REPEATED AUCTIONS OF INCENTIVE CONTRACTS,
INVESTMENT AND BIDDING PARITY
WITH AN APPLICATION TO TAKEOVERS

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ABSTRACT

This paper considers a two-period model of natural monopoly and second sourcing. The incumbent supplier invests in the first period. After observing the incumbent's first-period performance, the buyer may breakout in the second. The investment may be transferable to the second source or not; and may be monetary or in human capital.

The paper determines whether the incumbent should be favored at the reprocurement stage, and how the slope of his incentive scheme should evolve over time. It results from our analysis that the gains from second sourcing are not as high as one might hope.

Last it reinterprets the second source as a raider, and the breakout as a takeover. It discusses the desirability of defensive tactics, and obtains a rich set of testable implications concerning the size of managerial stock options, the amount of defensive tactics, the firm's performance and the probability of a takeover.

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I. INTRODUCTION

The regulation of a natural monopoly is often a repeated matter. If the regulated monopoly's performance is not adequate, it may be in the regulator's interest to look for another firm (or team of managers) to replace the incumbent. Second sourcing indeed occurs in the reprocurement of defense contracts, in the repeated bidding of franchises or in private contracting. Should auctions be set up, that sequentially pick the regulated firm? Should such auctions be concerned with bidding parity between the incumbent and the entrants? What is the incumbent firm's incentive to invest in physical capital? In human capital? The determination of the optimal breakout policy and its interaction with incentive schemes are the topics of this paper.

The "Chicago approach" to regulating a natural monopoly (Demsetz (1968), Stigler (1968), Posner (1972)) suggests that a monopoly franchise be awarded to the firm that offers to supply the product on the best terms. Franchise bidding may also be repeated over time to adjust for new, non-contracted-for circumstances or to encourage entry of another, more efficient firm. It allows the regulator to select the most efficient supplier at any point of time. Williamson (1976),[1] responding to this approach, has forcefully made the following points.[2]

1) Physical capital, and even more human capital, are not always easily transferable from one firm to the other. Hence symmetry between the firms is unusual at the franchise renewal stage. The incumbent enjoys an advantage over its competitors.

2) Even when the incumbent's capital is transferable, the corresponding investment is hard to measure. This is clearly true for non-monetary investments; for instance, the quality of past investment choices admits no monetary measure. Furthermore, accounting manipulations garble the measurement of monetary investments. For instance, the incumbent can integrate into supply or arrange kickbacks from the equipment suppliers; or he can affect depreciation charges. The prospect of possibly being replaced by an entrant lowers the incumbent's incentive to invest in capital which he will not be able to transfer at the right price.[3]

These two points form the building blocks of our model. We assume that part of the incumbent's investment is transferable (general) and part is non-transferable (specific) (point 1). Furthermore the regulator can observe the regulated firm's cost (or profit), but is unable to recover

the precise amount of investment from this aggregate accounting data (point 2).

The model has two periods. In the first, the regulator offers an incentive contract to a single firm (the incumbent, the first source). The incumbent's cost (which is the only variable observed by the regulator) is a function of the firm's intrinsic productivity or efficiency, the firm's first period "effort" and a monetary investment (by a simple relabelling of variables, the model also allows for a non-monetary investment). The firm knows its productivity and chooses both effort and investment. In the second period (reprocurement stage), the regulator can keep the incumbent or invite another firm (the entrant, the second source) to replace the incumbent. The entrant's intrinsic productivity is known to the entrant only and can be higher or lower than the incumbent's. The second-period cost of the selected firm depends on its efficiency, its second-period effort and on first-period investment (the entire investment for the incumbent, and only the transferable part for the entrant). We assume that the incumbent's and the entrant's efficiency parameters are drawn from a common distribution (that is, we attribute any ex-ante intrinsic discrepancy in second-period efficiency to non-transferable investment).

We focus on the interaction between the breakout rule and the intertemporal evolution of the slope of the incumbent's incentive scheme (optimal incentive schemes turn out to be linear in cost). We say that *bidding parity* obtains when the regulator selects the entrant if and only if his *second-period* efficiency exceeds the incumbent's, where these efficiencies include the effect of the first-period investment. The regulator favors the incumbent when he selects the entrant only if the entrant is sufficiently more efficient than the incumbent; and conversely. The Chicago school's recommendation alluded to above is tantamount to boosting bidding parity.

In the case of a transferable investment, any cost savings from the investment become savings for the second source if the first source is replaced. Because the investment is not observable and so cannot be compensated directly, the incumbent has too little incentive to invest since with some positive probability, the fruits of this costly investment will accrue to the second source. The regulator optimally uses both the breakout rule and the intertemporal evolution of the incentive scheme to correct this externality. First he favors the incumbent at the reprocurement stage to increase his incentive to invest (to see why this is optimal, note that a small departure from bidding parity implies only a negligible loss in ex-post productive efficiency). Second he provides for time-increasing incentives. The incumbent bears a small fraction of his first-period cost and therefore perceives investment as cheap. In contrast, he bears a high fraction of his second-period cost (if his contract is renewed), which, ex-ante gives him much incentive to invest.

The policy recommendations are quite different in the case of a *non-transferable* investment. In this case, the incumbent fully internalizes the social value of his cost savings, so that the previous externality does not exist. There however is a new effect: The incumbent has "on average" a cost advantage at the reprocurement stage. Our result, reminiscent of the theory of auctions with asymmetric bidders, is that, if the distribution of potential efficiencies satisfies the classic monotone hazard rate property, the auction should be biased in favor of the higher cost firm, i.e., the entrant. The slope of the incumbent's incentive scheme should be time-invariant.

Section II sets up the model, and section III solves for the optimal breakout rule and incentive schemes. Section IV studies a variant of the model in which the first-period effort to reduce first-period cost also reduces the second-period cost. This "learning-by-doing" investment

where β is the same parameter as in period 1 and e_2 is the effort exerted in period 2, at disutility $\psi(e_2)$.

The (potential) entrant has in period 2 a cost function:

$$C' = \beta' - e' - ki. \tag{3}$$

$\beta' \in [\underline{\beta}, \overline{\beta}]$ is the entrant's intrinsic cost parameter and is learned at the beginning of period 2 and e' is his level of effort. The entrant has the same function of disutility of effort as the incumbent. An additive uncertainty could be added to the costs without any change in our results, as will be clear from the cost linearity of optimal contracts.

Remark on non-monetary investments: In the introduction, we claimed that our model depicts both monetary and non-monetary investments. The formulation above assumes a monetary investment $(d(i)$ increases the first-period cost). To substantiate our claim, suppose that there is no monetary investment. The first-period cost is then

$$C_1 = \beta - \tilde{e} ,$$

where $\tilde{e}$ is the effort expected to reduce the first-period cost. The incumbent's managers exert a second-type of effort, that reduces the incumbent's second-period cost by $\tilde{\tilde{e}}$ (and the entrant's cost by $k\tilde{\tilde{e}}$). The first-period effort to obtain this cost reduction is $d(\tilde{\tilde{e}})$, so that the total first-period disutility of effort is $\psi(\tilde{e} + d(\tilde{\tilde{e}}))$. One may think of $d(\tilde{\tilde{e}})$ as the number of hours spent in the first-period on finding the right technology for the second period. A simple change in variables shows that this model is formally equivalent to the monetary investment model set up above: let $e_1 \equiv \tilde{e} + d(\tilde{\tilde{e}})$ denote the total first-period effort, and $i \equiv \tilde{\tilde{e}}$. Then, the first-period cost can be written:

$$C_1 = \beta - (e_1 - d(\tilde{\tilde{e}})) = \beta - e_1 + d(i).$$

The parameters β and β' are independently drawn from the same distribution with c.d.f. $F(\beta)$ and density function $f(\beta)$ continuous and positive on $[\underline{\beta}, \overline{\beta}]$ with $\dfrac{d}{d\beta}[F(\beta)/f(\beta)] \geq 0.$[5]

The regulator's problem is to organize production and transfers so as to maximize social welfare.

The incumbent's expected utility level is:

$$U = t - \psi(e_1) - \delta\pi\psi(e_2) \tag{4}$$

where δ is the discount factor, π is the probability that the incumbent will remain active in period 2, $t \equiv t_1 + \delta t_2$ is the net (i.e., in addition to the payment of realized costs by the regulator) expected (present discounted) transfer received by the firm from the regulator.

We will assume that the regulator has the ability to commit to two-period regulatory schemes.[6] To obtain the incumbent's participation the regulator must ensure that[7]

$$U \geq 0 \tag{5}$$

where the individual rationality (IR) level has been normalized to zero.

The entrant's utility level, if it is active in period 2, is:

$$V = t' - \psi(e') \tag{6}$$

where t' is the (expected) net transfer received from the regulator. The entrant's I.R. constraint is:

$$V \geq 0. \tag{7}$$

An utilitarian regulator wishes to maximize the sum of expected utilities of consumers and firms. Under complete information his instruments are the levels of investment, efforts, the transfers and the *breakout* rule (i.e., the choice of who is active in period 2).

Complete information implies that the (potential) entrant should be allowed to enter iff $\beta' < \beta^*(\beta, i) = \beta - (1 - k)i$.

Letting λ denote the shadow cost of public funds, the consumers' expected utility level is:

$$S - (1 + \lambda)(C_1 + t_1) + \delta(1 - F(\beta^*(\beta, i)))[S - (1 + \lambda)(C_2 + t_2)] \tag{8}$$

$$+ \delta \int_{\underline{\beta}}^{\beta^*(\beta, i)} (S - (1 + \lambda)(C'(\beta') + t'(\beta')))f(\beta')d\beta'$$

assuming that consumers have the same discount factor as the incumbent.

Since $\lambda > 0$, the IR constraints (5) and (7) are binding in the regulator's optimization program. This program thus reduces to:

$$\max_{\{e_1, e_2, e', i\}} \{S(1 + \delta) - (1 + \lambda)(\beta - e_1 + d(i) + \psi(e_1)) \tag{9}$$

$$- \delta(1 - F(\beta - (1 - k)i))(1 + \lambda)(\beta - e_2 - i + \psi(e_2))$$

$$- \delta(1 + \lambda) \int_{\underline{\beta}}^{\beta - (1 - k)i} (\beta' - e' - ki + \psi(e'))f(\beta')d\beta'\}$$

where e_1, e_2 and i are functions of β and e' is a function of β'. This is a quasi-concave problem[8] with first-order conditions:

$$\psi'(e_1) = \psi'(e_2) = \psi'(e') = 1 \tag{10}$$

$$d'(i) = \delta[(1 - F(\beta - (1-k)i)) + kF(\beta - (1-k)i)].$$

(11) tells us that investment should be set at the level that equates its marginal cost, $d'(i)$, with its expected social marginal utility which is δ if the investment is transferable ($k = 1$), but only $\delta(1 - F(\beta - i))$ if it is not ($k = 0$). The *positive externality* of the first-period investment on the entrant's cost must be internalized when it exists. (10) says that the marginal disutility of each type of effort must be equated to its marginal benefit.

In the next section we solve the regulator's optimization problem under incomplete information.

III. OPTIMAL REGULATION UNDER ASYMMETRIC INFORMATION

Suppose that the regulator still observes costs but does not know the parameters β and β' (even though it knows their distribution), and that it cannot observe effort levels. We also assume that the investment is unobservable by the regulator (the case of observable investment will be treated as a special case.)

The regulator's instruments are now cost reimbursement rules as well as a breakout rule. Using the revelation principle, this regulatory procedure can be viewed as a revelation mechanism for the incumbent composed of a contract $(C_1(\beta), C_2(\beta), t(\beta))$ and a breakout rule $\beta^*(\beta)$ and as a revelation mechanism for the entrant $(C'(\beta'/\beta), t'(\beta'/\beta))$. In this section, we use the abstract framework provided by the revelation principle to characterize the optimal allocation (efforts, investment, breakout rule). In section VI, we show how this optimal allocation can be implemented through familiar mechanisms like linear cost reimbursement rules, auctions and cancellation fees, and we develop some further empirical implications of the optimal regulatory scheme.

Before proceeding we should make a methodological point concerning the amount of information received by the entrant about the incumbent's productivity. The revelation principle tells us that the principal may w.l.o.g. ask the incumbent to truthfully announce his type: $\tilde{\beta} = \beta$. Should $\tilde{\beta}$ be revealed to the entrant? If not, the incumbent's first-period cost still reveals information about the incumbent's productivity. Is it worth distorting the first-period allocation to garble the entrant's information about β? For instance, if the optimal first-period regulation implies that C_1 perfectly reveals β (as will be the case here), would one want to induce some first-period pooling, so that the entrant would possess less information about β than the principal and possibly would bid more agressively? Fortunately the answer is no. Maskin and Tirole (1986), in their study of contracts designed by an informed principal, (here the regulator), show that, if preferences are *quasi-linear* (as is the case in this paper), the design of the contract for the entrant does not depend on whether the agent (here the entrant) knows the principal's information or not. Hence there is no point hiding the announcement $\tilde{\beta}$ from the entrant or distorting the first-period allocation.[9]

Let $U(\beta)$ be the rent extracted by an incumbent of type β. Following Laffont and Tirole (1987a), the incumbent's incentive compatibility and individual rationality constraints can be written:

$$\dot{U}(\beta) = -\psi'(\beta - C_1(\beta) + d(i)) - \delta(1 - F(\beta^*(\beta)))\psi'(\beta - C_2(\beta) - i) \tag{12}$$

$$U(\bar{\beta}) = 0 \tag{13}$$

with sufficient second-order conditions[10]

$$\frac{dC_1}{d\beta} \geq 0; \frac{dC_2}{d\beta} \geq 0; \frac{d\beta^*}{d\beta} \geq 0 \tag{14}$$

Equation (13) says that the least efficient type gets no rent at the optimum. Equation (12) stems from the fact that when the incumbent's intrinsic cost parameter is reduced by 1, the incumbent can reduce his effort by 1 in each period and obtain the same transfers. His rent is thus increased by $[\psi'(e_1) + \delta\pi\psi'(e_2)]$ where $\pi = (1 - F(\beta^*(\beta)))$ is the probability of no breakout.

Moreover, since investment is non-observable we must consider the (moral hazard) constraint[11] describing the incumbent's choice of investment:

$$-d'(i)\psi'(\beta - C_1(\beta) + d(i)) + \delta(1 - F(\beta^*(\beta)))\psi'(\beta - i - C_2(\beta)) = 0. \tag{15}$$

For, suppose that the firm contemplates a unit increase in investment. The extra investment cost is $d'(i)$. To keep the first-period cost (and thus reward) constant, effort must be increased by the same amount, at disutility $\psi'(e_1)d'(i)$. In turn, the second-period effort can be reduced by 1, saving disutility $\psi'(e_2)$, with probability $1 - F(\beta^*(\beta))$.

Similarly, let $V(\beta'/\beta)$ be the rent extracted by an entrant of cost characteristic β' when the incumbent's type is β. The entrant's incentive and IR constraints can be written:

$$\frac{\partial V}{\partial \beta'}(\beta'/\beta) = -\psi'(\beta' - ki - C'(\beta'/\beta)) \tag{16}$$

$$V(\beta^*(\beta)/\beta) = 0 \tag{17}$$

with the second order condition $\dfrac{dC'}{d\beta'} \geq 0$.

Integrating (16) with (17) as a boundary condition yields

$$V(\beta'/\beta) = \int_{\beta'}^{\beta^*(\beta)} \psi'(\tilde{\beta} - ki - C'(\tilde{\beta}/\beta))d\tilde{\beta}. \tag{18}$$

Using U and V as state variables, the regulator's maximization problem can be written as the following optimal control problem:

$$\text{Max} \int_{\underline{\beta}}^{\bar{\beta}} \{S(1 + \delta) - (1 + \lambda)(C_1(\beta) + \psi(\beta - C_1(\beta)) + d(i))) - \lambda U(\beta) \tag{19}$$

$$- \delta(1 - F(\beta^*(\beta)))(1 + \lambda)(C_2(\beta) + \psi(\beta - i - C_2(\beta)))$$

$$-\delta\int_{\underline{\beta}}^{\beta^*(\beta)}[(1+\lambda)(C'(\beta'/\beta)+\psi'(\beta'-ki-C'(\beta'/\beta))+\lambda V(\beta'/\beta))f(\beta')d\beta']f(\beta)d\beta$$

s.t. (12) (13) (15) (16) (17)

In this formulation, the regulator's objective function has been rewritten to separate the efficiency costs of the form $(1+\lambda)(C+\psi)$ and the "distributional" costs λU and λV.

Remark 1: As some second-order conditions are only sufficient, we do not impose them and check later that they are satisfied by our solution.

Remark 2: We do not allow the incumbent's contract to depend on the entrant's realized cost C' following a breakout. In the case of non-transferable investment, our omission does not involve any loss of generality because C' does not contain any information about i. However, it does involve a loss of generality for transferable investments (an artifact of the risk neutrality framework is that such a dependence would enable the first best level of investment to be achieved with sufficiently large penalties). We feel that ignoring such a dependence of t on C' is a good approximation to reality for several reasons. First, this dependence would create a delayed transfer or penalty. So the displaced incumbent would for instance be required to pay a penalty 5 or 10 years after the breakout which raises the issue of the feasibility of such long-run contracts (in contrast, our transfers can follow production immediately). Second, and maybe more importantly, the entrant's cost may be subject to manipulation. Indeed, ex-post, the entrant and the regulator have an incentive to tinker with accounting data on C' so as to force the incumbent to pay a penalty. So letting incumbent's reward depend on the entrant's cost may not be feasible after all. Third, in the presence of cost uncertainty and risk aversion (or alternatively of limited penalties), the incumbent would not bear a large fraction of its successor's realized cost. To summarize, while some dependence of the incumbent's reward on post-termination performance may be feasible in some instances, it is at most a limited instrument, which leaves ample scope for the policies described in this paper.[12]

Solving (19) we obtain:

Proposition 1: With transferable and unobservable investment, the optimal breakout rule favors the incumbent $(\beta^*(\beta) < \beta)$ *except at* $\beta = \underline{\beta}$, *where bidding parity obtains:* $\beta^*(\underline{\beta}) = \underline{\beta}$. *Bidding parity* $(\beta^*(\beta) = \beta)$ *holds when the investment is transferable and observable.*

Proof: see Appendix.

The intuition of this result is straightforward. When investment is transferable and observable, the regulator can directly force the incumbent to internalize the positive externality on the entrant's cost by imposing the right level of investment. As the firms' efficiencies are drawn from the same distributions, bidding parity should hold. Incentives questions remain separate from the breakout rule. If investment is unobservable, there is underinvestment because the incumbent

has no reason to internalize the externality. The regulator then mitigates this inefficiency by raising the probability that the incumbent remains active in period 2. This is achieved by favoring him in the breakout rule. An incumbent of type $\underline{\beta}$ has a zero probability of being replaced. He thus invests the socially optimal amount, and the selection rule need not be biased to encourage investment.

The next result is that the regulator also alters the incentive schemes to remedy this externality problem. This is best explained by replacing the non-linear transfer functions $t(C)$ by means of linear contracts as in Laffont and Tirole (1986).[13]

The transfers can then be written (see proof of Proposition 2)

$$t_1(C_1^q, C_1) = G_1(C_1^q) - K_1(C_1^q)(C_1 - C_1^q)$$

for the incumbent in period 1

$$t_2(C_2^q, C_2/C_1^q) = G_2(C_2^q, C_1^q) - K_2(C_2^q)(C_2 - C_2^q)$$

for the incumbent in period 2 (in case of no breakout)

$$t'(C'^a, C'/C_1^q) = G'(C'^a, C_1^q) - K'(C'^a)(C' - C'^a)$$

for the entrant in period 2 (in case of breakout)

where t_1, t_2 and t' are the net transfers (after cost reimbursement), G_1, G_2 are G' are the fixed components of the transfers, K_1, K_2, K' the slopes of the incentive schemes (these slopes are equal to 0 for cost-plus contracts and to 1 for fixed-price contracts), and "a" denotes an expected value.

The interesting questions refer to the slopes of the incentive schemes. We obtain

Proposition 2: With unobservable and at least partly transferable investment ($k > 0$), the incumbent's first-period's incentive scheme is "low-powered" relative to the second-period's ($K_1 < K_2$). Because the observable investment slope is time-invariant and lies between K_1 and K_2, unobservability calls for a flatter incentive scheme in the first period and a steeper incentive scheme in the second period.

Proof: see Appendix.

The intuition is that a contract resembling more a cost-plus contract in the first period lowers the incumbent's investment cost, while a contract closer to a fixed price contract in the second period allows the incumbent to cash the proceeds of the investment.

The results are quite different when investment is specific.

Proposition 3: (*i*) *With unobservable non-transferable investment the optimal breakout rule favors the entrant* ($\beta^*(\beta) > \beta - i$). (*ii*) *The unobservability of non-transferable investment imposes no cost on the regulator.*

Proof: see Appendix.

Part (ii) of Proposition 3 is unsurprising. A classical result in incentive theory is that the slope of the incumbent's incentive scheme must be time-invariant if investment is observable (see the proof of Proposition 3). Because there is no externality between the incumbent and the entrant when investment is non-transferable, and because the incumbent and the regulator intertemporal preferences coincide (due to the constant slope and identical discount factors), the incumbent correctly selects the socially optimal investment; that is, unobservability of investment imposes no social loss.

Part (i) of Proposition 3 is more subtle than part (ii) and relies on the monotone hazard rate assumption. To understand it, it is convenient to recall the static single firm regulatory problem. Let β be drawn from a cumulative distribution function $F(\cdot)$, with density $f(\cdot)$ on $[\underline{\beta}, \overline{\beta}]$. When choosing an incentive scheme for the firm, the regulator must trade off efficiency (which would call for a fixed price contract), and minimization of the firm's informational rent (which would call for a cost-plus contract). This trade off yields a distortion in the effort allocation for all $\beta > \underline{\beta}$. By reducing the distortion in effort for parameter β, the regulator realizes a gain proportional to $f(\beta)$. At the same time, it must give a higher rent to all types of firms that are more efficient than β (in proportion $F(\beta)$), because the latter can always mimic the behavior of a less efficient firm. At the optimum, the marginal gain in efficiency must equal the marginal cost associated with the firm's expected rent. Now consider our two-period model. Suppose that the incumbent's and the entrant's productivity parameters β and β' are independently drawn from the same distribution $F(\cdot)$ (that is, we want to attribute any observable discrepancy in intrinsic efficiency to the incumbency advantage). Suppose that, in the second period, the regulator does not favor the incumbent or the entrant, and consider parameters β and β' such that the two firms have the same *second-period* intrinsic efficiency. In the presence of specific investment, $\beta' = \beta^*(\beta) = \beta - i < \beta$. Thus, if we make the classic assumption that the hazard rate F/f is an increasing function, one has $F(\beta^*)/f(\beta^*) < F(\beta)/f(\beta)$. This means that at equal second-period intrinsic efficiency, the optimal regulation of the entrant calls for less distortion of effort than that of the incumbent. An equivalent way of rephrasing this intuition consists in noticing that the selection of a firm amounts to an upward truncation of the distribution of its productivity parameter. Thus, at equal second-period intrinsic efficiency, the regulator is less uncertain about the entrant's productivity than about the incumbent's, and therefore can regulate the entrant more efficiently. Specific investments thus call for favoring the entrant at the reprocurement stage. We call this effect the *rent differential effect*.

An interesting analogy with the literature can be drawn here. Demski, Sappington and Spiller (1987) offer a second sourcing example in which the purchaser selects the entrant rather than the incumbent to be the producer, even though he knows that the incumbent has lower production costs (Corollary 5, page 91. For similar results, see Caillaud [1985], and in the classic context of auctioning of an object, Myerson [1981] and McAfee-McMillan [1984]). The Demski et al. model

does not have any investment. However, the incumbent's and the entrant's production costs are in this example drawn from asymmetric distributions: the incumbent's cost distribution is assumed to stochastically dominate the entrant's. Our model does presume identical cost distributions ex-ante, but the existence of specific investment confers a (statistical) superiority on the incumbent ex-post. Like Demski et al., we find that this stochastic dominance by the incumbent calls for favoring the entrant.

Two last points to conclude this section:

First, in spite of the incentives to invest described in Propositions 1 and 2, it is still the case that the incumbent *underinvests relative to the social optimum.*[14]

Second, a reasonable conjecture is that the bias in the breakout rule $(\beta - i) - (\beta^*(\beta) - ki)$ be an increasing function of k. We have proved this result only in the case of observable investment and k in a neighborhood of 1. We suspect the property holds more generally.

IV. LEARNING BY DOING

An interesting variant of our model allows learning by doing rather than investment to reduce the second-period cost. We now assume that the incumbent's effort in period 1, e_1, affects costs in period 2.

$$C_2 = \beta - e_2 - (a + b)e_1 \tag{20}$$

and

$$C' = \beta' - e' - ae_1. \tag{21}$$

where $a, b \geq 0$. That is, the fraction $\tilde{k} \equiv a/(a + b)$ is transferable to the entrant. One may have in mind that the incumbent exerts effort that yields "tricks" or technologies that reduce his first-period production cost, and that will still be used in period 2.

Under complete information the breakout rule is $\beta^*(\beta) = \beta - be_1$. The optimal effort levels would be determined by the program:

$$\underset{\{e_1, e_2, e'\}}{\text{Max}} \quad \{S(1 + \delta) - (1 + \lambda)(\beta - e_1 + \psi(e_1)) \tag{22}$$

$$- \delta(1 - F(\beta - be_1))(1 + \lambda)(\beta - e_2 - (a + b)e_1 + \psi(e_2))$$

$$- \delta(1 + \lambda)\int_{\beta}^{\beta - be_1} (\beta' - e' - ae_1 + \psi(e'))f(\beta')d\beta'\}$$

with first order conditions.[15]

$$\psi'(e_1) = 1 + \delta a + \delta b(1 - F(\beta - be_1)) \tag{23}$$

$$\psi'(e_2) = 1 \tag{24}$$

$$\psi'(e') = 1. \tag{25}$$

In particular (23) equates the marginal disutility of effort to its total marginal social benefit, i.e., the first period benefit, 1, plus the transferable effect on second period, δa, plus the expected specific effect, $\delta b (1 - F(\beta - be_1))$.

Under incomplete information we must add the incentive constraints in the regulator's optimization program. Following the same lines of argument as in Section IV we obtain:

Proposition 4: With unobservable and fully transferable learning by doing ($b = 0$), the breakout rule favors the incumbent ($\beta*(\beta) < \beta$).

Proof: See Appendix.

There are now two effects favoring the incumbent: the externality effect of Proposition 1 and the *learning by doing effect*. Recall that the incumbent's informational rent comes from the possibility of mimicking a less efficient type's cost by exerting less effort. Under learning by doing, a reduction in the first-period effort reduces the second-period efficiency and rent, and this all the more if the probability of keeping the franchise is high. So, the regulator by increasing the probability of choosing the incumbent in the second period, makes it more costly for the incumbent to hide his efficiency in the first period. This effect (which does not exist for monetary investments) calls for favoring the incumbent.

When learning is partly specific, the relevant comparison for $\beta*(\beta)$ is with $\beta - be_1$. Now at $\beta* = \beta - be_1$ the rent obtained by the incumbent is higher at the parity point and this calls for favoring the entrant as in Proposition 3. It can be shown that either effect may dominate the other: see Laffont-Tirole (1987a). In particular, when the learning is purely specific ($a = 0$), we have two opposite incentive effects, the learning by doing effect and the rent differential effect.

A striking feature of the analysis in section III is that the slope of the incumbent's incentive scheme must be time-increasing to encourage him to invest. In contrast, when investment is embodied in the first-period effort, lowering the incumbent's cost of investing is achieved through a high, rather than low, slope of the first-period incentive scheme. That is, choosing a low first-period effort is costly to an incumbent who bears a high fraction of his first-period cost. (Indeed, $K_1(\beta)$ exceeds 1 for efficient βs, while in the solution in Section III, $K_1(\beta) \leq 1$ for all β). The next proposition specializes the model to the "uniform-quadratic case": β is distributed uniformly on $[\underline{\beta}, \bar{\beta}]$ and $\psi(e) = e^2/2$ (the result is ambiguous for the more general model):

Proposition 5: With unobservable learning by doing, in the uniform-quadratic case, the first-period incentive scheme is steeper than the second-period one: $K_1(\beta) > K_2(\beta)$ for all β.

V. DISCUSSION

Table 1 summarizes the analysis of the optimal allocation:

Nature of Investment		Breakout Rule	Time-Invariance of Slope of Incentive Schemes
Transferable	Observable Investment	Bidding Parity	Yes
	Unobservable Monetary or Nonmonetary Investment	Incumbent Favored (Externality effect)	No $(K_1 < K_2)$
	Learning by Doing	Incumbent Favored (Externality effect + learning effect)	No
Non-transferable	Observable Investment	Entrant Favored (Rent differential effect)	Yes
	Unobservable Monetary or Nonmonetary Investment		
	Learning by Doing	Ambiguous (Two opposite effects: learning and rent diffential)	No

The previous analysis aimed at generality and allowed many technological patterns. Before proceeding, it is worth assessing the relevance of the various effects leading the regulator to rig the bidding process. It should be clear that our focus is on sizeable, nonobservable investments. When investments matter, breakouts are most likely to be observed (and to be socially desirable) when the entrant is not too much at a cost disadvantage, i.e., when it benefits from the incumbent's investment. However, the incumbent should be favored at the reprocurement stage precisely when investment is transferable. These two facts lead us to a somewhat pessimistic assessment of how much regulators can hope to gain by using second sourcing in a natural monopoly situation involving substantial investments. Although substantial intrinsic cost differences between the firms may justify breakouts, it seems that our recommendations are more likely to apply to industries with transferable investments. In the rest of the paper, we focus on such industries. Section VI derives some further recommendations and testable implications of our model. Section VII shows how our results apply to takeovers (we would argue that in this case most of the firm's assets are transferable to a second source, i.e., to a raider).

VI. TRANSFERABLE INVESTMENT

We now specialize the model of Section III to transferable investment, a quadratic disutility of effort and a uniform distribution of cost parameters:

Assumption A:

A1) $k = 1$

A2) $\psi(e) = e^2/2$

A3) $F(\cdot)$ is uniform on [0,1]

A4) $1 > (2\lambda)/(1 + \lambda)$.

Assumption A4 is technical (and is consistent with the second-order conditions which require that λ not be too large).

We can now state:

Proposition 6: Under assumption A,

(i) *The bias in favor of the incumbent is higher, the less efficient the incumbent (that is,*

$$\frac{d}{d\beta}(\beta - \beta^*(\beta)) > 0).$$

(ii) *The incumbent exerts more effort in the second period than the type of the entrant which makes entry socially indifferent (that is, $e_2(\beta) > e'(\beta^*(\beta))$).*

Proof of Proposition 6: See Appendix 1.

Part (i) of Proposition 6 conveys an important intuition: An inefficient incumbent is replaced with high probability, and therefore invests little. The bidding process must then be biased considerably so as to encourage him to invest. Part ii) compares $e_2(\beta)$ and $e'(\beta^*(\beta))$. We knew that $e_2(\beta) > e'(\beta)$. However, there is a second effect, coming from the fact that $\beta^*(\beta) < \beta$ and that e' is decreasing. The two effects work in opposite directions, but the first dominates.

We saw in section III that transferable investments call for special incentives to invest: bias in the breakout rule and time-increasing incentives. An inefficient incumbent exerts a particularly high externality because of a high probability of breakout. Proposition 6 showed that the breakout rule is distorted more for inefficient incumbents. Proposition 7 is its counterpart for the distortion in the slopes of the incentive scheme: An inefficient incumbent should face incentives that sharply rise over time.

Proposition 7: Under assumption A and if λ is "not too large,"

$$\frac{d}{d\beta}(K_2(\beta) - K_1(\beta)) > 0.$$

Proof: available from the authors upon request.

Proposition 6 enables us to obtain some interesting results on the second-period bidding process. Like in Laffont-Tirole [1987b], one can view this bidding process as a first- or second-bid auction in which each bidder (here each firm) bids for the right to choose from a menu of monopoly linear incentive contracts. Unlike in our earlier auction paper, the menus of contracts differ between the two competitors, because of the asymmetry of the problem. Let $U_2(\beta)$ denote the incumbent's second-period rent associated with the right to choose in his menu of contracts. Similarly, let $U'(\beta')$ denote the entrant's second-period rent. From incentive compatibility, we know that:

$$dU_2/d\beta = -\psi'(e_2(\beta))$$

and

$$dU'/d\beta' = -\psi'(e'(\beta')).$$

$U_2(\cdot)$ and $U'(\cdot)$ are thus defined up to positive constants. Although we will be mainly interested in their derivatives, we normalize these functions by imposing second-period individual rationality constraints. That is,

$$U_2(\overline{\beta}) = 0$$

and

$$U'(\beta*(\overline{\beta})) = 0$$

[recall that the highest β' who may be allowed to produce is $\beta*(\overline{\beta})$].

Now consider a second-period first- or second-price auction in which each firm bids for the right to choose from its menu of linear incentive schemes. For simplicity, we treat the case of a second-price auction (the first-price auction yields the same outcome from the usual equivalence theorem). Then the incumbent bids $U_2(\beta)$ and the entrant bids $U'(\beta')$. Now, in general, the equation $U_2(\beta) = U'(\beta')$ yields $\beta' \neq \beta*(\beta)$, so that the second-price auction does not necessarily select the right firm. *The auction must thus be biased.* One way of doing so is to introduce a "golden parachute" or "cancellation fee" $G(\beta)$ to be paid to the incumbent if he is replaced. So, one can envision a first-period contracting process in which the incumbent chooses a first-period incentive scheme and a second-price golden parachute. The second-period allocation is determined by the above described auction.

In order for the right firm to be selected, the golden parachute must satisfy:

$$U_2(\beta) - G(\beta) = U'(\beta*(\beta)),$$

as the incumbent shades his second-period bid by $G(\beta)$. So

$$G(\beta) = \int_\beta^{\overline{\beta}} \psi'(e_2(x))dx - \int_{\beta*(\beta)}^{\beta*(\overline{\beta})} \psi'(e'(x))dx$$

or

$$G(\beta) = \int_{\beta}^{\bar{\beta}} [\psi'(e_2(x)) - \psi'(e'(\beta^*(x))) \frac{d\beta^*}{d\beta}(x)]dx.$$

We have:

Proposition 8: Under assumption A, the golden parachute is positive, and increases with the incumbent's efficiency (that is, $G(\beta) \geq 0$, $\dot{G}(\beta) < 0$).

Proof of Proposition 8: For a quadratic disutility of effort, one has:

$$G(\beta) = \int_{\beta}^{\bar{\beta}} (e_2 - e' \frac{d\beta^*}{d\beta})dx$$

Proposition 6 implies that $e_2 > e' \frac{d\beta^*}{d\beta}$.

Q.E.D.

As we mentioned earlier, the important result in Proposition 8 is that the golden parachute decreases with the firm's efficiency.

To summarize, the optimal allocation can be implemented by a second-period auction, in which each firm bids for the right to be the monopoly supplier. Efficient selection is obtained by offering in the first-period a golden parachute together with a first-period incentive scheme. The golden parachute is characterized in Proposition 8.

Rather than using cancellation fees (golden parachutes), the regulator can have the entrant pay an entry fee to bias the auction. Let $P(\beta)$ denote this entry fee[16] (P stands for "poison pill," because, as a rough description, a poison pill forces a raider to pay an extra-price to acquire the firm). In the context of our model, an entry fee is equivalent to a negative cancellation fee (in a more general model, the two instruments would not be perfect substitutes). Reinterpreting Proposition 8, we see that the entry fee should decrease with the incumbent's efficiency ($\dot{P}(\beta) > 0$): An efficient incumbent should be protected relatively less than an inefficient one.

Last, we summarize in Table 2 our recommendations and testable implications for transferable investments.

A	B
• Incumbent's performance (minus cost, profit)	• Probability of second sourcing
• Slope of the incumbent's incentive schemes (K_1, K_2)	• Intertemporal increase in the slope of the incumbent's incentive $(K_2 - K_1)$
• Cancellation fee	• Entry fee

Table 2. Variables in class A are positively correlated among each other, and are negatively correlated with the variables in class B.

VII. A REINTERPRETATION: TAKEOVERS AND MANAGERIAL MYOPIA.

As mentioned in the introduction, our model of second sourcing can shed some light on the desirability of takeovers. The entrant can be reinterpreted as a raider, the incumbent as the current managerial team. The accounting cost stands for per-period performance (profit or stock value). The cost parameter (β) is a measure of the inefficiency of current management, and the effort variable (e) refers to the possibility of self-dealing management (appropriation of profits, luxurious offices, personal jets, golf playing . . .). The reprocurement stage can be thought of as a tender offer.[17] The rigging of bidding parity in favor of the incumbent or the entrant is a rough formalization of defensive tactics and protakeover measures respectively.[18]

Our assumption that the incumbent's incentive scheme is not contingent on the entrant's performance translates into the assumption that the displaced managerial team does not keep substantial stock options in the firm after leaving. This latter assumption is made in most of the literature on the market for corporate control (e.g., Blair et al [1986], Grossman-Hart [1987], Harris-Raviv [1987]). Theoretical reasons can be found to motivate it. While the arguments advanced in the context of regulation (in particular the collusion argument - see section III) fare less well in this context, it is well-known that if the managers are risk averse, the raider and displaced managers have ex-post an incentive to renegotiate former contracts and may let the displaced managers resell stock options, which no longer serve an incentive purpose and create an excessive risk in the displace managers' portfolio.[19]

Another effect limiting the role of post-termination stock options is that, if there is no merger (so that the firm's stock remains traded), minority freeze-out problems are very acute. In this case, covenants must be imposed that greatly reduce the information value of the firm (see Holström-Tirole (1987) for an informal development of this point). At a more empirical level, this assumption also makes some sense. First, many acquired firms do not have outstanding shares after the takeover. So the incumbent manager automatically exercise their stock options. Second, even if the raider only acquires control, many managerial contracts specify that the managers must exercise their options within 90 days if their employment is terminated (so, in the context of our model, the options are exercised well before the investment pays off). We feel that stock options encourage the

incumbent managers to internalize the positive externality of *observable* investment on the raiders' post-takeover performance. Our point is that they very insufficiently or not at all make them internalize the effect of investments that are *not observable* by the market.[20]

Some implications of our model in the takeover context are (assuming that investment is transferred to the raider and is not of the learning by doing type):

1. Firm performance and probability of takeover are negatively correlated.
2. The use of defensive tactics to disadvantage the raider benefits the firm's shareholders.
3. The managers are given linear incentive schemes, which can be interpreted as stock options. Their incentive package also includes golden parachutes and/or poison pills.
4. The incumbent manager's stock options increase over time.
5. The size of the golden parachute is positively related to the number of stock options.
6. The size of the golden parachute is positively related to the firm's performance.
7. The amount of poison pills is negatively correlated with the incumbent manager's stock options.
8. The amount of poison pills is negatively correlated with the firm's performance.

Conclusion 2 suggests that defensive tactics are not necessarily harmful.[21] While most of the incentive literature on the topic views takeovers as a managerial discipline device, we do feel that the popular fear of managerial myopia should not be neglected by economists.

Remark 1: We should emphasize that our results are predictions for an optimal contract. Our view that the shareholders organize a bidding contest between managerial teams may be too simplistic. So caution should be exercised when applying our conclusions. But it is worth noting that Walking and Long [1986] found that managers with large stock holdings are less likely to oppose takeovers than managers with small stock holdings; and that Malatesta and Walking [1986] provided evidence that firms who adopt poison pill defenses are relatively unprofitable. Such empirical evidence is consistent with our normative analysis.

Remark 2: It is worth recalling the intuition of why the golden parachute (respectively, the poison pill) should increase (respectively, decrease) with the manager's ability and performance. A first guess might have been that bad managers should be encouraged to leave through high golden parachutes and low poison pills. This however, is not correct, as bidding between managers already selects the best managers. Our point is that the auction should be rigged to encourage managers to invest. A (good) manager with probability .9 of keeping his job picks roughly the right amount of investment, and further incentives are not needed. A (bad) manager probability .1 of keeping his job picks an inefficiently low investment (with probability .9, this investment goes to a rival manager). A low golden parachute of a high poison pill increase his probability of keeping his job and his incentive to invest.

Remark 3: Our paper supplies an *efficiency* reason for foreclosing entry. That is, a social planner, whose objective function puts equal weight on the incumbent and the entrant, biases the auctioning process against the entrant. When the principal is a private entity (as is the case for shareholders),

the contract signed between the principal and the incumbent does not internalize its effect on the entrant's welfare. Aghion and Bolton [1987] have shown that the desire to extract the entrant's rent leads the two initial parties to sign a contract that favors the incumbent (induces too little "trade" between the initial vertical structure and the entrant): There is socially too much foreclosure. Note that both Aghion and Bolton's and our theories yield the same positive implication: the incumbent is favored at the reprocurement stage. In our model, poison pills, for instance, have both *efficiency* as well as Aghion-Bolton's *anti-competitive* motives.

Remark 4: Hermalin (1987), and Stein (1988) also analyze the popular argument that the takeover threat may lead to underinvestment. Their models differ from ours in many respects and can be thought of as complementary. In these analyses, investment pays off before the raider enters the market for corporate control (i.e., in period 1, in the context of our model). Incumbent managers may not invest even in the presence of profitable opportunities, because the probability of success of the investment is positively correlated with the manager's ability, and a failure signals a low ability and may encourage a takeover. These papers emphasize how signaling (managerial career concerns) distorts managerial *decisions* (more generally than investments), that might convey information about managers. Our paper assumes in contrast that investment has long-delayed effects,[22] and we focus on the intertemporal evolution of managerial profit-sharing schemes.

VIII. CONCLUDING REMARKS

In this paper we bring some elements of answer in the agenda set by Williamson (1976) and the Chicago school concerning the optimal organization of franchise bidding for natural monopolies. We came up with a relatively pessimistic assessment of the virtues of second-sourcing (or takeover) when substantial investments are at stake.[23] The incumbent should be favored at the reprocurement stage precisely when the investment is transferable, that is when the second source is not too much at a cost disadvantage. Indeed the incumbent should be favored more, the higher the probability of second sourcing. To pursue this research it seems desirable to study various forms of non-commitment due either to incomplete contracting and renegotiation (see Grossman-Hart (1986), Klein et al (1978), Tirole (1986) and Williamson (1975) for investment concerns and Laffont-Tirole (1988b)) for the ratcheting problem; or to the possibility of mutually advantageous renegotiation (see Dewatripont (1986), Hart-Tirole (1987) and Laffont-Tirole (1988a)).

In an incomplete contract setting, property rights do serve as switching incentives together with cancellation and entry fees. For instance, in defense procurement, the government sometimes owns the property rights on data and technological information and sometimes does not. Leaving the property right to the defense contractor can be viewed as a way of biasing the reprocurement stage in his favor; for the government must bargain with and pay some money (the equivalent of a cancellation fee) to the defense contractor for the right to supply the relevant information to a second source. Property rights have thus some of the features of the switching incentives considered in this paper. In a takeover context, the corporate charter may influence the easiness with which a raider can take control of the firm, through super–majority provisions and staggered board elections (in this respect, it is interesting to note that Grossman and Hart (1987) argue informally that family–run

firms may sink considerable investments, and therefore may want to fight control changes through the allocation of voting rights).

Last, we showed that a rich yet tractable model can be built that yields testable equilibrium relationships between switching incentives (like golden parachutes and poison pills), managerial incentive schemes (like cost sharing and stock options), probability of second sourcing and incumbent's performance.

APPENDIX

Proof of Proposition 1:

The optimization problem is quasi-concave (for λ small enough) and separable. For given β and $\beta^*(\beta)$, we can maximize the inside integral with respect to C' under the constraints (16) and (17). The first-order condition of this control problem (see Laffont and Tirole (1987a) yields effort $e'(\beta') = e^*(\beta')$, where $e^*(\beta')$ is given by:

$$\psi'(e^*(\beta')) = 1 - \frac{\lambda}{1+\lambda} \frac{F(\beta')}{f(\beta')} \psi''(e^*(\beta')) \tag{A.1}$$

for any $\beta' < \beta^*(\beta)$. Equation (A.1) defines the optimal effort level and therefore the optimal C' function:

$$C'(\beta'/\beta) = \beta' - ki(\beta) - e^*(\beta'). \tag{A.2}$$

If he is selected $(\beta' < \beta^*(\beta))$, the entrant has rent:

$$V^*(\beta'/\beta) = \int_{\beta'}^{\beta^*(\beta)} \psi'(e^*(\tilde{\beta})) d\tilde{\beta}. \tag{A.3}$$

We can now maximize (19) with respect to $C_1(\beta)$, $C_2(\beta)$, $\beta^*(\beta)$ and $i(\beta)$ subject to (12), (13), and (15).

Let $\mu(\beta)$ (resp. $\nu(\beta)$) be the multiplier of the constraint (12) (resp. (15)).
The Pontryagin's principle yields:

$$\dot{\mu}(\beta) = -\frac{\partial H}{\partial U} = \lambda f(\beta) \tag{A.4}$$

Using the transversality condition at $\underline{\beta}$ we have:

$$\mu(\beta) = \lambda F(\beta). \tag{A.5}$$

Maximization with respect to C_1, C_2, β^*, i gives.

$$\psi'(e_1(\beta)) = 1 - \frac{\lambda F(\beta)}{(1+\lambda)f(\beta)} \psi''(e_1(\beta)) + \frac{\nu(\beta)d'(i)}{(1+\lambda)f(\beta)} \psi''(e_1(\beta)) \tag{A.6}$$

$$\psi'(e_2(\beta)) = 1 - \frac{\lambda}{1+\lambda} \frac{F(\beta)}{f(\beta)} \psi''(e_2(\beta)) - \frac{\nu(\beta)}{(1+\lambda)f(\beta)} \psi''(e_2(\beta)) \tag{A.7}$$

$$[\beta - i - e_2(\beta) + \psi(e_2(\beta))] - [\beta^* - ki - e'(\beta^*) + \psi(e'(\beta^*))] \tag{A.8}$$

$$= \frac{\lambda}{1+\lambda} \left[\frac{F(\beta^*)}{f(\beta^*)} \psi'(e'(\beta^*)) - \frac{F(\beta)}{f(\beta)} \psi'(e_2(\beta)) \right]$$

$$- \frac{v(\beta)}{(1+\lambda)f(\beta)} \psi'(e_2(\beta))$$

$$0 = -(1+\lambda)f(\beta)d'(i)\psi'(e_1(\beta)) + (1+\lambda)\delta(1-F(\beta^*(\beta)))\psi'(e_2(\beta))f(\beta) \tag{A.9}$$

$$- \lambda F(\beta)[d'(i)\psi''(e_1(\beta)) - \delta(1-F(\beta^*(\beta)))\psi''(e_2(\beta))]$$

$$+ v(\beta)[d'(i)^2\psi''(e_1(\beta)) + \psi'(e_1(\beta)) + \delta(1-F(\beta^*(\beta)))\psi''(e_2(\beta))]$$

$$+ f(\beta)k\delta[\int_{\underline{\beta}}^{\beta^*(\beta)} (1+\lambda)\psi'(e'(\beta'))f(\beta')d\beta' + \lambda\int_{\underline{\beta}}^{\beta^*(\beta)} \int_{\beta'}^{\beta^*(\beta)} \psi''(e'(\tilde{\beta})d\tilde{\beta}f(\beta')d\beta'].$$

Integrating the last line of (A.9) and using the first-order condition with respect to C' we can replace this last line by: $f(\beta)\delta k F(\beta^*(\beta))(1+\lambda)$. Using the other first order conditions, (A.9) reduces to:

$$v(\beta) = \frac{(1+\lambda)f(\beta)[d'(i) - \delta((1-F(\beta^*(\beta))) + kF(\beta^*(\beta)))]}{\psi'(e_1(\beta))} \tag{A.10}$$

We first show that the following result holds:

Lemma: $v(\beta) \le 0$ for any β.

Proof: Substituting (15) in (A.10) yields:

$$v(\beta) = \frac{(1+\lambda)f(\beta)}{[\psi'(e_1(\beta))]^2} \delta(1-F(\beta^*(\beta)))[\psi'(e_2(\beta)) - \psi'(e_1(\beta)) \tag{A.11}$$

$$- k \frac{F(\beta^*(\beta))}{1-F(\beta^*(\beta))} \cdot \psi'(e_1(\beta))].$$

Suppose on the contrary that $v(\beta) > 0$. From (A.11) and $\psi'' > 0$

$$e_2(\beta) > e_1(\beta). \tag{A.12}$$

From $\psi''' > 0$, we have

$$\psi''(e_2(\beta)) > \psi''(e_1(\beta)). \tag{A.13}$$

Let us now rewrite the first-order conditions relative to C_1 and C_2 as follows:

$$\psi'(e_1(\beta)) + \frac{\lambda}{1+\lambda} \frac{F(\beta)}{f(\beta)} \psi''(e_1(\beta)) = 1 + \frac{v(\beta)d'(i)}{(1+\lambda)f(\beta)} \psi''(e_1(\beta)). \tag{A.14}$$

$$\psi'(e_2(\beta)) + \frac{\lambda}{1+\lambda} \frac{F(\beta)}{f(\beta)} \psi''(e_2(\beta)) = 1 - \frac{v(\beta)}{(1+\lambda)f(\beta)} \psi''(e_2(\beta)). \tag{A.15}$$

If $v(\beta) > 0$, the left hand side of (A.14) is larger than the left hand side of (A.15) implying $e_1(\beta) > e_2(\beta)$, a contradiction.

We see from this lemma and (A.6) and (A.7) that $K_1 < K_2$ (since $\psi'(e_1(\beta)) < \psi'(e_2(\beta))$). The first period contract is closer to a cost-plus contract than the contract of the second period.

We show now that the incumbent is favored. Let

$$\Delta(\beta,\beta^*) \equiv (\beta^* - ki) - (\beta - i),$$

$$h(\beta,e_2) \equiv \psi(e_2) - e_2 + \frac{\lambda}{1+\lambda} \frac{F(\beta)}{f(\beta)} \psi'(e_2) + \frac{v(\beta)}{(1+\lambda)f(\beta)} \psi'(e_2)$$

and

$$g(\beta^*,e') \equiv \psi(e') - e' + \frac{\lambda}{1+\lambda} \frac{F(\beta^*)}{f(\beta^*)} \psi'(e').$$

Using (A.6) and (A.7), (A.8) can be written:

$$\Delta(\beta,\beta^*) = \max_{e_2} \{h(\beta,e_2)\} - \max_{e'}\{g(\beta^*,e')\}. \tag{A.16}$$

Equation (A.16) implies that $\Delta(\beta,\beta) < 0$, as $v(\beta) < 0$ implies that $h(\beta,e) < g(\beta,e)$ for all e. But the definition of Δ yields $\Delta(\beta,\beta) \geq 0$, a contradiction if $\beta^* = \beta$ were the solution. But

$$\frac{\partial}{\partial \beta^*} [\Delta(\beta,\beta^*) - \max_{e_2} \{h(\beta,e_2)\} + \max_{e'} \{g(\beta^*,e')\}] \tag{A.17}$$

$$= 1 + \frac{\lambda}{1+\lambda} \psi'(e') \frac{d}{d\beta^*} \left[\frac{F(\beta^*)}{f(\beta^*)} \right] > 0$$

Hence, for (A.16) to be satisfied, one needs $\beta^* < \beta$, which for $k = 1$ implies that the incumbent is favored.

When investment is observable or when $\beta = \underline{\beta}$, $v(\beta) = 0$. From (A.6) and (A.7), the incumbent's effort is identical in period 1 and 2, (A.8) then yields $\beta*(\beta) = \beta$.

<div align="right">Q.E.D.</div>

Proof of Proposition 2: From Laffont and Tirole (1986), we know that, under slightly stronger assumptions ensuring second-order conditions, we can rewrite the incentive contract of the entrant as a menu of incentive schemes which are linear in the cost overrun:

$$t'(C',\beta',\beta) = \tilde{G}(\beta',\beta) - \tilde{K}(\beta')(C' - C'*(\beta'/\beta) \tag{A.18}$$

with $\tilde{K}(\beta') = \psi'(e'*(\beta'))$ and $C'*(\beta'/\beta) = \beta' - e'*(\beta') - ki(\beta)$.

Denoting $C*'(\beta') = C'^a$ and remembering the second-order condition $\dfrac{dC'*}{d\beta'} \geq 0$.

$$t'(C',C'^a) = G(C'^a,C_1^a) - K(C'^a)(C' - C'^a)$$

with

$$K(C'^a) = \psi'(e*(\beta')) = \psi'(e*(\beta'^{-1}(C'^a)))$$

We can now extent the reasoning to the case of the incumbent. The transfer to the incumbent can be decomposed into two menus of linear incentive schemes, one for each period:

$$t_1(C_1,C_1^a) = G_2(C_1^a) - K_1(C_1^a)(C_1 - C_1^a)$$

$$t_2(C_2,C_2^a,C_1^a) = G_2(C_1^a,C_2^a) - K_2(C_2^a)(C_2 - C_2^a)$$

with

$$K_1(C_1^a) = \psi'(e_1*(\beta)) = \psi'(e_1*(\beta^{-1}(C_1^a)))$$

$$K_2(C_2^a) = \psi'(e_2*(\beta)) = \psi'(e_2*(\beta^{-1}(C_2^a)))$$

and the decomposition between G_1 and G_2 is arbitrary with a joint constraint (only their discounted sum matters, but one can choose G_1 and G_2 so that the I.R. constraint is binding in each period). From (A.6), (A.7) and $v(\beta) < 0$ we see that $K_1 < K_2$ since $\psi'(e_1(\beta)) < \psi'(e_2(\beta))$. When investment is observable $v(\beta) = 0$ and $K_1 = K_2$.

<div align="right">Q.E.D.</div>

Proof of Proposition 3

The intuition for the proof is that the incumbent fully internalizes the benefits of his investment when $k = 0$. Hence, the shadow price of the first-order condition for investment, $v(\beta)$, should be equal to 0 even when investment is unobservable. If $v(\beta) = 0$, then $e_1(\beta) = e_2(\beta) = e*(\beta)$ from (A.6) and (A.7). (A.10) yields

$$d'(i(\beta)) = \delta(1 - F(\beta*(\beta))). \tag{A.19}$$

and (A.9) is then satisfied. The functions $i(\beta)$ and $\beta*(\beta)$ are defined by equations (A.8) and (A.19). Note that (A.8) can be rewritten as:

$$\beta* - (\beta - i) = \max_e\{g(\beta,e)\} - \max_e\{g(\beta*,e)\}, \tag{A.20}$$

where

$$g(\beta,e) \equiv \psi(e) - e + \frac{\lambda}{1+\lambda}\frac{F(\beta)}{f(\beta)}\psi'(e).$$

From the envelope theorem and the monotone hazard rate condition, the right-hand side of (A.20) is decreasing in $\beta*$ and is thus positive for $\beta* < \beta$. Now suppose that $\beta* \leq \beta - i$. Then $\beta* < \beta$ and thus the right-hand side of (A.20) is strictly positive, while the left-hand side is non-positive, a contradiction. We conclude that $\beta* > \beta - i$.

Q.E.D.

Proof of Proposition 4

The first-order conditions of the regulator's quasi-concave maximization problem are:

$$\psi'(e'(\beta')) = 1 - \frac{\lambda}{1+\lambda}\frac{F(\beta')}{f(\beta')}\psi''(e'(\beta')) \tag{A.21}$$

$$\psi'(e_1(\beta)) = 1 + \delta a + \delta b(1 - F(\beta*(\beta))) - \frac{\lambda}{1+\lambda}\frac{F(\beta)}{f(\beta)}\psi''(e_1(\beta)) \tag{A.22}$$

$$\psi'(e_2(\beta)) = 1 - \frac{\lambda}{1+\lambda}\frac{F(\beta)}{f(\beta)}(1 - a - b)\psi''(e_2(\beta)) \tag{A.23}$$

$$\beta - be_1(\beta) - e_2(\beta) + \psi(e_2(\beta)) - (\beta* - e'(\beta*) + \psi(e'(\beta*))) \tag{A.24}$$

$$= \frac{\lambda}{1+\lambda}\left[\frac{F(\beta*)}{f(\beta*)}\psi'(e'(\beta*)) - (1 - a - b)\frac{F(\beta)}{f(\beta)}\psi'(e_2(\beta))\right]$$

At $a = 0$, $\beta^* = \beta$. Differentiating (A.24) and using (A.21) and (A.23) gives $\dfrac{d\beta^*}{da} < 0$ for any a, which proves Proposition 4.

<div align="right">Q.E.D.</div>

Proof of Proposition 6: We will assume that $\beta^*(\beta)$ and $v(\beta)$ are differentiable. This can be proved by using the implicit function theorem and the first-order conditions.

Let us first note that, $\dfrac{d\beta^*}{d\beta}(\underline{\beta}) < 1$. This is due to the fact that $\beta^*(\underline{\beta}) = \underline{\beta}$ and $\beta^*(\beta) < \beta$ for $\beta > \underline{\beta}$ (from Proposition 1).

Second, we know that $e' \equiv e'(\beta^*(\beta))$ is equal to $e_2 \equiv e_2(\beta)$ at $\beta = \underline{\beta}$ (from Proposition 1). Hence, at $\underline{\beta}$, one has $e_2 > e' \dfrac{d\beta^*}{d\beta}$. But differentiating (A.8) in the uniform-quadratic case, and using the first-order conditions (A.6) and (A.7) yields:

$$1 - \frac{d\beta^*}{d\beta} = \frac{\lambda}{1+\lambda}\left[e' \frac{d\beta^*}{d\beta} - e_2 \right] - \frac{e_2}{1+\lambda} \frac{dv}{d\beta}. \tag{A.25}$$

This implies that at $\beta = \underline{\beta}$, $dv/d\beta$ is negative. Now

$$\frac{d}{d\beta}(e' - e_2) = \frac{de'}{d\beta'} \frac{d\beta^*}{d\beta} - \frac{de_2}{d\beta}.$$

Using (A.6) and (A.7) in the linear-quadratic case yields:

$$\frac{d}{d\beta}(e' - e_2) = \frac{\lambda}{1+\lambda}\left[1 - \frac{d\beta^*}{d\beta} \right] + \frac{1}{1+\lambda} \frac{dv}{d\beta} \tag{A.26}$$

But (A.25) implies that, at $\beta = \underline{\beta}$,

$$1 - \frac{d\beta^*}{d\beta} < -\frac{e_2}{1+\lambda} \frac{dv}{d\beta} \quad \text{so that}$$

$$\frac{d}{d\beta}(e' - e_2) < \frac{1}{1+\lambda} \frac{dv}{d\beta}\left[1 - \frac{\lambda e_2}{1+\lambda} \right] < 0,$$

as $e_2(\underline{\beta}) = 1$ and $1 > (\lambda/(1+\lambda))$. So, $e' < e_2$ in a neighborhood of $\underline{\beta}$. Now, consider the lowest $\beta > \underline{\beta}$ such that:

either A: $\quad e'(\beta) \dfrac{d\beta^*}{d\beta}(\beta) = e_2(\beta)$

or B: $e'(\beta) = e_2(\beta)$

or C: $\dfrac{d\beta^*}{d\beta}(\beta) = 1.$

Condition A cannot be satisfied strictly before B or C is, as $\dfrac{d\beta^*}{d\beta} < 1$ and $e' < e_2$ in a neighborhood of $\underline{\beta}$.

Suppose that condition B is satisfied. So, at this β, $e'\dfrac{d\beta^*}{d\beta} \le e_2$ and $\dfrac{d\beta^*}{d\beta} \le 1$. The first inequality, together with (A.25) implies that

$$1 - \frac{d\beta^*}{d\beta} \le -\frac{e_2}{1+\lambda}\frac{dv}{d\beta}, \tag{A.27}$$

so that $\dfrac{dv}{d\beta} \le 0$. Using (A.26), and by the same reasoning as before, we obtain

$$\frac{d}{d\beta}(e' - e_2) \le \frac{1}{1+\lambda}\frac{dv}{d\beta}\left(1 - \frac{\lambda e_2}{1+\lambda}\right) \le 0 \tag{A.28}$$

(as $e_2(\beta) = e'(\beta^*(\beta)) < 1$, from equation (A.1)). So the function $e' - e_2$ cannot become positive at β, as it is negative earlier and has a negative slope.

Last, suppose condition C is satisfied. Equation (A.25) can be rewritten as:

$$\frac{\lambda}{1+\lambda}(e' - e_2) = \frac{e_2}{1+\lambda}\frac{dv}{d\beta}. \tag{A.29}$$

But (A.6) and (A.7) yield:

$$e' - e_2 = \frac{1}{1+\lambda}\frac{dv}{d\beta}. \tag{A.30}$$

It is easy to see that (A.29) and (A.30) are inconsistent unless $e_2 = \dfrac{\lambda}{1+\lambda}$.[20] But, from (A.6), and the fact that $v(\beta) < 0$, $e_2 > 1 - \dfrac{\lambda}{1+\lambda}$. Since we assumed that $1 > 2\lambda/(1+\lambda)$, we obtain a contradiction.

Thus, neither of the three conditions, A, B, or C can obtain to the right of $\underline{\beta}$. This proves Proposition 6.

Q.E.D.

FOOTNOTES

1) See also Goldberg (1976), and in the context of the regulation of electric utilities, Joskow and Schmalensee (1983). An early reference on the topic is Pigou (1920) (see Goldberg (1981) for a description of his contribution).

2) Williamson (1976) also mentions administrative and political incumbency advantages which we will not study here.

3) Williamson also makes the important point that contracts are necessarily incomplete. Indeed, investment has been a major concern in the literature on the expropriation of relation–specific investment under incomplete contracting (Williamson (1975, 1985) Grossman–Hart (1986). Hart–Moore (1985) Green and Laffont (1988)). While we also emphasize investment incentives, our paper departs from this literature in several important respects. First, it assumes away unforeseen contingencies and analyzes complete contracting. Second, the literature on incomplete contracting studies the role of ownership; we take ownership as given, and analyze switching incentives. Third, whether the parties can contract on investment does not matter in the absence of second sourcing in our model (while it does under incomplete contracting); assuming incomplete contracting away allows us to focus on the effects of second sourcing in a cleaner way.

4) $\psi''' \geq 0$ makes stochastic schemes non–optimal (see Laffont and Tirole (1987)).

5) This assumption of monotone hazard rate prevents bunching in the static model. It is satisfied by most usual distributions (uniform, exponential, Pareto, logistic ...).

6) See Laffont and Tirole (1988a) (1988b) for analyses of procurement with renegotiation proof commitment and short–term commitments respectively.

7) Because of our commitment assumption we need only consider an intertemporal individual rationality constraint.

8) For $k = 1$, the problem is always quasi–concave. For $k \neq 1$, the marginal cost of the investment high enough is a sufficient condition for quasi–concavity (see Laffont and Tirole (1987a)).

9) It should be noted that when one of the parties' preferences is not quasi–linear, an informed principal (regulator) strictly gains by not revealing his information to the agent (entrant) at or before the contract proposal stage. That is, by pooling at the contract proposal stage, the different types of principal (referring here to the possible values of β, by abuse of terminology) can trade the slack variables corresponding to the agent's individual rationality and incentive compatibility constraints. This may introduce a tension between first period efficiency and optimal regulation of the entrant. Also, the Maskin–Tirole result applies as long as the principal's information does not enter the agent's utility function (in particular, the agent's information can enter the principal's objective function, as is the case here).

An alternative proof of the fact that it is harmful to induce pooling in period 1 can be given as follows. From Laffont–Tirole (1987b) we know that the second period mechanism can be implemented by a dominant strategy (Vickrey) auction, which makes irrelevant the information transmitted by the observation of C_1. Then, pooling induces no gain on the second period and is harmful in the first.

10) See Guesnerie and Laffont (1984).

11) If the marginal cost of investment is high enough, the first–order approach we take here in this moral hazard problem is valid.

12) Note also that common auctions for contract renewal belong to the class of mechanisms considered here.

13) For extensions of this result see Laffont and Tirole (1987b), McAfee and McMillan (1987), Caillaud and et al. (1986), Melumad and Reichelstein (1986), Picard (1987), Rogerson (1987).

14) Apply the Lemma in the Appendix to equation (A.10).

15) These conditions are sufficient for $b^2\delta$ small.

16) $P(\beta)$ must satisfy: $U'(\beta^*(\beta)) - P(\beta) = U_2(\beta)$.

17) There is of course a large diversity of ways to acquire firms, from friendly mergers to proxy fights. The view that managerial teams bid against each other may be a good first approximation, and is taken, e.g. in Blair et. al. (1986), Grossman–Hart (1987) and Harris–Raviv (1987). It should be noted that other reasonable descriptions of the auctioning process would yield similar results as in this paper. For instance, suppose that the raider buys up the whole firm, which then goes private. The auction is then equivalent to offering a fixed–priced contract to the second source (that is, the raider is made residual claimant for the firm's second–period profit). Redoing the analysis by assuming that only a fixed–priced contract can be offered to the entrant does not alter our intuitions.

    Note also that our allowing discrimination among the raider's types yields the result that after a takeover, the firm goes private ($K' \approx 1$) when the raider is very efficient (β close to $\underline{\beta}$), and does not when the raider is less efficient ($K' < 1$ for higher βs).

18) A slight difference with our social planner formulation is that the shareholders do not care directly about the managers' welfare. But none of our qualitative results is affected by this change in the principal's objective function.

19) See Fudenberg-Tirole (1988) for an analysis of this issue in a model without takeovers.

20) While the process of investing per se is likely to be observed by the market, the investment expenditure may not be straightforwardly derived from accounting data (recall Williamson's argument), and the quality of the investment may be hard to assess. In a similar spirit, Ruback (1986, p. 72) argues that "the management of most corporations has private information about the future prospects of the firm. This information usually includes plans, strategies, ideas, and patents that cannot be made public. Even if they are efficient, market prices cannot include the value of information that the market does not have." To the extent that plans, strategies, ideas, and patents result from investments, Ruback's argument fits with the notion that a non-negligible fraction of investment is not reflected in the market valuation of the firm. So, we feel that post-termination stock options, although they can not be fully ruled out, are at most a limited instrument to induce managers to invest.

21) We suspect that the many shark repellants are far from being substitutes and involve fairly different social costs. It would also be worthwhile investigating how each favors the incumbent managerial team.

22) Closer in spirit to our work is the signal–jamming model of Stein (1987) in which a manager overborrows to mislead the market about his firm's worth.

23) We considered the case where the number of potential entrants was exogenous (actually equal to one but the analysis generalizes straightforwardly to any number). When this number is endogenous and increases with the expected rent to be gained in the second period auction, new effects should be taken into account. Favoring entrants now increases the competitiveness of the second period auction.

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