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The Role of Relational Contracts in Common Agency Games

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Abstract

Common agency models are usually divided into two categories. Public agency assumes that firms (the principals) can contract formally with a common agent, which may be interpreted as a service provider or a client, over the same set of variables, while in private agency at least one principal cannot contract over some variables available to others. This paper studies a setting in which firms are unable to contract formally over some variables but can nevertheless include them in a relational contract, in the sense that some payments cannot be put in force by court and must be self-enforced. I characterize the equilibrium and show that public and private outcomes may be seen as extreme cases when either players are very patient or, respectively, not patient at all. For intermediate discount factors, firms make use of all information available, but the need for self-enforceability limits the incentives that may be credibly offered in equilibrium.

Key words: Competition; Contract Theory; Common Agency; Incomplete Contracts

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INTRODUCTION

Strategic competition among firms frequently involve the use of contractual arrangements to capture a single agent, be it a given consumer, a service-provider, a policymaker or a business partner. Economic theory has studied competition in the field of contract theory through common agency models, which provide a framework to analyze situations where principal-agent relationships cannot be ruled by a single contract. When firms (the principals) are unable to coordinate, a first issue that arises is the information available to each of them: do they contract over the same set of variables or is there some restriction?

Public agency models deal with the first possibility: firms observe and can contract over the same variables. This is the case, for example, of firms that share a given service-provider, if it is obliged to disclose the same information to all of them, which are legally allowed to make use of this information. Private agency, on the other hand, studies situations in which at least one firm cannot contract on a variable available to another one. This additional source of incompleteness may take place for two different reasons. First, a firm may not observe an outcome that others do, and therefore is totally unable to contract on it; but any information available is still contractible and verifiable. Second, even if she observes all relevant outcomes, it may be the case that she is legally forbidden to include them into a contract, in the sense that an agreement based on certain outcomes cannot be enforced by court: some information is not contractible at all, despite being observed.

In some cases, however, principals should be expected to use all available information in some way if they can be rewarded for that[2] - even if they cannot write completely enforceable contracts based on it. A clear example comes from a retailer that sells products from two competing manufacturers. Each one would like the retailer to expose as much as possible its own brand, and as little as possible the other brand. Whereas each manufacturer can buy shelf-space, it is usually forbidden to pay for the other one not to get it[3]. In spite of this, it might be expected that each one would try to influence the retailer into not exposing the other's brand, even if this cannot be written in a contract[4].

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[2] *That is, if one allows for continuation payoffs. For a discussion of information disclosure and transparency in common agency games, see Ottaviani and Maier (2009).*

[3] *For example, Brazilian laws forbid it, and there are cases of companies that were fined for not complying.*

[4] *Despite my focus on non-enforceability, other reasons may be put forward, such as soft information or subjective evaluation of performance.*

Informal use of information arises in many economic settings. This is the case whenever individuals have some relevant piece of knowledge they cannot formally write down in a contract. If so, they cannot make use of an external mechanism, such as a court, to enforce the contract. Incentive theory has recently provided some insights into the role of self-enforced (or relational) contracts when agents see value at information that cannot be brought before a court. The objective of this paper is to apply the techniques of relational contracts to common agency games.

I present a repeated common agency setting where principals (firms or stakeholders in general) are allowed to use self-enforceable payments when formal contracts cannot include all information they observe about the agent's effort. Each principal can contract over two sets of variables: the first one is legally under her jurisdiction, meaning that she is able to enforce the contract when it comes to the variables in this set; the second one is legally under the other principal's jurisdiction, meaning that she cannot enforce it, which brings the need for relational contracts into the model. This may be understood as a middle point between private and public agency models: each principal can contract over all variables, but the contract is not enforceable by court for some of them. I intend to study this informal use of information in a fairly simple hidden-action framework so as to highlight the issue at hand, although many of the simplifying assumptions I use are not necessary.

I characterize the equilibrium under self-enforcement constraints and derive some of its properties. The main findings are related to the discount factor of players. The more patient they are, the more powered incentives based on 'unofficial' information become, which makes the equilibrium closer to the public agency one. This happens because the only way to use unofficial information is to rely on the continuation of the relationship to punish deviations and reward good behavior. When short-run and long-run principals coexist, I show that the latter benefits even more from self-enforceable instruments and can undo partially incentives from the former, who is hurt by the lack of ability to make promises.

MODEL

I consider a quasi-linear and risk neutral environment. There are two principals (labeled *1* and *2*) and one agent who play an infinitely-repeated game at dates $t=0,1,2,\dots$ and discount future payoffs at a common rate δ . At each date, the agent can choose two actions e_1 and e_2 ("effort") that influence in a non-deterministic way the principals' payoffs only at that date. Effort may be interpreted broadly – to fix ideas, one may interpret the common agent as a service provider to two firms (the principals), and effort as a measure of how careful he is in the execution of his tasks for each firm.

At the beginning of each period, principals simultaneously and non-cooperatively offer the agent a contract conditional on the observed outcome, and he may either accept or refuse both contracts[5]. In case of acceptance, he chooses effort levels, outcomes are observed and mandatory payments are made, while the principals choose whether to make any non-mandatory payments. If the agent refuses the contracts, he and the principals get their outside options, which I set equal to zero[6].

For simplicity, I will consider only two outcomes for each principal: success, in which case she obtains a value $K>0$; or failure, with value zero. Effort e_i exerted by the agent belongs to the closed interval $[0,1]$ and determines the probability of success $p(e_i)$[7]. I assume that $p(e_i)$ is differentiable and both the monotone likelihood ratio condition and the convexity of the distribution function condition hold[8]. Formally, the outcome due to principal i is a Bernoulli random variable X_i with parameter $p(e_i)$.

The agent incurs a cost of $c(e_i, e_j)$ when chooses effort levels e_i and e_j. I assume this cost function to be twice differentiable and strictly increasing in both variables, convex, and the cross-derivative c_{ij} to be strictly positive for all e_i and e_j, meaning that the marginal cost of effort provided to principal i is

[5] *Notice that the agent cannot accept only one contract, which means it is an intrinsic common agency game. For details, see Martimort (2006).*

[6] *For a detailed analysis of moral hazard models, one may refer to Laffont and Martimort (2002), Bolton and Dewatripont (2005) or Salanié (2005).*

[7] *One might assume that the agent chooses the probabilities p_i and p_j directly, as I do in the next section.*

[8] *So that the first-order approach is valid. See Rogerson (1985).*

increasing in the effort provided to principal j[9]. This will motivate each principal to incentive the agent not to exert much effort for the other one.
Principals are symmetric in every aspect and they cannot make negative transfers to the agent (limited liability assumption[10]). Throughout the paper, I will focus on equilibria with participation of the agent in which the limited liability constraint is binding and the most costly action is to be implemented. This is the case whenever K is large enough and the agent's reservation utility is low enough. I shall restrict myself in a first instance to look for stationary, renegotiation-proof contracts in equilibrium[11].
Given the stationarity assumption, it will be sufficient to deal with utility functions at each date (instead of considering the discounted sum of one-shot utilities), which can be written as follows.

$u_1 = K\, p(e_1) - t_1$
$u_2 = K\, p(e_2) - t_2$
$u_A = t_1 + t_2 - c(e_1, e_2)$

in which t_i stands for the transfer from principal i to the agent. This transfer can be written as a two-part tariff: w_i is paid when the outcome of principal i is a success, while b_i is paid when the outcome of the other principal is a failure[12].

$t_i = w_i + b_i$, $i=1,2$

The contractible payment is denoted by w_i: once the contract is signed, the principal cannot renege on it (one might assume that she would be imposed a very high fine by a court). I will consider three cases. In the public agency game, b_i is contractible and enforceable. In the private agency game, it is not contractible at all. In the relational agency setting, it is contractible but not enforceable by court, meaning that it must be self-enforced if it is to be used in equilibrium[13].
A relational contract is a vector $[\{w_i\}_i\ ,\ \{b_i\}_i]$, for $i=1,2$ at each date t, specifying a contractible compensation w and a contingent payment b. An equilibrium is a contract and a double choice of effort (e_1, e_2) by the agent. Since stationarity implies that w, b and e will not depend on time in equilibrium, time subscripts are not needed.
For notational simplicity, define the following vector:

$\pi_i(e_i, e_j)=[\ p(e_i)\ p(e_j)\ ;\ p(ei)(\ 1-p(e_j)\ )\ ;\ (1-p(ei))p(e_j)\ ;\ (1-p(ei))(1-p(e_j))\ ]$

for $i,j=1,2$.

THE ROLE OF ENFORCEABILITY
This section presents the equilibria under different assumptions on the enforceability of the bonus b. For the sake of clarity and without loss of generality, from now on I will consider $p(e_i) = e_i$.

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[9] *This is equivalent to assuming that effort provided to principal j affects directly the payoff of principal i.*
[10] *For a discussion of limited liability in relational contracts, see Fong and Li (2009).*
[11] *In a one-principal setting, Levin (2003) uses the repeated-game theory of Abreu et al. (1990) to show that if an equilibrium exists, then one can construct a stationary, renegotiation-proof equilibrium. See Fudenberg and Tirole (1990) for a discussion of repeated games.*
[12] *Since I will focus on equilibria in which the limited liability constraint is binding, one can set the contractible payment to be zero in case the outcome of principal i is a failure; and the non-contractible part to be zero in case the other principal's outcome is a success. This is the same as saying that each principal pays nothing to the agent - which is the maximum penalty they can impose - when outcomes are a failure to her and a success to the other principal.*
[13] *Notice that, in general, the principals could do better by choosing a specific transfer for each state of nature: {success, success}, {success, failure}, {failure, success} and {failure, failure}. However, allowing for this possibility does not affect the results presented here.*

The Public Agency Game
As a benchmark, I will present first the public agency game. In this case, each principal can contract freely with respect to both outcomes X_i and X_j. The analysis here is essentially the same as the one presented in Bernheim and Whinston (1986).

The problem of each principal is:

Max $_{wi,\, bi,\, ei,\, ej}\ \pi_i(e_i, e_j)\ [K- w_i; K- w_i - b_i; 0; - b_i]$

Subject to the incentive compatibility constraint (IC)[14]:

$e_i, e_j \in argmax_{\ ei,\, ej}\ \{ \pi_i(e_i, e_j)\ [w_i + w_j ; w_i + b_i ; w_j + b_j ; b_i + b_j] - c(e_i, e_j) \}$

The first-order approach makes it possible to rewrite (IC) as:

$[w_i - b_j]= \partial c(e_i, e_j)/\partial e_i$ (1)

for $i=1,2$.

This condition is intuitive: when choosing effort e_i, the agent considers only two impacts: an increased probability of getting w_i and a decreased probability of getting b_j.
The system formed by these two equations determines the agent's optimal response in the public agency game as a function of the transfers, which I shall denote by $e_i^{PuA}(w_i, w_j, b_i, b_j)$ and $e_j^{PuA}(w_i, w_j, b_i, b_j)$. One may then use the implicit function theorem to compute partial derivatives, which is all that is needed to solve the principal's problem. For future reference, these derivatives are:

$\partial e_i \,/\, \partial w_i = c_{jj}\ |D_2c| > 0$
$\partial e_i \,/\, \partial b_j = -c_{jj}\ |D_2c| < 0$
$\partial e_i \,/\, \partial w_j = -c_{ij}\ |D_2c| < 0$
$\partial e_i \,/\, \partial b_i = c_{ij}\ |D_2c| > 0$

where $|D_2c| = c_{ii}c_{jj} - c_{ij}^2$.

Notice that $\partial e_i \,/\, \partial w_i > \partial e_i \,/\, \partial b_i$ if and only if $c_{jj} > c_{ij}$. This means that if the cross impact is high enough, each principal will prefer to induce the agent not no exert effort to the other one. This happens because the marginal cost e_i becomes very low.

The first order condition with respect to w_i in principal i's problem boils down to:

$(K\text{-}w_i)\partial e_i^{PuA} /\partial w_i + b_i\ \partial e_j^{PuA} /\partial w_i = e_i$ (2)

for $i=1,2$.

In which I omit the arguments of the functions e_i^{PuA} and e_j^{PuA} for the sake of clarity. Notice that, due to the symmetry between principals, these two equations reduce to only one, since transfers (both contractible and non-contractible) and effort levels will be the same for the two of them.

Analogously, the first order condition with respect to b_i can be written as:

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[14] *This is the only restriction because I assume the limited liability constraint to be binding, so that the participation constraint is slack.*

$(K-w_i)\partial e_i^{PuA} / \partial b_i + b_i \partial e_j^{PuA} / \partial b_i = 1 - e_i$ (3)

for $i=1,2$.

Equations (2) and (3) determine implicitly the equilibrium values of w^{PuA} and b^{PuA} in the public agency game. Equation (1) can then be used to find the equilibrium level of effort.

The Private Agency Game

The second relevant benchmark is the case when principals do not contract with respect to the other one's outcome. The problem becomes:

$\text{Max}_{\,wi,\, ei,\, ej}\ \pi_i(e_i, e_j)\ [K- w_i; K- w_i ; 0; 0]$

Subject to the incentive compatibility constraint (IC)[15]:

$e_i, e_j \in \operatorname{argmax}_{\,ei,\, ej} \{ \pi_i(e_i, e_j)\ [w_i + w_j; w_i; w_j; 0] - c(e_i, e_j) \}$

The first-order approach allows one to replace (IC) by:

$w_i = \partial\, c(e_i, e_j) / \partial\, e_i$ (4)

for $i=1,2$.

Again, this equation gives the choice of effort as a function of transfers in the private agency game, which I will denote by $e_i^{PrA}(w_i, w_j)$. The first order condition of principal i's program is:

$(K- w_i)\partial\, e_i^{PrA}/\partial w_i = e_i$ (5)

Equation (5) gives the equilibrium payment w^{PrA} in the private agency game. Notice that it is not possible to tell whether the effort exerted by the agent is greater or smaller than in the previous case without imposing further structure on the model. I present in the next section a result that allows for such a comparison.

Relational Agency

The problem here is similar to the public agency one - but there is an additional constraint, namely a self-enforcement constraint. Let us assume that failure to comply with the relational contract is followed by a reversal to the worst possible future outcome (for example, the relationship is over). Thus, self-enforceability implies:

$[\delta/(1-\delta)]\{ \pi_i(e_i, e_j)\ [K- w_i; K- w_i - b_i; 0; - b_i] \} \geq b_i$ (6)

The left-hand side of equation (6) is the (expected) continuation payoff for each principal, should she make a contracted but non-enforceable payment[16]. The right-hand side is the maximum she could get by reneging on payment in a given period. Therefore, equation (6) must hold for both principals, as it guarantees that none of them would have an incentive to walk away[17].

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[15] *This is the only restriction because I assume the limited liability constraint to be binding, so that the participation constraint is slack.*

[16] *Notice that the payment made by principal i depends on the contractible variable X_i only through the enforceable payment w_i - there is no reason not to do so, since it would imply additional constraints. On the other hand, any payment conditional on X_j must be made through a non-enforceable transfer b.*

[17] *In principle, a similar restriction should hold for the agent, if he might be called upon to make non-enforceable payments (negative b). This possibility is ruled out by the limited liability assumption.*

A first issue to be addressed concerns the tightness of this additional constraint. The result presented in the proposition below is related to the possibility of implementing a public agency outcome even under self-enforceability constraints. The trivial proof will be omitted.

Proposition 1. For any public agency equilibrium, there is a value of δ close enough to one such that this equilibrium can be implemented in the relational agency game.

Proposition 1 may be seen as a kind of folk theorem: when players are very patient, the self-enforceability constraint becomes moot. It holds because present and continuation payoffs are perfect substitutes given risk neutrality. This result would hold even if failure to comply with equilibrium strategies would not lead to the worst possible outcome, as long as the stationarity assumption holds.

Proposition 1 suggests that, in this particular setting, departures from the public agency outcome may be explained not only by the contract incompleteness associated to private agency, but instead by players' lack of patience (low δ).

From now on, I will focus on the case where the self-enforcement constraint is binding (low δ), so that the public agency outcome is not feasible. The objective will be precisely to study the impact of this restriction on the optimal contract.

Principal *i*'s program is similar to the public agency problem. In particular, the optimal response of the agent to enforceable and non-enforceable payments is not changed.

$$e_i^{RA}(w_i, w_j, b_i, b_j) = e_i^{PuA}(w_i, w_j, b_i, b_j)$$

Let λ_i be the multiplier associated to the self-enforcement constraint (6). The first-order condition associated to the enforceable payment w_i is not changed, since it is not affected by the new constraint (although its equilibrium value will change, to make up for changes in b_i due to self-enforceability):

$$(K- w_i)\partial e_i^{RA} /\partial w_i \ + b_i \partial e_j^{RA} /\partial w_i \ = \ e_i^{RA} \qquad (7)$$

for $i=1,2$.

The first-order condition associated to b_i becomes:

$$[(K- w_i)\ \partial e_i^{RA} /\partial b_i + b_i\ \partial e_j^{RA} /\partial b_i - (1 - e_j^{RA})](1+ \lambda_i\ [\delta/(1- \delta)]) = \lambda_i \qquad (8)$$

for $i=1,2$.

Again, symmetry between principals allows one to reduce each of these systems to only one equation.

The next step is to actually study properties of the optimal relational contract and to compare it to the previous cases. The following proposition presents some results of comparative statics. The proof is a straightforward application of the implicit function theorem.

Proposition 2. Consider a symmetric equilibrium [w^{RA}, b^{RA}, e^{RA}] of the relational agency game. Assume the self-enforcement constraint to be binding. Then a decrease in the common discount factor δ causes a decrease in the non-enforceable payment b. Furthermore, if the cost function of the agent is such that $c_{ij} > c_{ii}$, then the enforceable payment w and the difference $(w_i - b_j)$ increase.

The first part of the proposition just states that, as each principal becomes more restricted in the use of b (because her lack of patience makes the set of promises she can make more restricted), she will use less of it in equilibrium[18].

However, the impact on w is not clear, since the decrease in b has two conflicting effects in this symmetric setting. First, it reduces the "sabotage power" of principal *i*, and therefore the incentive of the agent to exert effort for the other principal becomes larger. This increases the marginal cost of producing e_i (since $c_{ij} > 0$), so that principal *i* must make w_i greater. Second, in the other direction, it protects principal *i* from

[18] *One might understand this result in the following sense: less patient players are equivalent to a setting with more incomplete contracts, so that counter-productive incentives become more restricted.*

the other principal's sabotage, which reduces the payment she must give the agent to achieve any given level of effort.

The second part of the proposition establishes a condition under which the first effect is dominant, so that the increase in w (at least) compensates the decrease in b. In short, this is the case whenever hurting principal j is efficient enough from the point of view of principal i, in the sense that she can reach a high decrease in the marginal cost of the agent by reducing his effort for principal j. This amounts to assuming $c_{ij} > c_{ii}$: this impact is captured entirely by the cross-derivative c_{ij}. In this case, using b is very efficient, implying that a decrease in its use calls for a more than proportional increase in the enforceable payment w. Notice that this is just a sufficient condition.

With this result, it is possible to tell how the equilibrium level of effort is affected by the discount factor. The next corollary follows immediately from the first-order condition of the agent's problem.

Corollary 1. If $c_{ij} > c_{ii}$, then the equilibrium level of effort is decreasing in δ as long as the self-enforceability constraint is binding.

This follows because effort is increasing in the difference $(w_i – b_j)$.

Proposition 2 also permits a comparison between the relational agency equilibrium and the previous equilibria (public and private agency models). To do so, notice that private agency is equivalent to assuming $\delta = 0$, while public agency is equivalent to assuming δ close enough to one (in the sense of Proposition 1). In the former case, no positive value of b would attend the self-enforceability constraint; in the latter, its use is unrestricted.

The results presented in Proposition 2 are due to the double effect of a decrease in b (both b_i and b_j decrease), which depends on the symmetry between principals. The next section studies the asymmetric case.

ASYMMETRIC PRINCIPALS

In this section I will consider the effects of preventing one of the principals from using the non-enforceable payment b. This may be interpreted as the coexistence of two different kinds of principals: a long-term one, who can make promises and therefore use continuation payoffs, and a short-term one[19].

The first point to be noted is that the greater c_{ij}, the more hurt the short-term principal is. This happens because the long-term principal can use his additional instrument b to undo almost anything the other one might attempt to do, subject only to the self-enforceability constraint.

The problem of the long-term principal is the same as the relational agency one, whereas the short-term principal solves the private agency program. Throughout this section, I shall label principals i=LT (long-term) and j=ST (short-term).

First-order conditions with respect to w_{LT}, b_{LT} and w_{ST} become:

$$(K - w_{LT})\, \partial e_{LT}/\partial w_{LT} + b_{LT}\, \partial e_{ST}/\partial w_{LT} = e_{LT}$$
$$[(K- w_{LT})\, \partial e_{LT}/\partial b_{LT} + b_{LT} \partial e_{ST}/\partial b_{LT} - (1 - e_{ST})](1+ \lambda\, [\delta/ 1- \delta])= \lambda$$
$$(K- w_{ST})\, \partial e_{ST} /\partial w_{ST} = e_{ST}$$

The self-enforcement constraint must hold only for the long-term principal:

$$[\delta/ 1- \delta]\{ \pi_{LT}(e_i, e_j)[K- w_{LT} ;K - w_{LT} - b_{LT} ; 0 ; - b_{LT}] \} \geq b_{LT}$$

It is clear that the long-term principal reaches a higher payoff than in the symmetric setting, whereas the short-term one is worse off. Some properties of the equilibrium contract are summarized below. Again, the proof follows from the implicit function theorem.

Proposition 3. Consider an asymmetric equilibrium (w_{LT}, b_{LT}, w_{ST}, e_{LT}, e_{ST}) . Then:

[19] *The analysis in this section would be unchanged if one assumed that one of the principals had discount factor equal to zero.*

1. w_{ST} - b_{LT} < w^{RA} < w_{ST}
2. w^{RA} > w_{LT}
3. e_{LT} > e^{RA} > e_{ST}
4. A decrease in δ causes a decrease in e_{LT} and an increase in e_{ST}.

The first part shows how the asymmetry hurts the short-term principal: she increases the enforceable payment w_{ST} as a response to the lack of the non-enforceable instrument, but the other principal more than offsets this increase by adjusting b_{LT}. The second part shows the opposite effect for the long-term principal, who is able to diminish her contractible payment. The third line presents the same effects in terms of effort levels.

The last line is the analog of Proposition 2. Now, a decrease in the degree of patience affects only the long-term principal directly, by making the set of contracts she can offer more restricted. The impact on her is strictly adverse, which means that she loses ability to induce the agent to exert effort. On the other hand, the impact on the short-term principal is positive, by protecting her from counter-productive actions from the other principal.

CONCLUDING REMARKS

This paper is an attempt to understand how common agency games are affected when non-enforceable instruments are available to principals. As such, it helps understand real-world situations such as competition among firms for a given agent, such as a service provider. Received theory consider two polar cases: either all firms observe and contract over the same variables with the agent, or at least one firm is forbidden to use some variable.

I consider the case where firms design contract based on information even when it cannot be enforced by a court of law. Such informal agreements may be self-enforced in a repeated relationship: a firm will keep its word if it wants to keep doing business with the agent in the future. I show that if this is the case, then the most important factor in contractual design is the firms' degree of patience – or, in other words, the relevant time horizon for which they make decisions. When firms value the future, informal agreements may be relied upon and all the information is used. Otherwise, firms are restricted in the promises they can make, and only relationships based on current rewards are sustainable. When firms have different degrees of patience, or make decisions considering different time horizons, the short-sighted firm may be severely restricted.

Although most of the simplifying assumptions used in this model may be dropped, some of them are necessary for the results. The most important one concerns the stationary structure of the optimal contract, which has only been established in one-principal settings. Research should be extended into the optimal structure of non-stationary contracts.

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