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# Differential Delivery Dates, Retrievability and the Incentives Compatibility of Contracts

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## Abstract

Differential delivery dates ( $D^3$ ) of contract obligations characterize most contracts in real life.  $D^3$  puts the contractor who delivers last, in the words of David Hume (1769), in “a position of advantage” because reneging on his/her obligation can be profitable. Ex-ante remedies such as Coase’s “ownership”, Williamson’s “hostage”, Klein et al’s “vertical ownership”, Grossman and Hart’s “assignment of residual rights”, etc have been proposed. The principal’s decision to appropriate the quasi-rent generated by the agent delivering effort first under possibly weak public ordering and non-zero retrievability of delivered effort is explicitly modeled. We give the sufficient conditions for the preservation of the incentives compatibility of the simple P-A effort-in-advance contract in the  $D^3$  environment.

**JEL Classification:** D52, D86

**Key words:** incentives compatibility, quasi-rent appropriation, retrievability, incentives contract

## I. Introduction

The differential delivery dates of contract obligations by contractors is a very old problem first dealt with by David Hume (1769). He observed that the player who delivers after “one of the parties has performed already” is put in “a position of advantage.” If the agent delivers effort first and the principal delivers the wage later, the principal may be tempted to exploit his/her position of advantage by reneging on his/her own contract obligation. Ex-post opportunism by a contractor is a well-travelled territory opened up by the seminal idea of *asset specificity* and the *sequential nature* of the delivery (Williamson, 1971; 1975; Klein et al., 1978; Grossman and Hart, 1986). Most of the important advances here involve discovering ex-ante remedies to solve the  $D^3$  dilemma in environments of weak public ordering. Such for example are Williamson’s own hostage or bond mechanism, Williamson’s and Coasean ownership, Klein et al.’s vertical integration, Grossman and Hart’s assignment of residual rights, credible commitment devices, reputation, etc. (see e.g., Brousseau and Glachant, 2002b)

In the simplest textbook P-A contract theory where every relevant variable is symmetrically and perfectly known, the  $D^3$  aspect can be largely glossed over due to the Walrasian assumption of a strong and benevolent third party contract enforcer that adequately punishes contract violations and makes it unprofitable (Mas Collé, et al, 1995; Laffont and Mortimart, 2002; Brousseau and Glachant, 2002). When public ordering is strong, the  $D^3$  aspect of the contract becomes irrelevant; strong public ordering effectively transforms all contracts into spot contracts.

Absent this strong public ordering, the contract becomes incomplete and the incentives compatibility of the simple contract breaks down. For example when some contract feature such as agent type is non-observable, thus not enforceable by the courts, the use of self-revealing menu of contracts may attain second best welfare. Laffont and Mortimart’s (2002) or Laffont and Meleu’s (2000) *enforcement-proofness constraint* may be used to replace the participation constraint and restore the incentives compatibility of the contract. When effort is unobservable, the familiar ex-ante remedy is to impose the incentives compatibility constraint corresponding to the non-observable effort.

In many jurisdictions, the weakness of public ordering may come not from non-observability of contract provisions but from the fact that the principal is itself the contract enforcer. In the case of state procurement, as in public-private procurement contracts, the state is the principal as well as the enforcer of contracts and political considerations may render the state an unpredictable enforcer.

The problem of  $D^3$  or what I prefer to call the Humean problem is clearly a part of the domain opened up by O Williamson’s asset specificity: the delivery of specific assets creates *appropriable quasi-rent* (Klein et al, 1978) for party that has yet to deliver. If the latter fails or footdrags on the delivery and public ordering is weak, the first party will lose the whole or a part of the value of the delivered obligation. The  $D^3$  feature gives one party a delivery date advantage. This differs from monopoly rent as Klein et al (1978) explains:

“Once installed, an asset may be so expensive to remove or so specialized to a particular user that if the price paid to the owner were somehow reduced the asset’s services to that user would not be reduced. Thus, even if there were free and open competition for entry to the market, the specialization of the

installed asset to a particular user (or more accurately the high costs of making it available to others) creates a quasi rent, but no monopoly rent.”

The goal of this paper is modest: to explicitly model the decision of the party enjoying the delivery date advantage to appropriate the generated quasi-rent in order to derive the sufficient conditions for the preservation of the incentives compatibility of the simplest symmetric information P-A contract in the  $D^3$  environment. In Section II, we present the base symmetric information P-A contract model. We then argue that the incentives compatibility feature of the resulting contract is undermined under  $D^3$  and under weak public ordering. Under  $D^3$  we assume that the contract is effort-in-advance, i.e., the agent delivers first. In Section III, we explicitly model the decision of the principal to appropriate the quasi-rent after delivery of effort by the agent which explicitly incorporates two aspects: a possibly weak public ordering environment and the possibly non-zero retrievability of delivered effort. Unlike Klein et al (1978), we assume that the service of the asset to the principal may be reduced depending on the retrieval feature of the effort. We then give the condition (s) sufficient to preserve the incentives compatibility of the contract in the base model, in other words, the public ordering and retrievability conditions under which the principal has no incentives to exploit his/her position of advantage. These conditions suffice to preserve the Walrasian character of the simple P-A contract in the  $D^3$  environments.

## II. THE BASE MODEL

Consider the familiar optimal principal-agent (P-A) contract  $C(w^*, e^*)$  which solves the following program:

$$\begin{aligned} \text{Max}_{\{e, w\}} [f(e) - w] & \quad (P.1) \\ \text{s.t. } [u(w) - v(e)] & \geq U^0 \end{aligned}$$

where the revenue function  $R = f(e)$ , with  $f' = df/de > 0$ ,  $f'' < 0$ ,  $u(w)$  is A's utility function defined over  $w$ ,  $u' > 0$ ,  $u'' < 0$ ,  $v(e)$ ,  $v' > 0$ ,  $v'' < 0$ , is A's disutility of effort function and  $U^0$  is A's reservation utility. Both  $e$  and  $w$  are assumed costlessly observable. P promises to deliver  $w^*$ , and A promises to deliver  $e^*$ . A's payoff is  $w^*$  and P's is  $(f(e) - w^*)$ .

The Lagrangean multiplier,  $\lambda = (u')^{-1} > 0$  so A's participation constraint binds implying that A gets his reservation utility and supplies  $e^*$ . P, in turn, gets  $(f(e^*) - w^*)$ , which maximizes his profit and pays  $w^*$  to A. A has no incentive to supply  $e < e^*$  because at  $w^*$ ,  $e^*$  maximizes A's utility. P has no incentive to offer  $w < w^*$  because,  $w < w^*$  will give P less utility and  $e$  will fall to satisfy the constraint. If delivery of obligations  $w$  and  $e$  are simultaneous, as in a spot contract, the contract is robust against shirking. It is incentives compatible. But if the contract written in a  $D^3$  environment as in the case of “effort-in-advance” contracts, where  $e$  is delivered ahead of  $w$  and deployed effort is difficult to retrieve, features

common to most real contracts, the incentive to comply can break down without an additional alignment mechanism. In other words the contract becomes incomplete in the  $D^3$  environment.

Consider a day contract. Agent A is hired as a day laborer in the morning, supplies  $e$  through the day (say, sows a field), and gets paid at the end of the day. At the close of the day, the field has been sowed and P has gotten his  $f(e^*)$  for that day. Now P faces a decision either to pay A the contracted  $w^*$  or something less. If  $w^*$ , P gets his maximum within the contract. If P reneges and pays  $aw^* < w^*$ ,  $0 < a < 1$ , he gets higher utility  $[f(e^*) - aw^*]$ . If P pays  $aw^*$ , A realizes less than  $U^0$ . But A cannot retrieve  $e^*$  to offer to alternative employer. The  $D^3$  feature has resulted in the breakdown of the IC feature of the contract.

Assuming weak public enforcement of contracts, P will entertain the possibility to better his position by taking advantage of A's position weakened by delivery and costly retrieval. In the words of David Hume (1769), who first confronted this problem, A's delivery puts P "in a position of advantage" relative to A. Hume wondered why among farmers, the advantaged party does not always exercise his advantage. As observed, Hume's own solution was a combination of hardwired norm which he called "convention" towards cooperation and communitarian sanctions. The problem is most pronounced in jurisdictions where the state, the presumed enforcer of contracts, is itself the principal in contracts as in state procurement.

The familiar way to address this problem is for the agent to self-protect by reducing his own exposure  $e^*$ , that is, to recognize the adverse selection nature of the problem where P has the information advantage. This is done by replacing the PC in P.1 above by

$$hu(w) + (1-h)u(aw) - v(e) \geq U^0.$$

where "h" is the probability that P is an abider type, (1-h) the probability that he is a reneger and "a" is the extent of appropriation. Both "h" and "a" are presumed known and fixed. The corresponding first order conditions can be solved for  $e^*(U^0, h, a)$  and  $w^*(U^0, h, a)$  where  $(de^*/dh) > 0$  and  $(de^*/da) < 0$ . But this does not account for the possibility that "a" and "h" are interrelated and endogenous. That is, P's type may be endogenous to the environment and contract. We allow for this next.

### III. OPTIMAL QUASI-RENT APPROPRIATION

We first formally define the quasi-rent appropriation in this context:

*Definition 1:* Let  $a \in [0, 1]$  be the level of quasi-rent appropriation by P, that is, A receives from P the amount  $(1 - a)w^* \leq w^*$  for  $a \geq 0$ .

There are many possible deterrents to opportunism by P such as the probability of punishment meted by the public ordering, the capacity of A to retaliate/retrieve  $e$ , the loss of reputational capital to P (Klein, 2002), Hume's own hardwired "convention", etc. We will concentrate only on the first two above representing Klein's (2002) two genre of enforcement: that delivered by public ordering (what he calls court-enforcement) and that effected by a possible private ordering (what he calls contractual specification for self-enforcement).

Definition 2: A public ordering entity outside of the set of contractors imposes an expected penalty  $pL > 0$  on renegades from *observable* contract obligations where  $L$  is the statutory penalty and where  $p$ ,  $0 \leq p \leq 1$ , the probability of being punished in this possibly weak public ordering environment, is an increasing function of the extent “ $a$ ” of appropriation, that is,  $p(a)$ ,  $p' > 0$ ,  $p'' > 0$ ,  $p(0) = 0$ .

We assume that the existence of public ordering and its capability ( $pL$ ) is common knowledge. The expropriation by  $P$  triggers an attempt at retrieval of delivered effort  $e$  or some form of retaliation by  $A$ . This can directly affect the service of the delivered asset to  $P$ . We will represent this by a retrieval function.

Definition 3: The retrieval function  $e(a) = e^* - da$ ,  $d \geq 0$ .

Remark: The retrieval function gives the speed at which delivered effort degrades as appropriation rises. If  $d = 0$ , the service of the delivered effort is completely preserved.

Definition 4: The revenue function under possible retrieval/retaliation by  $A$  is  $R = f(e(a)) = g(a)$ ,  $g' \leq 0$ ,  $g'' < 0$ ,  $g(0) = f(e^*)$ ,  $g'(0) = 0$ .

The function  $g(a)$  embodies the capacity of  $A$  to retrieve  $e$  and/or retaliate in any form. The optimal appropriation  $a^*$  by  $P$ , for any  $w^*$  and  $L$  and suppressing other possible costs to  $P$ , once  $e^*$  has been delivered, is:

$$a^* = \operatorname{argmax} [g(a) - (1 - a)w^* - p(a)L]. \quad (1)$$

The first order necessary condition for an interior maximum is:

$$g' + w^* - p'(a^*)L = 0, \quad (2)$$

which can be solved for  $a^*$  as a function of  $w^*$  and  $L$ . The second order condition  $[g'' - p''L]$  is clearly negative. The optimal appropriation premium ( $a^*w^*$ ) is equivalent to Klein’s short term gains  $P$  can achieve by non-delivery. The following is obvious:

Claim 1: (i) Corner solution:  $a^* = 0$  if  $w^* < (p'L)$ ,  $(-g')$  or  $(p'L - g')$  for any  $a$ ; (ii) Interior solution: optimal quasi-rent appropriation  $a^*$  rises with  $w^*$  and falls with  $L$ .

Claim (1.i) gives the conditions under which quasi-rent appropriation will not occur: either a strong enough public ordering ( $p'L$ ) or a substantial enough retrievability ( $-g'$ ) or an adequate combination of the two ( $w^* < (p'L - g')$ ) when each alone is insufficient to deter opportunism by  $P$ . The latter combines

both public ordering and private ordering to complete the contract. This latter also implements Klein's (2002, p 61) observation that "contractors combine court-enforcement written contracts terms with self-enforced unwritten terms so as to optimally define the self-enforcing range of their relationship." Hume's own solution could be understood as subsumed under  $w^* < (p'L)$  where  $p'L$  includes both first party (hardwired convention) enforcement and third party enforcement (communitarian sanctions). When this happens, we say that the contract is self-enforcing in  $D^3$ .

Claim (1.ii) is as intuition suggests: a rise in  $w^*$  and/or a fall in statutory penalty  $L$  raises the optimal quasi-rent appropriation. The universe of Claim (1.ii) is the arena of the so-called Transactions Cost Theory of contracts (Brousseau and Glachant, 2002; Klein, 2002). In this scenario, additional private ordering devices must be found to complete the contract. In connection with last section's claim that the probability  $h$  of  $P$  being an abider may be endogenous and related to " $a$ ", we have:

*Corollary 1:* If either of the conditions in Claim (1.i) holds, then  $P$  will not renege.

#### IV. Staggered Delivery and Payment

When public ordering is weak or non-existent ( $p'L < w^*$ ), the incentives compatibility of  $C(w, e^*)$  under  $D^3$  can still be preserved by strengthening the retrieval property of the contract. From Claim (1.i), we know that when  $w^* < (-g')$ , there is no incentive to renege on contract  $C(w^*, e^*)$  even in  $D^3$ . When this happens we say that the contract has a strong retrieval property. The retrieval property could be inherent in  $e$  or it can be woven into the specification of the contract. For example when the contract length is one year, the payment of  $w$  may be staggered, say a twelfth every month for delivery of work promised for the month, rather than the whole amount at the end of the year which can be substantial and tempting. This staggering of payment has the effect of lowering the  $P$ 's opportunism gain. Weak public ordering has the effect of pushing the contract in the direction of spot contracting. When strong retrievability is woven into the contract, the  $D^3$  feature does not result in an incomplete contract. This is an example of Klein's observation of "...how contract terms may be used to facilitate self-enforcement." Deliberately weaving stronger retrievability into the contract may however entail some transactions cost and/or may make the exchange less efficient. What this suggests is that when public ordering is weak,  $A$  may demand and  $P$  may (or be forced to) agree to a delivery schedule that reduces the opportunism premium of  $P$  to harmless levels. This is as the Transaction Cost Theory of contracts views it. To quote Brousseau and Glachant (2002): "TCT insists on safeguards to protect each party from the potential for opportunistic behavior on behalf of the other and to provide incentives to commit to the transaction. In this regard, it emphasizes the *manipulation of the costs of breaking the agreement* – using security deposits ("hostages") or irreversible investments – and the *length of the commitment*."

And this facilitates self-enforcement and the existence of the contract. This choice of contract terms is common where weak public ordering is a given.

A propos our original question, the incentives compatibility of  $C(w^*, e^*)$  in  $D^3$  environments, we have shown the following:

*Corollary 2:* Suppose either of the conditions in Claim (1.i) holds. Then  $C(w^*, e^*)$  that solves (P.1) is incentives compatible in the  $D^3$  environment.

When neither of the conditions above are met and other deterrents (suppressed here) are collectively too weak, then quasi-rent appropriation will result ( $a^* > 0$ ) and the  $C(w^*, e^*)$  will fail to be incentives compatible in the  $D^3$  environment. The situation is especially rife in jurisdictions where the principal also happens to be the enforcer such as in state procurement contracts where politics may prompt non-delivery by the state. Then other adequate ex-ante private ordering such as ownership or vertical integration must be found for the exchange to exist.

## **V. Summary**

Our purpose in this paper is to give the conditions under which the incentives compatibility of the baseline symmetric information single-stage effort-in-advance contracts is robust against the introduction of the differential delivery dates ( $D^3$ ). When one party delivers his/her contract obligation ahead of others, he/she puts those others “in a position of advantage” as D Hume put it. The usual attack on the problem is to treat it as an adverse selection problem with A being in a position of informational disadvantage. This involves letting P’s type probability “h” and extent of appropriation “a” be fixed and known. The result is a contract with less effort into the bargain than when no such threat exists. But the type of P and the extent of appropriation may be endogenous to the environment and the contract. We model the optimal quasi-rent appropriation for the principal given the P-A contract when public ordering is weak. We derive the sufficient conditions for P not to abuse the position of advantage rendered him by the prior delivery by A. This involves a within-contract private ordering using the retrievability of e to augment the weak public ordering. The retrievability property need not be inherent in the investment e of A but can be woven into the fabric of the contract. Such for example is the staggering of the payments and delivery. In which case, the incentives compatibility of the P-A contract is preserved even under  $D^3$  and the likelihood of P’s reneging reduced to zero. When none of the ex-post deterrents are sufficient, the incentives compatibility of the contract is impaired and other ex-ante private ordering mechanisms must be adopted. Weaving self-enforcing specifications into the contract is especially important in jurisdictions where the state itself is the enforcer of contracts such as in state procurement.



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