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Abstract

We consider the regulation of a monopolistic market when the principal delegates to a regulatory agency two tasks: the supervision of the firm's unknown costs and the arrangement of a pricing mechanism. As usual, the agency may have an incentive to hide information from the principal to share the informative rent with the firm. The novelty of this paper is that both the regulatory mechanism and the side contracting between the agency and the firm are modelled as a bargaining process. This negotiation between the regulator and the monopoly induces a radical change in the extraprofit from private information, which is now equal to the standard informational rent weighted by the agency's bargaining power. This in turn affects the collusive stage, in particular the firm has the greatest incentive to collude when facing an agency with the same bargaining power. Then, we focus on the optimal organizational responses to the possibility of collusion. In our setting, where incompleteness of contracts prevents the design of a screening mechanism between the agency's types and thus Tirole's equivalence principle does not apply, we prove that the stronger the agency in the negotiation process, the greater the incentives for the principal to tolerate collusion in equilibrium.

Keywords: regulation, bargaining, collusion.

JEL classification: D73, D82, L51.

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1. Introduction

The aim of this paper is to examine collusion in the regulation of a monopolistic market when the political principal delegates to a regulatory agency two tasks: the supervision of the firm's unknown fixed costs and the negotiation with the firm over a pricing policy. While the role of supervision is standard, the presence of a bargaining process is the novelty of this paper. In this new setting we investigate the following questions: Which regulatory policy should we expect in such a situation? What are the characteristics of the collusive gains? Which is the best response to collusion? Which are the determinants of this response? This paper is a first attempt to derive some preliminary results.

We consider a standard three-tier regulatory hierarchy, where the political principal directs the activities of a regulatory agency, which in turn oversees the operation of a monopolistic firm. We innovate by assuming a regulatory framework *different* from the standard approach in the sense that we consider a principal which delegates to the agency a general negotiation with the firm on the pricing policy. The reason for this generalization is that usually regulation does *not* boil down to a passive enforcement of a policy, but actually involves a *negotiation* between the regulator and the firm. In other words, usually regulatory arrangements are the result of a *give-and-take* process rather than of a take-it-or-leave-it offer. Obviously another important issue to analyse would be the bargaining process between the political principal and the regulatory agencies, but in this paper we limit the scope within the negotiation between the supervising agency and the firm.

The literature on regulation has long ago recognized the relevance of introducing general bargaining processes in the interaction between regulator and firm. For example Kahn [**10**] observes that often public utilities represent cases of bilateral monopolies, while Spulber [**29, 30**] has proposed regulatory models dealing with bargaining processes. Similarly, Scarpa's [**27, 28**] work represents a preliminary attempt to model this aspect of regulatory cases. More recently, Inderst [**9**] has proposed a generalization of the standard procedure to bargaining, following a different approach with respect to this paper. Finally, Armstrong and Sappington in their impressive survey recognize that the standard formulation, which ignores negotiations between the regulator and the firm, ‹‹generally is adopted for technical convenience rather than for realism›› [**1**, p. 1564]. Also empirical studies support this view. Among others, Brotman [**6**] reports that in the USA negotiations with private firms are a normal way to decide on industry regulation.

We model this view assuming that a benevolent Congress delegates to a regulatory agency[1] two activities:[2] a *supervisory* job *and* a *bargaining* task. Therefore, in our model the regulator is *not* only a *mere conduit* of information about the firm's costs, but it carries out the *additional* task of negotiating a regulatory settlement with the firm. Moreover, as usual in collusion models, the agency cannot be trusted to perfectly enforce Congress's intent because it may be *self-interested* and have an incentive to *collude* with the firm by concealing its information from Congress in return of a side transfer from the firm[3]. However, differently from standard models, side contracting between the agency and the firm is considered as a bargaining activity *parallel* to the negotiations over the regulatory mechanism. The two bargaining stages are modelled using the Nash solution concept [**22**, **23**], which we will argue is the most effective way to deal with our view.

Our analysis shows how standard results are altered by these two bargaining processes. As expected when there is asymmetric information on fixed costs only, the regulatory mechanism agreed by the agency and the firm applies the *marginal cost pricing* to maximize the total gains from trade, and consumers *entirely subsidize* the total gains of the coalition. However, the introduction of negotiation between the regulator and the monopoly induces a radical change in the firm's extraprofit from pure asymmetric information, which is now equal to the standard informational rent weighted by the agency's bargaining power. This in turn affects the outcome of the collusive stage where the coalition gains are split between the agency and the firm according to their bargaining power. In particular, we show that the firm has the greatest incentive to collude when facing an agency which holds the same bargaining power, i.e. when the negotiation process is *symmetric*.

In the second part of the paper, we focus on the optimal organizational responses to the possibility of collusion. The well-known Tirole's [**32**] *equivalence principle* predicts that, under some conditions, deterring collusion is optimal in equilibrium. In our setting, incompleteness of contracts arising from institutional constraints prevents the Congress from devising a mechanism which perfectly discriminates between the agency's types, and thus

[1] We take Tirole's [**32**] assumption of *unique* regulator, which may be justified either by a cost of duplication of the regulatory function or by collusive behaviour between regulators.

[2] As in Laffont and Tirole [**16**], we assume that regulatory institutions result from a constitution drafted by some *benevolent* "founding fathers" or "social planners", which may be indentified with Congress. The latter delegates some activities to a public decision maker, which is represented by a regulatory agency.

[3] Tirole stresses the importance of reciprocity in the side contracting and states that ‹‹one-sided favors call for reciprocated ones›› [**32**, p. 185].

Tirole's equivalence principle does not apply[4]. In particular, Congress finds it optimal to *tolerate* collusion in equilibrium if the cost to induce the agency *not* to collude *outweighs* the expected stake in collusion, which is the benefit that consumers would enjoy by deterring collusion since they would save the subsidization of the gains of the coalition. In other terms, collusion is optimal when tolerating this possibility is *less* costly than deterring it. We explore this condition and show that the stronger the agency in the negotiation process, the greater the incentives for Congress to tolerate collusion in equilibrium. The idea is that a stronger agency can exact a higher bribe from the firm and thus the incentive reward to the agency for not colluding is more expensive. A *high* bargaining power of the agency in the negotiation process can make collusion too *costly* to fight. This result has obvious implications for the optimal design of regulatory agencies.

The paper is organized as follows. Section 2 describes the basic structures of the model. In Section 3, we derive the regulatory policy with a benevolent agency. In Section 4, we consider the case of a nonbenevolent agency. Section 5 derives the optimal institutional responses to collusion. Finally, we devote Section 6 to concluding remarks.

2. The model

2.1. The players

2.1.1. Firm

The firm's cost function C is

$$C(q,\theta) = VC(q) + \theta,$$

where $VC(q)$ denotes the variable costs which are assumed to be common knowledge, while the fixed cost $\theta \in \left[\theta^-, \theta^+\right] \subset R_+$ is private information of the firm. The idea is that regulated monopolies usually involve fixed investments and that their exact amount may be expected to be firm's private information.

The firm uses a *two-part* pricing policy, characterized by a unit price p and a fixed amount S. Therefore the *firm's profit* function is given by

$$\pi(p, S; \theta) = pq(p) + S - VC(q) - \theta.$$

[4] See e.g. Kofman and Lawarrée [**13**] and Tirole [**33**].

2.1.2. Consumers

The consumers are described by a standard consumer demand $q(p)$. Therefore the *consumer net surplus* is equal to the net benefit from the marketplace minus the aggregate fixed charges S[5] minus the transfer to the agency $T^C \geq 0$, collected through distortionary taxes, which impose a shadow cost $\lambda \geq 0$:

$$CS\left(p, S, T^C\right) = \int_p^{\infty} q\left(p^o\right) dp^o - S - (1+\lambda) T^C.$$

2.1.3. Congress

Congress is a benevolent principal concerned with consumer surplus only. It hires a regulator, which has a *twofold* role: supervising the firm's unknown fixed costs *and* bargaining with the firm over the regulatory mechanism. Therefore, the Congress's problem is to provide a delegation contract that considers both roles of the regulatory agencies: the compensation for supervision and the negotiation over a regulatory policy.

2.1.4. Regulatory agency

As said, the regulator has a *twofold* role: supervising the firm's unknown fixed costs *and* bargaining with the firm over the regulatory mechanism.

There are two types of agency: benevolent and self-interested. The *benevolent* regulator is drawn with (common knowledge) probability $\gamma \in [0,1]$ and *settles* for a transfer T, needed to finance its activity, equal to its reservation value $\overline{T}$, which is normalized to zero. Moreover, it *perfectly* internalizes Congress's interests during the bargaining process with the firm. Therefore, the utility function of a *benevolent agency* is

$$V_B = CS. \tag{1}$$

A *self-interested* regulator, which occurs with complementary probability $(1-\gamma)$, internalizes only *partly* Congress's interests and aims to receive a transfer $T \geq \overline{T}$. The utility function of a *nonbenevolent agency* is given by

$$V_{NB} = T + \beta CS, \tag{2}$$

[5] The fixed payment may be thought of as apportioned among consumers in such a manner that no consumer is excluded from purchasing the good.

where $\beta \in \left(0, \overline{\beta}\right)$, with $\overline{\beta} < 1$, is a parameter that captures the regulator's *degree of internalization* of Congress's objectives. If $\beta \to 0$, the agency is (almost) only interested in its private transfer. A higher β implies that it gives more weight to Congress's aim.

The *supervisory technology* is characterized by imperfect monitoring so that collusion is possible in some state of the world only.

2.1.5. Supervisory technology

The *supervisory technology* is assumed to be *à la* Tirole [**32**]: with probability $\zeta \in [0,1]$ the agency discovers the true θ, so the signal is *informative*, i.e. $\sigma = \theta$; with probability $(1-\zeta)$ the signal is *uninformative* and the agency learns nothing, so $\sigma = \phi$[6]. The signal is supposed to be *hard information* (i.e. verifiable)[7]. This means that, when observing the firm's cost parameter ($\sigma = \theta$), the agency can credibly report $r = \theta$ to the Congress since it can look at the evidence and verify that the regulator has announced the true cost parameter. However, the regulator may lie and convey a report $r = \phi$, by claiming that its search for information has been fruitless. Concealing information is the agency's degree of discretion: it could not announce a wrong cost parameter since this report could not be substantiated. Being the signal hard information, when the regulator learns nothing ($\sigma = \phi$), it can only announce $r = \phi$. Thus,

$$r \in \begin{cases} \{\theta, \phi\}, \text{ if } \sigma = \theta \\ \{\phi\}, \text{ if } \sigma = \phi. \end{cases}$$

As usual, the firm observes which signal the agency receives[8]. Finally, note that the degree of informativeness of supervisory technology, which is represented by ζ, is supposed to be exogeneous. This implies that we take the agency's effort to discover the cost parameter as given[9].

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[6] Kofman and Lawarrée argue that the assumption of imperfect monitoring is realistic, since ‹‹auditors do not have the material possibilities to examine all the frm's records; they select and examine only a sample of them, then make inferences regarding the situation of the firm, which they report to the principal›› [**12**, p. 633].

[7] See Laffont and Rochet [**15**] for an analysis of the difference between *hard information* and *soft information* models.

[8] We can suppose that before signing the collusive agreement the agency must disclose to the firm the signal it has received. This assumption rules out the possibility of blackmail by the agency. Khalil and Lawarrée [**11**] underline the importance of studying this phenomenon.

[9] Demski and Sappington [**7**] consider a regulatory problem where a self-interested regulator must be motivated to expend monitoring effort to become informed about the firm's expected productivity. Unfortunately, this study ignores the possibility of collusion.

2.2. Symplifying assumptions

2.2.1. Firm

The firm's variable cost function $VC(q)$ is supposed to be linear, and without loss of generality the costant marginal cost MC is normalized to zero. Therefore the firm's cost function writes as

$$C(q, \theta) = \theta, \tag{3}$$

i.e. the simplest possible functional form to justify a natural monopoly.

Thus the *firm's profit* function is given by

$$\pi(p, S, \theta) = pq(p) + S - \theta. \tag{4}$$

For the sake of convenience, we assume that fixed cost are small enough so that the monopoly will never close up production, i.e. the range of possible θ is bounded within a known interval such that there is never shut down.This assumption of known marginal costs and of smalll enough fixed costs together with our assumptions on the timing of the regulatory model imply that the optimal solution will not depend of the prior distribution of θ.

2.2.2. Consumers

Consumer demand is supposed to depend linearly on price.[10] Thus, without loss of generality, we consider the following simple expression

$$q(p) = 1 - p. \tag{5}$$

Hence, *consumer net surplus* reduces to

$$CS\left(p, S, T^C\right) = \frac{(1-p)^2}{2} - S - (1+\lambda)\, T^C. \tag{6}$$

2.3. Timing

The *timing* of the regulatory game is as follows.

1. Nature draws a type for the agency, which privately learns its type.

[10] As said before, the fixed payment is assumed to be apportioned among consumers in such a manner that no consumer is excluded from purchasing the good.

2. Congress offers to the agency a contract which determines a transfer $T^C(r)$ conditional on the report r and delegates the negotiations with the firm about a regulatory mechanism.

3. The contract is signed or rejected by the agency. If the contract is signed, Congress commits to enforce any regulatory mechanism arising from negotiations, provided that it is direct and incentive compatible whenever the agency reports that its supervisory activity has failed $(r = \phi)$[11].

4. The agency negotiates with the firm a regulatory mechanism $M = \left\{p\left(\widehat{\theta}\right), S\left(\widehat{\theta}\right), \widehat{\theta} \in \left[\theta^-, \theta^+\right]\right\}$, i.e. a price p for the good and a subsidy S to the firm. The outcome of this negotiation will depend on the firm's type $\theta \in \left[\theta^-, \theta^+\right]$ that at this time is unknown to both players and distributed according to the commonly known density function $f(\theta)$ defined over $\left[\theta^-, \theta^+\right]$, even if as usual both players perfectly anticipates next stages. Note that since at this stage the bargaining process regards the regulatory mechanism M and not the monopoly's report itself, information on the true θ does not matter for the outcome of the negotiation process.

5. Nature draws a type for the firm, according to the density function $f(\theta)$ and informs the firm about its type.

6. The agency performs its audit activity and learns the signal σ that is also observed by the firm, which in turn discovers the agency's type[12].

    - if $\sigma = r = \phi$, the supervisor activity has failed and this is known by the agency and the firm, which will then implement a direct incentive compatible mechanism $M = \left\{p\left(\widehat{\theta}\right), S\left(\widehat{\theta}\right), \widehat{\theta} \in \left[\theta^-, \theta^+\right]\right\}$ as decided at stage 4.

[11] See Section 2.4 for a discussion about the application of the *revelation principle* in this context.

[12] This assumption is made, among others, by Kofman and Lawarrée [**13**]. An informed agency reveals to be honest or dishonest, refusing or agreeing to side contract with the firm. Attempted bribery is not punishable, since it is extremely difficult or costly to prove. If the cost parameter is not discovered, the firm will not try to collude in equilibrium, but we may assume that a benevolent agency declares anyway that it will not accept any bribe, revealing its own type. Alternatively, the agency can show its type, since it is the party which takes the initiative to collude.

- if $\sigma = \theta$, the supervisor activity has succeded and this is known by the agency and the firm, which will then implement a direct mechanism $M = \left\{ p\left(\widehat{\theta}\right), S\left(\widehat{\theta}\right), \widehat{\theta} \in \left[\theta^-, \theta^+\right] \right\}$ as decided at stage 4. In this case, a benevolent agency always reports $r = \theta$. Instead, a dishonest agency has an incentive to collude with the firm concealing its information ($r = \phi$) asking for a side transfer $T^F(r)$ from the firm as a reward for its lie. This side transfer is again the outcome of the bargaining process between the agency and the monopoly which has taken place at stage 4.

7. Contracts are executed and the regulatory policy is implemented.

As a consequence of this structure, there are four cases to analyse, which occur with the probabilities shown in Table 1. In case I, the agency is benevolent and its signal is informative, i.e. it discovers the firm's costs. In case II, the agency is benevolent and its signal is uninformative, i.e. it does not learn the firm's cost. Cases III and IV refer to a nonbenevolent agency, whose supervisory activity fails and succeeds, respectively. This last case is the one relevant for collusion possibilities.

		SUPERVISORY TECHNOLOGY	
		IS ($\sigma = \theta$)	US ($\sigma = \phi$)
AGENCY TYPE	B	case I with pr. $\gamma\zeta$	case II with pr. $\gamma(1-\zeta)$
	NB	case IV with pr. $(1\text{-}\gamma)\zeta$	case III with pr. $(1-\gamma)(1-\zeta)$

Table 1. Cases and respective probabilities

2.4. Use of revelation principle and Nash bargaining solution

When the supervisory activity fails, the agency does *not* observe the firm's cost parameter. Therefore we are in a situation with asymmetric information, where differently from the standard principal-supervisor-agent model the bargaining power is shared between the informed agent and the uninformed supervisor.

In our model we assume that the uninformed supervisor and the informed agent bargain over direct incentive compatible mechanism: is this assumption restrictive? In other words, can we apply the revelation principle to our particular game?

Spulber [**30**, ch. 11] has shown that this crucial tool used in the principal-agent model may be applied to *any* negotiation process[13]. Our model is a specific case of the generalized principal-agent problem as defined by Myerson's [**20**], i.e. a situation where the principal (Congress) sets the rules of communication and the structure of incentives to which the other individuals (the agency and the firm) must react, and the implementation of a mechanism requires the coordination of actions by different agents. In particular in our model Congress sets the rules of the game which the agency and the firm must play: the Congress's problem is to design a coordination mechanism for the negotiation between the agency and the firm such that there is an equilibrium which gives Congress the highest possible expected payoff. For this general setting Myerson is able to extend the revelation principle in the sense that an optimal incentive-compatible direct mechanism is also optimal in the class of all coordination mechanisms which characterize the set of all outcomes that can be achieved as Bayesian equilibria of this class of games. Therefore, we can use the fact that a direct incentive-compatible mechanism can achieve the same outcome of any negotiation process where each privately-informed player has an incentive to correctly reveal its information.

In our setting Congress is modelled as the principal, i.e. a first mover that designes the game the other agents must play. Then, Congress commits to a direct incentive compatible mechanism, while the regulatory agency and the monopolistic firm act as followers in their choices of actions in the subsequent bargaining process, which is part of this generalized principal-agent model. A crucial point is what is this negotiation about. According to the timing of our regulatory game (see Section 2.3), if before negotiations the supervisory technology does not disclose the firm's fixed cost ($\sigma = r = \phi$), the agency is allowed to ask for the firm's type, by inducing truthful revelation. In fact, as argued above, thanks to Myerson's generalization of the revelation principle, without loss of generality we can restrict our attention to direct incentive compatible mechanisms. If the agency discovers the firm's type ($\sigma = \theta$), there is of course no need for direct revelation. In either case, negotiations are about a regulatory mechanism $M = \left\{p(\theta), S(\theta), \theta \in \left[\theta^-, \theta^+\right]\right\}$ in a situation of complete information. We decide to model this setting as a

[13] See the seminal paper of Myerson [**19**] for an application of the revelation principle to a bargaining problem. Myerson and Satterthwaite [**21**] characterize the set of allocation mechanisms that are Bayesian incentive compatible and individually rational in a bargaining problem between one buyer and one seller for a single object.

general bargaining game à la Nash. The Nash solution is then taken in expected terms since neither of the two parties knows firm's fixed costs when they meet to bargain (see Section 2.3). Our choice deserves some explanations.

The novelty of this paper is indeed that we assume that the agency negotiates with the firm on a regulatory mechanism $\{p, S\}$ and that, when there are possible gains from collusion, the nonbenevolent agency and the firm bargain over the splitting of these gains. Therefore we need to consider a model for both these negotiation processes.

As well known, the outcome of a bargaining game is very sensitive to all the details of the negotiation process as well as to the delay costs of the two players, i.e. to all the bargaining protocols. For example, in the simple one-shot simultaneous offer protocol, any outcome is a possible equilibrium even using strong refinement concepts.[14] A crucial point in the specification of a bargaining game is whether we assume that the players can commit to their actions, thus providing a specific extensive form. Obviously, in many setting it is difficult to provide a reliable specification of all the possible moves, of their sequence and of the information available to the players during the play. And even if we agree on a specific bargaining protocol, we should distinguish between bargaining games with or without asymmetric information. When the players have private information, bargaining games will typically have a plethora of equilibria for two distinct reasons. First, the presence of an infinite number of bargaining rounds permits history-dependent strategies that can often support a wide variety of equilibrium behaviors. Second, even if bargaining were allowed to last only a finite number of periods, there will typically exist a multiplicity of sequential equilibria because of out-of-equilibrium information sets, and thus the analysis must use very restrictive refinements.

Instead of describing the specific bargaining procedure in full detail, we choose to characterize the outcome by a more general approach. The driving idea of this paper is to use the cooperative asymmetric Nash model [**22**, **23**]. First, its generality allows to avoid the specification of a particular extensive form structure. Second, the Nash solution is efficient so that our results do not depend on the unexploited gains from trade in the specific bargaining procedures which may be considered. This means that our approach may underestimate the transaction costs between the colluding parties, but we capture this aspect with a shadow cost of side transfers (see Section 4) and even with possibly inefficient bargaining the precise value of these transac-

[14] See Sàkovics [**26**].

tion costs will anyway depend on the exact extensive form which is adopted. Third, the uniqueness of the Nash solution implies that the principal can anticipate the outcome of bargaining to determine its optimal reaction, which is crucial for this kind of collusion models. Finally, as we will show, this solution leads to easy calculations but also to interesting and plausible results.

Notice that our approach differs from the generalized Nash solution, which Harsaniy and Selten [**20**] have derived for the case of incomplete information.[15] The crucial difference is given by the presence in our model of an additional player, i.e. the principal/Congress, which does not participate directly in the bargaining stage but is able to design the rules of communication so that the revelation of information emerges before the negotiation game. This pre-play communication implies that the bargaining game occurs under complete information. As Spulber [**30,** ch. 2] emphasizes, a crucial feature of regulatory hearing processes is the *direct* interaction between players, which involves exchange of information and can result in a consensus, so that the bargaining game can be modelled as a cooperative game with complete information. Even though there are alternative cooperative concepts such as the Kalai-Smorodinsky solution, the asymmetric Nash bargaining solution is probably the most convincing and effective for our purposes.[16] According to the timing of our regulatory model, even the firm does not know its type when meeting the agency to bargain. This reflects the idea that firm needs some time and effort in order to figure out the amount of costs it will incur. Since both players are ignorant of firm's type when they meet, we take the Nash product in expected terms.

3. Benevolent agency

With probability γ the Congress faces a benevolent agency, which completely internalizes Congress's interest in consumer surplus and receives a reservation transfer $\overline{T} \equiv 0$.

For the moment, suppose that Congress *tolerates* the possibility of collusion. Hence, it offers a reward $T^C = \overline{T}$ to the agency, independently of its report r. As long as the regulator is benevolent, it transmits its information truthfully.

[15] See also Spulber [**29**] for a bargaining problem under asymmetric information in which the direct revelation of information occurs *during* the bargaining process.

[16] If for example we consider an infinite offer/counteroffer bargaining game with perfect information, then Rubinstein [**25**] has showed that there is a unique perfect equilibrium which reflects the outcome of the Nash model. It is well known that the Nash game can be justified using different extensive form structure, see e.g. Osborne and Rubinstein [**24**].

3.1. Case I: informative signal ($\sigma = r = \theta$)

A benevolent agency *discovers* the cost parameter with probability ζ and negotiates with the firm a regulatory mechanism without the threat of collusion. According to the timing in Section 2.3 and our discussion in Section 2.4, the optimization problem is the following

$$\max_{p,S} \int_{\theta^-}^{\theta^+} [V_B(p,S)]^{\alpha} \cdot [\pi(p,S)]^{1-\alpha} f(\theta)\, d\theta \quad s.t. \tag{7}$$

$$V_B(p,S) \geq 0 \tag{PC$_A$}$$

$$\pi(p,S) \geq 0, \tag{PC$_F$}$$

where the parameters α and $(1-\alpha) \in (0,1)$ denote respectively the agency's and the firm's bargaining power.

The nonnegativity constraints (PC$_A$) and (PC$_F$) are the agency's and firm's participation constraints. A benevolent agency is interested in consumer surplus, which must be nonnegative in order to induce the consumers to purchase the good. Notice that constraint (PC$_A$) implies the agency is supposed to require a nonnegative *ex post* utility. Following Laffont and Tirole's [**16**] approach, the agency's utility function can be assumed of the form $U(V_B) = V_B$ for $V_B \geq 0$ and $U(V_B) \to -\infty$ for $V_B < 0$[17]. Similarly, the firm cannot accept to produce by making *ex post* losses. This can be the result of limited liability constraints. Hence, also the disagreement payoffs are zero for both bargaining parties.

Substituting (1), as defined by (6), and (4) into (7) yields

$$\max_{p,S} \int_{\theta^-}^{\theta^+} \left[\frac{(1-p)^2}{2} - S\right]^{\alpha} \cdot [p(1-p) + S - \theta]^{1-\alpha} f(\theta)\, d\theta \ s.t.\ (PC_A),\ (PC_F). \tag{8}$$

After replacing the choice variable S with π from (4) into (8), the maximization problem may be rewritten as

$$\max_{p,\pi} \int_{\theta^-}^{\theta^+} \left[\frac{(1-p)^2}{2} + p(1-p) - \theta - \pi\right]^{\alpha} \cdot \pi^{1-\alpha} f(\theta)\, d\theta \ s.t.\ (PC_A),\ (PC_F).$$

Ignoring the constraints (PC$_A$) and (PC$_F$)[18], from the first-order condi-

[17] the same rational holds for a dishonest agency in Section 4.

[18] It can be easily shown that they are satisfied in equilibrium.

tion for p it is immediate to find that the *price* agreed by the regulated firm and a benevolent agency when the signal is informative is equal to

$$p_B^{IS} = MC \equiv 0. \tag{9}$$

The negotiated regulatory policy implements the marginal cost pricing, *independently* of bargaining powers. The agency and the firm do *not* have any incentive to distort price from marginal cost, since both prefer to maximize the total gains from trade. Not surprisingly, we will see that the firm tries to extract these gains through the subsidy S[19].

From the first-order condition for π we find the regulated *profit*

$$\pi_B^{IS} = (1-\alpha)\left[\frac{1}{2} - \theta\right] \equiv (1-\alpha)\, TGT(\theta), \tag{10}$$

i.e. the profit arising from negotiations is a share $(1-\alpha)$ of the total gains from trade $TGT(\theta)$ for fixed costs θ. Clearly, the stronger the agency the smaller the profit that the firm can obtain from the regulatory arrangement. Note that even though the agency discovers its costs the firm gets a profit which is strictly greater than its reservation value, clearly without any consequence on the allocative efficiency.

Substituting (9) and (10) into (4) yields the firm's *subsidy*

$$S_B^{IS} = (1-\alpha)\left[\frac{1}{2} - \theta\right] + \theta = (1-\alpha)\, TGT(\theta) + \theta, \tag{11}$$

i.e. the subsidy covers the fixed costs and assigns to the firm a share $(1-\alpha)$ of the total gains from trade $TGT(\theta)$. Obviously, an increase in the agency's bargaining power reduces the firm's subsidy. A very weak agency $(\alpha \to 0)$ allows the firm to get a high subsidy. If all the bargaining power is allocated to the agency $(\alpha \to 1)$ as in standard principal-agent models, the firm is just able to cover its fixed costs through subsidy $(S_B^{IS} \to \theta)$ and receives no profit.

The *consumer surplus* is given by

$$CS_B^{IS} = \alpha\left[\frac{1}{2} - \theta\right] = \alpha TGT(\theta), \tag{12}$$

[19] As well known, a monopolist that maximizes its profit subject to a non negative consumer surplus constraint would set a price equal to marginal cost and capture all the consumer gain through a subsidy.

i.e. it is a share α of the total gains from trade $TGT(\theta)$. The positive relation between CS and α shows that consumers *benefit* from a strong regulator.

We summarize the main results in the following Lemma.

Lemma 1 (B-IS) *If the agency is benevolent and the signal is informative, then the regulatory mechanism* $\left(p_B^{IS}, S_B^{IS}\right)$

- *applies marginal cost pricing, i.e.* $p_B^{IS} = MC$, *and*
- *gives the firm a subsidy* $S_B^{IS} = (1-\alpha)\, TGT(\theta) + \theta$, *which is decreasing in the agency's bargaining power* α.

3.2. Case II: uninformative signal ($\sigma = r = \phi$)

With probability $(1-\zeta)$ the supervisory activity *fails* and the agency does not observe the firm's cost parameter. This implies a situation of asymmetric information between the two players. As discussed in Section 2.4, we assume that before negotiations start the agency induces the firm to reveal honestly its type (see (ICC$_F$) below), so that the bargaining process between the agency and the firm occurs on a mechanism $M = \left\{p(\theta), S(\theta), \theta \in \left[\theta^-, \theta^+\right]\right\}$ under complete information. According to the timing in Section 2.3, the bargaining problem can be solved through the maximization of the following program

$$\max_{p(\theta),S(\theta)} \int_{\theta^-}^{\theta^+} \left[\frac{(1-p(\theta))^2}{2} - S(\theta)\right]^{\alpha} \cdot \left[p(\theta)(1-p(\theta)) + S(\theta) - \theta\right]^{1-\alpha} f(\theta)\, d\theta$$

$$s.t. \quad (PC_A),\ (PC_F),\ (ICC_F), \tag{13}$$

where[20] (ICC$_F$) is the incentive compatibility constraint of the firm, given by[21]

$$\pi(\theta) = \pi\left(\theta^+\right) + \theta^+ - \theta. \tag{ICC$_F$}$$

Substituting from (ICC$_F$) $\pi(\theta)$ with $\pi\left(\theta^+\right)$ into (13), the maximization problem becomes

$$\max_{p(\theta),\pi\left(\theta^+\right)} \int_{\theta^-}^{\theta^+} \left[\frac{(1-p(\theta))^2}{2} + p(\theta)(1-p(\theta)) - \pi(\theta^+) - \theta^+\right]^{\alpha}$$

[20] Notice that (PC$_A$) and (PC$_F$) are exactly the same constraints as in case I.

[21] In Appendix we provide a formal derivation of (ICC$_F$).

$$\cdot \left[\pi\left(\theta^{+}\right)+\theta^{+}-\theta\right]^{1-\alpha} \quad s.t. \quad (PC_A)\,,\ (PC_F)\,.$$

Ignoring the constraints (PC_A) and (PC_F),[22] after a simple manipulation the first-order condition for $p(\theta)$ gives

$$p_B^{US} = MC = 0. \tag{14}$$

Expression (14) is equal to (9), so the equilibrium pricing policy does *not* depend on the firm's type. The *price* agreed by *any* regulated firm and a benevolent agency when the signal is uninformative is just equal to the commonly known marginal cost.

The failure of the audit activity does *not* prevent the negotiated pricing policy from being allocatively efficient. Clearly this result depends on the fact that the uncertainty just concerns the fixed costs and therefore there is no reason to distort the price since both the agency and the firm share the same objective of maximizing the total gains from trade and this is not affected by asymmetric information. Formally the point is that the incentive compatibility constraint (ICC_F) does not depend on price as long as the firm's private information is about the fixed costs.

The regulated *profit* of the most *inefficient* firm is derived by the following first-order condition

$$-\pi\left(\theta^{+}\right)+(1-\alpha)\left(\frac{1}{2}-\theta^{+}\right)=0,$$

from which we get

$$\pi_B^{US}\left(\theta^{+}\right)=(1-\alpha)\left[\frac{1}{2}-\theta^{+}\right]=(1-\alpha)\,TGT\left(\theta^{+}\right)=\pi_B^{US}\left(\theta^{+}\right). \tag{15}$$

A comparison between (15) and (10) reveals that $\pi_B^{US}\left(\theta^{+}\right)$ is the *same* profit that a θ^{+}-firm would get if the agency discovers its costs. As usual, the most inefficient firm does *not* have any informational advantage and then there is no need to reward it for its private information.

From (ICC_F) we get immediately the regulated *profit* of a type θ firm

$$\pi_B^{US}(\theta)=\pi_B^{US}\left(\theta^{+}\right)+\theta^{+}-\theta. \tag{16}$$

Expression (16) shows that as usual under asymmetric information a θ-firm is able to obtain an *informational rent* $\left(\theta^{+}-\theta\right)$ from its informational

[22] It can be easily shown that they are satisfied in equilibrium.

advantage, in addition to the θ^+-firm's profit. Taking the difference between (16) and (10) yields

$$\Delta\pi(\theta) \equiv \pi_B^{US}(\theta) - \pi_B^{IS}(\theta) = \alpha\left(\theta^+ - \theta\right). \tag{17}$$

Expression (17) represents the *extra profit* that a firm of type θ can extract just from pure asymmetric information, for a given allocation of bargaining power. Note that this extraprofit is *lower* than the usual informational rent $\left(\theta^+ - \theta\right)$, as $\alpha \in (0,1)$. Moreover, there is a positive relation between α and $\Delta\pi(\theta)$. This implies that the *stronger* the agency in the bargaining process, the *greater* the firm's extra profit from its pure informational advantage.

We state this result in the following Proposition.

Proposition 2 *The regulated firm obtains an extraprofit $\Delta\pi(\theta)$ from asymmetric information which is lower than the standard informational rent $\left(\theta^+ - \theta\right)$ and equal to this rent weighted by the agency's bargaining power α.*

The point is that there is an a upper bound on the *possible profits* of a type θ monopoly given by the total gains from trade $TGT(\theta)$. These total gains from trade are splitted between the agency and the firm according to their bargaining power: as long as the agency's signal is uninformative a type θ firm can appropriate a further share of gains from trade which belongs to the agency and thus must depend on the bargaining power of the latter, as the following way of rewritting firm's profits shows

$$\pi_B^{US}(\theta) = (1-\alpha)\, TGT(\theta) + \alpha\left(\theta^+ - \theta\right), \tag{18}$$

which is immediately derived from (17) using (10). In other words, as the firm receives a rent *even* with informative signal because of its bargaining power, which is equal to $(1-\alpha)\, TGT(\theta)$, this power puts an upper bound on the additional rent it can get under asymmetric information. If the firm has all the bargaining power ($\alpha \to 0$), it is able to capture all the gains from trade under complete information and so it cannot obtain more when exploiting its informational advantage ($\pi_B^{US}(\theta) \to TGT(\theta)$ and $\Delta\pi(\theta) \to 0$). If all the bargaining power is allocated to the agency ($\alpha \to 1$), as in the standard principal-agent model, the firm does not get any profit with informative signal but it is able to extract the full informational rent if the audit technology fails ($\pi_B^{US}(\theta) = \Delta\pi \to \left(\theta^+ - \theta\right)$). When the bargaining power is shared between the two players, an intermediate situation occurs in which the firm's extra profit is only a part α of the informational rent. The results in (17) and (18) have crucial implications for the following analysis.

Replacing (16), as defined by (15), and (14) into (4), after some manipulations we get

$$S_B^{US}(\theta) - S_B^{IS}(\theta) = \alpha\left(\theta^+ - \theta\right) = \Delta\pi(\theta). \tag{19}$$

It is immediate to notice from (19) that the extraprofit $\Delta\pi\left(\theta\right)$ appropriated by the θ-firm is *enterely subsidized* by consumers.

After some substitutions, we derive the *consumer surplus loss* under asymmetric information, which is given by

$$\left|CS_B^{US}\left(\theta\right) - CS_B^{IS}\left(\theta\right)\right| = \alpha\left(\theta^+ - \theta\right) = \Delta\pi\left(\theta\right). \tag{20}$$

Not surprisingly, (20) shows that consumers make a loss just equal to the firm's extraprofit $\Delta\pi\left(\theta\right)$ that they subsidize.

We summarize the main findings in the following Lemma.

Lemma 3 (B-US) *If the agency is benevolent and the signal is uninformative, then the regulatory mechanism* $\left(p_B^{US}, S_B^{US}\right)$

• *applies the marginal cost pricing, i.e.* $p_B^{US} = MC$*, and*

• *entirely subsidizes the firm's extra profit from asymmetric information, i.e.* $S_B^{US}(\theta) - S_B^{IS}(\theta) = \Delta\pi(\theta)$.

In particular, the firm's profit $\pi_B^{US}\left(\theta\right)$ *has two components:*

• *the share of total gains from trade appropriated because of its bargaining power* $\left(1-\alpha\right)TGT\left(\theta\right)$

• *the pure extraprofit from asymmetric information* $\Delta\pi(\theta)$ *equal to the usual informational rent* $\left(\theta^+ - \theta\right)$ *weighted by the agency's bargaining power* α.

3.3 Expected payoffs with a benevolent agency

Hiring a benevolent regulator which detects the firm's cost parameter with probability ζ allows consumers to gain an expected surplus equal to

$$E\left[CS_B\right] \equiv \zeta CS_B^{IS} + \left(1-\zeta\right)CS_B^{US} = CS_B^{US} + \zeta\alpha\left(\theta^+ - \theta\right). \tag{21}$$

Expression (21) shows the impact of the *twofold* regulatory role on the consumer expected welfare. An increase in the agency's bargaining power (α goes up) clearly benefits consumers that enjoy a raise in their expected surplus. However, notice that the extraction of the firm's informational rent $\left(\theta^+ - \theta\right)$ crucially needs the *joint* action of monitoring and of bargaining activities. The term $\zeta\alpha$ can be thought of as the degree of joint effectiveness of the twofold role of the regulator. An agency with all the bargaining power

($\alpha \to 1$) could *not* capture any part (in expected value) of the informational rent if its audit technology were completely inefficient ($\zeta = 0$). On the other hand, a perfect supervisory activity ($\zeta = 1$) would be fruitless if it were *not* associated with some bargaining ability ($\alpha \to 0$).[23]

Substituting (17) into (21) yields

$$E\left[CS_B\right] = CS_B^{US} + \zeta \Delta\pi(\theta). \tag{22}$$

Consumers obtain the surplus under asymmetric information plus the expected benefit of *avoiding* the subsidization of the firm's extraprofit, which occurs when the audit activity succeeds. Hence, the term $\zeta\Delta\pi(\theta)$ is the consumer expected gain from discovering the firm's cost parameter.

The firm's expected profit is equal to the profit when the audit technology succeeds plus the extraprofit $\Delta\pi(\theta)$, which can be extracted with probability $(1 - \zeta)$

$$E\left[\pi_B\right] \equiv \zeta\pi_B^{SI} + (1-\zeta)\,\pi_B^{AI} = \pi_B^{SI} + (1-\zeta)\,\Delta\pi(\theta). \tag{23}$$

4. Nonbenevolent agency

A *nonbenevolent* agency, which is drawn with probability $(1 - \gamma)$, is partially interested in consumer surplus and partially in its private transfer T. This transfer may come either from consumers, through the taxes they pay, or from the firm, which may give a bribe to the agency for the concealment of the informative signal.

For the time being, we assume that Congress tolerates the possibility of collusion. Section 5 examines possible institutional choices by Congress to avoid this threat. Hence, for the moment Congress continues to offer a constant reward $T^C = \overline{T}$ to the agency, independently of its report r, so that a dishonest regulator has an incentive to collude with the firm. In the following subsections, we consider cases III and IV of Table 1, respectively.

4.1. Case III: uninformative signal ($\sigma = r = \phi$)

If the supervisory activity *fails*, the agency does *not* have any discretion and can only convey the uninformative signal to Congress. The firm enjoys its informational advantage *without* bribing the agency. Following the

[23] As we have seen, in this case the firm would not actually receive the informational rent, since it can extract all the gains from trade even when the signal is informative.

same procedure as in Subsection 3.2, the bargaining outcome can be derived through the following maximization program

$$\max_{p(\theta),S(\theta)} \int_{\theta^-}^{\theta^+} \left\{ T + \beta \left[\frac{(1-p(\theta))^2}{2} - S(\theta) \right] \right\}^{\alpha}$$

$$\cdot \left[p(\theta)(1-p(\theta)) + S(\theta) - \theta \right]^{1-\alpha} f(\theta)\, d\theta \quad s.t \quad (PC_A), (PC_F), (ICC_F). \tag{24}$$

The expression in curly braces represents the utility of a nonbenevolent agency, which is given by (2).[24]

Since the regulator is not able to collect any private transfer, the program in (24) boils down to (13) except for the parameter β, which obviously does not affect the solution to the problem.

This observation leads to the following conclusion.

Lemma 4 (NB-US) *If the agency is nonbenevolent and the signal is uninformative, the regulatory mechanism* $\left(p_{NB}^{US}, S_{NB}^{US}\right)$ *is the same as with a benevolent agency, i.e.* $\left(p_{NB}^{US}, S_{NB}^{US}\right) = \left(p_{NB}^{IS}, S_{NB}^{IS}\right)$*, since there is no scope for collusion.*

4.2. Case IV: informative signal and scope for collusion ($\sigma = \theta$ & $r \in \{\theta, \phi\}$)

The agency's detection of the firm's cost parameter *opens* the possibility of collusion. The firm has a stake in the agency's report, since the retention of the informative signal guarantees the extra profit $\Delta\pi$ given by (17). Hence, the firm may be willing to sign a side contract with the agency which provides for the concealment of information in exchange for a covert transfer T^F. As long as Congress tolerates the possibility of such a coalition and offers $T^C = 0$ to the agency, the latter has an incentive to reach a collusive agreement with the firm.

The side contract between the firm and the regulator is supposed to be enforceable, even though it is illegal. This assumption, common in the literature, is clearly a shortcut since it simply presumes that any gain from

[24] Notice that the participation contraint (PC_A) is now given by $V_{NB} \geq 0$, because the agency is nonbenevolent. As in the benevolent case we assume that the agency requires nonnegative *ex post* utility.

trade between parties is realized.[25]

According to Stigler's [**31**], collusion is driven by two crucial factors: the *stake in collusion* and the *organization costs*. In our setting, the stake in collusion crucially depends on the informational rent kept by the firm when the agency hides its information: as Tirole [**33**] emphasizes, collusion is likely to be a serious issue only if there is incomplete information. In our model, the stake in collusion is given by the extra profit $\Delta\pi(\theta)$ that the θ-firm can obtain if its private information is concealed from Congress.

The firm's costs of organizing are represented by transfer costs,[26] which are related to the deadweight loss associated with the side transfer of income from the firm to the regulator.[27] Following Laffont and Tirole [**17**], we capture this inefficiency by introducing an exogenous shadow cost of side transfers $\mu \geq 0$. The idea is that a monetary equivalent of one dollar received by the agency costs $(1+\mu)$ dollars to the firm. This parameter determines the transaction technology between the firm and the agency. If $\mu \to +\infty$, the transaction technology is too inefficient and no coalition forms. Otherwise, the transaction technology makes collusion profitable. When $\mu = 0$, there is no deadweight loss from side contracting.

According to the timing of the game in Section 2.3, the firm and the agency bargain at the same time over a regulatory mechanism $\{p, S\}$ *and* a side contract. The regulatory arrangement arising from collusive negotiations allows the firm to keep its informational advantage over Congress $(r = \phi)$ even though the agency is informed about the firm's costs $(\sigma = \theta)$. The side contract specifies a covert transfer $T^F(r) \geq 0$, which is paid by the firm to the agency only if the informative signal is retained $(\sigma = \theta \;\&\; r = \phi)$ and costs $(1+\mu)T^F(r)$ to the firm.

We assume that in case of *disagreement* about the side contract the agency and the firm continue to bargain over the regulatory mechanism and can reach the no-collusion outcome $\left(V_{NB}^D, \pi_{NB}^D\right)$.[28] Given the timing of the game in Section 2.3 and the discussion in Section 2.4, the solution to this

[25] The enforcement of side contracts may actually be assumed to rely on non-judicial mechanisms, like reputation in long-term relationships or the "word of honor" in the one-shot relationships. Among others, see Laffont and Tirole [**18**, ch. 11] for a discussion on this issue.

[26] Furthermore, the firm incurs mobilization costs to collect information and intervene in specific regulatory issues. These costs are ignored in our setting.

[27] A monetary bribe exposes the parties to the possibility of legal sanctions. Alternatively, the agency's staff values nonmonetary side transfers (for entertainment, jobs after the tenure in the agency,...) *less* than the monetary expenses incurred by the firm.

[28] We follow Tirole's [**32**] view that each party can guarantee itself the no-side-contract outcome.

bargaining problem arises from the maximization of the Nash product (in expected terms) of the two parties' gains in utility over the no-side-contract outcome. Formally,

$$\max_{T^F,p,S} \int_{\theta^-}^{\theta^+} \left[V_{NB}\left(T^F,p,S\right) - V_{NB}^D\right]^{\alpha} \cdot \left[\pi\left(T^F,p,S\right) - \pi_{NB}^D\right]^{1-\alpha} f(\theta)\, d\theta \tag{24}$$

s.t.

$$V_{NB} \geq V_{NB}^D \tag{PC$_A$}$$

$$\pi \geq \pi_{NB}^D \tag{PC$_F$}$$

$$T^F \geq 0 \tag{C$_{T^F}$}$$

$$\pi = \pi_B^{US}\left(\theta^+\right) + \theta^+ - \theta - (1+\mu)\, T^F. \tag{ICC$_F^C$}$$

The last constraint (ICC$_F^C$) indicates the profit of the θ-type firm under collusion. The rationale is the following. When the collusive agency lies and claims that its supervisory activity has failed, Congress requires that the negotiated policy be incentive compatible, in order to induce the true revelation of private information. Hence, (ICC$_F^C$) can be defined as the "incentive compatibility constraint" under collusion, which specifies the firm's profit. The θ-type firm is given the profit of the most inefficient firm, which is independent of the agency's type, i.e. $\pi_B^{US}\left(\theta^+\right) = \pi_{NB}^{US}\left(\theta^+\right)$ from Lemma 4, plus the information rent $\left(\theta^+ - \theta\right)$. This amount, which corresponds to (ICC$_F$) in Section 3.2, represents the gross earning of the firm from collusion and is financed by consumers. The firm spends a part of this gain, equal to $(1+\mu)\, T^F$, to pay a side transfer T^F to the agency.

We have assumed that, in case of disagreement about the side contract, the agency and the firm continue to negotiate over the regulatory mechanism. In this case, we would be in the same setting of Section 3.1 except for the parameter β. The agency would not receive any bribe ($T^F = 0$) and would reveal the informative signal to Congress, which could save the extraprofit to the firm ($\Delta\pi = 0$). Hence, the agency's no-collusion utility is equal to the consumer surplus CS_B^{IS} weighted by β (i.e. $V_{NB}^D = \beta CS_B^{IS}$).

The firm's no-collusion profit is given by π_B^{IS} (i.e. $\pi_{NB}^D = \pi_B^{IS}$). After substituting (2), as defined by (6), and (4), the maximization problem in (24) becomes

$$\max_{T^F, p(\theta), S(\theta)} \int_{\theta^-}^{\theta^+} \left[T^F + \beta \left(\frac{(1 - p(\theta))^2}{2} - S(\theta) \right) - \beta CS_B^{IS} \right]^{\alpha}$$

$$\cdot \left(\pi - \pi_B^{IS} \right)^{1-\alpha} f(\theta) \, d\theta \quad s.t. \qquad (PC_A), \ (PC_F), \ (C_{T^F}), \ \left(ICC_F^C \right). \quad (25)$$

If we replace from (4) the choice variable S with π and notice from (ICC_F^C) that π is entirely determined by T^F, the program in (25) boils down to the maximization with respect to $p(\theta)$ and T^F. Substituting (ICC_F^C), as specified by (15), and (10) into (25) yields after some manipulations

$$\max_{T^F, p(\theta)} \int_{\theta^-}^{\theta^+} \left\{ T^F + \beta \left[\frac{(1 - p(\theta))^2}{2} - (1 - \alpha) TGT \left(\theta^+ \right) - \theta^+ + (1 + \mu) T^F \right. \right.$$

$$\left. \left. + p(\theta) (1 - p(\theta)) - CS_B^{IS} \right] \right\}^{\alpha} \cdot \left[\alpha \left(\theta^+ - \theta \right) - (1 + \mu) T^F \right]^{1-\alpha} f(\theta) \, d\theta \quad (26)$$

$$s.t. \qquad (PC_A), \ (PC_F), \ (C_{T^F}).$$

Notice from (26) that the firm's gain in profit over the no-collusion outcome, represented by the second factor of the Nash product, is just the informational extra profit $\Delta\pi(\theta) = \alpha \left(\theta^+ - \theta \right)$, which the firm can extract when the agency conceals its signal, minus the expense $(1 + \mu) T^F$ to bribe the agency.

Ignoring for the moment all the constraints,[29] from the first-order condition for $p(\theta)$, the collusive price agreed by the regulated firm and a non-benevolent agency with informative signal is the same of the one agreed with benevolent agency

$$p_{NB}^{IS} = p_B^{IS} = MC = 0. \quad (27)$$

[29] It can be easily shown that (PC_F) and (C_{T^F}) are satisfied in equilibrium. We will discuss later about (PC_A).

Expression (27) shows that collusion between the firm and the agency does *not* affect the equilibrium price, which is still equal to marginal costs. Of course, neither of the two parties has any interest in inducing allocative inefficiency: once the gains from trade are maximized, then consumer surplus can be eroded through the subsidy.

After some manipulations, the first-order condition for T^F can be written as

$$-(1+\mu)[1+\beta(1+\mu)]T^F + \alpha\left(\theta^+ - \theta\right)[\alpha + \beta(1+\mu)] = 0. \tag{28}$$

In equilibrium, the *side transfer* is given by

$$T^F_{NB} = \alpha\frac{\alpha + \beta(1+\mu)}{(1+\mu)[1+\beta(1+\mu)]}\left(\theta^+ - \theta\right) = \frac{\alpha + \beta(1+\mu)}{(1+\mu)[1+\beta(1+\mu)]}\Delta\pi(\theta). \tag{29}$$

The bribe that the agency can extort from the firm is increasing in its bargaining power. If $\alpha \to 0$, the regulator does not collect anything ($T^F_{NB} \to 0$) since it is too weak. If $\alpha \to 1$, all the bargaining power is allocated to the agency and the side transfer tends to

$$\lim_{\alpha\to 1} T^F_{NB} = \frac{\theta^+ - \theta}{1+\mu} = \frac{\Delta\pi(\theta)}{1+\mu}, \tag{30}$$

which is just the maximum extra profit that the firm can obtain from asymmetric information discounted by the shadow cost of side transfers. It represents the maximum possible reward to the agency for manipulating the evidence. Note that the side transfer in (30) approximates the *take-it-or-leave-it* call for a bribe taken by the agency[30].

Expression (29) shows that there is a positive relation between T^F_{NB} and β. The greater the weight the nonbenevolent agency attaches to consumer surplus, the higher the amount of side transfer that it requires to hide its information. Hence, β can be thought of as the inverse of the *level of corruptibility* of the regulator. An increase in β implies more disutility from lying (in terms of consumer surplus loss) and makes the agency more costly to bribe.

Using (27) and (29) we immediately find that $V_{NB} - V^D_{NB} \geq 0$ if $\beta \leq \frac{\sqrt{\alpha}}{1+\mu}$. This means that a nonbenevolent agency will reach a collusive agreement as long as its level of corruptibility is sufficiently high. For $\beta > \frac{\sqrt{\alpha}}{1+\mu}$, a dishonest agency will does collude since no bribe can compensate its disutility

[30] See, among others, Laffont [**14**, ch. 2].

from lying, and then there is no difference between the two types of agency. Since we are interested in the possibility of collusion, we focus hereafter our attention to the case $\overline{\beta} \leq \frac{\sqrt{\alpha}}{1+\mu}$.

Not surprisingly, the side transfer to the regulator is decreasing in the transaction costs of collusion. If $\mu = 0$, the side contracting is fully efficient and the firm can afford to pay a high bribe. If $\mu \to +\infty$, transaction technology is so inefficient that collusion is unfeasible ($T_{NB}^{F} \to 0$).

Finally, it is important to notice from (29) the positive relation between the side transfer T_{NB}^{F} and the informational rent $\left(\theta^{+} - \theta\right)$. A more inefficient firm has a reduced stake in collusion and offers a smaller side payment to the agency. In particular, the θ^{+}-firm does not bribe the regulator at all ($T_{NB}^{F} = 0$) since it has no informational advantage to keep. This result is consistent with the standard formulation of collusion models.

After substituting (29) into (ICC_{F}^{C}), as specified by (15), and using (10), we get the firm's *extra rent* $\Delta\pi^{C}(\theta)$ *from collusion*, i.e. the extra gain that the θ-firm can obtain by colluding with the agency

$$\Delta\pi^{C}(\theta) \equiv \pi_{NB}^{IS}(\theta) - \pi_{B}^{IS}(\theta) = \frac{1-\alpha}{1+\beta(1+\mu)}\Delta\pi(\theta). \tag{31}$$

Expression (31) shows how the θ-firm's extra profit $\Delta\pi(\theta) = \alpha\left(\theta^{+} - \theta\right)$, which represents the total stake in collusion, can be *split* between the agency and the firm. The latter only obtains a fraction of the total pie, which is equal to $\frac{1-\alpha}{1+\beta(1+\mu)}\Delta\pi < \Delta\pi$. The remaining part $(1+\mu)T_{NB}^{F}$ just finances the bribe to the agency.

Consider the relation between $\Delta\pi^{C}$ and α. If the bargaining power is *concentrated* in the hands of just one party (which implies $\alpha \to 0$ or $\alpha \to 1$), the firm is *indifferent* whether to collude or not ($\Delta\pi^{C} \to 0$). Two opposite reasons lead to this result. A very strong firm ($\alpha \to 0$) is able to extract all the gains from trade even with informative signal and does not have any stake in the agency's report. A very weak firm ($\alpha \to 1$), even if it has the greatest stake in keeping an informational advantage ($\Delta\pi \to \left(\theta^{+} - \theta\right)$, from (17)), cannot retain any part of the information rent arising from the concealment of the signal. Only if the negotiation process does *not* degenerate into a take-it-or-leave-it offer and the bargaining power is split between the two parties, collusion becomes strictly profitable for the firm ($\Delta\pi^{C} >> 0$).

The following result is immediate, but of some interest.

Proposition 5 *The firm maximizes its extra rent from collusion $\Delta\pi^{C}$ when the bargaining process is symmetric, i.e. $\alpha = \frac{1}{2}$.*

While the share of the collusion gains in (31) obtained by the firm is proportional to its bargaining power, the pure informational extraprofit $\Delta\pi$ depends on the agency's bargaining power, as showed by (17), and thus the product is maximized when these two opposite effects equilibrate. Proposition 5 indicates that the firm has the greatest incentive to form a coalition with an agency which holds the same bargaining strength, i.e. it will be more interested in finding an illegal compromise with its counterpart if their bargaining power differential is reduced.

To better understand how the gains from the side trading are split between the firm and the agency, let us observe Figure 1, which illustrates the patterns of $\Delta\pi^C$ (thin solid line) and T^F_{NB} (thick solid line) as functions of α. The difference between the total stake in collusion $\Delta\pi$ (dashed thin line) and the total stake discounted by the shadow cost of side transfers $\frac{\Delta\pi}{1+\mu}$ (dashed thick line) captures the deadweight loss from the side contracting.[31]

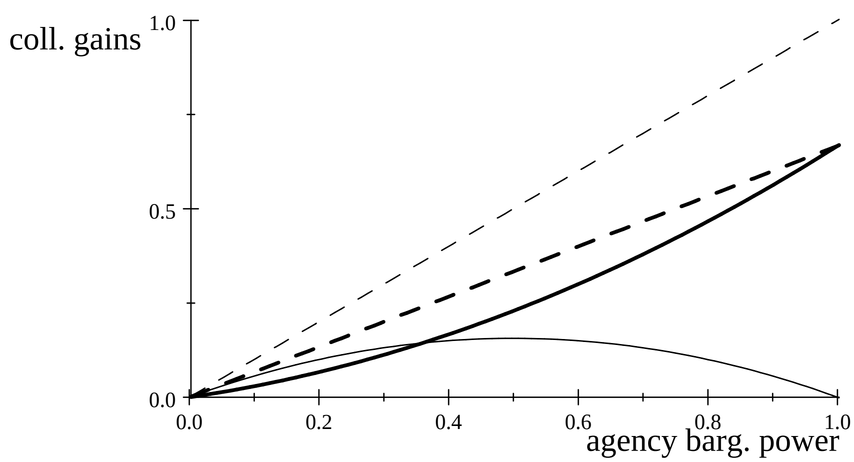

Fig. 1. Gains from the side contracting

A quite strong firm (α small enough) captures almost all the gains of the coalition. An increase in the agency's bargaining power reduces the fraction of the total pie appropriated by the firm, since the regulator requires a greater side transfer. Nevertheless, the firm gets an increasing extra rent from collusion as long as it is stronger than the agency ($\alpha < \frac{1}{2}$). Hence, the benefit to the firm from an increase in the total stake in collusion induced by α outweighs the cost of a reduced bargaining power. When power relations

[31] The functions depicted in Figure 1 are derived by assuming $(\theta^+ - \theta) = 1$, $\mu = 0.5$ and $\beta = 0.4$.

are reversed ($\alpha > \frac{1}{2}$), the trade-off becomes detrimental to the firm, whose gain from collusion decreases.

Figure 1 shows that there exists a critical point α^c at which the two parties get the same gain from collusion, which is equal to

$$\alpha^c = \frac{(1+\mu)(1-\beta)}{2+\mu}. \tag{32}$$

If $\alpha < \alpha^c$, the firm is able to gain from the collusive coalition more than the agency. Since α^c is increasing in μ, the transaction costs of collusion widen the range $(0, \alpha^c)$ in which the firm's extra rent exceeds the side transfer to the agency. Hence, the inefficiency of the side contracting penalizes relatively more the regulator.

The negative relation between β and α^c implies that a reduction in the agency's level of corruptibility (β goes up) widens the range $(\alpha^c, 1)$ in which the agency gets more than the firm from the collusive agreement. This occurs since bribing the agency becomes more expensive for the firm.

We know from (ICC_F^C) that under collusion consumers finance the firm's profit *as if* the signal were uninformative, since the agency claims before Congress that it has not discovered the cost parameter. Since the price in (27) is still allocatively efficient, in equilibrium consumers pay a subsidy $S_{NB}^{IS} = S_B^{US}$. Using (19), we get

$$S_{NB}^{SI}(\theta) - S_B^{SI}(\theta) = \Delta S^C(\theta) = \Delta\pi(\theta). \tag{33}$$

The *extra subsidy* in (33) *entirely* finances the total gains of the coalition. Collusion *penalizes* consumers who receive the *same* surplus as when the audit fails.

We summarize the main results in the following Lemma.

Lemma 6 (NB-SI) *If the agency is nonbenevolent and the signal is informative, there is scope for collusion as long as Congress tolerates this threat. The regulatory mechanism* $\left(p_{NB}^{IS}, S_{NB}^{IS}\right)$ *has the following characteristics*

- *applies marginal cost pricing, i.e.* $p_{NB}^{IS} = MC$
- *entirely subsidize the total stake in collusion* $\Delta\pi(\theta)$.

The gains of the coalition are split between colluding partners according to their bargaining power and the firm gets the highest extra rent from collusion when the barganing process is symmetric.

4.3. Expected payoffs with a nonbenevolent agency

The consumer expected surplus loss with a corruptible regulator is equal to

$$|E[CS_{NB}] - E[CS_B]| \equiv \left|\Delta E\left[CS^C\right]\right| = \zeta\Delta\pi. \tag{34}$$

The agency's dishonesty is consumer welfare detrimental, since the expected total stake in collusion $\zeta\Delta\pi$ is financed by consumers through a subsidy. Notice the positive relation between $\left|\Delta E\left[CS^C\right]\right|$ and ζ: a higher quality of the supervision technology worsens the consumers' condition since it makes collusion more likely.

The firm's expected profit is given by the profit with uninformative signal reduced by the expected expense to bribe the agency

$$E[\pi_{NB}] \equiv \zeta\pi_{NB}^{IS} + (1-\zeta)\,\pi_{NB}^{US} = \pi_B^{US} - \zeta(1+\mu)\,T_{NB}^F. \tag{35}$$

Subtracting (23) from (35), after some manipulations we get the firm's expected benefit from bargaining with a collusive agency

$$E[\pi_{NB}] - E[\pi_B] = \zeta\left[\Delta\pi - (1+\mu)\,T_{NB}^F\right] = \zeta\Delta\pi^C. \tag{36}$$

Expression (36) indicates the expected difference between the total stake and the total cost of collusion for the firm, which determines the firm's expected extra rent from bribing the agency.

5. The institutional responses to collusion

So far we have supposed that Congress *tout court* tolerates the possibility of collusion. In this section we characterize the institutional responses that Congress should devise to give consumers the highest (expected) surplus. We consider two options only: either the Congress can *deter* collusion through an incentive payment to the agency at least equal to the bribe that it receives from the firm[32] or, alternatively, collusion is *allowed* in equilibrium. Of course, this assumption is restrictive but it is quite common in literature and it can be justified by institutional settings that allow compensation contingent to agency's report only. Therefore to fight collusion, Congress is supposed to design an incentive scheme which applies to *both* an honest regulator and a dishonest one. As Tirole [**33**] suggests, the impossibility of discriminating between the agency's types may be thought of as Congress's uncertainty about a binary transaction technology of collusion. Indeed, as shown in Subsection 4.2 if $\mu \to +\infty$ the side contracting is so inefficient to make collusion unfeasible, i.e. we obtain the same outcome as with a

[32] Following Laffont [**14**, ch. 2], we assume that limited liability constraints prevent Congress from designing a system of punishments and fines against the agency.

benevolent agency. For lower values of μ, collusion becomes profitable, i.e. we find the same outcome as with a nonbenevolent agency.

Baiman *et al.* [**2**] rule out the screening assumption by modelling the option to collude as a random event which is not an inherent characteristic of a subject but it is associated with the environment. In Kofman and Lawarrée's [**13**] model, the principal is not able to discriminate between the different types of auditors because the latter have the same utility function but different strategy spaces.[33] We suppose that incompletness of contracts arising from institutional constraints prevents Congress from devising an incentive compatible mechanism which induces the self-selection of regulators according to their type. In other words, Congress cannot distinguish between the regulator's types because legal arrangements prohibit to make the reward of the agency's staff contingent on some variables that reveal the regulator's type.[34] Collusion literature has shown that removing the screening condition implies that Tirole's equivalence principle does not apply. Starting from this observation, we will first derive a condition for the optimality of *allowing* collusion. Then, we will show that an increase in the agency's bargaining power makes this condition more likely to hold in equilibrium.

If Congress decides to *prevent* collusion, the consumer expected surplus is equal to

$$E\left[CS^{NC}\right] = E\left[CS_B\right] - \zeta\left(1+\lambda\right)T^F_{NB}. \tag{37}$$

In order to get the no-collusion outcome and the associated consumer expected surplus $E\left[CS_B\right]$, Congress has to design a bunching mechanism. This scheme gives *any* type of informed agency, which occurs with probability ζ, the minimum reward to deter collusion $T^C = T^F_{NB}$. The reward is paid by consumers through possibly distortionary taxes that involve a social cost λ.

If Congress *tolerates* collusion, the consumer expected surplus is given by

[33] In Kofman and Lawarrée's words, ‹‹the auditors have no feature that enables the principal to discriminate between them by means of providing different incentives. If the principal were simply to ask for type reports, promising a high reward for dishonest auditors, every auditor would claim to be dishonest; if he were to threaten punishment for the dishonest auditors, every auditor would claim to be honest›› [**13**, p. 386].

[34] For instance, it may be common knowledge that the regulatory staff coming from a certain region is more likely to collude, but rewards to commissioners cannot be differentiated on the basis of their origins.

$$E\left[CS^{C}\right] \equiv \gamma E\left[CS_{B}\right] + (1-\gamma) E\left[CS_{NB}\right] = CS^{US} + \gamma\zeta\Delta\pi, \tag{38}$$

by (22). Consumers are expected to receive a surplus equal to $CS^{US} \equiv CS_{B}^{US} = CS_{NB}^{US}$ (from Lemma 4) plus the extraction of the firm's extraprofit $\Delta\pi$ if the agency is benevolent and informed, which occurs with probability $\gamma\zeta$.

When designing the optimal response to collusion, Congress compares costs and benefits of its strategy. Tolerating collusion turns out to be optimal if and only if the cost incurred to induce the agency not to collude (weakly) outweighs the expected benefit of extracting the stake in collusion. The condition for the optimality of allowing collusion is then formally expounded in the following Proposition.

Proposition 7 *Congress finds it optimal to allow collusion in equilibrium if and only if the cost of rewarding the agency for not colluding (weakly) exceeds the expected total stake in collusion. That is,* $E\left[CS^{C}\right] \geq E\left[CS^{NC}\right]$ *if and only if*

$$(1+\lambda) T_{NB}^{F} \geq (1-\gamma) \Delta\pi. \tag{39}$$

Note that the incentive reward T_{NB}^{F} on the left-hand side of (39) costs $(1+\lambda) T_{NB}^{F}$ to consumers, since taxes entail a deadweight loss. Furthermore, the total stake in collusion $\Delta\pi$ on the right-hand side of (39) is weighted by $(1-\gamma)$, because only the self-interested agency would need to be remunerated in order to disclose its information and to spare consumers the extrasubsidization, while the reward to a benevolent agency represents a sheer waste of resources.

First, let us analyze the impact of γ on condition (39). As γ increases, the righ-hand side of (39) decreases. Hence, a raise in the probability of drawing a benevolent agency makes *more* attractive to allow collusion. The rationale for this result is obvious. Collusion literature has emphasized that if the probability of an honest regulator is sufficiently high, costly measures to eliminate collusion may become unnecessary and the optimal contract may allow collusion in equilibrium.

In this framework, we want to examine the impact of the agency's bargaining power on condition (39). We know from (29) and (17) that T_{NB}^{F} and $\Delta\pi$ are *both* increasing in α. A *trade-off* between deterring and allowing collusion emerges. On one hand, a stronger agency (α goes up) can extort a higher bribe from the firm. Tolerating collusion becomes more attractive since this allows to save the incentive payment to the agency. On the other hand, the agency's bargaining power increases the total stake in collusion. Deterring collusion is more desirable because the gains of the coalition can be appropriated by consumers. To see which effect prevails in equilibrium, we substitute (17) and (29) into (39) and get

$$\frac{\alpha+\beta\left(1+\mu\right)}{\left(1+\mu\right)\left[1+\beta\left(1+\mu\right)\right]}\geq\frac{1-\gamma}{1+\lambda}. \tag{40}$$

This point deserves a bit more discussion. We know from equation (38) that a stronger agency raises consumer surplus, even if it is possibly collusive. This occurs because the regulator internalizes (at least partially) consumers' interests. Equation (37) shows that on one hand, by keeping the incentive payment constant and preventing collusion, a higher bargaining power of the agency increases consumer surplus. On the other hand, a stronger agency makes more expensive to deter collusion, since a higher incentive reward should be paid to the agency.

The result of this trade-off is expressed in the following Proposition.

Proposition 8 *There exists a threshold value* α^**, given by*

$$\alpha^*\equiv\frac{1+\mu}{1+\lambda}\left[\left(1-\gamma\right)\left(1+\beta\mu\right)-\beta\left(\gamma+\lambda\right)\right], \tag{41}$$

such that if $\alpha\in[\alpha^*,1)$*, then collusion is allowed in equilibrium. Otherwise, collusion is deterred.*

The proof comes straightforwardly from (40). Of course, collusion not is desirable *tout court*, since consumers would be better off if side transfers were infeasible, but it can be allowed when it is too *costly* to fight.

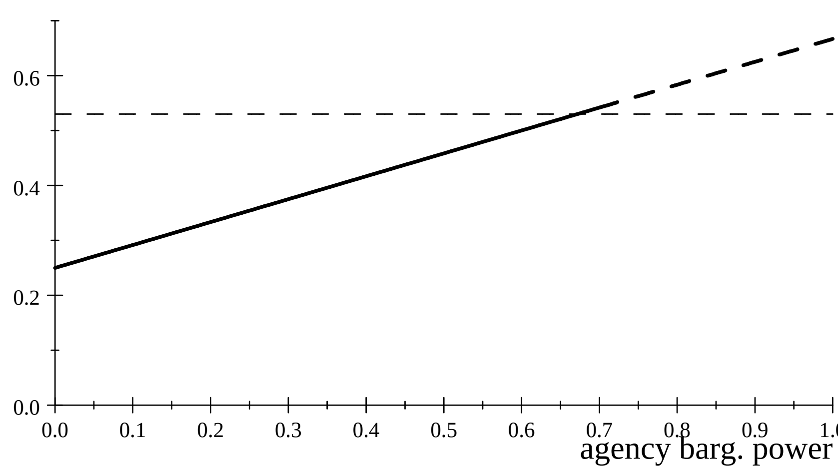

Fig. 2. Optimality of allowing collusion.

In Figure 2[35] the upward sloping line captures the positive relation between α and the left-hand side in (40). The horizontal line denotes the threshold value on the right-hand side of (40). If the agency is quite weak, i.e. $\alpha \in (0, \alpha^*)$, *deterring* collusion turns out to be optimal (see the solid thick line in Figure). However, with a sufficiently *strong* agency, i.e. $\alpha \in [\alpha^*, 1)$, it is *less costly* for Congress to allow collusion in equilibrium (see the dashed thick line).

Notice from (41) that α^* is increasing in μ. When transaction costs of collusion are lower (μ goes down), the range $[\alpha^*, 1)$ over which collusion is desirable increases, since side contracting is more efficient. We find a similar result when taxation is more distortionary (λ increases), since transfers are more costly for consumers.

At the limit, when all the bargaining power is allocated to the agency ($\alpha \to 1$), condition (40) becomes

$$1 + \lambda \geq (1 - \gamma)(1 + \mu), \tag{42}$$

Condition (42) indicates that allowing collusion is desirable if the social cost of a income unit given to the agency outweighs the expected cost of a unit of bribe from the firm to the agency. When the regulator extracts the entire stake in collusion ($\alpha \to 1$), side transfers will be tolerated if they are more efficient than public transfers. If γ is sufficiently high, the expected cost of side trading is small and Congress finds it optimal to *tolerate* collusion.

As long as (42) holds and then allowing collusion may be optimal, a lower level of corruptibility of the agency (β goes up) increases the desirability of allowing collusion (α^* decreases). The agency is less willing to collude and exacts a higher side transfer from the firm, because it internalizes more the surplus loss incurred by consumers. Hence, the agency's stance binds in some way the incentives of the firm to Congress's interests, by making collusion less profitable to the firm.

6. Concluding remarks

In this paper, we have generalized the standard results on regulation and collusion in a monopolistic market with asymmetric information on fixed costs, when the regulatory mechanism is no longer a take-or-leave-it offer

[35] The functions in Figure 2 are depicted, by assuming $\beta = 0.4$, $\gamma = 0.3$, $\lambda = 0.3$ and $\mu = 0.5$.

but the outcome of a bargaining process between the regulatory agency and the regulated firm. The agency, which may be honest or dishonest, is delegated by a benevolent Congress to monitor the firm's unknown fixed costs. To this end, the regulator adopts a standard supervision technology. Furthermore, it carries out the additional task of negotiating with the firm a regulatory mechanism.

Even if the results have been obtained in a quite simple context, our analysis has shown how standard results are altered by the two bargaining processes and that they are a specific case of our more general approach. In particular we have focused on the effects of players' bargaining power on equilibrium values. The regulatory mechanism agreed by the agency and the firm applies the marginal cost pricing to maximize the total gains from trade, and consumers entirely subsidize the gains of the coalition. The introduction of a negotiation between the regulator and the monopoly induce a radical change in the firm's extra profit from pure asymmetric information, which is now equal to the standard informational rent weighted by the agency's bargaining power. This in turn significantly affects the outcome of the collusive stage where the coalition gains are split between the agency and the firm according to their bargaining power. In particular, we have found that the firm has the greatest incentive to collude when facing an agency which holds the same bargaining power, i.e. when the negotiation process is *symmetric*.

In the second part of the paper, we have characterized the optimal institutional responses to collusion assuming institutional constraints that iust allow transfers contingent to agency's reports only. Removing the possibility of screening, we have derived a condition for the optimality of *allowing* collusion in equilibrium. Clearly, *tolerating* collusion turns out to be optimal when the consumer expected benefit from saving the subsidization of the stake in collusion does not cover the expense of the incentive reward to the agency for not colluding. We have explored this condition and shown that a stronger agency makes it more desirable to allow collusion in equilibrium. The idea is that a stronger agency exacts a higher bribe from the firm and collusion therefore may become too costly to fight.

We believe that our simple generalization provides a useful insight on the role of the bargaining power in institutions or in organizations. Of course, this is just a simple step towards more realistic and complex analysis of the negotiation processes whithin a hierarchy's structure.

Our model may be extended in a variety of directions. First of all, the supervisory technology may be modified in order to consider the possibility that the agency can forge the evidence by announcing a wrong cost parameter. This would allow to study the phenomenon of blakmail. Another possibility is to extend the model by endogenizing the agency's effort to audit, since in practice the regulator can affect the functioning of the supervisory technology and moral hazard turns out to be an important issue. Finally, it may be interesting to see what happens if Congress - whose objective function can be generalized by including the firm's profit - is allowed to charge pecuniary and nonpecuniary punishments to the agency.

Appendix

In this appendix we derive the firm's incentive compatibility constraint (ICC_F) for the cost specification in (3) and show that this represents a local necessary condition which is also globally sufficient.

The class of global incentive compatible mechanisms must satisfy the following set of conditions

$$\pi(\theta) \equiv \pi(\theta, \theta) \geq \pi\left(\widehat{\theta}, \theta\right), \forall\, \widehat{\theta}, \theta \in \left[\theta^-, \theta^+\right]. \tag{43}$$

In order to induce a firm not to lie, the profit $\pi(\theta, \theta)$ obtained by telling the truth has to be at least as great as the profit $\pi\left(\widehat{\theta}, \theta\right)$ that the firm could get for any report $\widehat{\theta}$.

Following the Baron [**3**] approach, we use (3) and (4) and rewrite $\pi\left(\widehat{\theta}, \theta\right)$ as

$$\pi\left(\widehat{\theta}, \theta\right) = p\left(\widehat{\theta}\right) q\left(p\left(\widehat{\theta}\right)\right) + S\left(\widehat{\theta}\right) - \theta = \pi\left(\widehat{\theta}\right) + \widehat{\theta} - \theta, \tag{44}$$

where $\pi\left(\widehat{\theta}\right) \equiv \pi\left(\widehat{\theta}, \widehat{\theta}\right)$. Substituting $\pi\left(\widehat{\theta}, \theta\right)$ from (44) into (43) and combining terms yields

$$\pi(\theta) - \pi\left(\widehat{\theta}\right) \geq \widehat{\theta} - \theta, \forall\, \widehat{\theta}, \theta \in \left[\theta^-, \theta^+\right]. \tag{45}$$

Reversing the roles of θ and $\widehat{\theta}$ implies

$$\pi(\theta) - \pi\left(\widehat{\theta}\right) \leq \widehat{\theta} - \theta, \forall\, \theta, \widehat{\theta} \in \left[\theta^-, \theta^+\right]. \tag{46}$$

Since (44) and (45) must hold simultaneously for any $\widehat{\theta}, \theta \in \left[\theta^-, \theta^+\right]$, we get

$$\pi\left(\widehat{\theta}\right) - \pi(\theta) = \theta - \widehat{\theta}.$$

Dividing both sides by $\widehat{\theta} - \theta$ and taking the limit as $\widehat{\theta} \to \theta$ yields

$$\frac{d\pi(\theta)}{d\theta} = -1. \tag{47}$$

where the right-hand side of (A.5) is derived by applying de l'Hospital's theorem.

Since a derivative is a local property of a function, (47) is a *local* condition which indicates that for any incentive compatible mechanism the profit of the firm viewed across the possible types is a decreasing function of θ. By integrating both sides, we get the local condition for the incentive compatibility (ICC_F) seen in the paper

$$\pi(\theta) = \pi(\theta^+) + \theta^+ - \theta. \tag{48}$$

To show that this condition is also globally sufficient, we derive (47) for $\widehat{\theta} = \theta$ and substitute $\pi\left(\widehat{\theta}\right)$ into (43), which becomes

$$\pi\left(\widehat{\theta}, \theta\right) = \pi(\theta^+) + \theta^+ - \theta. \tag{49}$$

Finally, a quick look at (48) and (49) shows that

$$\pi\left(\widehat{\theta}, \theta\right) = \pi(\theta).$$

Since the global incentive compatibility condition (43) is satisfied, (48) is also *globally sufficient*.

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