Binding and Non-Binding Contracts: A Theoretical Appraisal

D'Agostino, Elena and Lisciandra, Maurizio

University of Messina

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Elena D'Agostino[2]

University of Messina

Maurizio Lisciandra[3]

University of Messina

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[2]University of Messina. Department of Economics, Business, Environmental and Quantitative Methods (SEAM), Piazza Pugliatti 1, 98122 Messina, Italy. Email: edagostino@unime.it.

[3]University of Messina. Department of Economics, Business, Environmental and Quantitative Methods (SEAM), Piazza Pugliatti 1, 98122 Messina, Italy. Corresponding author, email: mlisciandra@unime.it.

Abstract

In a fully self-enforcing environment, individuals can execute market transactions exclusively on the basis of trust. However, the presence of individuals showing self-regarding preferences causes serious impediments to the development and even the existence of market transactions. An enforcing legal system helps to control for the lack of trust existing in every modern society. The article provides a theoretical investigation accompanied by a numerical simulation of the impact of the introduction of a costly legal system that makes contracts binding. Therefore, it investigates the choice between legally binding contracts, which are costly to verify and enforce, and non-binding contracts, which simply rely on trust, in both one-shot and repeated interactions. We find that a legal system protecting property rights mainly produces benefits when effort is particularly valuable. In the other circumstances, the benefits are marginal. A subset of parameters also exists in which the legal system is detrimental. This is especially the case of standardized production. Finally, reputation unleashes its welfare-enhancing properties when effort is very valuable, otherwise the benefits are trivial.

Keywords: contract choice; trust; contract enforceability; reputation; incomplete contracts.

JEL: C70; D02; D03; D86; K12.

1 Introduction

Contract law textbooks usually suggest that if the parties are gentlemen, contracts could simply be finalized by a handshake. These contracts rely on the honorability and honesty of the counterparties, which give rise to trust as an enforcement mechanism.[1] In the words of Arrow (1974), trust is indeed an important lubricant of the social system. Nevertheless, according to a saying recalled by Grosheide (1998: 91), "honor does not belong to the province of civil law" and some individuals can act strategically and decide whether to fulfill or to breach an agreement if it is legally non-binding. Therefore, we can generally distinguish two types of individuals: one type showing "emotional" preferences and precommitting to behave honestly; another type acting without precommitment according to self-regarding preferences and representing a serious setback to self-enforceability and even to the emergence of markets.[2]

One of the main purposes of a legal system is to provide alternative devices to solve the crucial problem of contract enforcement. As highlighted by Bolton and Dewatripont (2005), without legal institutions to enforce contracts, trade may turn out to be inefficient if rational individuals do not trust their counterparty to carry out the agreed transaction. However, contracts are often difficult to enforce, regardless of the object of the transaction. The main reason is that contracts are usually incomplete, making it very costly for parties to invest in enforcement by legal means (Spier, 1992; Irlenbusch, 2006). Examples are easy to find in agricultural contracts, family law, house maintenance services, and international contracts. Institutions are mainly responsible for this difficulty due to the problems related to third-party verification of the terms of the con-

[1] The rationale for honest behavior is referred to in different strands of the literature. For instance, guilt aversion (Charness and Dufwenberg, 2006; Battigalli and Dufwenberg, 2007) or lying aversion (Gneezy, 2005; Lundquist *et al.*, 2009) helps to explain honest behavior in unenforceable economic transactions.

[2] See, for instance, the experimental work of Fehr *et al.* (1997), in which social preferences, if able to be disclosed, produce efficiency gains and increase the size and extent of trade.

tract and the enforcement costs in courts (Boehm, 2013; Cappelen *et al.*, 2014). Reputation effects have also been considered in the literature (MacLeod and Malcomson, 1989; Klein and Murphy, 1997; Baker *et al.*, 2002) as the main (and possibly cheapest) way to solve the problem of contract enforceability without incurring any legal/institutional costs.

Given this background, in this paper, we provide further insights into the following issues. Legal institutions, especially courts of law, regulate property rights and allow for legally binding contracts. However, as argued, these tasks are carried out at a cost *vis-à-vis* a fully self-enforcing environment in which individuals can costlessly execute market transactions exclusively on the basis of trust. We therefore want to compare the impact on social welfare of an enforcing legal system in which individuals can choose between binding contracts, which are enforceable at a cost, and non-binding contracts, which are only self-enforceable, with that in a setting in which an enforcing legal system is absent and individuals can only adopt non-binding contracts. The main research questions in this respect are the following. How much do we gain in terms of social surplus when we introduce a legal system with its enforcement schemes so that individuals can choose whether to use it or otherwise to adopt non-binding contracts and rely on trust? What drives the choice, when possible, between binding and non-binding contracts? What is the role of reputation when individuals face this choice? To answer these questions, first we need to investigate the equilibrium conditions of the choice between legally binding and costly contracts and non-binding contracts in both one-shot and repeated games. Then, we provide an estimate through numerical simulations of the efficiency in terms of social welfare achieved with respect to the putative first-best contract of a setting in which only non-binding (self-enforceable) contracts exist.[3] Finally, we

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

estimate the efficiency achieved when individuals are confronted with the choice between binding and non-binding contracts.

Our main findings are the following. A legal system protecting property rights produces mainly benefits. These benefits can be measured carefully through our numerical simulations given our assumptions. As expected, large benefits can be achieved when enforcement is not very costly in an untrustworthy environment. Important gains from trade can especially be achieved in high-quality production, timely deliveries, etc. and in all circumstances in which effort productivity is important. In this case, widespread honesty is not a sufficient enforcement device and, therefore, an enforcing legal system may be socially desirable. However, a legal system can also be detrimental with respect to a fully self-enforcing environment. This occurs for a subset of parameters, especially for standardized production. Finally, reputation has welfare-enhancing properties when effort is very valuable, whereas the benefits are trivial for standardized production.

This paper relates to two important strands of theoretical literature: principal-agent models and signaling theory. Consider a set-up with an enforcing legal system. We propose a principal-agent model in which the two parties enter a transaction in which the principal is the contract designer and has to decide whether to propose a binding or a non-binding contract. The agent decides whether to accept or reject the offer. If the agent rejects it, the game ends. If the agent accepts it, then he provides the service required and waits for the principal to pay the expected price for the service, which is observable at no cost. We refer to a contract as binding when one of the two parties (the principal) bears ex ante some costs that make the terms of the agreement legally verifiable in front of an impartial third party (e.g., a court of law), so that the principal has to honor the contract and pay the price whenever the observed service corresponds to that originally required. We refer to a contract as non-binding when the terms of the contract remain unverifiable and therefore unenforceable or when ex post verifiability is too costly and thus unavailable. Accordingly, honesty, and consequently trust, will necessarily play a role. The principal decides whether or not to fulfill the agreement according to her type: an honest principal will always fulfill it, whereas a purely self-interested principal will not, unless it is strategically convenient for her reputation.

In the modern principal-agent literature, emotional or social preferences have assumed increasing relevance. In the binding contract, emotional or social preferences cannot be disclosed due to the full completeness of the contract. On the contrary, this type of preferences are relevant to the non-binding contract due to its incomplete nature. In general, we can distinguish between one-sided reciprocity, or one-sided giving, and two-sided reciprocity, or more simply reciprocity. In one-sided giving, one party shares with another party without consideration of the other party's sharing behavior, whereas reciprocal behavior is generally the tendency to reciprocate kind acts with kindness and unkind acts with spite.[4] Our case can be assimilated to the first category. Both principal and agent can show emotional preferences, although agents cannot disclose their emotional preferences because they cannot reciprocate the principal's acts. The set-up of the model implies that the agent simply fulfills the required duty by delivering exactly the required effort once he enters the transaction.[5] The principal then decides whether to honor the contract according to his propensity for honesty. In a way, the principal rewards the agent's trust, not his pro-social behavior, and more realistically the principal acts to adhere to social or moral norms. The role of emotional behavior as a contract enforcement device has

[4]Regarding one-sided reciprocity, see Fehr *et al.* (1997); concerning two-sided reciprocity, see Fehr and Schmidt (2007). For a comparison between one-sided and two-sided reciprocity, see Malmendier *et al.* (2013).

[5]The principal can perfectly observe the agent's effort at no cost, so that the agent cannot "cheat."

been investigated theoretically and experimentally by many influential economists.[6] For the purpose of this paper, we are not interested in the driving forces behind behaving fairly and honestly to fulfill non-binding contracts. We simply assume that a share of individuals precommit to behaving honestly, meaning that they do not consider breaching an agreement as a feasible strategy.

The principal's type is private information. Initially, signaling theory produced models with agents holding private information (for instance Spence, 1973). Later, several important papers, starting with Myerson (1983), reversed the asymmetric information in favor of principals. Maskin and Tirole (1990) also showed that an "informed principal" can easily be found in real market transactions (e.g., franchising agreements). Cases may also occur in which a principal has full bargaining power against an agent in the supply of goods or services, such as outsourcing contracts in which a large firm exploits its contracting power and makes a take-it-or-leave-it offer to a small firm, which is only required to satisfy a participation constraint. In our informed principal set-up, the principal's choice regarding the contract to propose can be interpreted as a signal of the principal's type, regardless of the nature of the transaction. It corresponds to the intention to fulfill or renege on a non-binding promise and confirms the classical view in economics, initiated by the seminal paper by Crawford and Sobel (1982), that non-binding contracts are nothing but cheap talk. Honest principals would like to signal and separate themselves in equilibrium in order to be "recognized" by the agent. However, contrary to many signaling games (see for instance Cho and Kreps, 1987), whenever a non-binding contract is proposed in equilibrium, the agent is not able to recognize the principal's type and, therefore, no separating equilibrium exists. This depends on the structure of preferences that induces selfish principals always to mimic honest principals.

[6] Just to cite a few authors, see Akerlof (1982), Geanakoplos *et al.* (1989), Rabin (1993), and Fehr *et al.* (1997). For an extensive overview of the topic, see Fehr and Schmidt (2003).

A similar conclusion arises even when allowing parties to trade repeatedly.

The paper is organized as follows. The next section provides the general specification of the model. Sections 3 and 4 present the results for the one-shot game and for the repeated game, respectively, when an enforcing legal system allows for a choice between binding and non-binding contracts. Section 5 describes the welfare comparisons between the social optimum and various types of decentralized solutions. Finally, Section 6 discusses the main results and concludes the paper.

2 The model

In the following principal-agent model, a risk-neutral principal (P) (she) asks a risk-neutral agent (A) (he) to provide a service requiring a positive effort level (e) in exchange for a positive price (p). P makes a take-it-or-leave-it offer (e, p) to A, who decides whether to accept or reject the offer.[7] If A rejects the offer, the game ends; if A accepts the offer, he provides an effort level $\tilde{e}$ and waits for P to pay the promised price. P observes $\tilde{e}$ at no cost.[8] Thus, no moral hazard exists. P can choose between an unenforceable or non-binding (NB) contract and a binding (B) contract. Potential punishment threats are not included in the model as enforcement mechanisms.

The terms of an NB contract (e^{NB}, p^{NB}) are *not* verifiable and *not* enforceable by a court of law. Thus, in case of a breach of the contract, the law does not provide a remedy because of the absence of an enforcing legal system *tout court*.

[7] As in Fehr *et al.* (1997), we consider a very competitive market of services supplied by numerous agents. This allows principals to have strong bargaining power and offer contracts with expected zero rents for the agents.

[8] The assumption of perfect observability of the agent's effort makes trust unilateral: the agent has to decide whether or not the principal deserves trust. The perfect observability of effort can also be found in Gächter and Falk (2002), Charness and Dufwenberg (2006), and Fehr and Schmidt (2007). When effort is not perfectly observable, as in MacLeod and Malcomson (1989), the principal can solicit the agent's fairness to provide high effort levels through generous bonuses. In this case, trust becomes bilateral.

We can also suppose that the contract is far too costly either to enforce ex post in front of a court of law or to verify ex post by an independent third party. Therefore, the NB contract can be considered as a gentlemen's agreement in which P promises p^{NB} in exchange for e^{NB}. If A accepts the agreement and delivers the required effort level (i.e., $\tilde{e} = e^{NB}$), then P is free to fulfill or renege on her promise to pay the price p^{NB}. In this context, A appeals to the honesty of P to recompense the placed trust.

The terms of a B contract (e^B, p^B) are verifiable and enforceable by a court of law, making it legally binding. Nevertheless, making the contract fully binding ex ante has a cost, which is calculated as a fraction of the price, cp^B, with $c \in (0, 1)$. Thus, if A accepts a B contract and delivers the required effort level (i.e., $\tilde{e} = e^B$), he can enforce the payment of p^B. For example, consider the following contractual pre-commitment. P deposits in advance p^B to a third party (e.g., a bank) with a written and fully verifiable contract, in which, if A fulfills his duties by supplying e^B, the third party is committed to making this money readily available to A. This also justifies the proportionality of the fee with respect to the value of transaction p^B.[9] However, c may be interpreted in many ways. An inefficient legal system, which can also be caused by bad politics, raises the costs of verifiability and enforceability. We may expect that countries with evolved legal systems with low transaction costs, reduced corruption, and an efficient judiciary can provide lower costs of verifiability and enforceability.

We assume that P is randomly drawn from a population of individuals who can be either honest (H) or selfish (S). S acts strategically and only cares about her monetary utility, whereas H precommits to fulfilling the contract even if it is unenforceable by third parties. The principal's type is private information, but the share of honest individuals, $\alpha \in (0, 1)$, is common knowledge. Therefore, this model is characterized by a two-type, two-action signaling game in which P is

[9] Along these lines, cp^B can also be seen in terms of the foregone interests.

the sender and A the receiver: since the principal's type is private information, the contract proposal is a potential signal about her type. As it stands, the distinction in the model between H and S arises only in the NB contracts. Several explanations can be given for a principal being of the H-type. For instance, H-type individuals can be guilt-averse if they do not live up to the terms of the contract or do not follow some social norms of honesty.[10] Thus, we assume that breaking a promise or exploiting another person's trust implies a considerable psychic cost (f) that induces the H-type individuals to fulfill their obligation (Gürtler, 2008). Concerning the agents, since effort is observable at no cost, no A can cheat on his effort level; therefore, distinguishing between honest and selfish agents is meaningless. Thus, to simplify the notation, H and S will apply only to principals.

Regardless of the contract offered, we assume that P, independently of her type, never pays A if she observes $\tilde{e} \neq \{e^B, e^{NB}\}$. This can be justified using the Roman words *inadimplenti non est adimplendum*, meaning that an individual is not obliged to respect his or her obligation if the counterpart has not respected his or her own.[11]

P's revenue from A's performance is described by the production function $y(e) = e^{\beta}$, where $\beta \in (0, 2)$ is exogenous and measures the marginal returns to effort.[12] Its value is common knowledge. This is mainly a technological parameter, but it can also be subjective. For example, suppose that your TV is broken, your favorite program is about to start, and you call for a repair service. If you have other TVs, your β can be relatively small, but if you have

[10] With regard to guilt aversion in promises, see Charness and Dufwenberg (2006), and Battigalli and Dufwenberg (2007). In relation to preferences including further moral considerations, see Camerer (2003) and Konow (2003).

[11] Since effort is perfectly observable, P does not need to appeal to the agent's reciprocal behavior. Therefore, contrary to Fehr *et al.* (2007), we exclude any additional reward or bonus to be paid to the agent that differs from the promised price.

[12] $\beta \geq 2$ would cause negative or infinite utility to principals. If $\beta < 1$, the production function shows decreasing returns to effort; if $\beta = 1$, the returns are constant; and if $\beta > 1$, the returns are increasing.

only one TV, your β can be very high. In general, β is high when effort is very valuable, such as for goods/services with strict time delivery, high-quality goods/services, and highly demanding markets with strong competitors and discerning customers. On the contrary, β is low for standardized goods and in all cases in which effort is not very valuable. Finally, we assume that the agent's cost of providing a given effort e follows a standard cost function $k(e) = \frac{1}{2}e^2$.[13]

If an NB contract is offered, the utility functions are as follows:

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

For simplicity, we consider $f = 0$ if the principal is S-type, and $f = \infty$ if she is H-type.[14] Thus, $U_P^{NB} = U_H^{NB} = U_S^{NB}$, whereas if $\tilde{e} = e^{NB}$, then $U_S^{\overline{NB}} = y(e^{NB})$ and $U_H^{\overline{NB}} = -\infty$.

If a B contract is offered, the utility functions are as follows:

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

In sum, the timing of the game consists of three stages. In stage 1, P observes her own type, and decides whether to offer a B or an NB contract to A according to the levels of α, β, and c. In stage 2, A decides whether to

[13] For similar specifications of the cost of effort function, see Milgrom and Roberts (1992), Schaefer (1998), Azar (2007), and Gürtler (2008), among others.

[14] As described by Sacconi and Grimalda (2007), individuals, such as the H-type principals here, are not motivated necessarily by the personal value attached to the outcomes of their actions, but rather by the fact that these actions satisfy some social norms.

accept or reject the offer. If A rejects the offer, the game ends and both players obtain zero; otherwise, A decides on the effort level to provide and waits for the payment. In stage 3, if the contract is binding and $\tilde{e} = e^B$, P pays p^B, whereas, if the contract is non-binding and $\tilde{e} = e^{NB}$, P decides whether or not to pay p^{NB} according to her type.

Players are matched randomly and interact only once in a one-shot game. Below, this hypothesis will be relaxed to allow for finitely repeated interactions. We solve both games by searching for perfect Bayesian equilibria. The following proposition introduces some equilibrium properties that hold in both games.

Proposition 1 *(a) Rejecting the principal's offer ($\tilde{e} = 0$) strictly dominates the delivery of an effort level $\tilde{e} \neq \left\{e^B, e^{NB}\right\}$.*

(b) No separating equilibrium exists.

(c) Deviating to an NB contract is never profitable.

Proof. See the Appendix.

Part (a) implies that A either delivers the requested effort or does not accept the offer. For instance, providing levels of effort that are higher than e^B or e^{NB} - in accordance with the contract accepted - is simply not rewarding for A, because no P experiences a positive psychological impact that would reciprocate this behavior. As mentioned above, the H-type behavior is intended only in terms of fulfilling the promise and no incentive effect will occur as in (two-sided) reciprocity models. Part (b) implies that only pooling equilibria can exist. Offering an NB contract is more convenient to S than to H, since S will not pay the price and will not experience any psychological cost in reneging on the promise. Thus, whenever H prefers to offer an NB contract, S has the same incentive and must mimic H to make A accept the offer. Finally, part (c) implies that to prove the existence of a given equilibrium it is sufficient to prove that the parties cannot profitably deviate to any B contract.

3 One-shot game

Proposition 2 *In a one-shot game, there exists an equilibrium in which P offers a B contract, which A 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 H and S offer an NB contract that A accepts.*

Proof. See the Appendix.

The results predict that an NB contract may arise in equilibrium as the probability α of facing an honest principal increases and/or the enforcement costs c increase.[15] In this case, multiple equilibria arise in NB contracts, with A always obtaining zero and P obtaining positive payoffs. Unfortunately, we cannot reduce the number of equilibria by applying standard refinements, such as the Intuitive Criterion or the Divinity Criterion, because for any given equilibrium, A cannot exclude that a deviation to another equilibrium comes from one type of principal only.[16] Both H-type and S-type principals share the same preferences for the agent's beliefs (i.e., while trading, both types prefer A to believe that he is trading with an H-type) and for the equilibrium contracts. This implies that when one type strictly prefers one equilibrium to another, the other type holds the same order of preferences. As a consequence, given two equilibria in the class of NB contracts, NB_1 and NB_2, if H has an incentive to deviate from NB_1 to NB_2, the same must hold for S. The same reasoning applies to any deviation from equilibria in B contracts to equilibria in NB contracts. In other words, whatever signal H sends, S always has an incentive to mimic and exploit the asymmetric information. The problem of multiple pooling equilibria is, however, of little relevance: since P chooses which contract to

[15] Similar results can be found in Berg *et al.* (1995), Fehr *et al.* (1997), and Fehr and Schmidt (2003).

[16] See Cho and Kreps (1987) for the Intuitive Criterion and Banks and Sobel (1987) for the Divinity Criterion.

propose, it is plausible that she will choose the maximizing contract. Hence, in the subsequent analysis, it will turn out to be reasonable as well as useful to consider exclusively the principal's profit-maximizing equilibrium. This helps to solve the repeated game with no loss of generality and does not affect the results for the subsequent welfare analysis.

4 Repeated game

Suppose the game is played repeatedly in a fixed matching for a finite number of periods T, in which the value is common knowledge. The discount factor is assumed to be equal to 1.[17] In each period, P decides whether to propose an NB or a B contract to A. If P proposes an NB contract and breaches it in period $t(< T)$, then A infers that she is an S-type, and he will therefore refuse any NB contract from this principal in the future, only accepting B contracts. Nevertheless, S may have the incentive to acquire strategic reputation for future transactions and consequently fulfill non-binding contracts. Thus, we observe that in a one-shot game, A bases his beliefs, and therefore decides how much trust to place in his counterpart, exclusively on the share of honest individuals (i.e., α). In the repeated game, A bases his beliefs on α and on the incentive for S to engage in reputation building.[18] S can acquire two levels of reputation. One level of reputation is such that S proposes and fulfills an NB contract, that is, S does not have an incentive to deviate to breaching the contract. This reputation is enough to sustain NB contracts and avoid the punishment for breaching, but it is not enough to affect A's beliefs. Thus, although A trusts any P proposing an NB contract, the contract is second-best and we can refer to it as a second-best reputation. A first-best reputation is such that S proposes

[17] Gürtler (2008), in a similar setting, considers a discount factor varying between 0 and 1.
[18] Of course, A's beliefs are also updated according to the history of the transactions.

and fulfills a first-best (FB) contract as if the agents' beliefs are such that $\alpha = 1$, that is as if A were to meet an H-type principal and no breach of the contract occurs.[19] If an FB contract is proposed in equilibrium, this must maximize P's utility.[20] Accordingly, in an FB equilibrium the utility functions are the following:

$$U_P^{FB} = U_S^{FB} = U_H^{FB} = \beta^{\frac{\beta}{2-\beta}} \left(1 - \frac{\beta}{2}\right) \text{ and } U_A^{FB} = 0.$$

Breaking the FB contract, which arises only off the equilibrium path, would yield the following utilities:

$$U_S^{\overline{FB}} = \beta^{\frac{\beta}{2-\beta}}, \, U_H^{\overline{FB}} = -\infty \text{ and } U_A^{FB} < 0.$$

Consider the following lemma:

Lemma 1 *(a) S always breaks any promise in the last period T.*

(b) If a B contract is chosen in equilibrium in the periods $t+1, ..., T$, then S always breaks any promise in period t.

Proof. See the Appendix.

This lemma implies that A considers the last period T or the period before applying the B contract as a one-shot game. In particular, part (a) implies that no equilibrium exists, in which the FB contract is offered in period T. Consequently, in period T only NB or B contracts can be offered, with S breaching the NB contract as in the one-shot game. Part (b) implies that no equilibrium exists in which the FB contract is offered in periods $1, ..., t$ and a

[19] Seen differently but achieving the same result is the case in which no enforcement costs could occur (i.e., $c = 0$).

[20] Suppose that a non-maximizing FB contract is proposed in equilibrium in a certain period $t < T$. A is sure to be paid because any P would fulfill the contract. Nevertheless, P can profitably deviate to offering the profit-maximizing FB contract, which A would be willing to accept.

B contract is offered thereafter. This marks an important difference from the NB contract. The FB contract can be offered and accepted only if A is sure about its fulfillment.

Proposition 3 *In a repeated game,*

(a) There is an equilibrium in which the B contract 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 exist $T-1$ classes of equilibria, in which the FB contract applies in the periods $1, ..., t^*$, with $t^* \leq T-1$, and an NB contract thereafter, which S always honors except in period T.

(c) If $\underline{\alpha} < \alpha \leq \overline{\alpha}$, there also exists a class of equilibria, in which an NB contract applies in each period, which S always honors except in period T.

Proof. See the Appendix.

Equilibrium multiplicity also affects repeated games, as highlighted by Fudenberg and Maskin (1986). Multiple equilibria cannot be reduced by using standard refinements, but as in the one-shot game, it is plausible to assume profit-maximizing principals and sketch some general considerations about the effects of reputation on parties' behavior and welfare.

As in the one-shot game, $\forall \alpha < 1/2$ and $\forall c \in (0, 1)$, the equilibrium is a B contract in each period. This shows that reputation is not enough to fill the lack of trust generated by low levels of α. In other words, a threshold level of α exists below which reputation cannot induce the adoption of NB contracts. In our model, this threshold requires at least the majority of players to be honest (i.e., $\underline{\alpha}$), and it depends on the enforcement costs existing in the legal system and for that specific transaction.

Proposition 3 implies a result that is coherent with the reputational effects provided by repeated interactions: the FB contract can be implemented even if $\alpha < 1$. As mentioned above, in repeated games, A's trust in the counterpart depends on α and on the incentive for S to acquire strategic reputation for future transactions. If this incentive is very strong, strategic reputation can trigger FB contracts. The incentive to acquire a first-best reputation is higher the lower are the gains from reneging on FB contracts, and as the repeated games approach the final period T, this incentive decreases and only a second-best reputation can be spent in front of A. The first-best reputation depends on the main variables at stake. It is easy to check their impact on $\overline{\alpha}$ and t^*.[21] In particular, as the share of honest individuals decreases, FB contracts become less sustainable over time and give way to NB contracts ($\frac{\partial t^*}{\partial \alpha} > 0$, $\frac{\partial \overline{\alpha}}{\partial \alpha} = 0$). Eventually, the strategic reputation may not be sufficient to fill the lack of trust generated by low levels of honesty (i.e., $\alpha \leq \underline{\alpha}$) to make informal agreements work. Increasing enforcement costs reduce the convenience of offering B contracts. This induces S-type principals to invest more in reputation ($\frac{\partial t^*}{\partial c} > 0$, $\frac{\partial \overline{\alpha}}{\partial c} < 0$). Interestingly, if honesty is not widespread or the legal system is particularly efficient (by keeping c at low levels) such that $\alpha \leq \underline{\alpha}$, the strategic reputation plays no role because only B contracts would be used. *Ceteris paribus*, honesty feeds strategic reputation, but there must be sufficient honest individuals in the population (such that $\alpha > \underline{\alpha}$) to release the positive effects of the strategic reputation on the trust levels.

The variable β, measuring the marginal returns to effort, also has an impact on reputation ($\frac{\partial t^*}{\partial \beta} < 0$, $\frac{\partial \overline{\alpha}}{\partial \beta} > 0$). As β increases, second-best non-binding con-

[21] Consider the lower endpoint of condition (9) in the proof of Proposition 3 and solve 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 reach its maximum, that is, $T - 1$.

tracts expand at the expense of FB contracts.[22] On the contrary, as β decreases, a first-best reputation is more easily sustainable. This result can be interpreted in the following way. High levels of β refer to production functions in which effort is very valuable, for example, in terms of quality of production, timely delivery, etc. The required effort is, therefore, very high and so is its remuneration. This situation increases the incentive for S to break the FB contract due to the increasing gains to be achieved from reneging (i.e., $\frac{\partial(U_S^{\overline{FB}} - U_S^{FB})}{\partial \beta} > 0$). However, an increasing share of honest individuals in the society can contrast this negative effect. Thus, honesty becomes crucial to trigger high effort levels when effort is very valuable.

As regards the number of interactions T, its increase implies a higher t^*, which, as it stands, is not especially informative. Nevertheless, since $\frac{\partial(\frac{t^*(T)}{T})}{\partial T} > 0$, as T increases, the number of FB contracts increases more than the number of NB contracts for a given triple (α, β, c). Further, consider that $\frac{\partial \overline{\alpha}}{\partial T} < 0$. Thus, as expected and as suggested by some influential literature (Gächter and Falk 2002, Brown *et al.* 2004), the more numerous the transactions, the more reputation will be acquired.

Finally, when P fulfills the NB contract, A raises a positive payoff. This is the cost for H-type principals of pooling equilibria, or read differently, the cost of the lack of good signals (see Proposition 1(b)). As a consequence, the agent's expected utility increases as t^* decreases and reaches its highest level in the equilibrium in which the NB contract applies each period. When information on individuals' type is rather uncertain, that is, when α is neither close to 0 (i.e., an untrustworthy P) nor close to 1 (i.e., a trustworthy P) the benefits of a second-best reputation are partly diverted to the agents. In this case, the less informed party receives a benefit from uncertainty, which is paid in total by the more informed party, who needs to acquire reputation in repeated games.

[22] Nevertheless, α must be at least higher than 1/2 to implement non-binding agreements.

5 Welfare analysis

In this section, we compare the welfare achieved by the private solution arising from a decentralized choice with that of the public solution, in which the production is centralized and all the players follow the instructions of a central planner. We proceed in the following way. First, we assess the environment in which a one-shot transaction relies exclusively on the trust level existing in a society, in which an enforcing legal system does not exist and only NB contracts can be applied. Second, we introduce a legal system with its enforcement schemes so that individuals have the choice of whether to use it or otherwise rely on trust, as described in the previous sections through the choice between costly B contracts and NB contracts. Third, we add the repeated interactions, as shown in section 4, to assess the impact of strategic reputation on the levels of welfare.

The optimal public solution identifies the first-best social surplus that is achievable as if no enforcement cost and no asymmetric information could occur, whereby a social planner can impose the efficient effort level. The public solution corresponds to what we referred to in the previous section as an FB contract. We call W the welfare function identifying the social surplus. The first-best social surplus is:

$$W_{FB} = \beta^{\frac{\beta}{2-\beta}} \left(\frac{2-\beta}{2}\right).$$ [23]

This is the maximum achievable social surplus for any given β.

5.1 No enforcing legal system

Consider a transaction in which no legal system exists or is able to enforce the terms of the exchange. What we presented as an NB contract mirrors this

[23] The result follows from $\max_e \left\{e^{\beta} - \frac{1}{2}e^2\right\}$. Note that $\frac{\partial W_{FB}}{\partial \beta} > 0$ if $\beta > 1$.

situation exactly. The welfare function for NB contracts yields the following social surplus:

$$W_{NB} = (\alpha\beta)^{\frac{\beta}{2-\beta}} \left(\frac{2-\alpha\beta}{2}\right),^{24}$$

wherein W_{NB} is calculated in the profit-maximizing equilibrium.[25]

In the following, we measure the efficiency levels (η) achievable under a decentralized solution in terms of the distance between its social surplus and the first-best social surplus. Therefore, W_{NB} will be compared in percentage terms with W_{FB}. The comparison will be evaluated over the space $\alpha \times \beta =]0, 1[\times]0, 2[$ with each variable uniformly distributed. Trivially, η crucially depends on the values of α and β, as shown in Figure 1.

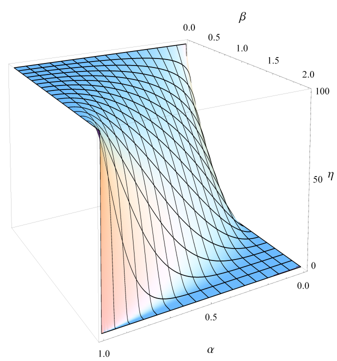


Figure 1. Efficiency levels in the absence of an enforcing legal system.

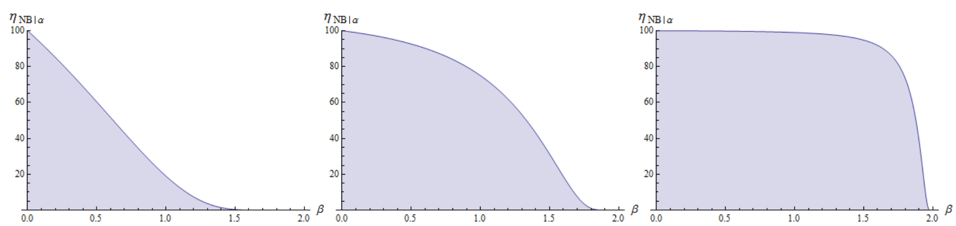
We find that the overall efficiency level in the absence of an enforcing legal system, calculated for the entire domain of the plane (α, β), is:

$$\eta_{NB} = 100 \cdot \int_{\alpha=0}^{1} \int_{\beta=0}^{2} \frac{1}{2} \frac{W_{NB}}{W_{FB}} d\alpha d\beta = 61.37\%.$$

[24] Note that $\frac{\partial W_{NB}}{\partial \alpha} > 0$, and $\frac{\partial W_{NB}}{\partial \beta} > 0$ if $\beta > \widehat{\beta}(\alpha) > 1$ with $\alpha > 1/2$.

[25] Since A obtains zero in the NB equilibria predicted in Propositions 2 and 3, it emerges that W_{NB}, which is calculated in the profit-maximizing equilibrium, is the highest social surplus achievable when an NB contract is offered.

This value implies that self-enforcing transactions waste, on average, slightly less than 40% of the surplus with respect to a putative equilibrium in first-best. In Figure 1, the overall efficiency level corresponds to the volume of the surface in the cuboid. We can also compute η_{NB} for given levels of α in the entire domain of β. Figure 2 presents the efficiency levels of W_{NB} conditioned for $\alpha = \{0.1, 0.5, 0.9\}$, corresponding to the sections of the surface in Figure 1.



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

Figure 2. Efficiency levels in the absence of an enforcing legal system for given levels of α.

We observe that, independently of the values of α, the loss in efficiency increases in β, but is compensated for by the positive impact of high levels of α. The visual impression of the figures above can be translated into numerical terms in the following table, which presents the efficiency function conditioned for both α and β.

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

Table 1. Efficiency levels (%) in the absence of an enforcing legal system.

Low levels of β (i.e., 0.1) allow for high levels of efficiency, even in the presence of low levels of α, whereas, high levels of β (i.e., 1.9) reduce efficiency even in the presence of high values of α. This means that self-enforcing transactions are not generally able to achieve high efficiency levels in the presence of increasing marginal returns to effort. In other words, when effort is highly valuable, a centralized solution considerably reduces the distortions occurring in incomplete contracting. As effort shows diminishing marginal returns, as we normally expect in common production functions, the private solution approaches the public solution.

5.2 One-shot game

As expected, the absence of a legal system, in which only unenforceable transactions can be clinched, generally yields serious inefficiencies for low levels of trust (i.e., low α). These inefficiencies are, however, attenuated for transactions in which effort is not valuable. In particular, if β is low, such as in standardized production, an enforcing legal system may not be very useful. For high levels of β, such as in high-quality production, timely deliveries, etc., an enforcing legal system may be socially desirable.

Consider the hypothetical introduction of an enforcing legal system, protecting property rights and allowing for verifiable and enforceable contracts. In these circumstances, individuals can decide whether to apply a B or an NB contract, as in sections 2 to 4. Assume that this option refers to a one-shot transaction. From proposition 2, the profit-maximizing equilibrium in the one-shot game (OS) contemplates the adoption of a B contract if $\alpha \leq \underline{\alpha}$ and an NB contract if $\alpha > \underline{\alpha}$. Accordingly, the welfare function of the one-shot game, W_{OS}, is the following

$$W_{OS} = \begin{array}{c} W_{NB} \text{ if } \alpha > \underline{\alpha} \\ W_B \text{ if } \alpha \leq \underline{\alpha} \end{array}, \text{ where } W_B = \left(\tfrac{\beta}{1+c}\right)^{\frac{\beta}{2-\beta}} \left(\tfrac{2-\beta}{2}\right).$$

First, we know that the choice between B contracts and NB contracts does not depend on β. This implies that for each couple of values (α, c), the efficiency levels are evaluated for the entire domain of β either in a B contract or in an NB contract, depending on the choice made in the OS setting. The overall efficiency level of the OS setting is:

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

This is a striking result if compared with η_{NB}, because it shows that introducing an enforcing legal system and, therefore, widening the contractual choice over transactions improves the overall efficiency by about 9 percentage points with respect to a transaction system that is exclusively based on trust.[26] Nonetheless, the one-shot game wastes on average slightly less than 30% of the potential social surplus achievable with a public solution.

Consider η_{OS} for specific values of α, c, and β, as shown in Table 2.

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

In Table 2, the NB contract is chosen, regardless of β, for $\alpha = 0.9$ and $c = \{0.5; 0.9\}$, and the B contract is chosen otherwise. Even if β does not play any role in the contractual choice, the level of β plays a role in the efficiency levels achieved by the chosen contract. For $\beta = 0.1$, the efficiency is particularly high and close to 100% for any combination of (α, c). For $\beta = 1$, the efficiency is

[26] To our knowledge, this is the first time that the benefits of the legal system are evaluated in terms of its efficiency.

still high and greater than 90%, for either low levels of c or high levels of α, and it significantly decreases otherwise. Finally, for $\beta = 1.9$, the efficiency collapses to values very close to 0; a reduction in c and/or an increase in α lessens this negative effect.

In more detail, by comparing Table 1 and Table 2 it is easy to check that the region where the B contract is chosen can be split into two further regions: one where the choice of the B contract is welfare-improving with respect to the NB contract and another where the NB contract outperforms the B contract in terms of social surplus (and thus in terms of efficiency), although the NB contract is not eventually chosen. In Table 2, the first region includes the cases of $\alpha = 0.1$, regardless of c and β; the cases of $\alpha = 0.5$ and $c = 0.1$, regardless of β; and the case $\alpha = 0.5$, $c = 0.5$, $\beta = 1.9$. The second region includes the remaining cases to which the NB contract does not apply. The following lemma defines the second region more rigorously.

Lemma 2 *If* $\alpha > \underline{\alpha}$ *then* $W_{OS}(= W_{NB}) \geq W_B$*. If* $\alpha \leq \underline{\alpha}$ *then there exist* $\hat{\alpha} = \alpha(c) > 0$ *and* $\hat{\beta} = \beta(\alpha, c) > 0$ *such that* $W_{OS}(= W_B) < W_{NB}$ *for* $\alpha > \hat{\alpha}$ *and* $\beta \leq \hat{\beta}$*.*

Proof. See the Appendix.

As seen above, in terms of efficiency, the gains from the first region are higher overall than the loss from the second region. The figure below depicts the second region, which is actually a surface.

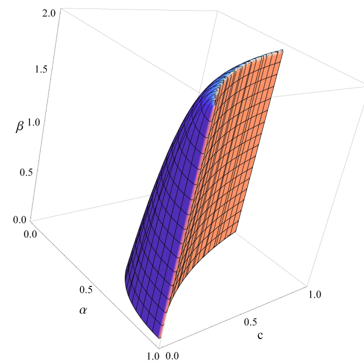


Figure 3. Surface with welfare-improving NB contracts as B contracts are chosen.

Lemma 2 and Figure 3 show that the region becomes smaller as β grows. We can conclude that, in a one-shot game, the introduction of an enforcing legal system, and the consequent freedom regarding which contract to choose, is detrimental to the social surplus for a level of α beyond a certain threshold, but below $\underline{\alpha}$, and especially for diminishing marginal returns to effort. On the contrary, the choice of binding agreements helps to improve the efficiency as the enforcement costs are kept low and honest behavior is not widespread. In addition, for high levels of β, a self-enforcing system of trade is highly inefficient, and the opportunity to appeal to a formal and protected exchange is welfare-improving and becomes socially desirable, especially if enforcement is not particularly costly.

5.3 Repeated game

In this section, we want to understand whether or not strategic reputation affects efficiency. The overall efficiency level of the multiple equilibria in the space $(\alpha \times \beta \times c \times T)$ in repeated games, η_{RG}, is described by the ratio of their welfare function (W_{RG}), comprising the sum of the social surpluses achieved in each period, and the welfare function of the equilibria in which parties would trade with FB contracts in every period (W_{RFB}):

$$\eta_{RG} = 100 \cdot \int\limits_{\alpha=0}^{1}\int\limits_{c=0}^{1}\int\limits_{\beta=0}^{2} \frac{1}{2}\frac{W_{RG}}{W_{RFB}} = \left\{ \begin{array}{c} 70.71\% \text{ if } T = 10 \\ 71.86\% \text{ if } T = 100 \\ 72.98\% \text{ if } T = 1000 \end{array} \right\}.^{27}$$

From the numerical simulations, we can appreciate a certain increase in the overall efficiency levels with respect to one-shot games. This is due to the transactions occurring with FB contracts if $\alpha > \overline{\alpha}$ (see Proposition 3). As expected, as T increases, the efficiency increases accordingly. We have shown above that, for a given triple (α, β, c) as $\alpha > \overline{\alpha}$, an increase in T brings about a relatively larger number of FB contracts with respect to NB contracts, which increases the average social surplus and, consequently, the overall efficiency levels of the repeated-game setting. Nevertheless, the increase in overall efficiency does not seem to be very sensitive to an increase in T: the interactions must become very large (e.g., from 10 to 1000) to achieve an increase in overall efficiency of about 2 percentage points.

Table 3 presents the efficiency levels. Note that changes in T can affect the efficiency levels only for the cases of $\alpha = 0.9$ and $c = \{0.5, 0.9\}$, regardless of β; that is, for $\alpha > \overline{\alpha}$, where NB and FB contracts apply. In all other cases, the efficiency levels do not change and are equal to those calculated for the one-shot setting. For these reasons, the table below displays the changes in T only for $\alpha = 0.9$ to appreciate the changes in the efficiency levels.

[27] W_{RG} is calculated by assuming that principals maximize their utility when proposing an NB contract in some periods as $\alpha > \underline{\alpha}$. Therefore, W_{RG} corresponds to the maximum social surplus achievable when an NB contract is chosen in one or more periods.

		α				
		0.1	**0.5**	**0.9**		
				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 3. Punctual efficiency levels (%) of repeated-game equilibria for β={0.1,1.0,1.9}.

In more detail, the table above highlights that the main efficiency gains with respect to the one-shot setting arise for increasing marginal returns to effort (i.e., $\beta = 1.9$) and when non-binding agreements are clinched (i.e., $\alpha = 0.9$ and $c = \{0.5, 0.9\}$). This is due to the positive effects of reputation on trust, which allow the implementation of FB contracts. 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 (i.e., from 39.17% to 92.52%). Nevertheless, with the same triple, no difference is seen between $T = 100$ and $T = 10$. This means that the number of interactions may not be high enough to implement equilibria with some FB contracts during the first interactions (as predicted by Proposition 3). For a low number of interactions, the incentive for S to break FB contracts is high because the "time span" is not long enough. The agents would then only accept NB contracts until the end of the games, because they do not put enough trust in the incentive for S to acquire reputation. In other words, a first-best reputation can be acquired and trust can be granted only if

T exceeds a certain threshold, otherwise it is not sustainable and, consequently, it does not play any role.

In sum, without repeated interactions, the gains from trade may remain largely unexploited for all forms of production in which effort is very valuable (i.e., high β), such as high-quality goods/services, goods/services for which the time delivery is of extreme importance, and in general all goods/services in which the agent's effort can make the difference with respect to the principal's competitors or the customers' satisfaction. The introduction of repeated interactions in the production of these goods and services can trigger reputational mechanisms that fill the efficiency gap and increase the social surplus. However, these gains can be obtained only when informal agreements are normally chosen (i.e., $\alpha = 0.9$ and $c = \{0.5, 0.9\}$) and only if the transactions are repeated a certain number of times such that a "strong" (first-best) reputation can be acquired. In all other cases in which effort is very valuable, the legal system induces individuals to apply B contracts; consequently, the positive effects that reputation can produce do not come to light. Finally, reputation is not particularly valuable - regardless of the contract chosen - in standardized production and in all kinds of production in which increasing levels of effort do not provide large gains.

6 Discussion and conclusion

We have used a simple model to examine the choice between binding and non-binding contracts by two types of informed principals, one who is honest and fulfills her non-binding promises and another one who acts on purely selfish grounds and may renege on her promises if convenient. We have also assessed the welfare implications for parties' transactions when an enforcing legal system is introduced and allows for binding contracts, which are verifiable and enforceable at a cost. The choice between these two types of contracts in equilibrium depends on two variables: the enforcement costs and the widespread honesty level. In particular, the worse the legal institutions, the more likely are gentlemen's agreements among the parties. This holds in both a one-shot game and a finitely repeated game, independently of the number of interactions, meaning that reputation does not affect the choice of contract to implement. A third variable, measuring the marginal returns to effort, does not influence this choice.

In repeated games, a principal can acquire two levels of reputation. The first is a "first-best" reputation, whereby the agent fully trusts the principal to fulfill what we called a first-best contract. In this case, the agent's trust is equal to certainty, and this is incorporated into a non-binding contract that requires higher effort levels than any other non-binding contracts. The second level is a "second-best" reputation, whereby the agent trusts the principal to fulfill a non-binding contract. Nevertheless, the levels of trust are not sufficient to allow the principal to incorporate certainty fully into a non-binding contract. The selfish principal would still be tempted to breach a first-best contract.

Of course, reputation works only if non-binding contracts are implemented, that is, only for high shares of honest individuals and/or high enforcement costs. In these circumstances, we find that when effort is highly valuable, for example, in terms of quality of production, timely delivery, etc., the selfish principal cannot acquire a first-best reputation due to the high gains to be achieved from reneging. On the contrary, if effort is not particularly valuable, such as in standardized production, petty trade, or traditional agricultural contracts, a first-best reputation can more easily be established. Thus, reputation cannot sustain very valuable contracts and only an increasing share of honest individuals in the society can contrast this negative effect.

This model has been scrutinized in terms of the achievable efficiency levels. Through numerical simulations, we have accurately estimated the overall efficiency level (i.e., in the entire range of the variables) of the non-binding contracts as if no legal system could enforce the terms of a contract and only self-enforcing agreements can take place by relying exclusively on the share of honest individuals existing in a society. Trading without an enforcing legal system wastes roughly less than 40% of all the social surplus that a social planner could otherwise achieve by coordinating the transactions. Self-enforcing transactions generally achieve rather low efficiency levels in the presence of increasing marginal returns to effort. As effort shows diminishing marginal returns, as we normally expect in a large part of production functions, the private solution approaches the public solution.

Interestingly, once a legal system protecting property rights is introduced, and consequently, once individuals can choose between legally binding contracts and informal non-binding contracts, then the overall efficiency level increases by about nine percentage points. The gains occur mainly with low shares of honest individuals, low enforcement costs, and especially when effort is highly valuable. In these circumstances, an enforcing legal system may be socially desirable. However, this is not always the case when the shares of honest individuals and the levels of enforcement costs are neither too high nor too low. In this case, an enforcing legal system can be a welfare-reducing institution since, from a social viewpoint, an informal agreement would have performed better but it is not eventually chosen. This problem is more significant when effort is not particularly valuable.

If the interaction is repeated a finite number of times, reputational effects may come into play. Of course, reputation can play a role only if individuals' honesty or strategic behavior can be disclosed, as in the non-binding agreements. We find that the most considerable gains in terms of efficiency arise for increasing marginal returns to effort, but only if the game is repeated a sufficient number of times to trigger a first-best reputation that can be spent for a long period. Thus, reputation can be a very important welfare-enhancing factor in the production of goods or services with strict timely delivery schedules, goods or services providing high standards, and, in general, all goods or services for which effort is critical with respect to competition or customers' satisfaction. When repeated interactions occur, the enforcing legal system sacrifices the welfare-enhancing role of reputation, especially in the production of these goods and services when a binding form of agreement is usually chosen. Finally, in the circumstances in which the production of goods or services does not rely heavily on effort productivity, repeated interactions do not generate large efficiency gains because the efficiency levels are already substantial both with and without an enforcing legal system.

These results may re-open an old debate regarding whether or not a centralized public solution has to be preferred to free exchange to maximize the social surplus. The generally accepted solution of public intervention suggests that the social planner should intervene with regulatory practices when private contracting cannot assure an efficient outcome. In our model, this case arises in the presence of increasing marginal returns to effort. However, for long-term interactions and with a widespread trustworthy contractual environment, reputation is *ceteris paribus* a good substitute for regulatory practices to increase social surplus. Therefore, if effort is particularly valuable, a social planner might only intervene by reducing the enforcement costs and/or by strengthening individuals' sense of honesty, if lacking. On the contrary, if effort is not valuable, the parties should be left to trade freely, because the efficiency gains are already largely exploited.

The model that we present can be subject to further developments. The introduction of imperfect observability of effort would incorporate the issues related to two-sided reciprocity; consequently, different types of agents would then matter. Another possible extension could allow for a continuum of individual types, beyond the honest *vs.* selfish ones, as assumed above. Types can differ according to the psychological impact of their dishonest/honest behavior. For instance, individuals' utility can capture the extent of honest behavior, which may be considered limited in monetary terms, describing a sort of limitation to human generosity. Therefore, individuals can renege on their promise or fulfill it according to the value of the transaction. Usually, promises referring to transactions of very modest value are fulfilled, whereas the risk of reneging may increase as the value grows. Hence, taking into account the degree of honesty would be challenging, to evaluate how crucial the role of honesty and its intensity are for the contractual choice and efficiency levels.

Appendix

Proof of Proposition 1. (a) Since P can observe $\tilde{e}$ at no cost, providing $\tilde{e} < \left\{e^B, e^{NB}\right\}$ will immediately imply an infringement of the contract. We assumed that independently of the type of P and the type of contract, P never pays A as a consequence of the infringement. Providing $\tilde{e} > \left\{e^B, e^{NB}\right\}$ does not entail any additional reward, thereby implying only an increase in $k(e)$. As a result, the best strategies for A are either rejecting the contract (i.e., $\tilde{e} = 0$) or providing exactly the level of effort requested according to the type of contract (i.e., $\tilde{e} = \left\{e^B, e^{NB}\right\}$).

(b) In a separating equilibrium, A would be able to infer P's type by the signal (viz. the contract) she sends. Suppose a separating equilibrium exists such that H offers an NB contract and S offers a B contract. The following condition should hold:

$$U_H^{NB} \geq U_P^B \geq U_S^{\overline{NB}}. \tag{1}$$

Transitivity implies that $U_H^{NB} = y(e^{NB}) - p^{NB} \geq y(e^{NB}) = U_S^{\overline{NB}}$. By assumption, however, $p^{NB} > 0$, thus, $U_H^{NB} < U_S^{\overline{NB}}$, which contradicts condition 1. Thus, S would profitably deviate from a B contract by proposing an NB contract. Now suppose that a separating equilibrium exists such that H offers a B contract and S offers an NB contract. A knows that S never fulfills the promise, so he will reject any offer of an NB contract. Thus, S would profitably offer a B contract. The same reasoning excludes any separating equilibrium for the two types of principal offering an NB contract with different levels of price and/or effort.

Suppose that H proposes an NB contract by paying an installment λp^{NB} with $\lambda \in (0,1)$ before that A supplies the required effort, in order to signal her type and discourage S to propose an NB contract. H will eventually pay the price promised, whereas S would lose the installment if she wants to signal to be a H-type. Therefore, the signal is credible if it is sufficiently high to discourage S from proposing an NB contract in equilibrium and paying the installment. Assume that A will provide the effort requested after having received the installment; the following condition must hold:

$$y(e^{NB}) - p^{NB} > y(e^B) - (1+c)p^B > y(e^{NB}) - \lambda p^{NB}. \tag{2}$$

This condition never holds $\forall\ \lambda < 1$.

(c) In general, consider a game between two players where one has private information. An equilibrium exists if the player with private information has no profitable deviation, whatever the beliefs the other player can hold about that deviation. In our case, consider a pooling equilibrium in which both types of P

offer a given contract, but one or both types deviate to an NB contract. A has to form some beliefs about such a deviation. Suppose A believes that the deviation comes from an H-type principal, so that A would accept the proposal as long as his expected utility is non-negative. However, this out-of-equilibrium belief is inconsistent because S would always deviate to an NB contract in order to exploit A's beliefs. Thus, A's beliefs that a deviation to an NB contract would come from S must be strictly positive. In addition, the deviating principal can not exclude that A holds adverse beliefs that such a deviation comes from S, then A would reject the deviating contract. This excludes any profitable deviation to any off-equilibrium NB contracts. ■

Proof of Proposition 2. Consider an equilibrium where both types of P offer a B contract. A will accept a B contract (p^B, e^B) if it satisfies his participation constraint:

$$p \geq \frac{1}{2}e^2. \tag{3}$$

P has full bargaining power, thus she can satisfy the agent's participation constraint as an equality without loss of generality. Substituting (3) holding as an equality into the principal's utility function, U_P^B, and maximizing with respect to e, we obtain e^B and p^B, such that:

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

Both e^B and p^B are increasing in β and decreasing in c. A principal offering a B contract will therefore obtain:

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

This equilibrium exists because (i) Proposition 1(c) proves that deviating to an NB contract is never profitable, and (ii) P cannot profitably deviate to any other B contract because she would get a lower payoff. Thus, the B contract at equilibrium is always profit-maximizing. Note that $\forall c \in (0,1)$ and $\forall \beta \in (0,2)$, $U_P^B > 0$. In addition, U_P^B is always decreasing in c, whereas it is increasing in β only if $\beta \geq \bar{\beta}(c)$, with $\bar{\beta}(c) > 1$.

Consider now an equilibrium where both types of P offer an NB contract. A's expected utility will be:

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

Thus, A will accept the offer if and only if:

$$p \geq \frac{1}{2\alpha} e^2. \tag{4}$$

This participation constraint holds as an equality without loss of generality. Since $U_H^{NB} = e^\beta - \frac{1}{2\alpha} e^2 < e^\beta = U_S^{NB}$, if H has no incentive to deviate to a B contract, then it must also be true for S. Therefore, we can exclude that such a deviation is profitable if:

$$U_H^{NB} = e^\beta - \frac{1}{2\alpha} e^2 > \left(\frac{\beta}{1+c} \right)^{\frac{\beta}{2-\beta}} \left(1 - \frac{\beta}{2} \right) = U_P^B. \tag{5}$$

Thus, any couple $(e, p(e))$ satisfying condition (5) is an equilibrium because Proposition 1(c) excludes any deviation to another NB contract. To prove that this class of equilibria $(e, p(e))$ in NB contracts is non-empty, we maximize U_H^{NB}

with respect to e. We obtain:

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

Note that both e^{NB} and p^{NB} are always increasing at an increasing rate in α, and if $\alpha \geq 1/2$, also increasing in β.[28] The H-type principal will then obtain:

$$U_H^{NB} = (\alpha\beta)^{\frac{\beta}{2-\beta}}\left(1 - \frac{\beta}{2}\right), \tag{6}$$

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 $\forall\beta \in (0,2)$, $U_H^{NB} > 0$. S will only care about her monetary utility. Thus, she will renege on the contract and will obtain:

$$U_S^{\overline{NB}} = (\alpha\beta)^{\frac{\beta}{2-\beta}} \;(> U_S^{NB} = U_H^{NB}).$$

Finally, substituting equation (6) into condition (5) we find that the class of equilibria (e^{NB}, p^{NB}) in NB contracts is non-empty if and only if $\alpha > \frac{1}{1+c} = \underline{\alpha}$. Note that $\underline{\alpha} > 1/2$. ■

Proof of Lemma 1. The proofs of both parts (a) and (b) follow straightforward from the fact that S has no interest to maintain reputation in period t if $t = T$, or if a B contract is offered from period $t+1$ onwards. ■

Proof of Proposition 3. (a) Consider a backward induction procedure. Starting from period T, regardless of the value of $\alpha \in (0,1)$, consider an equilibrium in which P offers a profit-maximizing B contract (e^B, p^B). This equilibrium exists because, on one hand, Proposition 1(c) excludes in any period a

[28] This last result is experimentally corroborated in a two-sided reciprocity setting by Englmaier and Leider (2010). They find that the agent is more willing to reciprocate as the magnitude of the benefit to the principal from his effort increases.

deviation to an NB contract, and on the other hand, deviating to another B contract is simply not profitable for P. This reasoning applies to all periods $t < T$. We now prove that this equilibrium is unique if $\alpha \leq \underline{\alpha}$. Note that in the last period T, A would refuse the FB contract due to Lemma 1(a). Consider then a putative equilibrium where P proposes an NB contract. If $\alpha \leq \underline{\alpha}$ then $U_H^{NB} \leq U_H^B$, thus, A would reject an NB contract because it would only come from S. Consequently, only a B contract applies in T. Consider now the period $T-1$. Due to Lemma 1(b), S will always renege on her promise, therefore, A would refuse any NB or FB contracts. A similar reasoning applies to all $t < T$. Hence, the equilibrium is unique.

(b) Consider the equilibrium where the FB contract is offered in each period until period $t^* < T$ and an NB contract is offered thereafter. Consider the last period T; we know that a deviation to the FB contract is refused by A due to Lemma 1(a). A deviation to another NB contract (e.g., by charging a different price or by requiring a different effort level) is also excluded by Proposition 1(c). Finally, Proposition 2 shows that no deviation to a B contract is profitable to P since $\alpha > \overline{\alpha} > \underline{\alpha}$, and the class of equilibria in the NB contracts is non-empty. Thus an NB contract applies in period T. Suppose now that $t^* < T-1$. For every $t \in [t^*+1, T-1]$, $\alpha > \underline{\alpha}$ implies that any P has no profitable deviation to a B contract and Proposition 1(c) implies that P has no profitable deviation to another NB contract. Since any breaking of an NB contract would be punished by A by accepting only B contracts, it is easy to show that S has no profitable deviation to breaking the contract in any period. Then, two conditions must hold contemporaneously. First, S has a profitable deviation to breaking FB in t^*+1. Second, S has no profitable deviation to breaking FB in t^*. Thus, it must hold that

$$(t^*+1)U_P^{FB} + (T-t^*-2)U_P^{NB} + U_S^{\overline{NB}} < t^* U_P^{FB} + U_S^{\overline{FB}} + (T-t^*-1)U_P^B, \quad (7)$$

and

$$t^*U_P^{FB} + (T - t^* - 1)U_P^{NB} + U_S^{\overline{NB}} > (t^* - 1)U_P^{FB} + U_S^{\overline{FB}} + (T - t^*)U_P^{B}. \quad (8)$$

Conditions (7) and (8) hold contemporaneously at least for the profit-maximizing NB contract if α falls in the following interval:

$$\left[\frac{\frac{\beta}{2} + (T - t^*)\left(\frac{1}{1+c}\right)^{\frac{\beta}{2-\beta}}\left(1 - \frac{\beta}{2}\right)}{(T - t^* - 1)\left(1 - \frac{\beta}{2}\right) + 1}\right]^{\frac{2-\beta}{\beta}} < \alpha < \left[\frac{\frac{\beta}{2} + (T - t^* - 1)\left(\frac{1}{1+c}\right)^{\frac{\beta}{2-\beta}}\left(1 - \frac{\beta}{2}\right)}{(T - t^* - 2)\left(1 - \frac{\beta}{2}\right) + 1}\right]^{\frac{2-\beta}{\beta}} < 1. \quad (9)$$

The endpoints of the interval are increasing in t^* and $T - 2$ intervals exist with the lower endpoint for $t^* = 1$ equal to:

$$\overline{\alpha} = \left[\frac{\frac{\beta}{2} + (T - 1)\left(\frac{1}{1+c}\right)^{\frac{\beta}{2-\beta}}\left(1 - \frac{\beta}{2}\right)}{(T - 2)\left(1 - \frac{\beta}{2}\right) + 1}\right]^{\frac{2-\beta}{\beta}}. \quad (10)$$

Finally, if $t^* = T - 1$, condition (7) does not apply because in no circumstance does A accept an FB contract in the last period due to Lemma 1(b). Condition (8) applies, meaning that S should have no profitable deviation to breaking the FB contract in $t^* = T - 1$. Therefore, condition (8) holds if:

$$\left[\frac{\beta}{2} + \left(\frac{1}{1+c}\right)^{\frac{\beta}{2-\beta}}\left(1 - \frac{\beta}{2}\right)\right]^{\frac{2-\beta}{\beta}} < \alpha < 1. \quad (11)$$

As expected, the lower endpoint of this interval is equal to the upper endpoint of the interval in condition (9) when $t^* = T - 2$. It follows that $(T - 1)$ classes of equilibria exist as $\alpha > \overline{\alpha}$, with α monotone and increasing in t^*, and each class corresponds to different intervals of $\overline{\alpha} < \alpha < 1$, which do not intersect with each other.[29]

[29] Trivially, if the game is played infinitely and the discount factor is equal to 1, there exists

(c) If $\underline{\alpha} < \alpha \leq \overline{\alpha}$ then no t^* exists satisfying condition (8); thus, the FB contract is never offered in equilibrium. The inequality $\alpha > \underline{\alpha}$ implies that any P has no profitable deviation to a B contract, and Proposition 1(c) implies that P has no profitable deviation to another NB contract. Finally, since any breaking of an NB contract would be punished by A by accepting only B contracts, it is easy to show that S has no profitable deviation to breaking the contract in any period. Consequently, there exists a class of equilibria where an NB contract applies in each period. ■

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

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an equilibrium where an FB contract is offered in each period.

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