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Claar, Victor V

West Virginia University

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AN INCENTIVE-COMPATIBILITY APPROACH TO THE PROBLEM OF MONITORING A BUREAUCRAT

VICTOR V. CLAAR
West Virginia University

Abstract: An incentive-compatibility framework for regulating a monopolist with unknown costs is applied to the sponsor's problem of monitoring a bureau. Following Mueller (1989), the bureau does not make take-it-or-leave-it budget proposals to the sponsor. Rather, the bureau must announce a marginal cost per unit of output to the sponsor. Given that report, the sponsor chooses a price that it will pay to the bureau for each unit of output, and the sponsor chooses the level of output as well. The analysis reveals the price per unit of output that the sponsor must pay to the bureau to maximize social welfare.

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INTRODUCTION

While Gordon Tullock (1965) and Anthony Downs (1967) provide two early insightful looks into the nature of bureaucracies, the first systematic attempt to analyze bureaucracies within a public choice framework is that of William Niskanen (1971). In his seminal work, *Bureaucracies and Representative Government*, Niskanen presents and develops a model wherein a bureau is able to obtain budgets greater than those desired by its sponsor.

Most works that follow in the tradition of Niskanen analyze bilateral, one-period games between the bureau and its sponsor in a partial equilibrium setting. Such efforts include papers by Miller (1977) and by Moene (1986). Miller views the conflict over the size of the bureau's budget as a bargaining game between the supplier of bureaucratic output—the bureau—and the demander of bureaucratic output—the sponsor; Moene considers the possible outcomes associated with whether the bureau or the sponsor moves first when decisions are made sequentially under conditions of uncertainty. More recently, Chan and Mestelman (1988) analyze the strategic behavior between a bureau and its sponsor

in a general equilibrium setting, while Carlsen and Haugen (1994) evaluate bureaucratic interaction in multi-period games where the sponsor and the bureau move alternately. Wintrobe (1997) provides a good review of this literature.

In nearly all such analyses that follow in the tradition of Niskanen, a bureau's ability to obtain budgets that are larger than the sponsor desires stems from three important assumptions regarding the bargaining environment. First, the bureau is a monopolist supplier of the particular public good it produces. Second, due to the nonmarket nature of a bureau's output, only the bureau knows its true cost schedule. Third, the bureau is permitted to make take-it-or-leave-it budget proposals to its sponsor. However, as Mueller (1989) notes, a bureau's ability to present take-it-or-leave-it budget proposals to its sponsor "... gives the bureau an extremely strong agenda-setting role, a fact that presumably occurs to the sponsor. The sponsor might reasonably request that the bureau state the costs of a range of outputs from which the sponsor then chooses" (255).

Drawing upon the analyses of Breton and Wintrobe (1975) and Bendor, Taylor, and Van Gaalen (1985), Mueller then proceeds to develop a model wherein the sponsor chooses a level of output based upon a bureau's announced price per unit of output. In Mueller's setup, the bureau maximizes its budget subject to the constraint that its total budget must be at least as large as its total cost. So, the budget-maximizing bureau presents the sponsor with a price per unit at which it will supply bureaucratic output. Based upon the bureau's reported price, the sponsor selects a level of output for the bureau in accordance with the sponsor's demand schedule for the bureau's output. However, since the sponsor's demand schedule is known to the bureau as well as the sponsor, the bureau will overstate its price report

whenever doing so will result in a larger budget. Hence, Mueller concludes that in this new bargaining environment, the bureau will be able to expand its budget beyond its sponsor's preferred level only when the sponsor's demand for the bureau's output is own-price inelastic (256).

Following Mueller, this paper also replaces the assumption that the bureau is permitted to make take-it-or-leave-it budget proposals to the sponsor. Beyond Mueller, though, I permit the sponsor of the monopoly bureau to regulate the bureau as a monopolist. That is, in addition to selecting the level of output, the sponsor selects a price per unit of output that it will pay the bureau based upon a report that the bureau makes concerning its marginal cost per unit of output. In order to analyze such a situation, I adapt Baron and Myerson's (1982) incentive-compatibility framework for regulating a monopolist with unknown costs to the sponsor's problem of monitoring a bureau with unknown costs.[1] Adapting Baron and Myerson's model to a bureaucracy context is fairly straightforward since the two main assumptions of their analysis—that the regulated firm is a monopolist whose costs are unknown to the regulator—are the two of Niskanen's institutional assumptions that I, like Mueller, retain.

Within the incentive-compatibility framework I derive a welfare-maximizing price per unit of output that the sponsor pays the bureau. The analysis reveals that the welfare-maximizing pricing policy deviates from standard $P = MC$ efficient-pricing policies due to the informational advantage concerning its costs that the bureau enjoys. As a component of the regulatory policy described below, the sponsor utilizes a subsidy in order to encourage the bureau to produce, as well as to induce the bureau to report truthfully its costs.

THE MODEL

As mentioned above, Baron and Myerson derive an optimal policy for regulating a monopolistic firm with unknown costs. What follows, then, constitutes an examination of the sponsor's monitoring problem in a sponsor-bureau relationship within a modified version of the Baron-Myerson model.

I assume that the bureau has a cost function of the form

$$C(Q, \theta) = \theta Q + K, \qquad (1)$$

where Q represents a level of output, K represents fixed costs, and θ is the bureau's true marginal cost. I also assume that the true value of θ is known only to the bureau.

Now suppose that the bureau must announce to its sponsor a marginal cost θ_R and, based upon that report, the sponsor chooses a unit price P that it will pay to the bureau for each unit of output, as well as a subsidy T. That is, $P(\theta_R)$ will be the price per unit and $T(\theta_R)$ will be the subsidy that the sponsor pays to the bureau given the bureau's report regarding its cost. Following Baron and Myerson, I employ a Bayesian approach wherein the sponsor is assumed to have some subjective prior probability distribution for the unknown parameter θ prior to receiving any cost report from the bureau. I let $f(\theta)$ be the density function for this probability distribution, assuming that f is a continuous function with $f(\theta) > 0$ over the interval $[\theta^-, \theta^+]$ and with $F(\theta)$ denoting the cumulative distribution function for θ. I also make the common assumption that the ratio $F(\theta)/f(\theta)$ is nondecreasing in θ.[2]

Suppose also that the sponsor chooses the level of output Q according to its demand

schedule,

$$Q = Q(P),\ Q'(P) < 0, \qquad (2)$$

which is known to the bureau. Thus the sponsor has three basic regulatory instruments available: (i) the sponsor can decide whether the bureau should continue to exist at all; (ii) if the bureau does exist, then its price or quantity of output may be regulated; and (iii) the bureau may be given a subsidy $T(\theta)$.

Finally, I assume that the bureau is a budget-surplus maximizer. That is, the bureau seeks to obtain a budget that provides as much funding as possible in excess of the bureau's true cost of producing a given level of output; Migué and Bélanger have referred to this excess as the bureau's "discretionary budget" (1974, 29). This excess funding is spent by the bureau on items that give it additional utility; while these items also appear to the sponsor to contribute to the bureau's actual output, they do not. For example, a bureau could have its offices redecorated, fund frequent trips to conferences for its employees, opt for a higher level of prestige in selecting company cars, order engraved stationery, give its employees coffee mugs with the bureau's logo on them, enjoy frequent business lunches, give raises to its employees, advertise its services in national publications, create a nifty web site, and supply the public at large with a broad array of free publications. Wyckoff (1990) provides a diagrammatic analysis of such "slack maximizing" bureaus.

Assuming that the bureau is a budget-surplus maximizer implies that the bureau has an incentive to overstate its true cost when making its report to the sponsor. To understand why this is true, consider the following example. Suppose that a bureau with the true cost

θ reports that its actual cost is θ_R. Also, suppose that the sponsor believes the bureau and sets $P(\theta)$ and $T(\theta)$ such that

$$P(\theta_R) = \theta_R;\ T(\theta_R) = K. \tag{3}$$

The bureau's budget surplus ψ in this case would be

$$\begin{aligned} \psi(\theta_R;\ \theta) &= P(\theta_R)Q(P(\theta_R)) - \theta Q(P(\theta_R)) \\ &= \theta_R Q(P(\theta_R)) - \theta Q(P(\theta_R)) \\ &= (\theta_R - \theta)Q(P(\theta_R)). \end{aligned} \tag{4}$$

As a budget-surplus maximizer, the bureau will choose to report θ_R subject to the first-order condition for budget-surplus maximization,

$$Q(\theta_R) + \theta_R Q' - \theta Q' = 0, \tag{5}$$

which implies that

$$\theta_R^* > \theta. \tag{6}$$

Thus the bureau has an incentive to overstate its cost if the sponsor believes whatever the bureau reports regarding its cost.

Niskanen has suggested that bureaucracies should be restructured to resemble more closely competitive markets. Following this suggestion, the sponsor should just set the price paid for each unit of output equal to the bureau's marginal cost of production. However, due to the information asymmetry involved, the true marginal cost is unknown to the sponsor.

Moreover, as described above, the bureau has an incentive to overstate its true marginal cost when making its report to the sponsor. Hence, the sponsor needs to design a scheme that assures truthful reporting from the bureau.

Therefore, an incentive compatibility condition is required in order to guarantee that the bureau has no incentive to misrepresent its cost:

$$\psi(\theta) \equiv \psi(\theta;\, \theta) \geq \psi(\theta_R;\, \theta),\ \forall\ \theta,\ \theta_R \in [\theta^-,\ \theta^+]. \qquad \textbf{(7)}$$

That is, the bureau's sponsor can do no better than to design a regulatory scheme that assures the bureau that its budget surplus from truthfully reporting its cost, $\psi(\theta)$, will be at least as large as it would be if the bureau overstated its cost, $\psi(\theta_R; \theta)$. In addition to the incentive compatibility condition given in **(7)**, I assume that the sponsor must cover all of the bureau's costs; hence the regulatory policy will also satisfy the individual rationality condition,

$$\psi(\theta) \geq 0. \qquad \textbf{(8)}$$

DERIVATION OF THE OPTIMAL PRICING POLICY

In their paper, Baron and Myerson assume that the regulator—in this case the sponsor—of a monopoly maximizes social welfare as given by

$$\text{Welfare} = \text{Consumer Surplus} + \alpha(\text{Producer Surplus}),\ 0 \leq \alpha \leq 1,$$

where α discounts producer surplus relative to consumer surplus in social welfare. While Baron and Myerson introduce the weight α in order to analyze a wide variety of possible welfare implications, one obvious benefit of permitting $\alpha < 1$ is that it avoids the rather

uninteresting result that the sponsor's optimal policy is to set $P(\theta) = \theta$. In the present context, however, it makes a good bit of intuitive sense that the sponsor would want to discount the analog to producer surplus, ψ. In fact, it seems reasonable that the sponsor would not want to consider any part of the bureau's budget surplus as a part of social welfare. Therefore, in the present context, the appropriate value of α is zero.

Assuming that $\alpha = 0$, the sponsor's problem is to maximize welfare of the form

$$\int_{\theta^-}^{\theta^+} \left\{ \int_{P(\theta)}^{\infty} Q(P^0)dP^0 - T(\theta) \right\} f(\theta)d\theta; \qquad \textbf{(9)}$$

that is, the sponsor maximizes the expected value of the consumer surplus less the subsidy paid to the bureau over all possible values of θ. Substituting the definition of $\psi(\theta)$,

$$\psi(\theta) = P(\theta)Q(P(\theta)) + T(\theta) - C(Q(P(\theta)), \theta), \qquad \textbf{(10)}$$

into **(9)** in order to eliminate $T(\theta)$ produces a new expression for social welfare:

$$\int_{\theta^-}^{\theta^+} \left\{ \int_{P(\theta)}^{\infty} Q(P^0)dP^0 + P(\theta)Q(P(\theta)) - C(Q(P(\theta)), \theta) - \psi(\theta) \right\} f(\theta)d\theta. \qquad \textbf{(11)}$$

Now, utilizing the fact—which I prove in the appendix—that

$$\psi(\theta) = \psi(\theta^+) + \int_{\theta}^{\theta^+} C_\theta(Q(P(\theta^0)), \theta^0)d\theta^0, \qquad \textbf{(12)}$$

integration by parts reveals that

$$\int_{\theta^-}^{\theta^+} \psi(\theta) f(\theta) d\theta = \psi(\theta^+) + \int_{\theta^-}^{\theta^+} Q(P(\theta)) F(\theta) d\theta. \quad \textbf{(13)}$$

Substituting **(13)** into **(11)** and simplifying yields the social welfare function

$$W = \int_{\theta^-}^{\theta^+} \left\{ \int_{P(\theta)}^{\infty} Q(P^0) dP^0 + P(\theta) Q(P(\theta)) - \left(\theta + \frac{F(\theta)}{f(\theta)} \right) Q(P(\theta)) - K \right\} f(\theta) d\theta - \psi(\theta^+). \quad \textbf{(14)}$$

Given the sponsor's goal of maximizing social welfare as expressed in **(14)**, it is optimal for the sponsor to set $P(\theta)$ such that

$$P(\theta) = \theta + \frac{F(\theta)}{f(\theta)} \quad \forall \theta. \quad \textbf{(15)}$$

That is, the welfare-maximizing $P(\theta)$ consists of the θ reported by the bureau plus information rents that the sponsor must pay due to the information asymmetry present in the problem.[3] These information rents are reflected by the ratio $F(\theta)/f(\theta)$, and indicate the surplus gained by the bureau owing to its informational advantage concerning its costs.[4]

It is important to note that the optimal pricing policy given in **(15)** is only optimal in a constrained sense. That is, because the regulatory policy must satisfy the constraint that the bureau should have an incentive to report truthfully its costs, the policy articulated in **(15)** represents only a constrained optimum, and thereby results in a welfare loss due to the information asymmetry. To see this, consider the fact that under the optimal pricing policy the sponsor pays the bureau a price per unit of output that exceeds the true marginal cost of producing that output, θ, even though—under the incentive compatibility condition—the

bureau does, in fact, report its true cost. Nevertheless, due to the revelation principle, regulatory policies beyond direct revelation do not need to be considered since they can provide no better expected equilibrium outcome for the sponsor.[5]

CONCLUSION

Since at least as early as Dupuit (1844), economists have considered pricing policies for goods and services in a social welfare context. In the classic analyses of Dupuit and Hotelling (1938), a regulator has complete information concerning the costs of the supplier of a bridge. The bridge has a marginal cost of zero and a fixed cost of construction. Dupuit and Hotelling conclude that—under full information—the welfare-maximizing pricing policy is to set the price equal to the marginal cost. Further, in order to induce the firm to build the bridge, the firm should be paid a subsidy sufficient to cover its fixed costs.

Of course, regulators frequently do not possess complete information concerning a monopolist's costs of production. Baron and Myerson derive the socially optimal pricing policy in such a case.

In this paper I have adapted Baron and Myerson's incentive compatibility framework for regulating a monopolist with unknown costs to the sponsor's problem of monitoring a bureau. To do so, I have followed Mueller and replaced Niskanen's institutional assumption that the bureau has the ability to make take-it-or-leave-it budget proposals to the sponsor, while leaving in place the assumptions that the bureau is a monopolist in supply and that only the bureau knows its true cost schedule. More specifically, I assume that in addition to Mueller's assumption that the sponsor selects the quantity of bureaucratic output, the sponsor

chooses a price per unit of output that it will pay to the bureau based upon the bureau's reported marginal cost per unit of output.

My analysis demonstrates that the sponsor's welfare-maximizing pricing policy depends necessarily upon the sponsor's prior information concerning the bureau's costs. In fact, the optimal pricing rule depends upon only the sponsor's information about the bureau's costs. Further, the welfare-maximizing pricing policy indicates that the bureau should be paid a price per unit of output that exceeds the bureau's marginal cost of producing a unit of output. This deviation of the optimal pricing policy from the usual $P = MC$ pricing policy arises due to the information asymmetry present between the sponsor and the bureau. As a part of the policy articulated here, the sponsor utilizes a subsidy in order to encourage the bureau to produce, as well as to induce the bureau to make truthful reports concerning its costs.

In a notable extension of Baron and Myerson's incentive compatibility framework for regulating a monopolist with unknown costs, Baron and Besanko (1984a) modify the Baron-Myerson model to permit the regulator to conduct random audits of costs. Hence, the analysis of the present paper could be extended by incorporating the possibility of random audits by the sponsor.

APPENDIX

LEMMA: *For any feasible regulatory policy, it is true that*

$$\psi(\theta) = \psi(\theta^+) + \int_{\theta}^{\theta^+} C_{\theta}(Q(P(\theta^0)), \theta^0) d\theta^0. \quad \textbf{(12)}$$

PROOF: I have already shown that the bureau's budget surplus from misreporting θ is

$$\psi(\theta_R; \theta) = P(\theta_R)Q(P(\theta_R)) - \theta Q(P(\theta_R)). \quad \textbf{(4)}$$

Now consider a firm that has true cost θ_R and reports θ_R. Its budget surplus is

$$\psi(\theta_R; \theta_R) = \psi(\theta_R) = P(\theta_R)Q(P(\theta_R)) - \theta_R Q(P(\theta_R)). \quad \textbf{(16)}$$

Then, substituting **(16)** into **(4)**,

$$\begin{aligned} \psi(\theta_R; \theta) &= \psi(\theta_R) + \theta_R Q(P(\theta_R)) - \theta Q(P(\theta_R)) \\ &= \psi(\theta_R) + C(Q(P(\theta_R)), \theta_R) - C(Q(P(\theta_R)), \theta). \end{aligned} \quad \textbf{(17)}$$

It follows that the incentive compatibility condition given in **(7)**, together with **(17)**, implies that

$$\psi(\theta) - \psi(\theta_R) \geq C(Q(P(\theta_R)), \theta_R) - C(Q(P(\theta_R)), \theta). \quad \textbf{(18)}$$

Now, reversing the roles of θ and θ_R—i.e. $\psi(\theta_R; \theta_R) = \psi(\theta_R) \geq \psi(\theta; \theta_R)$—gives

$$\psi(\theta) - \psi(\theta_R) \leq C(Q(P(\theta_R)), \theta_R) - C(Q(P(\theta_R)), \theta). \quad \textbf{(19)}$$

Combining **(18)** and **(19)** produces

$$\begin{aligned} & C(Q(P(\theta_R)),\ \theta_R) - C(Q(P(\theta_R)),\ \theta) \\ & \geq \psi(\theta) - \psi(\theta_R) \geq C(Q(P(\theta_R)),\ \theta_R) - C(Q(P(\theta_R)),\ \theta). \end{aligned} \tag{20}$$

Dividing **(20)** by the quantity $(\theta - \theta_R)$ and taking the limit as $\theta_R \to \theta$ reveals that

$$\frac{d\psi(\theta)}{d\theta} = -C_\theta(Q(P(\theta_R)),\ \theta_R). \tag{21}$$

Finally, integrating **(21)** demonstrates that

$$\psi(\theta) = \psi(\theta^+) + \int_{\theta}^{\theta^+} C_\theta(Q(P(\theta^0)),\ \theta^0)d\theta^0 \tag{12}$$

must hold for any feasible regulatory policy. □

NOTES

1. While Baron and Myerson's model constitutes a portion of the industrial organization literature, adaptation of their incentive compatibility framework to other contexts is not new. For example, Prusa (1990) and Gresik and Nelson (1994) have modified the Baron-Myerson model to address a government's transfer pricing problem when dealing with a foreign-owned subsidiary of a multinational enterprise.

2. See, for example, Prusa (164), Gresik and Nelson (316), and Lewis and Sappington (1989, 298). Laffont and Tirole provide one intuitive interpretation of this assumption (1993, 66-67). Bagnoli and Bergstrom (1989) list a variety of distributions that satisfy this assumption, including such usual distributions as uniform, normal, logistic, chi-squared, exponential, and Laplace.

3. As Baron and Myerson have already shown (920-21), the subsidy under the optimal regulatory policy is of the form

$$T(\theta) = \int_{\theta}^{\theta^+} Q(P(\theta^0))d\theta^0 - [P(\theta)Q(P(\theta)) - \theta Q(P(\theta)) - K],$$

and may be either positive or negative. The role of the subsidy is to ensure that the individual rationality condition given in **(8)** is satisfied; i.e. the sponsor must cover all of the bureau's costs.

4. See Baron and Besanko (1984b) for further thoughts concerning the interpretation of these information rents.

5. While the foundational work on the revelation principle may be found in

Dasgupta, Hammond, and Maskin (1979), Gibbard (1973), Harris and Townsend (1981), and Myerson (1979), a particularly clear exposition is provided by Kreps (1990, 691-700) .

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