and choosing between a *non-enforceable contract*, which is fully incomplete, representing a handshake agreement, and an *enforceable contract*, which is costly to draft but verifiable by an impartial court of law. Since the beginning, we need to clarify that we are not interested in the driving forces inducing individuals to behave fairly as other investigations do when introducing different motivations to fairness.[7] We simply assume that fair individuals precommit to behave fairly, meaning that breaking a promise is not considered a feasible strategy even if the contract is non-enforceable. On the contrary, selfish individuals act without precommitment, and strategically decide whether to fulfil or break a given promise according to their self-regarding preferences.

As in Fehr *et al.* (2007) our model confirms that non-enforceable contracts are preferred in equilibrium as the proportion of fair individuals increases and/or the cost of drafting an enforceable contract decreases. The model also confirms that the outcome in equilibrium assures higher levels of welfare when the contract chosen is non-enforceable. However, as mentioned above, even if non-enforceable contracts are welfare-improving, the efficiency levels are seriously undermined by increasing returns to scale, unless fairness is considerably widespread and reputational effects can effectively play a role through a large number of interactions.

To our knowledge, this is the first attempt to make some accurate predictions about the efficiency levels in contract theory through analytical and graphical simulations.[8] Not only are we able to measure the efficiency of the two contracts separately but we are also able to measure the efficiency of players' choice in one-shot and repeated games in percentage of the first-best equilibrium. This further contribution to the existing literature gives rise to quantitative predictions and normative results. In particular, we can assess in which circumstances the decentralized choice is "good" or alternatively the policy maker can intervene by orienting individuals' choices.

The paper is organized as follows. Next section provides the general specification of the model. In sections 3 and 4 we present results respectively for the one-shot game and the repeated game. A welfare comparison between the social optimum and the decentralized solution is the topic of section 5. In this section, we will be able to accurately distinguish in which circumstances and how much the introduction of fair-minded players is beneficial to the society. Finally, section 6 summarizes the main results achieved and concludes the paper.

[7] Two main theoretical strands attempted to model fairness: the intention-based fairness models or reciprocal fairness models (Rabin 1993; Levine 1998; Charness and Rabin 2002; Dufwenberg and Kirchsteiger 2004; Falk and Fischbacher 2006) and the inequity aversion models (Fehr and Schmidt 1999; Bolton and Ockenfels 2000).

[8] The adoption of mathematical software (Mathematica 8.0) allow for the composition of often-complicated solutions of optimization problems, which could not have otherwise been interpreted.

2 The Model

A risk-neutral principal (she) asks a risk-neutral agent (he) to provide a service produced in a competitive market that requires a positive effort level (e) in exchange of a price (p). The principal can choose between two different contracts: one is not enforceable (NE) in front of a court of law, and for this reason it can be considered a sort of handshake or gentlemen's agreement, the other is enforceable (E) but also costly to draft and to enforce. Whichever contract is proposed, the agent decides whether to accept or reject the principal's offer. If the agent rejects, the game ends; if the agent accepts, he will provide the service and asks for a price. The principal is assumed to observe the agent's effort level at no cost and pays the price if the contract is enforceable, whereas she has the option to renege on the promise if the contract is not enforceable.[9] Then, the game ends. We now describe the game in detail.

Players

Players are randomly drawn from a population of individuals who can be either (S)elfish or (F)air. S only cares about her monetary utility whereas F precommits to fulfil the contract even if non-enforceable by third parties. Individual's type is private information, although the probability $\alpha \in (0, 1)$ that an individual is F is common knowledge. As mentioned in the introduction, we are not interested in the reasons why individuals may decide to behave fairly, so that we do not incorporate fairness into the utility functions. Additionally our approach to fairness draws on the notion of *one-sided reciprocity*, such as only one player (the principal) can respond reciprocally to a given action of the other player (the agent).[10] Indeed, the principal is the last player and can verify the agent's effort at no cost, thus no hidden shirking is allowed. Consequently, as it stands, the distinction between fair and selfish agents is irrelevant.

Contracts

The principal decides which contract to propose to the agent. If she offers NE, she makes a promise in terms of a price p^{NE} to be paid to the agent in exchange of a specific effort e^{NE}. If the agent accepts the agreement, he delivers an effort level $\tilde{e}$ and waits for the principal to return the promised price. In this sense, the agent appeals to the fairness of the principal to recompense the placed trust. The principal observes $\tilde{e}$ at no cost and decides whether to fulfil or break the promise according to her type: F will always fulfil the promise if $\tilde{e} = e^{NE}$,

[9] The perfect observability of effort can also be found in Gächter and Falk (2002) and Fehr and Schmidt (2007). When effort is not perfectly observable as in MacLeod and Malcomson (1989) the principal can solicit agent's fairness to provide high effort levels through generous bonuses. The assumption of perfect observability of the agent's effort shifts the trust requirements to the principal. The agent has to decide whether the principal deserves trust or not.

[10] This "one-way" reciprocity has been experimentally investigated in Fehr *et al.* (1997) with the weak reciprocity treatment. On the contrary, the implicit contract in Fehr *et al.* (2007), so called "bonus contract", is a two-sided reciprocity framework by giving the agent the freedom to choose the effort level and, if satisfactory, the principal may reciprocate.

whereas S will always break it. If the principal observes $\tilde{e} \neq e^{NE}$, she will not pay the agent, independently of her type.[11] Such an assumption can be justified using the Roman words "*inademplendi non est ademplendum*", meaning that in case of missed or wrong contractual performance one party cannot ask the other to satisfy any contractual duties.

If the principal offers E, she is bound to pay a price p^E in exchange of a given effort e^E, and pays a fee or transaction cost to be calculated as a fraction of the price, cp^E with $c \in (0, 1)$, covering the cost of writing the contract and making it fully enforceable.[12] The value of c is common knowledge. If the agent accepts the contract and delivers the required effort (i.e., $\tilde{e} = e^E$), he can enforce the payment of p^E. Thus, breaking the promise is sanctioned by the contract itself implying no difference between principal's types.[13]

Payoffs

Principals' revenue from the agent's performance is described by the production function $y(e) = e^{\beta}$ where β is exogenous and measures the returns to scale. Technology is allowed to show different returns to scale: decreasing returns to scale ($0 < \beta < 1$), constant returns to scale ($\beta = 1$), and increasing returns to scale ($1 < \beta < 2$).[14] The level of β is common knowledge. We assume that (A)gent's cost of providing effort e follows a standard cost function $k(e) = \frac{1}{2}e^2$.[15]

In a non-enforceable contract the utility functions are the following:

$$\begin{aligned} U_P^{NE} &= y(e) - p^{NE} && \text{principal's utility from fulfilling NE} \\ U_P^{\overline{NE}} &= y(e) && \text{principal's utility from reneging on NE} \\ U_A^{NE} &= \alpha(p^{NE} - k(e)) + (1-\alpha)(-k(e)) && \text{agent's expected utility from NE.} \end{aligned}$$

In an enforceable contract the utility functions are the following:

$$\begin{aligned} U_P^{E} &= y(e) - (1+c)p^{E} && \text{principal's utility from E} \\ U_A^{E} &= p^{E} - k(e) && \text{agent's utility from E.} \end{aligned}$$

[11] An important difference with the non-enforceable contract designed in the experimental investigation of Fehr *et al.* (2007) is that in our model the agent does not obtain any additional reward beyond the promised price in the handshake agreement, whereas in their model the agent calls for a generous voluntary bonus by eliciting an effort level higher than that required by the principal. This observation highlights the difference between the notion of fairness in Fehr *et al.* (2007), which derives from inequity aversion considerations, whereas in our context might be more related to abiding social norms or simply bilateral informal agreements.

[12] This is a plausible assumption. For instance, lawyer's fee or litigation costs usually depend on the contract value; in our case the price. We might have used different enforcement cost functions such as costs with fixed and variable parts, however because of the subjectivity in the simulations of the magnitude of the fixed part we discarded these functions.

[13] Again, in Fehr *et al.* (2007) the so called "incentive contract" shows some similarities with our enforceable contract.

[14] $\beta \geq 2$ would cause negative or infinite utility to principals.

[15] For similar specification of the cost of effort function see among many Milgrom and Roberts (1992), Schaefer (1998), and Azar (2007).

To sum up, the game consists of three stages. In stage 1, the principal observes her own type, and decides whether to offer an enforceable or a non-enforceable contract to the agent according to the levels of α, β, and c. Consequently, she sets the price, depending on the type of contract chosen, and asks for a specific effort level. In stage 2, the agent decides whether to accept or reject the offer. If the agent rejects the offer the game ends and both players get zero, otherwise the agent provides the effort and expects the payment. In stage 3, if the contract is enforceable, the principal pays p^E; if the contract is not enforceable, the principal chooses to pay or not to pay p^{NE} according to her own type.

Players match randomly and interact only once in a one-shot game. Further on, this hypothesis will be relaxed allowing for repeated interactions. We solve both games searching for perfect Bayesian equilibria.

Lemma 1 *Rejecting the principal's offer ($\tilde{e} = 0$) strictly dominates delivering an effort level $\tilde{e} \neq \left\{e^E, e^{NE}\right\}$.*

Proof. The proof follows straightforward from the assumption that the principal can observe $\tilde{e}$ at no cost. Thus, A should not provide an effort level lower than either e^{NE} in a non-enforceable contract or e^E in an enforceable contract. This would imply an infringement of the contract with the consequence that the principal will never pay the price, regardless of her type and the type of contract proposed. Further, supplying $\tilde{e} > \left\{e^E, e^{NE}\right\}$ would not entail an additional reward thereby implying only an increase in the cost of effort. As a result, the best strategies for A are either rejecting the contract or providing the requested effort. ■

3 One-Shot Game

Proposition 1 *No separating equilibrium can exist for both types of principal offering different contracts or non-enforceable contracts with different levels of effort and/or price.*

Proof. Suppose there exists a separating equilibrium such that F offers a non-enforceable contract and S offers an enforceable contract. The following condition should apply:

$$U_P^{NE} > U_P^E > U_P^{\overline{NE}} \tag{1}$$

Condition (1) implies $y(e^{NE}) - p(e^{NE}) > y(e^{NE})$, which is unfeasible because $p(e^{NE}) > 0$. Thus, since condition (1) is not satisfied, this equilibrium does not exist because S would profitably deviate from E by proposing NE, and eventually reneging on the contract once received A's effort. Suppose now there exists a separating equilibrium such that F offers an enforceable contract and S offers a non-enforceable contract. A knows that S never fulfils the promise, so that he will always reject any offer of a non-enforceable contract coming only from selfish principals. Thus, this equilibrium does not exist and S would profitably offer an enforceable contract. The same reasoning excludes any equilibrium for the two types of principal offering a non-enforceable contract with different levels of price and/or effort. ■

Proposition 1 therefore implies that S is necessarily induced to mimic F.

Proposition 2 *In a one-shot game there exists an equilibrium in which the principal offers an enforceable contract, which the agent accepts. This is a unique equilibrium if* $\alpha \leq \underline{\alpha} = \frac{1}{1+c}$*, whereas if* $\alpha > \underline{\alpha}$ *there also exists a class of equilibria in which both* F *and* S *offer a non-enforceable contract, which the agent accepts.*

Proof. Suppose that both types of principal offer an enforceable contract. It is always an equilibrium because no principal has an interest to deviate to offering a non-enforceable contract because A would consider such a deviation coming from S due to the adverse inference, and therefore would reject it. Therefore, A will accept an enforceable contract for any e and p satisfying his participation constraint, which for simplicity holds with a reservation utility equal to 0, that is

$$p \geq \frac{1}{2}e^2. \tag{1}$$

The free-entry condition implies that condition (1) holds as an equality. Substituting (1) into the principal's utility function, U_P^E, and maximizing with respect to e, we obtain e^E and p^E, such that

$$\begin{aligned} e^E &= \left(\frac{\beta}{1+c}\right)^{\frac{1}{2-\beta}} \\ p^E &= \frac{1}{2}\left(\frac{\beta}{1+c}\right)^{\frac{2}{2-\beta}}. \end{aligned}$$

Both e^E and p^{NE} are increasing in β and decreasing in c. Any principal offering an enforceable contract will therefore obtain

$$U_P^E = \left(\frac{\beta}{1+c}\right)^{\frac{\beta}{2-\beta}}\left(1-\frac{\beta}{2}\right).$$

No principal can profitably deviate to any other enforceable contract because she would get a lower payoff. Note that $\forall c \in (0,1)$ and $\forall \beta \in (0,2)$, $U_P^E > 0$. U_P^E is always decreasing in c, whereas it is increasing in β only if $\beta \geq \bar{\beta}(c)$, with $\bar{\beta}(c) > 1$.

Suppose that both types of principal offer a non-enforceable contract. A's expected utility will be

$$U_A^{NE} = \alpha\left(p - \frac{1}{2}e^2\right) + (1-\alpha)\left(-\frac{1}{2}e^2\right).$$

Thus, A will accept the offer if and only if

$$p \geq \frac{1}{2\alpha} e^2. \tag{2}$$

Because of the free-entry condition we will limit our analysis to the equilibria in which the agent gets 0. If such a class of equilibria exist, F and S get respectively $e^\beta - \frac{1}{2\alpha}e^2$ and e^β. Since $\frac{1}{2\alpha}e^2 > 0$ if F has no incentive to deviate to an enforceable contract, then it must be true also for S. We can therefore exclude that such a deviation is profitable if

$$U_P^{NE} = e^\beta - \frac{1}{2\alpha}e^2 > \left(\frac{\beta}{1+c}\right)^{\frac{\beta}{2-\beta}} \left(1 - \frac{\beta}{2}\right), \tag{3}$$

where the right-hand side corresponds to the maximum payoff a principal can get from an enforceable contract. Any couple $(p(e), e)$ satisfying condition (3) is an equilibrium in this class, and no principal can profitably deviate to any other non-enforceable contract since the agent infers that this deviation would come from S. In order to prove that this class of equilibria is non-empty, we now maximize U_P^{NE} with respect to e. We obtain

$$\begin{aligned} e^{NE} &= (\alpha\beta)^{\frac{1}{2-\beta}} \\ p^{NE} &= \frac{1}{2}\alpha^{\frac{\beta}{2-\beta}}\beta^{\frac{2}{2-\beta}}. \end{aligned}$$

Note that both e^{NE} and p^{NE} are always increasing at an increasing rate in α, and if $\alpha \geq 1/2$, also in β.[16] F will get

$$U_P^{NE} = (\alpha\beta)^{\frac{\beta}{2-\beta}} \left(1 - \frac{\beta}{2}\right), \tag{4}$$

which is always increasing in α, and in β if $\alpha \geq 1/2$ and $\beta \geq \bar{\beta}(\alpha)$, with $\bar{\beta}(\alpha) > 1$. Note that $\forall\alpha \in (0,1)$ and $\forall\beta \in (0,2)$, $U_P^{NE} > 0$. Proposition 1 implies that S cannot offer any other non-enforceable contract because A would infer her type and reject the proposal. Thus, S will get

$$U_P^{\overline{NE}} = (\alpha\beta)^{\frac{\beta}{2-\beta}} > U_P^{NE}.$$

Substituting (4) into condition (3) we find that this class of equilibria is non-empty if and only if $\alpha > \frac{1}{1+c} = \underline{\alpha}$. ■

As shown in this proof, the model is characterized by multiple equilibria if the proportion of fair principals is high enough to sustain also a class of non-enforceable equilibria. Refinements such as the *intuitive criterion* or *divinity*

[16] This result is experimentally corroborated by Englmaier and Leider (2010), who find that the agent is more willing to reciprocate as the magnitude of the benefit to the principal from his effort increases.

do not apply. Nevertheless, multiplicity does not affect the results presented in section 5 on the welfare analysis.

Not surprisingly, the results predict that a non-enforceable contract may arise in equilibrium as the probability that the principal is fair increases and/or the enforcement costs increase.[17] What is less obvious is why the coefficient β, measuring the returns to scale, does not play any role for the existence of equilibria in NE. As it can be noticed by comparing U_P^{NE} and U_P^{E} the impact of β is identical in both contracts, meaning that technology is neutral with respect to the type of contract proposed. Besides, returns to scale are not relevant for the agent while deciding whether to accept or reject a given offer as they do not affect his participation constraint.[18] This result is consistent with the experimental literature, showing that large increases in parties' revenues do not affect parties' behavior and their attitude to fairness.[19] If the principal is assumed to be fair and to fulfil a promise, not only does the value of transaction not affect her commitment but also her contract choice.

Lemma 2 *F cannot send a credible signal to the agent about her true type.*

Proof. Consider F offering a non-enforceable contract and deciding to pay a first installment λp^{NE} with $\lambda \in (0,1)$ before the agent supplies the effort required so that to discourage S to propose a non-enforceable contract, thereby signalling her fair type. With this form of signalling nothing would change for F, who eventually pays the price promised. Conversely, S would lose the first installment if she wants to signal to be an F type. Therefore, the signal is credible if it is sufficiently high to discourage S from proposing a non-enforceable contract in equilibrium and paying the first installment. However, no credible signal can be sent because S has always an interest to mimic F by sending distorted signals about her true type. Indeed, in order to make the signal working the following condition must hold

$$y(e^{NE}) - p^{NE} > y(e^{E}) - (1+c)p^{E} > y(e^{NE}) - \lambda p^{NE}. \tag{5}$$

However, this condition will never hold $\forall\ \lambda < 1$.[20] ■

[17] Similar results can be found in Berg *et al.* 1995, Fehr *et al.* 1997, Fehr and Schmidt 2002.

[18] For example, the results predict that a customer calling an electrician in order to substitute a broken electrical cable, which costs to the electrician a given effort level, will offer the same type of contract if the service allows for either replacing a plug or the entire electrical house system. On the contrary, which contract will be implemented depends crucially on the costs of drafting and making the contract enforceable, and the level of trust placed by the electrician to be eventually paid.

[19] This has been tested in the ultimatum games (Cameron 1999) and in the gift-exchange games (Fehr *et al.* 2002).

[20] For simplicity we have assumed that agents are all F type. However, this assumption does not change the ineffectiveness of signalling. If agents were also of two types, the utility functions of the principals would become $U_P^{NE} = \alpha y(e^{NE}) - \lambda p^{NE} - \alpha(1-\lambda)p^{NE}$ and $U_P^{\overline{NE}} = \alpha y(e^{NE}) - \lambda p^{NE}$, with still $U_P^{\overline{NE}} > U_P^{NE}\ \forall \lambda < 1$. Besides, note that if $\lambda = 1$, condition (5) still does not hold, however the non-fulfilment risk shifts completely towards the principals but the results of Proposition (1) still hold.

4 Repeated game

Suppose the game is played repeatedly for a finite number of periods T, whose value is common knowledge. The discount factor is assumed to be equal to 1. In each period the principal decides which contract to propose to the agent, either enforceable or non-enforceable. Matching is random, meaning that any principal can match with any agent in each period. All players have perfect knowledge of other players' behavior in previous interactions; this means that if a principal breaks a promise of payment in a non-enforceable contract, any agent will refuse a non-enforceable contract from that principal thereafter because he has inferred her selfish type.[21]

Given the multiplicity of equilibria with non-enforceable contracts characterizing the one-shot game, within this class we will refer to the equilibrium in which the principal maximizes her payoff. Accordingly, we will assume that whenever NE is chosen in equilibrium in some periods, it corresponds to the equilibrium in which the agent gets 0, and a principal gets either $(\alpha\beta)^{\frac{\beta}{2-\beta}}\left(1-\frac{\beta}{2}\right)$ or $(\alpha\beta)^{\frac{\beta}{2-\beta}}$ respectively from either honouring or breaking the contract.

Since the game is repeated, S may have an interest to acquire strategic reputation for future transactions by proposing and fulfilling a non-enforceable contract. If this incentive exists, the agent would trust all principals who propose a non-enforceable contract. This would give rise to a first-best contract (FB), in which no asymmetric information or enforcement costs would occur. Thus, FB corresponds to either a non-enforceable contract with $\alpha = 1$ or an enforceable contract with $c = 0$. Accordingly, a principal proposing FB gets $U_P^{FB} = \beta^{\frac{\beta}{2-\beta}}\left(1-\frac{\beta}{2}\right)$ from fulfilling, and $U_P^{\overline{FB}} = \beta^{\frac{\beta}{2-\beta}}$ from reneging on the promise. If both types of principal fulfil FB, the agent's expected utility would be 0, otherwise it would be negative. This means that the agent would accept FB along the equilibrium path in repeated games only if S has no incentive to break the promise.

Lemma 3 *a)* $U_P^{FB} > \max\left\{U_P^E, U_P^{NE}\right\}$.
b) $U_P^{\overline{FB}} > U_P^{FB}$ *and* $U_P^{\overline{NE}} > U_P^{NE}$.
c) S always breaks any promise in the last period T.
d) If E is chosen in equilibrium in periods $(t+1, ..., T)$, S always breaks any promise in period t.

Proof. Proofs of parts *a)* and *b)* are trivial. Proof of part *c)* follows straightforward from the definition of selfishness**.** The last period corresponds to a one-shot game since there is no longer reputation to be acquired, so that S is always induced to break a nonenforceable contract. Similarly, S has no interest to acquire reputation at time t if an enforceable contract will be applied thereafter, this proving part d). ■

[21] The same results would hold assuming that the principal always matches with the same agent over time.

It is worthwhile noting that Lemma 3c implies that no equilibrium in which FB applies in period T can exist. Additionally, Lemma 3d implies that no equilibrium in which FB can apply in period $(1, ..., t)$ and E thereafter exists.

Proposition 3 *In a repeated game,*

a. There is an equilibrium in which E applies in each period, and it is unique if $\alpha \leq \underline{\alpha}$.

b. If $\alpha > \overline{\alpha} = \left[\frac{\frac{\beta}{2}+(T-1)\left(\frac{1}{1+c}\right)^{\frac{\beta}{2-\beta}}\left(1-\frac{\beta}{2}\right)}{(T-2)\left(1-\frac{\beta}{2}\right)+1}\right]^{\frac{2-\beta}{\beta}}$*, there also exists a class of* $(T-1)$ *equilibria in which* FB *applies in periods* $(1, ..., t^*)$ *with* $t^* \leq T-1$*, and* NE *thereafter, which* S *always honors except in period* T.

c. If $\underline{\alpha} < \alpha \leq \overline{\alpha}$*, there also exists an equilibrium in which* NE *applies in each period, which* S *always honors except in period* T.

Proof. We will recall throughout the proof the following conditions: *i)* agents would punish any deviation by rejecting any contract but E thereafter, *ii)* $U_P^{FB} > U_P^E$ due to Lemma 3a, *iii)* $U_P^{NE} > U_P^E$ if $\alpha > \underline{\alpha}$, and *iv)* $U_P^{NE} \leq U_P^E$ if $\alpha \leq \underline{\alpha}$.

a. Suppose there exists an equilibrium in which both types of principals offer E in each period such that $e = e^E$ and $p = p^E$. The analysis of the one-shot game implies that no principal can profitably deviate to NE or FB in any period because A infers that it would come from S. At the same time, any other deviation to any enforceable contract offering $e \neq e^E$ and/or $p \neq p^E$ is not maximizing for the principals, thus the above equilibrium exists. Condition *iv)* implies that F would prefer E to NE in any period. Thus, any NE will be refused by the agent because it would come from S. Consequently, Lemma 3c and 3d exclude that FB can apply in any period. Therefore, if $\alpha \leq \underline{\alpha}$ the equilibrium in enforceable contracts in each period is unique.

b. Consider the following equilibrium: FB in periods $(1, ..., t^*)$ and NE in periods $(t^* + 1, ..., T)$. By applying the backward induction, consider the last period. Condition *iii)* implies that no principal has an interest to deviate to E if $\alpha > \underline{\alpha}$, and A's adverse inference excludes that any principal can profitably deviate to FB. In any other $t > t^*$, any deviation from NE to FB would not be accepted by A because of the adverse inference, and conditions *i)* and *iii)* imply that no S has an interest to deviate to reneging NE and necessarily applying E from $t+1$ onwards. In t^* Lemma 3a implies that no principal has interest to deviate to E or NE. Further, S has no interest to break FB if and only if

$$t^* U_P^{FB} + (T - t^* - 1) U_P^{NE} + U_P^{\overline{NE}} > (t^* - 1) U_P^{FB} + U_P^{\overline{FB}} + (T - t^*) U_P^E, \quad (6)$$

that is

$$\alpha > \left[\frac{\frac{\beta}{2} + (T - t^*)\left(\frac{1}{1+c}\right)^{\frac{\beta}{2-\beta}}\left(1 - \frac{\beta}{2}\right)}{(T - t^* - 1)\left(1 - \frac{\beta}{2}\right) + 1}\right]^{\frac{2-\beta}{\beta}}. \quad (7)$$

Besides, conditions *i)* and *iii)* imply that if S has no interest to break FB in period t^*, she has neither interest to break FB in any $t < t^*$. Thus, the equilibrium in which FB applies in periods $(1, ..., t^*)$ and NE in periods $(t^* + 1, ..., T)$ exists. The right-hand side of condition (7) is increasing in t^*, and substituting for $t^* = 1$ it follows that there exists a class of $(T-1)$ equilibria as $\alpha > \overline{\alpha}$, with α monotone and increasing in t^*, and each equilibrium of this class corresponds to different sub-intervals of $\alpha > \overline{\alpha}$, which do not intersect with each other.[22]

c. If $\underline{\alpha} < \alpha \leq \overline{\alpha}$ then there does not exist any t^* satisfying condition (6), thus no FB can be applied. Condition *iii)* implies that no principal has interest to break NE apart from S in period T and to deviate to proposing E in any period. Consequently the equilibrium in which NE applies in each period exists.

■

Although we have used the profit maximizing equilibrium in NE, we find that multiplicity affects also repeated games, as highlighted by Fudenberg and Masking (1986). Nevertheless, our results allow to sketch some general considerations about the effect of reputation on parties' behavior and welfare. Precisely, we are interested in verifying how t^* changes in α, β, c, and T. In other words, we are interested in verifying how changes in the variables affect the number of FB. Solving condition (7) for t^*, we find that:

$$t^* < T - \frac{\beta}{2-\beta} \frac{1 - \alpha^{\frac{\beta}{2-\beta}}}{\alpha^{\frac{\beta}{2-\beta}} - \left(\frac{1}{1+c}\right)^{\frac{\beta}{2-\beta}}}.$$

The first partial derivative of the right-hand side in the above inequality, within the interval of definition $\alpha > \overline{\alpha}$, is positive in α and c, and negative in β. Further, as $\alpha \to 1$, t^* tends to its maximum, that is $T-1$. As expected, an increase in the overall level of fairness yields a higher number of FB, but also an increase in c imposes individuals to invest more in trust since enforceable contracts becomes more expensive. On the contrary, as β increases the incentive for S to break FB gets higher due to the increasing gains from reneging. As to the number of interactions T, its increase implies a higher t^*, which as it stands is not very informative. However, it is easy to show that $\frac{t^*(T)}{T}$ increases with T, thereby implying that as T increases the number of FB increases more than NE for a given triple (α, β, c). Thus, as expected and suggested by some influential literature (Brown *et al.* 2004; Gächter and Falk 2002), the more numerous the transactions the more reputation in first-best will be acquired.

We discuss now some implications.

First, neither T nor β influence the existence of equilibria with non-enforceable contracts with respect to the unique equilibrium in which enforceable contracts are applied. In particular, this means that reputation does not help to informalize contracts, even for negligible transactions.

[22] Trivially, if the game is played infinitely and the discount factor is equal to 1, FB applying in each period will be an equilibrium.

Second, $\forall\alpha < 1/2$ and $\forall c \in (0,1)$ the equilibrium in repeated games is E in each period as in the one-shot game; this shows how reputation is not enough to fill the lack of trust generated by low levels of α. In other words, there is a threshold level of α below which reputation cannot induce the adoption of non-enforceable contracts. In our model this threshold requires at least the majority of players to be fair, and however it depends on the enforcement costs existing in the legal system. Thus, even with repeated interactions, fairness should be reasonably widespread to make informal agreements work.

Third, note that $\frac{\partial\bar{\alpha}}{\partial\beta} > 0$. This result shows that for given levels of c and T, the higher β the more widespread fairness should be so as to implement FB and thus efficient contracts. Vice versa, if β is rather small, relatively low levels of α allow for the introduction of FB. This result corroborates what found in terms of t^*: *ceteris paribus* as returns to scale increase, that is transactions become more valuable, the number of FB in equilibrium diminish, and only an increase in the levels of fairness can counteract this effect; the contrary occurs for lower returns to scale. The reason of this finding is straightforward. Since $\lim_{\beta\to 0}(U_P^{\overline{FB}} - U_P^{FB}) = 0$, S is not induced to break FB because the gains from reneging gets very low for $\beta \to 0$, thus fairness does not play an important role and can also be rather limited, although it must be sufficient to sustain informal agreements. On the contrary, $\lim_{\beta\to 2}(U_P^{\overline{FB}} - U_P^{FB}) = \infty$, namely the principal's return from breaking FB gets exponentially high as $\beta \to 2$ such that acquiring reputation in first-best may not be as profitable. In the latter case fairness is crucial to contrast the incentive for S to deviate. In other words, high-value transactions (i.e., high β) make reputation less effective in implementing FB. This can only be contrasted by fairness. At a first glance, it seems rather intuitive thinking about the importance of reputation for high-valued transactions, in which the high-stake should induce any player to behave strategically fair, and consequently making the levels of fairness in the society less crucial. On the contrary, this finding claims the opposite, that is the gains from breaking FB (i.e., $U_P^{\overline{FB}} - U_P^{FB}$) become very high with high-value transactions and may exceed the gains from reputation in first-best (i.e. $U_P^{FB} - U_P^{NE}$).[23] As a result, high-value transactions require high levels of fairness to keep production levels high and to avoid a fall in welfare levels.

Fourth, fulfilling NE by both types of principals enables the agent to raise a positive payoff equal to $(T - t^* - 1)p^{NE}(1-\alpha)$. As a consequence, the agent earns more as t^* decreases and his expected utility is at its maximum in the equilibrium with all NE. When information on individuals' type is rather uncertain, that is when α is neither close to 0, in which only E can be implemented, nor to 1, in which all FB are implemented apart from the last period, the benefits of reputation in second-best acquired by S is partly diverted to the agents. Therefore, with intermediate levels of fairness the less informed party receives a benefit from uncertainty, which is totally paid by the more informed party who needs to acquire reputation.

[23] *A fortiori* as the discount factor is less than one.

5 Welfare Analysis

In this section we provide a comparison between the private solution arising from a decentralized choice, such as described in the previous sections, and the public solution in which production is centralized and all players follow the instructions of a central planner. We first present some features which are common to both the one-shot game and the repeated games and then we focus on each game type.

The optimal public solution identifies the first-best social surplus since no enforcement cost and no asymmetric information occur, and provides a benchmark to assess the efficiency of a decentralized solution in equilibrium where, on the one hand, enforceable contracts suffer from enforcement costs and, on the other hand, non-enforceable contracts introduce asymmetric information over principals' types. In particular, we will be able to measure how distant the social surplus achievable under a decentralized solution is from first-best.

Call W the welfare function identifying the social surplus. It is easy to show that the first-best social surplus is:[24]

$$W_{FB} = \beta^{\frac{\beta}{2-\beta}} \left(\frac{2-\beta}{2} \right)$$

The welfare functions for E and NE yield respectively the following social surpluses:[25]

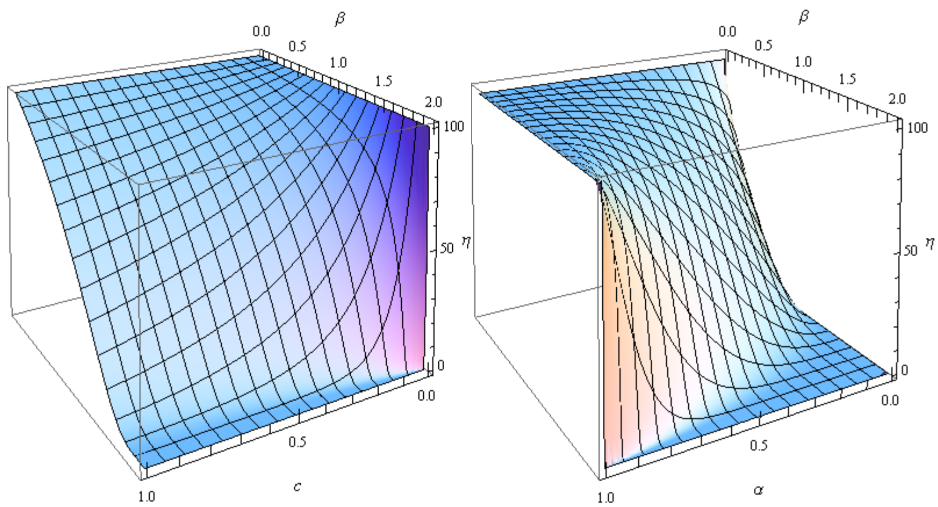
$$W_E = \left(\frac{\beta}{1+c} \right)^{\frac{\beta}{2-\beta}} \left(\frac{2-\beta}{2} \right) \qquad \text{and} \qquad W_{NE} = (\alpha\beta)^{\frac{\beta}{2-\beta}} \left(\frac{2-\alpha\beta}{2} \right),$$

where W_{NE} is calculated for the equilibrium in which the principal maximizes her profits. This implies that W_{NE} is the higher social welfare achievable in a non-enforceable equilibrium.

As said in the previous section, a first-best contract corresponds to either E with $c = 0$, or NE with $\alpha = 1$. In the following, W_E and W_{NE} will be compared in percentage terms with W_{FB}, as mentioned the latter being the maximum achievable social surplus for any given β. The comparison will be evaluated over the space $\alpha \times \beta \times c =]0,1[\times]0,2[\times]0,1[$. Of course, the efficiency levels (η) crucially depend on the values of α and β for NE and on the values of c and β for E, as shown in Figure 1.

[24] The result follows from $\max_e \left\{ e^{\beta} - \frac{1}{2}e^2 \right\}$.

[25] Note that these functions do not refer to the private choice between E and NE in equilibrium, but simply want to capture the efficiency of the two contract settings taken separately.



a. η_E b. η_{NE}

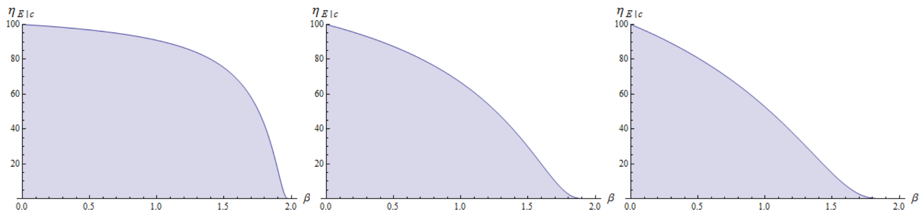
Figure 1. Efficiency levels of enforceable and non-enforceable contracts taken separately.

We find that the overall efficiency level of each contract, calculated for the entire domain of planes (c, β) and (α, β) respectively for E and NE are

$$\eta_E = \int_{c=0}^{1} \int_{\beta=0}^{2} \frac{W_E}{W_{FB}} \cdot 100 = 61.50\% \quad \text{and} \quad \eta_{NE} = \int_{\alpha=0}^{1} \int_{\beta=0}^{2} \frac{W_{NE}}{W_{FB}} \cdot 100 = 61.37\%$$

These values mean that both contracts waste on average slightly less than 40% of surplus with respect to a putative FB equilibrium. Graphically, the overall efficiency levels correspond to the volumes of the surfaces in the cuboids of Figure 1. This result allows to draw the observation that in absolute and very general terms the two contract settings are very similar in terms of efficiency. In order to address into more detail the reasons of such an outcome we need to analyze the role of the three variables under scrutiny: α, β, and c. To do so we start by computing η_E and η_{NE} respectively for given levels of c and α in the entire interval of β. Figure 2 below presents the efficiency levels of W_E conditioned for $c = \{0.1, 0.5, 0.9\}$, measured by the sections of the surface in Figure 1a. The analytical expression is the following

$$\eta_{E|c} = \int_{\beta=0}^{2} \frac{W_E}{W_{FB}} \cdot 100.$$

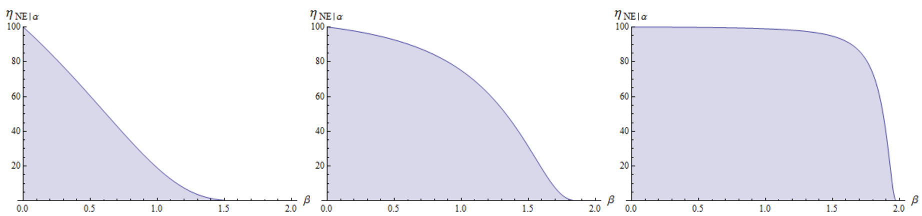


a. $c = 0.1$ b. $c = 0.5$ c. $c = 0.9$

Figure 2. Efficiency levels of an enforceable contract for given enforcement costs.

Similarly, Figure 3 below shows the efficiency levels of W_{NE} conditioned for $\alpha = \{0.1, 0.5, 0.9\}$, measured by sections of the surface in Figure 1b. The analytical expression is the following

$$\eta_{NE|\alpha} = \int_{\beta=0}^{2} \frac{W_{NE}}{W_{FB}} \cdot 100.$$



a. $\alpha = 0.1$ b. $\alpha = 0.5$ c. $\alpha = 0.9$

Figure 3. Efficiency levels of a non-enforceable contract for given levels of fairness.

Comparing Figures 2 and 3, we see that, independently on the values of α and c, the loss in efficiency increases in β, but is compensated by the positive impact of low levels of c or high levels of α, depending on the contract we consider. The visual impression of the above figures can be translated into numerical terms in the following tables, which present $\eta_{E|c}$ and $\eta_{NE|\alpha}$.

E	
c	$\eta_{E\|c}$
0.1	80.4
0.5	57.8
0.9	49.0

NE	
α	$\eta_{NE\|\alpha}$
0.1	31.7
0.5	61.6
0.9	91.0

Table 1. Efficiency Levels (%) of E and NE conditioned for specific values of α and c in the entire range of β.

It is worthwhile noting from Table 1 that $\Delta\eta_{E|\alpha} > \Delta\eta_{E|c}$ for equal variations in α and c. For a more complete analysis of the efficiency levels of the two contracts taken separately we now assume specific values for β, representing different returns to scale, as described in Table 2.

enforceable contracts

c \ β	**0.1**	**1.0**	**1.9**
0.1	99.50	90.90	16.35
0.5	97.89	66.67	0.05
0.9	96.68	52.63	0.001

non-enforceable contracts

α \ β	**0.1**	**1.0**	**1.9**
0.1	92.78	19.00	$\approx$0
0.5	98.95	75.00	0.002
0.9	99.97	99.00	39.17

Table 2. Punctual efficiency levels (%) of E and NE.

What we expect from Table 2 is that E and NE yield very high (low) η if respectively c tends to 0 (1) and α tends to 1 (0), as shown in Table 1. However, the outcome crucially depends on β in both contract settings. Precisely, decreasing returns to scale allow for high levels of efficiency even in the presence of high levels of c or low levels of α; whereas increasing returns to scale push efficiency down to low levels even in the presence of low values of c or high values of α. This means that none of the two contracts is able to warrant high efficiency levels in the presence of valuable transactions.[26] In other words, when effort is highly valuable, a centralized solution considerably reduce the distortions occurring in private contracting due respectively to the enforcement costs in E and the asymmetric information in NE. Even if these distortions (i.e., enforcement costs and/or asymmetric information) may appear relatively small, they can severely undermine the transaction because of their negative impact on the optimal effort.

5.1 One-shot game

Proposition 2 has proved the existence of the equilibrium in NE if $\alpha > \underline{\alpha}$, and uniquely E otherwise. Accordingly, the maximum welfare function of the one-shot game (OS) under scrutiny, W_{OS}, is simply

$$W_{OS} = \begin{matrix} W_{NE} \text{ if } \alpha > \underline{\alpha} \\ W_E \text{ if } \alpha \leq \underline{\alpha} \end{matrix}$$

First, we know that the choice between E and NE does not depend on β. This implies that for each couple of values (α, c) the efficiency levels are evaluated for the entire interval of β either in E or in NE, depending on the choice made in the OS setting.

[26] This result evokes what inferred from the previous section.

Lemma 4 *If NE is chosen in equilibrium (i.e., $\alpha > \underline{\alpha}$) then $W_{OS} \geq W_E$, whereas if E is chosen in equilibrium (i.e., $\alpha \leq \underline{\alpha}$) then there exist $\hat{\alpha} = \alpha(c)$ and $\hat{\beta} = \beta(\alpha, c) > 0$ such that $W_{OS} < W_{NE}$ for $\alpha > \hat{\alpha}$ and $\beta \leq \hat{\beta}$.*

Proof. This Lemma depends on the fact that principals choose on the basis of their returns and not on the basis of welfare maximization. While $U_P^E = W_E$, the same is not true for NE, where $U_P^{NE} < W_{NE}\ \forall(\alpha, \beta)$. Thus, if $\alpha > \underline{\alpha}$ then $U_P^{NE} > U_P^E = W_E$, this trivially implies that $W_{OS} \geq W_E$. If $\alpha \leq \underline{\alpha}$ then there is a region of (α, β, c) such that $W_{NE} > W_E$ if $\alpha(1+c) > \left(\frac{2-\beta}{2-\alpha\beta}\right)^{\frac{2-\beta}{\beta}}$. Since the right-hand side of the last inequality is lower than one, increasing in β, and $\lim_{\beta\to 0}\left(\frac{2-\beta}{2-\alpha\beta}\right)^{\frac{2-\beta}{\beta}} = e^{1-\alpha}$, there exists $\hat{\alpha} = \alpha(c) = -productlog[-\frac{1}{(1+c)e}]$ such that $\forall\alpha > \hat{\alpha}$ there exists $\hat{\beta} = \beta(\alpha, c)$ such that $\forall\beta \leq \hat{\beta}\ W_{NE} > W_E = W_{OS}$. ■

This Lemma implies that if a non-enforceable contract is chosen, the consequent maximum social surplus arising in the one-shot model is always not lower than the social surplus accruing from applying exclusively enforceable contracts. In other words, by introducing in the contractual choice informal agreements, and if these agreements are actually chosen, they may improve overall welfare, and consequently social efficiency. On the contrary, enforceable contracts in a one-shot game are detrimental to efficiency for a level of fairness beyond a certain threshold and especially for low-value transactions. In these circumstances, a non-enforceable contract would be welfare-improving, but it is not eventually chosen.

The overall efficiency level of the OS setting is

$$\eta_{OS} = \int_{\alpha=0}^{1}\int_{c=0}^{1}\int_{\beta=0}^{2} \frac{W_{OS}}{W_{FB}} \cdot 100 = 70.27\%.$$

This is a striking result because it shows that widening contractual choice over transactions improves social efficiency, and we are also able to measure the improvement, which is about 10 percentage points with respect to each of the two contracts taken separately.[27] Nonetheless, the one-shot game wastes on average slightly less than 30% of social surplus.

Once again, we now try to understand the efficiency loss by isolating the role of α, β, and c. Let start analyzing the η_{OS} for specific values of α and c, evaluated in the entire range of β, as shown in Table 3.

[27] To our knowledge, this is the first time that contract choice widening is evaluated in terms of its social efficiency.

		α		
		0.1	**0.5**	**0.9**
c	**0.1**	80.4	80.4	80.4
	0.5	57.8	57.8	91.0
	0.9	49.0	49.0	91.0

Table 3. Efficiency levels (%) in one-shot games $\forall\beta$.

Table 3 can be considered a composition of the two tables in Table 1. Indeed, for specific levels of α and c chosen as reference points, NE can be chosen for $\alpha = 0.9$ and $c = \{0.5, 0.9\}$, and E otherwise. From the table we can infer that efficiency noticeably drops for medium/large values of c and medium/low values of α, as Lemma 4 warned. In general, these results simply predict that a one-shot game tends to be more efficient as c decreases and/or α increases. Especially, the adoption of NE due to widespread fairness, and the consequential reduction in asymmetric information, tends to considerably improve efficiency levels.

In Table 3 we have described $\eta_{OS|\alpha,c}$; we now want to specify in Table 4 some reference values for β to find $\eta_{OS|\alpha,c,\beta}$.

		α								
		case $\beta = 0.1$			case $\beta = 1$			case $\beta = 1.9$		
		0.1	**0.5**	**0.9**	**0.1**	**0.5**	**0.9**	**0.1**	**0.5**	**0.9**
c	**0.1**	99.50	99.50	99.50	90.91	90.91	90.91	16.35	16.35	16.35
	0.5	97.89	97.89	99.97	66.67	66.67	99.00	0.05	0.05	39.17
	0.9	96.68	96.68	99.97	52.63	52.63	99.00	0.001	0.001	39.17

Table 4. Punctual efficiency levels (%) of one-shot games equilibria for β={0.1,1.0,1.9}.

For decreasing returns to scale, efficiency is particularly high and close to 100% for any combination of (α, c). For constant returns to scale, efficiency is still high and larger than 90% only for either low levels of c or high levels of α, and significantly decreases otherwise. Finally, for increasing returns to scale efficiency collapses very close to 0, unless c is very small and/or α is very large; which, however, only allows for efficiency levels below 50%.

As already mentioned, players choose according to their own utility functions, which may be at odds with the social welfare function. This yields the result that even if β does not play any role for the existence of the equilibrium in NE in the one-shot game, it does play a crucial role in measuring how efficient an equilibrium is. Regardless of the contract chosen in one-shot games, both contracts suffer severely from efficiency losses for increasing returns to scale, especially when returns to scale are highly increasing. Thus, if very valuable transactions arise sporadically, without the chance to acquire reputation, that is in a one-shot fashion, then a centralized solution may be desirable in order not to waste social surplus.

5.2 Repeated game

Once we move to a dynamic setting, such as the repeated game with finite periods, we want to understand how strategic reputation impacts on efficiency. We can actually appreciate a certain increase in the efficiency levels, obtained through the implementation of FB in a variable number of periods in some regions of the surface (α, β, c). The overall efficiency level of the multiple equilibria in the space $(\alpha \times \beta \times c)$ in repeated games, η_{RG}, is described by the ratio of its welfare function (W_{RG}) and the welfare function of the equilibrium in which parties would trade in FB in every period (W_{FB}):[28]

$$\eta_{RG} = \int_{\alpha=0}^{1}\int_{c=0}^{1}\int_{\beta=0}^{2} \frac{W_{RG}}{W_{FB}} \cdot 100 = \left\{ \begin{array}{c} 70.71\% \text{ if } T = 10 \\ 71.86\% \text{ if } T = 100 \\ 72.98\% \text{ if } T = 1000 \end{array} \right\}$$

The simulation shows that as T increases, efficiency increases accordingly. We have shown that for a given triple (α, β, c) as $\alpha > \overline{\alpha}$, an increase in T brings about a relatively larger number of FB with respect to NE, thereby increasing the average social surplus, and consequently the efficiency levels of the repeated game setting. However, as we may notice, apparently the increase in efficiency does not seem very sensitive to an increase in T: interactions must get very large in order to achieve an increase in efficiency levels for the entire setting of about 2 percentage points.

Getting into more details, as done in the previous tables, we will show in Table 5 the efficiency levels of this setting for the entire range of β and in Table 6 the punctual efficiency levels, by evaluating efficiency also as T increases. Note that, apart from $\alpha = 0.9$ and $c = \{0.5, 0.9\}$ where non-enforceable contracts are applied, the efficiency levels in repeated games are the same as in the one-shot game.

		α				
				0.9		
		0.1	**0.5**	T=10	T=100	T=1000
c	**0.1**	80.4	80.4	80.4	80.4	80.4
	0.5	57.8	57.8	92.3	94.5	96.4
	0.9	49.0	49.0	92.4	94.5	96.4

Table 5. Efficiency levels (%) in repeated games $\forall\beta$.

[28] W_{RG} is calculated by assuming the NE maximizing principals' utility; therefore, W_{RG} corresponds to the maximum social welfare achievable when NE is chosen in one or more periods.

			α				
					0.9		
			0.1	**0.5**	T=10	T=100	T=1000
case $\beta = 0.1$	c	**0.1**	99.50	99.50	99.50	99.50	99.50
		0.5	97.89	97.89	99.997	99.9997	≈100
		0.9	96.68	96.68	99.997	99.9997	≈100
case $\beta = 1$	c	**0.1**	90.91	90.91	90.91	90.91	90.91
		0.5	66.67	66.67	99.90	99.99	99.999
		0.9	52.63	52.63	99.90	99.99	99.999
case $\beta = 1.9$	c	**0.1**	16.35	16.35	16.35	16.35	16.35
		0.5	0.05	0.05	39.17	39.17	92.52
		0.9	0.001	0.001	39.17	39.17	92.58

Table 6. Punctual efficiency levels (%) of repeated games equilibria for β={0.1,1.0,1.9}.

From the above tables we can now better understand where the improvements of η_{RG} with respect to η_{OS} come from. The inefficiencies of high-powered technologies in one-shot games both without and with contractual choice can be considerably reduced by reputation in a repeated setting. Indeed, important efficiency gains can be appreciated when informal agreements are clinched (i.e., $\alpha = 0.9$ and $c = \{0.5, 0.9\}$) and reputation in first-best becomes effective (i.e., high T) for very valuable transactions (i.e., $\beta = 1.9$). In all other circumstances, gains from more numerous interactions are trivial. Consider the following triple ($\alpha = 0.9, \beta = 1.9, c = 0.5$): the difference in efficiency levels between $T = 1,000$ and $T = 100$ is substantial. However, with the same triple there is no difference between $T = 10$ and $T = 100$, meaning that the number of interactions are not enough to implement equilibria with some FB during the first interactions, and only NE can be implemented leaving the same efficiency levels regardless of T below a certain threshold. This means that, only beyond a certain number of interactions, acquiring reputation in first-best becomes viable for S because it turns acceptable as riskless for the agent. In other words, *good* reputation can be acquired and granted only if T exceeds a certain threshold, yielding efficiency gains compensating the waste of efficiency characterizing the one-shot game and its second-best equilibrium. If T is not high enough, reputation does not play any role.

Thus, a policy-maker should set all possible conditions to make reputation an available option through repeated interactions when the underlying contract includes valuable transactions. While we move to an unfair environment, repeated interactions cannot release their efficiency gains because enforceable contracts will be implemented, so that acquiring reputation has no relevance.

6 Conclusion

We have provided a simple model examining the choice between enforceable and non-enforceable contracts when, on the one hand, drafting enforceable contracts is costly and, on the other hand, fulfilling a non-enforceable contract is left to parties' fairness. We find that the choice between enforceable and non-enforceable contracts in equilibrium depends on two variables: the enforcement costs and the fairness level. Results hold in both a one-shot game and in a finitely repeated game, independently on the number of interactions, meaning that reputation does not affect the choice on the type of contract to be implemented. A third variable, which we refer to as the value-enhancing technology adopted, and reflecting the return to scale of the agent's effort, does not influence the choice between enforceable and non-enforceable contracts in equilibrium, but is crucial in terms of efficiency.

In general, contracts are fully efficient if enforceable at no cost or if they consist of gentlemen's agreements between fair parties. If none of these conditions hold, then every contract can only assure a second-best outcome and consequently suffers from loss of efficiency. The crucial question is how far from the first-best the equilibrium outcome is. Through mathematical simulations and graphical representations we have been able to answer to this question by evaluating accurately the efficiency levels of all equilibria as a percentage of the first-best solution achievable by a centralized choice.

First, we find that as the two contracts are taken separately, in other words with no regard to the choice about which one to apply, both severely suffer from efficiency losses in valuable transactions. *Second*, while we give the chance to individuals to choose which of the two contracts to implement if they face each other only once, that is with no regard to reputation, overall efficiency improves of about 10 percentage points, and it is particularly noticeable that social welfare tends to be higher when non-enforceable contracts are implemented in equilibrium due to a widespread fairness. However, also one-shot games severely suffer from efficiency losses for increasing returns to scale, especially when returns to scale are highly increasing. This would suggest that in sporadic and valuable transactions, enforcement costs and asymmetric information over individuals' fairness should be considerably reduced in order to capture maximal social surpluses. *Third*, reputation through repeated interactions would help further to improve overall efficiency. The improvement is primarily achieved in the region of increasing returns to scale, in which reputation granted by widespread fairness and longer interactions reduce the efficiency losses experienced in one-shot games, but only for a very large number of interactions. Indeed, only beyond a certain threshold, the number of interactions makes reputation working. Thus, when principals cannot credibly acquire reputation, repeated interactions cannot release their efficiency gains because only second-best contracts can reasonably be implemented. In the last circumstance, policy makers should focus their action towards a reduction in enforcement costs or, otherwise, by spreading fair-mindedness.

In sum, the impact of both the enforcement costs and the fairness level on efficiency is crucially conditioned by technology. Regardless of the contract chosen and for every combination of α and c, low-powered technologies sustain effort levels and allow for efficiency levels in equilibrium that are very close to the first-best solution, thereby making fairness almost irrelevant. Whereas high-powered technologies cannot exploit first-best effort levels and push efficiency down to very low levels which could be contrasted only by high levels of fairness - becoming now relevant - coupled with long-term reputation.

These results may re-open an old debate referring to whether a centralized public solution has to be preferred to free exchange in order to maximize social welfare. The generally accepted solution of public intervention suggests that the social planner should intervene when private contracting can not assure an efficient outcome. In our model, this is particularly the case in the presence of increasing returns to scale. We can conclude that, independently on enforcement costs and fairness levels, low-rate technology transactions should be left to parties' freedom, whereas high-rate technology transactions should be regulated. Reputation can overcome regulatory practices only for long-term interactions and with an already widespread trustworthy contractual environment due to significant levels of fairness.

The model we present can be subject to further development. For example, different types of agents could be introduced if effort were not freely observable. Besides, we have considered two types of principals: fair *vs.* selfish. A possible extension could allow for a continuum of individual types, taking into account the degree of fairness, so as to evaluate how crucial the role of fairness and its intensity are on contractual choice and efficiency levels**.** Finally, the psychological impact can be modelled so as to capture the extent of fair behavior, which may be considered limited in monetary terms, describing a sort of limitation to human generosity.

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