GOVERNMENT INTERVENTION IN PRODUCTION AND INCENTIVES THEORY: A REVIEW OF RECENT CONTRIBUTIONS

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December 1987 MIT-EL 87-019WP

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This work was supported by the National Science Foundation, the Commissariat Général du Plan, and the Center for Energy Policy Research at M.I.T. This paper is an outgrowth of discussions among the authors in 1984 and served as a basis for a lecture given by R. Guesnerie in that year's IMSSS summer workshop at Stanford University. The authors are grateful to David Sappington, Stanley Besen, and an Associate Editor for helpful comments, and to a referee for a very carefully executed and useful report. Baron [1987], Besanko-Sappington [1987] and Sappington-Stiglitz [1987] offer surveys with a somewhat different selection of topics.

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Abstract

This paper reviews the recent literature on regulation under asymmetric information. If first develops the conceptual framework and offers a reminder of the techniques used in the field. It then applies the framework and techniques to a variety of situations, with or without the use of accounting data. Next, the analysis is extended to dynamics with or without commitment. The paper concludes with desirable directions for research.

Key words: Asymmetric information, Regulation, Public firms, Incentives, Auditing.

1. Introduction.

This survey reviews the literature on government regulation under asymmetric information.[1] This literature typically assumes that the "regulated firm" knows more about its environment or technological possibilities than does the regulating body (the two parties are referred to as the "firm" and the "planner" in this paper). The firm is an "informational monopoly" in that it earns rents due to its private information (as opposed to a "natural monopoly" associated with increasing returns to scale). The purpose of modelling informational asymmetries explicitly is, at a normative level, to formalize the imperfect control of regulated firms and to derive optimal incentive schemes. At a positive level, it allows the assessment of pricing and cost reimbursement rules currently being used. For instance, it may shed some light on how far from optimal are average cost pricing, or more generally Boiteaux-Ramsey pricing, and rate-of-return regulation. As usual, the cost of a more careful description of informational realities is the adoption of a partial equlibrium framework.

The paper focuses more on "hidden information" than on "hidden actions." These two situations are commonly recognized as polar cases of principal-agent models with asymmetric information (see Arrow [1985] and Milgrom [1987]). In the principal/agent model, the agent (here, the firm) obtains some private and exogenous information before or after the contract is signed. It then takes some actions that result, perhaps randomly, in outcomes. The principal (here,

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[1] For reviews of the literatures on non convexities in production and Ramsey pricing with symmetric information, see respectively Guesnerie [1984] and Sheshinski [1984].

the planner) is able to costlessly observe some of the agent's actions and some of the outcomes, and makes a transfer to the agent that is a function of the observable variables. Note that comunication may be part of the agent's (observable) actions.

The "hidden information" model refers to cases in which the planner can infer from the observations every action taken by the firm conditional on the agent's private information (the agent does not face randomness when taking actions). By contrast, the hidden action or "moral hazard" model refers to the case in which the agent does not obtain private information before choosing actions, but some noise prevents the principal from inferring the agent's actions from the observations. Most of the paper focuses on a special kind of hidden knowledge, "adverse selection," in which the agent obtains his private information before signing the contract with the principal, and the principal designs the contract.

The paper is organized as follows: Section 2 discusses the different modelling options concerning the objectives of the planner and the behavior of the firm; Section 3 analyzes the basic static framework and presents the standard techniques; Section 4 studies some variations on this basic model, in which the firm is "responsive" to incentives, whereas Section 5 discusses the cases in which the planner cannot extract any information from the firm; Section 6 analyzes cost manipulation by the firm; Section 7 analyzes the dynamics of regulation, pointing out the role of commitment and finally, Section 8 gathers some concluding remarks and proposes further lines of research, emphasizing the hierarchical aspects of public and private firms' control.

2. Modelling options.

2.1 Planner's objectives.

Most of the studies presented here can be viewed as exploratory. Ambition to generality is somewhat premature and almost all the models describe very stylized facts. There is a single firm;[2] its production technology is formalized as the transformation of one (or at most two) input(s) into one or sometimes several outputs. The analysis is partial equilibrium in the sense that it isolates the subsector from the economy under consideration and formalizes in a very crude way the impact of policies on the rest of the economy.

We will describe the modelling options that have been taken in the literature through a simple example.

Firm: The firm produces an output, the quantity of which is q; it faces the cost function $C(q)$, and receives a transfer t from the planner. The commodity may be a marketed good; the firm then receives both the transfer t and the market revenue $P(q)q$, where $P(q)$ is the inverse demand function. Or it can be a non-marketed good delivered freely to consumers (in which case t is the firm's only income). The profit is equal to $\pi = P(q)q+t-C(q)$ and $\pi = t-C(q)$ respectively.

Consumption: The consumers' gross surplus is $S(q) = \int_0^q P(\tau)d\tau$, and their net surplus is $S(q)-P(q)q-t$ for a marketed good, and $S(q)-t$ for a non-marketed

[2] Since this survey was written, two topics related to the competition among firms have been particularly developed, which, due to lack of space, we will not discuss: second sourcing (Anton-Yao [1987], Caillaud [1986], Demski-Sappington-Spiller [1987], Laffont-Tirole [1987a]), and auctioning (Laffont-Tirole [1987b], McAfee-McMillan [1987] and Riordan-Sappington [1987]).

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<u>Planner</u>: Standard first-best analysis describes social welfare as the sum of consumers' net surplus and of producer's surplus (profit). This formulation can be viewed as the specification of the general equilibrium surplus discussed in Guesnerie [1984] under a number of restrictive conditions, including the absence of income effects and the assumption that the sector is small enough to have no influence on input prices. However, because of the existence of distributional considerations and because there are costs associated with monetary transfers from the planner to the firm, the first-best criterion has been modified in two ways. The first consists in introducing <u>distributional considerations</u> through a coefficient (1-k) affecting the firm's profit (or in a more general way the firm's welfare). The second introduces a <u>cost of public funds</u>: raising and transferring through public channels \$1 is assumed to cost \$(1+k') to society (for instance, taxation in other sectors distorts incentives). The following table summarizes the various objective functions:[3]

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[3]Note that, in the case of a non-marketed good the formulations in terms of ditributional objectives or of cost of public funds are similar, (identify respectively $\left(\frac{S(q)}{1-k}, \frac{k}{1-k}\right)$ in the first case to $(S(q), k')$ in the second one).

In the cost of public funds case, whether the good is market or not does not change the planners' objectives. However, the firm's objectives are different. Note that if we had taken net rather than gross transfers as a control variable, social objectives would have looked different while private objectives would have been identical. The solution thus depends on whether or not the good is marketed, and not only on total surplus S(q).

	Distributional Objectives	Cost of Public Funds
Non-marketed Good	$[S(q)-t]+(1-k)[t-C(q)]$	$S(q)-C(q)-k't$
Marketed Good	$[S(q)-P(q)q-t]+(1-k)[P(q)q+t-C(q)]$	$S(q)-C(q)-k't$

The two formulations in general lead to similar qualitative results. For the techniques developed in Section 3 and for the derivation of most results surveyed in the paper, the crucial assumptions are that the firm prefers transfers, the planner does not and both are risk neutral.

More generally, the planner can take a monetary measure of the firm's welfare into account and not only its profit. This remark makes particular sense for those firms whose objectives are not limited to profit maximization but also include slack for instance (this will be a feature of some models considered later).

The formalizations of the planner's objectives summarized in the previous table have several shortcomings. Some are obvious but can be eliminated at the cost of an increase in complexity. For example, in the case of a multi-agent firm, which will be considered later, the evaluation of social welfare might discriminate among the different agents. The main objection, however, concerns the absence of clear general equilibrium justifications. One can justify the distributional-objectives version in the case of an economy in which the producer is a wealthy man who produces the good from his own endowment while the rest of the economy consists of identical poor small consumers; the cost of public funds is classically justified by the use of distortionary taxation for raising funds. A more satisfactory justification should rest on a second-best model, itself based on explicit informational constraints, at the margin of which we would consider the effects on the optimal solution of the perturbations created by a change in the firm's production and transfers. The clarification of the above questions is certainly a priority in the present state of the theory.

In the tradition of welfare economics, the formulation adopted here views the planner as an exogenously given "arbitrator." Attempts have been made to study in particular the "political economy" aspects of the planner's intervention, so as to endogenize the social welfare function.[4] In particular, the so-called "economic theory of bureaucracy" emphasizes that the legal-political system favors the occurrence of inefficiencies and distortions of goals in public organizations. An examination of these inefficiencies in the light of social choice and incentives theories should take into account the legal and informational aspects of the political process. The approach taken here is not inconsistent with a positive theory of bureaucracy. An analysis of the control of bureaucracies, itself based on asymmetric information, will yield a more satisfactory formalization of the planner's objectives.

2.2 The firm's behavior.

A key feature of the problem of control of production is how the firm reacts to incentives. A number of different hypotheses are made in the literature we are surveying. As we emphasize below, this variety of behavioral assumptions often reflects the variety of situations that inspire the contributions, rather than a more fundamental reflection on what

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[4]See Aumann-Kurz [1977], Guesnerie-Oddou [1981] and the literature on social choice.

distinguishes the various types of organization.

In the first modelling option, the firm maximizes its profit (e.g., Averch-Johnson [1962], Baron-Myerson [1982]). A second common modelling option has the firm trade off between some variable called effort, and money (e.g., Holmstrom [1982a], Laffont-Tirole [1986]). Other contributions introduce even more complex objectives that are arguably less primitive than effort and money (the managers' utility function may then be a reduced form, as we discuss below).

The predominantly British literature on the control of nationalized firms in mixed economies emphasizes the role of workers, generally through unions, in the decision process of such firms. Some formalizations of the nationalized firm's behavior trade off between managers' or workers' interests and social objectives (Rees [1982] and Gravelle [1982]).[5] Ward [1958] offered another objective function for the firm, which was to maximize profits per worker. He argued that this labor-management hypothesis could explain the behavior of nationalized industries. The consequences of this extreme assumption under asymmetric information are studied in Guesnerie-Laffont

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[5]One might wonder whether as a sociological law the emphasis put on labor power in the explanation of nationalized firms behavior increases with the size of the nationalized sector in the country of citizenship of the authors. This does not seem to be the case since in France where the size of the public sector is comparable to the size of the British one, most of the theoretical literature at least until recently seemed to accept the idea that the decisions of the public sector correctly internalized the government objectives. In fact, the debate on the investment program in nuclear plants of Electricite de France was probably the first time when the argument that the public firm behaved in its own interest against public interest has been consistently and publicly put forward.

[1984a,b].

The (aforementioned) large body of literature on the economic theory of bureaucracy mainly focuses on non-market organizations. It generally expresses a distrust of public organization, and has been popularized by the Public Choice School associated with the names of Buchanan and Tullock. According to the views advocated in this literature, inefficiencies in public organization originate in the behavior of bureaucrats who trade off between the public interest and their own private interests. The main emphasis has been put on managers' objectives described in formalized models either as budget maximizers (Niskanen [1971]) or as trading off the size of the organization and the volume of "discretionary budget" (Migue-Bellanger [1974]). Note that size has often been considered a plausible objective of managers even in the context of private firms (Williamson [1964]).[6] Of course, such *ad hoc* approaches need not be inconsistent with the approaches reviewed in this survey, which assume that money and effort are the primitive arguments of the managers' utility functions. For example, managers may use their superior information to claim that productivity is (naturally) low and obtain a larger work force (which enables the employees to slack more or to be promoted more easily).

Last, we should stress that the differences in behavior between public and private organizations may be due not to differences in objectives, but rather to differences in the structure of control. A fundamentalist viewpoint would take identical objectives for various organizations and show how the

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[6]Some more basic reflections on the theory of the firm are found in Holmstrom [1982b] and Holmstrom-Tirole [1987].

legal and administrative environments of the firm induce its employees to emphasize particular aspects of their objective functions.

3. Static framework: techniques and classification.

3.1 Techniques.

We focus here on a standard model of adverse selection (although we later introduce moral hazard considerations). The planner acts as a Stackelberg leader by proposing a contract to the firm. This contract, to which both parties are fully committed[7] once it has been signed, is based on the variables observable by both sides and generally implies transfers from the planner to the firm. Both the firm and the planner are modelled as single maximizing agents. The firm (or the dominant agent(s) controlling the firm) has some objective function (profit, profit per capita, trade-off between profit and effort, etc...). It knows more about the production technology than does the planner. The informational advantage of the firm at the time the contract is signed allows it to extract a rent. The planner computes the optimal contract as a Bayesian statistician who has a prior on the uncertain parameters.

The firm has private information on a one-dimensional characteristic θ. The parameter θ belongs to a connected set $\Theta = [\underline{\theta},\bar{\theta}]$. The (possibly indirect) utility of the firm, denoted U, depends (a) on a vector ℓ (in $\mathbb{F}^L$), each component of which is publicly observable, (b) on the amount of transfer, t, it receives and (c) on the characteristic θ. The firm has a reservation

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[7] We will discuss in more detail later the commitment issue in Section 7.

utility level $\bar{U}$, which corresponds to its payoff in an outside option.

<u>A1</u>: U is C^2 and $\partial_t U$ is strictly positive.

The planner has some prior probability on θ, with density $\nu(\theta)$.[8] His objective function is $W(\ell,\theta)-kt$.

From the revelation principle (see, e.g., Dasgupta-Hammond-Maskin [1979], Myerson [1979]) there is no loss of generality to restricting attention to <u>truthful</u> <u>direct</u> <u>mechanisms</u> ℓ,t: $\theta \in \Theta \Rightarrow \{\ell(\theta),t(\theta)\}$. For such mechanisms the announcement of the truth is optimal for each agent:

$$\theta \in \operatorname{Arg}\max_{\tilde{\theta}\in\Theta} U(\ell(\tilde{\theta}),t(\tilde{\theta}),\theta)$$

The truthful mechanism is said to be individually rational if:

$$\forall\theta\in\Theta,\ U(\ell(\theta),t(\theta),\theta) \geq \bar{U}$$

The problem of the derivation of feasible and optimal contracts in this framework has been the subject of a number of studies. Our present understanding relies much on the contributions of Mirrlees [1971, 1975], Spence [1974], Mussa-Rosen [1978], Laffont-Maskin [1980], Maskin-Riley [1984] and Myerson [1979](to quote only a few). The statements of results which are presented below are borrowed from the systematic investigation of Guesnerie-Laffont [1984a]. Besides gains in rigor and generality in the

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[8] In most cases, the model can also be interpreted as relative to a continuum of different agents with different θ covering Θ.

argument,[9] Guesnerie and Laffont provide a tool which is precise yet sufficiently flexible to be used in a systematic way (i.e., to avoid unnecessary duplications of argument). This aim explains the emphasis put on the concept of "surrogate" social welfare, introduced in the next pages, which is systematically used later.

The problem may be decomposed as follows. (1) What are the feasible contracts or, more precisely, what are the truthful direct mechanisms? (2) What is the optimal contract? [In this paper, "allocation" refers to the function $\ell(\cdot)$, and "mechanism," "contract," "solution" or "outcome" refer to the pair of functions $\{\ell(\cdot), t(\cdot)\}$.]

The first question is the implementability problem. Implementability is defined with reference to an allocation $\ell(\theta)$; $\ell(\theta)$ is implementable if there exists a transfer function $t(\theta)$ such that $\{\ell(\theta), t(\theta)\}$ is a truthful mechanism.

Guesnerie-Laffont assumes that the firm's and the regulator's utility functions are C^2 and that the distribution $\nu(\theta)$ is continuous. The implementation question receives the following answer (for piecewise C^1 functions ℓ):[10]

(T1): If a piecewise C^1 function ℓ is implementable, then, there exists a transfer function $t(\cdot)$ such that:

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[9] Sufficient conditions for implementability are sometimes not analyzed in the literature.

[10] A piecewise C^0 function is continuous except at a finite number of points of jump discontinuities. A piecewise C^1 function is a primitive of a piecewise C^0 function. See Hadley-Kemp [1971, p. 15-16]. See also footnote 11.

$$\frac{dt}{d\theta} = - \sum_i \left(\frac{\partial_{\ell_i} U}{\partial_t U} \right) \frac{d\ell_i}{d\theta}$$

and

$$\sum_i \frac{\partial}{\partial\theta} \left(\frac{\partial_{\ell_i} U}{\partial_t U} \right) \cdot \frac{d\ell_i}{d\theta} \geq 0,$$

$\forall \ell, t, \theta$ such that $\ell = \ell(\theta), t = t(\theta)$ and where $\ell(\cdot)$ is differentiable at θ.

The first condition is the first order necessary condition for $\tilde{\theta} = \theta$ to be an extremum of the firm's maximization problem; the second condition is the second-order condition for $\tilde{\theta} = \theta$ to be a local maximum, taking into account the previous differential equation.

A number of assumptions must be made for the analysis of sufficiency:

<u>A2</u>$^+$: On its domain of definition, the signs of the components of the vector $\partial_\theta \left(\frac{\partial_\ell U}{\partial_t U} \right)$ remain the same, <u>say positive</u> (after changing some ℓ_i in $-\ell_i$ if necessary. A2$^-$ is the same assumption with a negative sign).

<u>A3</u>: $\exists K > 0$ such that $\forall (\ell, t, \theta)$ in the domain and for t large enough:

$$\left|\left| \frac{\partial_\ell U}{\partial_t U} (\ell, t, \theta) \right|\right| < K|t|.$$

A2$^+$ (with straightforward notation) is a single crossing property of indifference curves (Spence-Mirrlees conditions). A3 is more technical and ensures the existence of a solution to the incentive compatibility differential equation.

($\underline{T2}$): Assume A1-2^+-3, then any piecewise C^1 function such that

$$\forall i \quad \frac{d\ell_i}{d\theta} \geq 0, \text{ is implementable.}$$

(T2) refers to global incentive compatibility. It is only in the one dimensional case (L = 1) that $\frac{d\ell}{d\theta} \geq 0$ is, under the assumptions mentioned, a necessary and sufficient condition of implementability. In the n-dimensional case, $\frac{d\ell_i}{d\theta} \geq 0$ for all i is sufficient, but not necessary.

Consider now the optimization problem.

(a) In case of costless transfers, i.e. k = 0, it is assumed that:

A4: $W(\ell,\theta)$ is C^2 in (ℓ,θ), strictly concave in ℓ, and such that $\bar{\ell}(\theta)$, which is defined by $\partial_\ell W(\bar{\ell}(\theta),\theta) = 0$, is C^1 and has a finite number of local extrema.

Let us specialize to the one-dimensional problem from now on. The one dimensional planner's problem can be written:[11]

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[11]The approach in this survey uses standard optimal control theory (see, e.g., Hadley-Kemp [1971]). This theory requires that (a) the state variables be piecewise C^1, and the control variables be piecewise C^0; and (b) the valuation functional and the state evolution equations be C^1 in the state and control variables. [Note that here W is C^1 in ℓ; we will look at piecewise-C^1 $\ell(\cdot)$].

Under A1, $A2^+$, and A3, one can more generally prove that $\ell(\cdot)$ is implementable (through an appropriate transfer function) if and only if it is weakly increasing. The one-dimensional planner's problem in which $\ell(\cdot)$ is not a priori restricted to be piecewise C^1 can be shown under A4 to have a unique solution, and this solution is piecewise C^1. Hence, our approach does not put undue restrictions on $\ell(\cdot)$.

Caillaud [1986] presents a model in which the optimal mechanism is discontinuous.

$$\max_{\ell(\cdot)} \int_{\underline{\theta}}^{\bar{\theta}} W(\ell(\theta),\theta)\nu(\theta)d\theta$$

s.t. for almost every θ

$\frac{d\ell}{d\theta}(\theta) \geq 0$ (implementability condition)

t(·) is then given by (T1) and any constant of integration such that for all θ,

$U(\ell(\theta),t(\theta),\theta) \geq \bar{U}$ (individual rationality).

(T3) under A1 - A4, and with costless transfers there exists a unique optimal (piecewise C^1) solution ℓ^*; it coincides with the symmetric information allocation on some areas where the latter increases, and is constant elsewhere, that is, on a finite number of disjoint intervals (bunching).

Note that we assume that all types of firm operate. However, the planner may want to induce a "cut-off" point above $\underline{\theta}$. This cut-off point, θ_0, if it exists, necessarily satisfies $W(\ell^*(\theta_0),\theta_0) = 0$.

(b) When transfers are costly ($k \neq 0$), we assume separability:

A5: $U = V(\ell,\theta)+t$ and $\partial^2_{\ell\theta}V > 0$, $\partial_\theta V > 0$.

A5 implies $A2^+$ and A3.

As transfers are costly, the individual rationality constraint becomes binding; but as the firm's indirect utility is increasing in θ (A5 plus the envelope theorem), it reduces to:

$$V(\ell(\underline{\theta}),\underline{\theta}))+t(\underline{\theta}) \geq \bar{U}.$$

Let us define the "surrogate social welfare function":

$$\tilde{W}(\ell,\theta) = W(\ell,\theta) - \frac{\Psi(\theta)}{\nu(\theta)}\partial_\theta V(\ell,\theta)+kV(\ell,\theta)$$

where $\Psi(\theta) = \int_\theta^{\bar{\theta}} k\nu(x)dx.$

Transfers no longer explicitly appear in the surrogate social welfare function. In order to obtain an intuitive interpretation of this function, let us explain how its derivative with respect to ℓ incorporates the effect of a small virtual change $\delta\ell$ affecting the agent θ, all other things being equal. The first term $\nu(\theta)\partial_\ell W\cdot\delta\ell$ represents the direct effect on social welfare. The term $-k\cdot\nu(\theta)\cdot\partial_\ell V\cdot\delta\ell$ is the product of the social cost of transfers by the compensating transfer $-\partial_\ell V\cdot\delta\ell$ which has to be made to the firms θ concerned. The last term is $\Psi(\theta)\partial^2_{\theta\ell}V\cdot\delta\ell$ where $\partial^2_{\theta\ell}V\cdot\delta\ell$ can be interpreted as the uniform increase in transfer to any agent $\theta' > \theta$ which is needed to restore incentive compatibility, and $\Psi(\theta)$ is the social cost of a uniform unit transfer in the upper tail of the distribution.

It can indeed be shown after elimination of the term $\int_{\underline{\theta}}^{\bar{\theta}} t(\theta)\nu(\theta)d\theta$ in the planner's objectives (using the incentive compatibility condition) that his problem is equivalent to:

$$\text{Max} \int_{\underline{\theta}}^{\bar{\theta}} \tilde{W}(\ell(\theta),\theta)\nu(\theta)d\theta$$

$$\text{s.t. } \frac{d\ell}{d\theta}(\theta) \geq 0 \text{ a.e.}$$

$t(\theta)$ is then given by (T1) together with the boundary condition that the individual rationality constraint is binding in $\underline{\theta}$.

We are thus back to the case k = 0 and similar conclusions are obtained.

Finally, a conclusion with the same flavor is also obtained for multidimensional mechanisms.

(T4): If the unconstrained maximum of the surrogate social welfare function is monotonic, it solves the planner's problem on the broader domain of piecewise C^1 allocation mechanisms.

The technical analysis developed to treat adverse selection models can also be used in contexts in which the firm learns θ *after* signing the contract. The only difference is that the constant of integration of the transfer function is determined by an expected individual rationality constraint:

$$\int_{\underline{\theta}}^{\bar{\theta}} U(\ell(\theta), t(\theta), \theta)\nu(\theta)d\theta \geq \bar{U}.$$

When the firm either faces bankruptcy or limited liability constraints or is infinitely risk averse, the situation is very similar to adverse selection models (see Sappington [1983b]).

3.2 A first classification of models.

The articles we are reviewing here can be classified according to two criteria.

The first is the criterion of cost observability which leads us to consider two cases:

First, the planner monitors the firm's output, but cannot observe any accounting data. Alternatively, the data are too garbled to allow any precise inference. This situation is more likely if the firm is independent of the planner or if it is regulated for a particular project and can transfer expenses to and from other projects. This assumption is made in Baron-Myerson [1982], Sappington [1982], Guesnerie-Laffont [1984a and b]. In this case, the firm extracts a monetary rent from its superior information.

Second, the planner observes the firm's cost or profit. The observation of accounting variables allows the planner to offer cost reimbursement or profit sharing rules. Because the firm need not be the residual claimant for its cost or profit, X-inefficiency (Leibenstein [1966]) becomes an issue: the firm's choice of an unobservable action called effort need not be socially optimal (whereas it would be optimal conditional on output in the first case). The firm then extracts a rent from its private information on θ and from its freedom to choose the level of effort in the form of monetary rent and a slack rent.

The second criterion that we introduce concerns the _firm's responsiveness to the planner's objectives_. To this purpose, let us define two situations of reference. In the _full information_ case, the information structure of the original model is modified so that both parties have complete information on θ at the beginning of the relationship (at the contracting date). The optimal full information outcome is the full information allocation and the full information transfer. The _symmetric information_ refers to a situation in which only the planner's information is modified so that he has the same information on θ as the firm at any point in time. The symmetric information contract consists of the symmetric information allocation and the symmetric information transfer.

The firm is _responsive_ if the symmetric information allocation is implementable. The optimal assymetric information allocation may, however, be different from the symmetric information allocation when transfers are costly to the planner.

Note that in adverse selection models, where the firm has complete information on θ at the contracting date, the full information and symmetric information situations coincide. In models where the firm learns θ after the contracting date, and in which both parties are risk-neutral, the full information and symmetric information allocations coincide, although the transfers do not, as they reflect respectively *ex post* and *ex ante* individual rationality constraints. Responsiveness is thus equivalent to the implementability of the full information allocation in these two classes of models.

According to this criterion, the profit maximizing firm of Baron-Myerson is responsive, whereas the labor-managed firm of Guesnerie-Laffont is not (see below).

In the one-dimensional framework, the $A2^+$($A2^-$) condition describes the set of implementable C^1 piecewise allocations as being the set of weakly increasing (decreasing) allocations. Therefore, if $A2^+$ holds ($A2^-$), the firm is responsive if and only if the symmetric allocation is weakly increasing (decreasing).

Note that when transfers are socially neutral, (i.e., $k = k' = 0$), there may exist a Groves scheme, i.e., a transfer function $t(\ell)$ that makes the firm internalize the social value of its choices (see below for an example). In this case the symmetric information allocation is thus implementable and the firm is responsive. This may also (but is unlikely to) happen if transfers are socially costly and if there exists a transfer function $t(\ell)$ that turns the firm's preferences on ℓ given $t(\ell)$, into the planner's preferences on ℓ given the symmetric information transfer function.

The above criteria are not to be taken too strictly; they mainly have the purpose of allowing a convenient classification. Sections 4 and 6 consider the case of responsive firms and emphasize respectively monetary and slack rents. Section 5 considers the case of monetary rent without responsive firms.

4. Informational monetary rent with responsive firms.

4.1 Variations on the basic model.

The models in this section have the basic structure described in Baron-Myerson [1982] and Sappington [1982]'s pioneering articles. Some characteristics of the cost function of the firm are unobservable to the planner; the cost function can be written $C(\theta,q)$ where θ is the (vector of) unknown parameter(s) and q the output level. (So: $L = 1$ and $\ell = q$). The firm behaves according to the standard profit maximization criterion and has some reservation value for profit.

This principal-agent problem has a rather straightforward solution in the case where there is no cost of transferring money to the firm ($k = k' = 0$). In this case, the (*ex-post*) social welfare can be written $W(q,\theta) = S(q)-C(q,\theta)$ where $S(q)$ is the social surplus. The symmmetric information allocation can be reached under asymmetric information by giving the firm a monetary reward $S(q)$ when it produces q. Then the firm's maximization problem coincides with the planner's maximization problem and the scheme is said to implement the symmetric information allocation $\bar{q}(\theta)$. This result, which was noted by Loeb-Magat [1979] when q is the quantity of a pure public good is nothing else than <u>the transposition to our problem of the Groves-Clarke-Vickrey mechanism</u>. In essence, it is extremely general; in particular, it applies whatever the unknown parameter space is as well as to the case of several outputs. The nature of the informational rent obtained by the firm is clear: it is equal to the difference between the net social surplus and the net social surplus generated by the least productive firm (among those which should remain in operation). Hence, it increases with the productivity of the firm.

More difficult questions appear when the social welfare function incorporates a disutility of the transfer, either because of a redistributive concern, or because of the presence of a cost of public funds (see subsection 2.1). As previously, the symmetric information allocation is implementable through a Groves mechanism but the expected value of the associated transfer is too high. The optimal solution trades off between the financial or distributional losses associated with the expected transfer and the efficiency losses generated by the departure from the symmetric information (efficient) output. The monetary rent obtained by the firm decreases when compared to the monetary rent obtained under the Groves mechanism.

The linear quadratic case.

Let us describe the solution under the following simplifying assumptions. The good is a non-marketed good and the uncertain parameter is one-dimensional. The model is called "linear quadratic" in the sense that the cost function is linear $C(\theta,q) = \frac{1}{\theta} q$ where θ is the unknown productivity and the surplus function is quadratic $S(q) = \alpha q - \frac{\beta}{2} q^2$ so that the marginal willingness to pay for the non-marketed good (the equivalent of the demand function for a private good) is linear: $P(q) = \alpha - \beta q$.

With a cost of public funds, the *ex-post* social welfare is $W = \alpha q - \beta \frac{q^2}{\theta} - \frac{q}{\theta} - k't$. With a uniform distribution of θ over a segment

$[\underline{\theta},\bar{\theta}]$ of length 1,[12] the surrogate social welfare of subsection 3.1 takes the form:

$$\tilde{W} = \alpha q - \frac{\beta}{2} q^2 - \frac{q}{\theta} - k' \frac{\bar{\theta} q}{\theta^2} .$$

The term $\frac{\bar{\theta}}{\theta^2}$ represents the effect of a unit change of q for a θ agent on the total transfers needed to restore incentive compatibility for agents $\theta' \geq \theta$ (c.f. section 3.1, page 15). It follows from (T2) of subsection 3.1 that the optimal (incomplete information) output $q^*(\theta)$ satisfies:

$$\alpha - \beta q^*(\theta) = \frac{1}{\theta}(1 + \frac{\bar{\theta} k'}{\theta}).$$

Note that for $\theta = \bar{\theta}$ the right hand side becomes $\frac{1}{\bar{\theta}}(1+k')$. "At the top," the social marginal willingness to pay equals the social marginal cost (here, the true marginal cost multiplied by a coefficient that reflects the fact that the social cost associated with an expenditure of $1 by the firm, backed by the planner, is $(1+k')).

We can now look at a number of variants of the linear-quadratic model, with uniform distribution, by combining the options private-public good, cost of public funds-distributional concern: the main points of the analysis in

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[12]The analysis is similar as long as the distribution satisfies the "monotone hazard rate property," i.e., $\frac{\int_{\theta}^{\bar{\theta}} \nu(x)\,dx}{\nu(\theta)}$ is non increasing (this condition is also satisfied for instance by the exponential distributions).

each case are gathered in the following table. Within each of the main four boxes, line 1 gives the market price of the commodity when the planner implements the full information second best optimum (denoted by $(\bar{\cdot})$). Lines 2 and 3 refer to the imperfect information second best optimum: line 2 exhibits the surrogate welfare function while line 3 gives the expression of the price of the commodity. Note that the upper right-hand side box gathers the results obtained above, the lower left-hand side corresponds to the linear quadratic version of Baron-Myerson's model.

	Distributional Objectives (1 - k)	Cost of Public Funds (k')
Non-marketed good ($U = -\frac{q}{\theta} + t$)	1. $\bar{p}(\theta) = \frac{1}{\theta}$ 2. $S(q) - \frac{q}{\theta} - k\left[\frac{\bar{\theta}-\theta}{\theta^2}\right]q$ 3. $p^*(\theta) = \frac{1}{\theta}(1+k(\frac{\bar{\theta}}{\theta} - 1))$	1. $\bar{p}(\theta) = \frac{1}{\theta}(1+k')$ 2. $S(q) - \frac{q}{\theta} - k'\frac{\bar{\theta}}{\theta^2}q$ 3. $p^*(\theta) = \frac{1}{\theta}(1 + k'\frac{\bar{\theta}}{\theta})$
Marketed Good ($U = -\frac{q}{\theta} + qP(q)+t$)	1. $\bar{p}(\theta) = \frac{1}{\theta}$ 2. $S(q) - \frac{q}{\theta} - k\left[\frac{\bar{\theta} - \theta}{\theta^2}\right]q$ 3. $p^*(\theta) = \frac{1}{\theta}(1+k(\frac{\bar{\theta}}{\theta} - 1))$	1. $\bar{p}(\theta)=\frac{1}{\theta}\left[\frac{1}{1+2k'}\right][1+k'(\alpha\theta+1)]$ 2. $S(q) - \frac{q}{\theta} - k'\left[\frac{\bar{\theta}q}{\theta^2} - qP(q)\right]$ 3. $p^*(\theta)=\frac{1}{\theta}\left[\frac{1}{1+2k'}\right]\left[1+k'\left(\alpha\theta+\frac{\bar{\theta}}{\theta}\right)\right]$

A number of observations can be made from this table:

(a) In all cases, $k = 0$ or $k' = 0$ imply $p^*(\theta) = \bar{p}(\theta)$. The (first-best) symmetric information policy is obtained because the firm is responsive and transfers are costless. As mentioned earlier, in all cases, the scheme that implements the symmetric information policy is a Groves scheme. Although the firm always retains the entire social surplus, the transfer takes a different form for public goods ($t(q) = S(q)$ as seen above) and private goods ($t(q) = S(q)-P(q)q$).

(b) Where there are distributional objectives, the public good case and the private good case have the same solution (lines 2 and 3 are identical). This is not surprising since in that case, only the total transfer from consumers to the firm matters (and not the part going through public channels).

(c) The different forms taken by the surrogate social welfare function come from the differences in the planner's objectives and not from the incentive compatibility constraint. For example, the interpretation of $\frac{\bar{\theta}}{\theta^2}$, sketched above for the public good-cost of public funds case, also holds for the other cases.

(d) Line 3 shows that in all cases <u>the regulated price is superior to the full information marginal social cost</u>, the equality being only restored for $\theta = \bar{\theta}$ (this is similar to the well-known result of "no distortion at the top" of the income tax literature; see Seade [1977]). Also for a fixed θ, the discrepancy increases with k and k'. This fits with the discussion on the planner's trade-off between equity and efficiency: when $k(k')$ increases, the planner is less eager to correct efficiency biases.

<u>Remark</u>: Guesnerie and Laffont [1984b] consider a firm's objective function which depends on its profit and its size. Using the techniques developed

above, they show that the concern for size mitigates the monopolist's tendency to restrict output. While the firm's employees often prefer a larger size, it would be desirable to obtain the reduced form objective function from more fundamental organizational considerations.

In all cases, the optimal solution trades off efficiency (which is obtained with Groves schemes) and costly transfers. The nature of the trade-off is clearly visualized from the comparison of the non linear payment schemes associated with the optimal incentive schemes, and corresponding to different values of the cost of transfers. Figure 1 sketches the optimal non linear payment scheme for a firm producing a public good for different values of the coefficient of cost of public goods.

Assume that it is always desirable to have all θ in operation and that the least productive firm $\underline{\theta}$ has the cost function associated with the line (1). The non linear Groves scheme $(t(q) = S(q))$ is depicted by (2). It is optimal for $k = 0$, as well as its translation (3) which satisfies firm $\underline{\theta}$'s individual rationality constraint. When k increases, the optimal production for the firm $\underline{\theta}$ becomes smaller and the rest of the payment scheme becomes flatter (4), (5). Both the expected surplus and the expected value of transfers decrease.

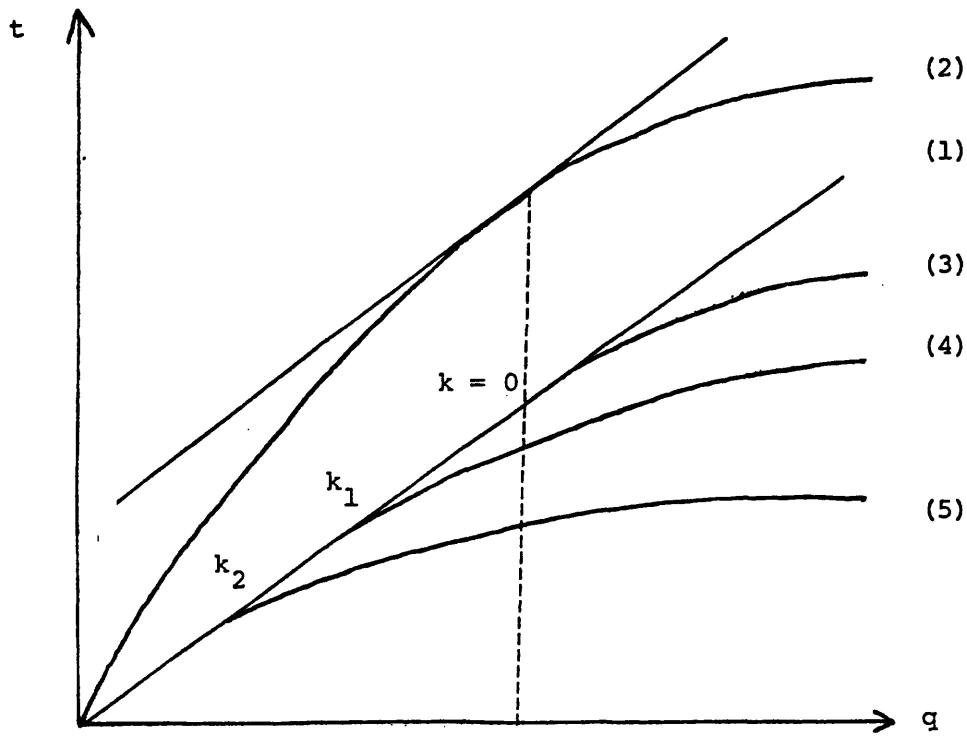

Figure 1

Fixed cost.

Until now, we have assumed that the firm's cost was proportional to output, i.e., there was no fixed cost.

When the fixed cost is publicly known, the same transfer scheme as before is optimal (of course, the determination of the cut-off point takes into account the fact that the fixed cost must be paid to the firm).

Assume now that the fixed cost is unknown (the case considered in Baron-Myerson). We shall first suppose that the proportional cost is known (equal to one, say), $1/\theta$ becoming the fixed cost. The optimal solution has straightforward features. The planner should reimburse a fixed amount of fixed cost $\frac{1}{\theta_0}$, and then enforce a price equal to the marginal social cost (see the above table). Firms with a fixed cost above $\frac{1}{\theta_0}$ do not produce whereas the others enjoy a monetary rent $\frac{1}{\theta_0} - \frac{1}{\theta}$. The main problem of the principal in this case is to determine the cut-off point θ_0. It increases with k, k'.

To combine an unknown fixed cost with an unknown proportional cost as done by Baron-Myerson, some consistency assumptions must be made. In fact, when the privately known parameter is a productivity parameter, one might suppose that both marginal and fixed costs are positively correlated and, for example, decrease when the productivity parameter increases. Then the analysis proceeds as above. The optimal pricing policy depends only upon marginal cost, and determines the transfer up to a constant. Taking into account the fixed cost, one then determines the constant in the transfer function and the (unique) cut-off point simultaneously.

However, if θ decreases marginal cost and increases fixed cost, the correlation becomes negative. Depending on the relative effects of θ upon marginal and fixed costs, the variations of the firm's utility and of the planner's objective function with respect to θ may not be monotonic; there may then exist several cut-off points that determine domains where the firm's activity is socially beneficial and domains where it is not.

A further extension of the model is the case where both variable and fixed costs are unknown to the planner, and are partially or even non correlated in the planner's prior. Rochet [1984] focuses on this problem in the Baron-Myerson setting. The planner wants to regulate a monopoly whose cost function depends on a two-dimensional unknown parameter (θ_1,θ_2): the first determines the proportional cost, while the second determines the fixed cost.

As in the original Baron-Myerson paper the regulating policy is restricted to one of the following form:

$r(\tilde{\theta}_1,\tilde{\theta}_2)$: the probability that the firm will be allowed to produce.

$q(\tilde{\theta}_1,\tilde{\theta}_2)$: the regulated quantity.

$t(\tilde{\theta}_1, \tilde{\theta}_2)$: the monetary transfers to the firm.

The most important feature in the paper is that, although the optimal policy in the one-dimensional case is deterministic, strict randomization in general is obtained in the two-dimensional case for a set of characteristics of positive measure. Also, on the subsets where the optimal scheme is such that $r \neq 1$, the optimal regulated price can depend on θ_2, and is not independent of the demand function (as in the one-dimensional case with distributional objectives).

On the subsets where the optimal r is equal to 1, if the prior on θ_1 is independent of θ_2 and uniform, the optimal quantity is the Baron-Myerson regulated quantity. Rochet finally exhibits a partial differential equation and other relations that together characterize the optimal allocation in the general case. Dana [1987], Engers [1987], Laffont-Maskin-Rochet [1987], and Quinzii-Rochet [1985] also give some indications about the way of dealing with multidimensional incentives.

4.2 Imperfect cost observability.

The observability assumption of the Baron-Myerson analysis amounts to positing that cost observation is impossible. Baron-Besanko [1984a] introduces in this framework the possibility of observing cost with an error and with an observation cost. Precisely, the principal may decide to audit, in which case he observes a "noisy" estimate of marginal cost $C_1 = \frac{1}{\theta} + \varepsilon$ where

ε is random with zero mean, and θ the true productivity.[13] ε is a measurement error (it could also be an *ex-post* randomness in cost). The firm is still assumed to be risk-neutral.

Assume first that auditing is costless. If, furthermore, θ is observed without error, the full information optimum could be implemented. In fact, the conclusion remains if there are errors in measurement. Suppose the planner announces an output policy, a preobservation transfer $t(\tilde{\theta}) = 0$ for all $\tilde{\theta}$ and reimburses the firm according to the observed total cost. The firm has a zero expected profit whatever its announcement and, as it is risk-neutral, it has no strict interest in lying, whatever the announced output policy. There is no incentive compatibility problem and the full information optimum can be implemented.

Let us now follow Baron and Besanko by introducing a fixed cost of auditing. The planner precommits to a probability of auditing as a function of the announcement $\tilde{\theta}$.[14] We shall first stress that in the absence of bounds on possible transfers and penalties it is usually possible to approximate the full information solution with a probabilistic scheme. The argument is reminiscent of the classical argument of Mirrlees [1975]. Consider an output

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[13] Note here a slight difference with Baron-Besanko's formulation where total (and not marginal) cost is observed. Only minor differences in the argument are implied by our different hypothesis.

[14] Commitment on a probabilistic auditing *a priori* requires something like a public lottery. As the optimization problem is linear in probabilities, the optimal policy is bang-bang. Note, however, that our next reasoning, which shows that in the absence of bounds on transfers the full information allocation can be approximated, relies on the use of a probabilistic scheme.

$q(\theta)$ and let $p(\theta)$ be the corresponding market price (in the case of a private good). Assume that the distribution of ε, with cumulative distribution F, is symmetric and single peaked, and consider the following policy:

1. The preobservation transfer is zero.

2. If C_1, the observed unit cost, satisfies $|C_1 - \frac{1}{\tilde{\theta}}| > \alpha > 0$, the firm pays a penalty N and is reimbursed $C_1 q(\tilde{\theta})$; if $|C_1 - \frac{1}{\tilde{\theta}}| \leq \alpha$, the firm receives a bonus B in excess of the reimbursement $C_1 q(\tilde{\theta})$. B and N are related by $AB = (1-A)N$ where $A \overset{def}{=} F(\alpha)-F(-\alpha)$, and the planner audits with probability $\frac{1}{\sqrt{N}}$.

Because of the properties of the distribution function and of the incentive scheme the mechanism is approximately incentive compatible (the announcement $\tilde{\theta}$ becomes close to θ) for N large.[15] In particular, the full information optimal allocation $\bar{q}$ is approximately implemented by this scheme, which furthermore minimizes the expected transfer cost.

Following Baron and Besanko let us introduce bounds in the penalty system: N is constrained to belong to the interval $[0,\bar{N}]$.[16] Basically, *ex-post* transfers are constrained downwards. The principal cannot use a policy in which a smaller probability of auditing goes together with an increase in penalties. The flavor of the optimal auditing and pricing scheme

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[15]There is a small chance of being audited. The expected ex-post penalty when $\tilde{\theta} \neq \theta$ is of the order of $\sqrt{N}$, whereas the gain from lying, when auditing does not occur, is finite.

[16]On the role of bounds in penalties or risk aversion, the reader will fruitfully consult the literature on moral hazard: see Polinsky-Shavell [1979], Nalebuff-Stiglitz [1983], Nalebuff-Scharfstein [1987] and Bolton [1985].

derived by Baron-Besanko can be briefly given:

1. As already mentioned in footnote 14, the optimal auditing policy is bang-bang. In fact, the probability of auditing is one for productivity announcements smaller than some threshold level and zero for higher announcements. Only "suspect" θ's are audited.

2. The optimal pricing and transfer policies in the non-auditing region are the same as in Baron-Myerson (up to a constant for the transfer function).

3. In the auditing region, the firm pays the penalty $\bar{N}$ whenever the observed productivity is high (to counteract its tendency to announce an underestimated productivity) and zero otherwise. Note that if *ex-post* low cost may be penalized, it only happens for high *ex-ante* announcements. An interesting finding is that the cut-off point for the penalty is the maximum likelihood estimate of total cost given the announcement $\bar{\theta}$.

The previous results rely upon the assumption that the individual rationality constraint only binds for the lowest θ, which is not necessarily the case. This surprising fact comes from the penalty and auditing policy: the usual argument that a high productivity firm can mimic the action taken by a low productivity firm and still obtain more, does not apply; a high productivity firm has a high probability of having a low C_1 and therefore, of being penalized if it pretends to have low productivity. One has then to check if the optimal policy satisfies the individual rationality constraint. If one is unlucky, the independence of the pricing rule with respect to auditing disappears.[17]

4.3 Input versus output control.

The literature we review assumes that regulation concerns one or two observable variables and that technological uncertainty is one-dimensional. Assuming that only one observable variable is the object of regulation, but that one can choose this variable from among a number of possible candidates (i.e., observing more than one variable is too costly), we wish to address the question of the choice of this variable. For instance, in the context of the control of production, one has to compare control via output (which may be costly because of the difficulty of measuring the quality dimension) and control via an input (which may be costly because of the possibility of secret purchases and resales).

There is not perfect symmetry between input control and output control in the following sense: if a firm commits to the delivery of some output level,

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[17] Baron-Besanko's paper relates also to Green-Laffont [1986]; this latter paper focuses on the formalization of monitoring technology, i.e., on sophisticated mechanisms that involve a mean of detecting announcements which are obviously far from the true characteristics. Mechanisms where the set of possible announcements attainable by a θ-agent depends on θ, are especially studied. In this framework, the Revelation principle fails. Changing a direct mechanism into a truthful direct one, according to the standard argument of the Revelation principle, changes the available set of outcomes for an agent. The Green-Laffont technology of control has to be clearly distinguished from Baron-Besanko's; the latter gives a noisy estimator of θ which only depends on θ; in the former the information transmitted to the principal depends on the agent's characteristic and announcement.

Let us note that the Baron-Besanko model has some analogy with the literature on the use of bonus penalty systems in automobile insurance in the presence of adverse selection (see, e.g., Dionne [1983], Henriet-Rochet [1986]).

it is very unlikely to produce more and destroy the excess. On the contrary if the firm has a right to the delivery of some input quantity, it may be in its interest to destroy some or to produce inefficiently.

Assuming for the moment that the full utilization of input(s) can be ascertained, is it better to control output or to control input? From the following simple example one can guess that input or output control are not equivalent. Take a firm producing a public good with unknown productivity θ; its utility function is $t - \frac{q}{\theta}$ as a function of output and t-x as a function of the amount of input x; increasing function $q(\theta)$ are implementable in one case, whereas any function $x(\theta)$ is weakly implementable in the other case (in particular, the symmetric information allocation can be reached by simply reimbursing the cost of the input up to a constant).

To go further, let us use the Guesnerie-Laffont [1984a] formalism. The firm's utility is denoted $U(q,t,\theta)$. If output q is related to input x through the relationship $q = f(x,\theta)$, the utility function as a function of (x,t,θ) is $\tilde{U}(x,t,\theta) = U(f(x,\theta),t,\theta)$. The "constant sign" condition $A2^{+}$ associated with this new function is:

$$\partial_{\theta}\left(\frac{\partial_x \tilde{U}}{\partial_t \tilde{U}}\right) = \partial_{\theta}\left(\frac{\partial_q U}{\partial_t U}\right)\partial_x f + \frac{\partial_q U}{\partial_t U}\partial^2_{x\theta} f > 0.$$

It is not implied by and does not imply the "constant sign" condition associated with the first utility function i.e., $\partial_{\theta}\left(\frac{\partial_q U}{\partial_t U}\right) > 0$. This suggests that input and output control will generally not be equivalent (for the discussion of a similar problem in another context, see Maskin-Riley [1985]).

When the full utilization of input(s) cannot be ascertained, a moral hazard problem arises. Let us consider a firm using two complementary factors, labor L and capital K, to produce an output $q = \text{Min}\ \{K,L\}$, as in

Crampes [1983]. If this production function is common knowledge, output control is sufficient since it is in the interest of the firm to produce efficiently ($K = L = q$). However, if the planner can control only one of the inputs, say capital K, and if he proposes an allocation K superior to the "pseudo-monopolistic" production of the firm q^{PM} (such a production maximizes monopoly profit gross of the capital expenditure and is clearly above the usual monopolistic production) then the firm will choose to use only $L = q^{PM}$ and destroy the excess capital. Hence, if this pseudo-monopolistic production is smaller than the first-best one, the planner cannot implement the first-best allocation and his best strategy consists of proposing $K = q^{PM}$ to the firm.

Now assume that the planner cannot prevent input destruction, and cannot observe the firm's productivity of capital: $q = \text{Min}\left\{\frac{K}{\theta}, L\right\}$. In controlling K the planner faces both moral hazard and adverse selection problems. If efficiency could be imposed, the optimal mechanism could be derived according to standard techniques. It would be some increasing function $K^*(\theta)$, the precise characteristics of which depend upon the planner's objectives. The optimal production would be $q^*(\theta) = \frac{K^*(\theta)}{\theta}$. Under moral hazard, the optimal production is equal to min $\{q^*(\theta), q^{PM}(\theta)\}$. The introduction of some substitutability between the inputs would lead to less clear-cut conclusions: excessive substitution of labor by capital would replace pure destruction but the nature of the problem would not be much different.

4.4 Multidimensional output.

In Baron and Myerson only one output is produced. The multi-output case has been studied by Sappington [1983a]. The cost function is separable in each output and technological uncertainty is one dimensional.

In this framework the standard results are generalized. This is not surprising in view of the results of adverse selection problems with several observables reported in Section 3. The optimal trade-off induces a distortion in the technological choice and in the pricing policy. Ramsey prices need not be optimal and cost minimization may not be desirable.

5. Non responsiveness.

The model we use here is a simplified version of the model of the labor-managed firm in Guesnerie-Laffont [1984a]. The firm's output is $\theta f(\ell)$ where ℓ is the number of workers; f describes a decreasing returns to scale technology and θ is a productivity parameter known only to the firm. The observable variable is not the output, as in Baron-Myerson but the number of (homogeneous) workers.[18] However, the significant difference between this model and those of the preceding section concerns the objective function of the firm. Here it is assumed that the core of employees (the workers or the managers) has superior information about the productivity of the firm. It must decide the size of the staff, under the constraint that all employees must be treated equally. As is usual in the theories of the labor-managed firm, this begs the question of the hiring (firing) process. Let us posit that the firm's behavior is described by the maximization of income per employee, i.e., that its objective function is $\frac{\theta f(\ell)-K+t}{\ell}$, where the price of the output is one and K is a fixed cost.

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[18] Because output is sometimes easy to observe, one may want to think of θ as being the output price -- which may not be observable because of price discounts. See also below for another interpretation.

Under symmetric information, the socially optimal employment ℓ grows with productivity θ. Can this symmetric information employment policy be implemented, and thus be the asymmetric information optimal policy for a planner without concern for transfers? It turns out that the utility function of the firm satisfies the single crossing condition but that indifference curves rotate with θ in the wrong sense. In other words, it satisfies the wrong single crossing condition so that the symmetric information employment cannot be implemented. In the terminology suggested above the firm is non responsive. This phenomenon deserves further explanations. We know that a labor-managed firm restricts production; it produces less than its competitive counterpart. It is also known that the firm displays the Ward pathology; when the price of its output (or its marginal productivity) increases, employment decreases.[19] It can be precisely shown that what we have called non responsiveness is closely related to Ward's pathology (see Guesnerie-Laffont [1984a]). The crucial point is not, however, that the labor-managed firm restricts production (so does the profit-maximizing monopolist) but that the marginal willingness to increase production (measured, for example, by the increase in production which is accepted in counterpart of one more dollar of transfer) decreases with productivity (the contrary happens with a private monopoly).

Let us now give a sketch of proof of non-responsiveness (i.e., of the fact that incentive compatibility requires employment not to increase with productivity) in the case where θ, the productivity parameter, can only take

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[19] On this subject, see the classical references Ward [1958], Meade [1944], Vaneck [1970], and the recent survey of Bonin and Puttermans [1987].

two values. A contract is then a set $\{\underline{\ell},\underline{t}\}$ and $\{\bar{\ell},\bar{t}\}$. With straightforward notations the incentive compatibility constraints can be written:

$$\frac{\bar{\theta}f(\bar{\ell})-K+\bar{t}}{\bar{\ell}} \geq \frac{\bar{\theta}f(\underline{\ell})-K+\underline{t}}{\underline{\ell}}, \quad \frac{\underline{\theta}f(\underline{\ell})-K+\underline{t}}{\underline{\ell}} \geq \frac{\underline{\theta}f(\bar{\ell})-K+\bar{t}}{\bar{\ell}}.$$

The reader will easily check that the two incentive compatibility constraints imply:

$$(\bar{\theta}-\underline{\theta})\left[\frac{f(\bar{\ell})}{\bar{\ell}}-\frac{f(\underline{\ell})}{\underline{\ell}}\right] \geq 0$$

or using the fact that there are decreasing returns: $(\bar{\theta}-\underline{\theta})(\bar{\ell}-\underline{\ell}) \leq 0$.

Whether transfers are costly or not, the optimal contract consists of a fixed size to the firm (independent of its productivity) and a fixed transfer allowing the less productive firm (or, more generally, the cut-off firm) to meet its individual rationality constraint. The optimal policy fixes the number of workers, i.e., does not try to extract information.[20]

The fact that the observed variable is labor rather than output is not a significant difference from the Baron-Myerson's analysis, while the assumption of the maximization of profit per capita is. Were the firm to maximize profit $\{\theta f(\ell)-K+t-w\ell\}$ (where w is the workers' reservation wage), assumption A5 would be satisfied, and from theorem 1, the implementable allocations $\ell(\theta)$ would be non-decreasing. The firm would be responsive.

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[20]In the terminology of the incentives literature, the optimal mechanism "bunches" all types of firm. In contrast, the optimal Baron-Myerson mechanism at least partly separates the possible types (fully separates them if the hazard rate of the distribution over θ is weakly decreasing).

In conclusion, this work leads to views on the control problems that are somewhat opposite to the ones drawn from Baron-Myerson. In Baron-Myerson type problems, some policies can implement the symmetric information optimum; as these policies are too costly in terms of transfers, the principal has to trade off in the design of optimal policies. The optimal policy, however, provides rewards that gradually adjust to performances (although in a non-linear way). In Guesnerie-Laffont, the optimal policy takes the extreme form of a pure quota.

6. Monetary and slack rents.

Let us suppose with Laffont-Tirole [1986] that the firm can manipulate its cost. Assume at the outset that cost is entirely determined by the unknown technology parameter and the level of an observable variable called effort and is perfectly observable. Later we introduce forecast or observation errors.

We make two brief remarks here. First, in all previous models but Baron-Besanko's, the introduction of the effort variable would not affect qualitative conclusions: Because cost is not observable in these models, the firm fully bears its cost and chooses the socially optimal effort conditional on output. The endogenous choice of effort really becomes an issue when cost is observed, and therefore is not necessarily borne by the firm. Second, the nature of effort is not much discussed here. Such a discussion would bring us back to the question of the interactions which take place within the firm and hence to the problems of the nature of the firm and of the relevance of its description as a utility-maximizing agent. One can think of effort as the effort of managers (workers), the objective function including a disutility of effort in addition to a linear utility of transfers.

The firm's private information is its cost parameter $\frac{1}{\theta}$. Effort decreases marginal cost so that the cost function can be written $C = \left[\frac{1}{\theta e}\right]q$. The disutility of effort is $\varphi(e)$ and the good to be produced is a public good. The planner maximizes a social welfare function that places the same weight on consumers' surplus as on the firm's welfare and takes into account the cost of public funds. Since cost but not effort can be observed, in order to discourage shirking not all costs are reimbursed.

Although the problem includes an unobservable effort associated with the concept of moral hazard, it is an adverse selection problem in the sense of Section 1. The variables c (marginal cost) and q (production) are observed without error: so, L = 2. The utility function of the firm can actually be written as a function of q, c, θ the parameter and t the transfer. Similarly, (after elimination of e) the social welfare can be viewed as depending on q,c,t and θ. This gives rise to a two-dimensional version of the problem considered in Section 3. For example, under the previous assumptions, the disutility of effort being equal to $\frac{e^2}{2}$ and $c = \frac{1}{\theta e}$, the agent's utility can be written $U = t-qc-\frac{1}{2}\left[\frac{1}{\theta c}\right]^2$ (the agent is income risk-neutral); with the quadratic social surplus function $\alpha q - \frac{\beta}{2}q^2$ and a uniform distribution for θ the surrogate social welfare function $\tilde{W}$ associated with the problem is:

$$\tilde{W} = \alpha q - \frac{\beta}{2}q^2 - (1+k')\left[qc + \frac{1}{2}\frac{1}{(\theta c)^2}\right] - \frac{(\bar{\theta}-\theta)k'}{\theta^3 c^2}.$$

For the optimal policy the partial derivatives of $\tilde{W}$ with respect to c and q are equal to zero.

More generally, the incentive compatible mechanisms (including the optimal one) are associated with three functions $q(\theta)$, $C(\theta)$, $t(\theta)$, which define a curve in the three-dimensional space over which the firm maximizes its utility.(We use $C(\theta) = c(\theta)q(\theta)$ from now on because we will shortly assume that total cost is observed with an additive error; we can then give an economic interpretation in terms of cost reimbursement rules). The planner can propose a "knife-edged" mechanism, defined by $\{(q,C,t) \mid \exists\theta$ s.t. $q(\theta) = q$, $C(\theta) = C$ and $t(\theta) \geq t\}$.

The implementability of this knife-edged mechanism requires a perfect observation of the variables q and C. Unfortunately, the mechanism is not robust to the introduction of forecast and accounting errors and therefore does not seem very realistic. Laffont and Tirole emphasize the implementation of the optimal allocation through linear schemes of the form $\{q(\theta), \tilde{t} = a(\theta)\tilde{C} + b(\theta)\}$ where $\tilde{C}$ denotes the observed cost. If $\tilde{C}$ is the sum of C (previously defined) and a random, zero-mean variable ε, the expected transfer for the firm when it chooses an effort yielding expected cost C is $E\tilde{t} = a(\theta)C + b(\theta)$. Thus, the action $\{q(\theta),C(\theta)\}$ associated with the knife-edged mechanism is still available to the agent and gives him an expected transfer $t(\theta)$, if $b(\theta)$ is chosen such that $b(\theta) = t(\theta)-a(\theta)C(\theta)$. In order for this action to be optimal for the agent, the slope of the reward scheme $a(\theta)$ must be equal to the partial derivative of the agent's utility function with respect to C, evaluated at $\{q(\theta),C(\theta)\}$. In other words, the lines $t = a(\theta)C + b(\theta)$, which generate a "ruled" surface in the space $\{q,C,t\}$, must be tangent to the section of agent θ's indifference surface at $\{q(\theta),C(\theta),t(\theta)\}$. However, this condition is not sufficient. The ruled surface must also never intersect the family of indifference surfaces through $\{q(\theta),C(\theta),t(\theta)\}$. If this latter condition is also satisfied, the family of linear schemes implements the knife-edged mechanism whatever the distribution of the random noise ε. A more systematic analysis and general results on the implementability of the adverse selection allocation under noisy observation can be found in

Caillaud-Guesnerie-Rey [1986].[21]

Let us now return to the Laffont-Tirole solution.

The firm, which has private information when signing the contract, selects among several "incentive contracts," where an incentive contract shares cost in a linear way. The linear transfer function is the sum of $b(\theta)$, which depends upon the announcement of the cost parameter and can be paid before production occurs and a penalty $a(\theta)C$, where $a(\theta)$ is negative and increases in absolute value with productivity. High productivity firms are thus more encouraged to exert effort. There is greater effort distortion than in the cost unobservability case, but this is more than offset by the reduction in price distortion.

Two points should be made in conclusion. First, there is a striking difference between the Laffont-Tirole and Baron-Besanko conclusions since in the latter case, but not in the former, low costs are penalized (note, however, that only high announced costs are audited). This difference is due to the presence of unobservable effort. Second, the Laffont-Tirole model exhibits another example of firm responsiveness.

7. The Dynamics of regulation.

Until now we have assumed that all information is known (possibly privately) when the parties sign the contract and that the contract is binding. These two assumptions are now relaxed successively.

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[21] See also Melumad-Reichelstein [1985], McAfee-McMillan [1986, 1987], Picard [1985], Picard-Rey [1987] and Rogerson [1987].

7.1 Dynamics under full commitment.

If the relationship lasts long enough, which is the case for most regulated firms, private and public information may vary over time. On the one hand, the firm's true parameters can change over time either through exogenous shocks or through a non-observable action. On the other hand, a party can obtain more precise information about some unknown parameter from the other party's behavior.

In this subsection we follow Baron-Besanko [1984b] in considering a two-period Baron-Myerson model. At the contracting date (the beginning of the first period), the firm privately knows its first-period efficiency parameter, and the planner can commit to a two-period contract. The firm learns its second period efficiency parameter at the beginning of the second period. The contract involves revelation at each period, and specifies for each period a transfer and an output that depend on past and present announcements. The individual rationality constraint must be satisfied at the contracting date and, unless the firm can also commit, at the beginning of the second period so that the firm does not quit after the first period.

As a point of reference, we start with a case of dynamic framework with no dynamics: full commitment and perfect correlation of the information over time. It is common knowledge that the marginal cost is the same in both periods $\frac{1}{\theta_1} = \frac{1}{\theta_2} = \frac{1}{\theta}$. We can then restrict attention to truthful mechanisms based on a single (first period) announcement of the characteristic. Proposing two different outcomes for two different periods is equivalent to proposing, in the static framework, the first outcome with probability $1/(1+\delta)$ and the second one with probability $\delta/(1+\delta)$, where δ is the discount factor: as the optimal static contract is non stochastic, the optimal mechanism elicits the information only once and gives the Baron-Myerson allocation twice, i.e., the static scheme dominates every revision scheme. The intuition is that subdividing periods in a length of time over which the environment is stationary cannot improve welfare.

Let us now analyze the case of full commitment and no correlation over time. For example, the firm's marginal costs in the two periods, $\frac{1}{\theta_1}$ and $\frac{1}{\theta_2}$, are independently drawn from the same distribution. The optimal allocation is easy to describe, as the two parties in effect sign two different contracts. The first period allocation is the optimal static one. The contract for the second period is signed under symmetric information, and therefore gives the symmetric information allocation. The firm is induced to equalize its second-period marginal cost and the marginal social value of its product, and is put at its individual rationality level through a lump-sum transfer.

Although it is a "convex combination" of the previous two cases, the case of full commitment and imperfect correlation is somewhat more interesting. Now the second-period transfer and pricing policies affect the first period individual rationality and incentive compatibility constraints, as the firm already has some information about θ_2 at date one. Baron and Besanko obtain the following result: in the first period the pricing policy is the Baron-Myerson static one. In the second period the pricing policy is intermediate between the symmetric information and the Baron-Myerson pricing policies.

We first give an intuition about the second period pricing policy. Suppose the second-period allocation is the full information allocation, and consider a small increase in the price above the full information price (a small decrease in the quantity): this introduces only a second-order distortion in the second-period welfare. However, it implies a first order reduction in the pace at which the second period profit decreases with the second period marginal cost $\frac{1}{\theta_2}$ (this pace is proportional to the produced quantity by the envelope theorem). As θ_1 and θ_2 are positively correlated, a general decrease in the output under the socially optimal (full information) output implies a decrease in the absolute value of the negative slope of the expected second period profit as a function of $\frac{1}{\theta_1}$. So, given that the overall expected profit is exogenously fixed for the lowest level of θ_1 (highest level of $\frac{1}{\theta_1}$) (individual rationality constraint), pricing slightly above the full information price in the second-period saves to the first order on the first-period transfer.

Lastly, we explain why Baron and Besanko obtain the static pricing policy in the first period. After all, the first-period transfer is used to correct the static and dynamic incentives to lie (as optimally the second-period pricing does depend on the announced first-period marginal cost).[22] But the two problems are separable; in particular, the marginal transfer cost is constant. So there is no effect of the second-period pricing policy on the

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[22]Baron and Besanko find the following pricing policy:

$$p_2 = \alpha_2 - k \frac{\frac{\partial F_2}{\partial \alpha_1}(\alpha_1, \alpha_2)}{f_2(\alpha_1, \alpha_2)} \cdot \frac{F_1(\alpha_1)}{f_1(\alpha_1)}$$

where $\alpha_1 = \frac{1}{\theta_1}$, $\alpha_2 = \frac{1}{\theta_2}$, $f_1(F_1)$ is the distribution (cumulative distribution) of α_1, $f_2(F_2)$ is the distribution (cumulative distribution) of α_2 given α_1 and (1-k) is the weight of the firm's profit in social welfare.

first-period one.[23]

7.2 Commitment versus non commitment.

What is usually called commitment is the opportunity to restrict one's own set of future possible choices or actions. It involves in fact credible warranties that some future choices are destroyed.

Commitment even in a static framework is an important feature of regulation. The planner commits to a contract: he binds himself to use the revealed information of the firm in the specific way it was agreed upon. This self-constrained behavior must be credible. Were the firm uncertain about the planner's action, it would anticipate the strategic use of its announcement (or production) and things would get more intricate.

A relationship may last a long time, involving many actions from both sides, and still be like a one-period agreement if no new information accrues and if both parties are able to commit for the entire duration of the contract. It is important to note that commitment is (weakly) desirable, since the planner can commit to the strategy that he would choose in the absence of commitment. This induces the firm to take the same decisions as in the non-commitment case.

However, commitment is not always possible. We must admit that we do not have any good single explanation as to why commitment fails to occur more frequently in the real world. Several possibilities are suggested.

[23]Pratt-Zeckhauser [1986], Baron-Besanko [1984b], and Tirole [1984] study problems where an unobservable action (investment) as well as uncertainty change the efficiency parameter over time. Under commitment and ex-post bilateral asymmetry of information (the binding contract is signed under symmetric information), Pratt-Zeckhauser and Tirole generalize the d'Aspremont-Gerard Varet [1979] results and find that the first-best in effort level and in decision is implementable. But under no commitment, underinvestment is the rule. In Baron-Besanko the unobservable action can be interpreted as investment; under full commitment and in case of independence of the second period information with respect to the first period inforamtion, the first-best level of investment is realized.

First, enforceability of binding contracts may require a third party (although reputation effects may alleviate the problem). The latter must have some powerful means to force each party to respect the agreement and he must acquire the information that both parties know. He must be able to observe what both parties can observe. And despite his powerful role, he must be neutral, not collude with one party and not try to fulfill his own objectives (this difficulty arises also in a static model). This combination of characteristics may not be achieved easily.[24]

Second, contingencies may be costly to describe or even be unforeseen. Contracts are then incomplete and must be renegotiated (renegotiation can take the extreme form of the exercise of authority as in Grossman-Hart [1986] and Williamson [1985], see also Hart-Moore [1985]).

Third, the two parties may tear up the current contract and renegotiate a better contract for both of them (as in Dewatripont [1980] and Hart-Tirole [1987]). This possibility clearly creates a problem with the full commitment case analyzed above, where a low productivity firm produces an inefficient output in the second period even though its type is common knowledge.

Fourth, the parties may simply be unable to commit; this argument is particularly relevant in a regulatory or planning context, where the current administration may not be able to bind future ones. Future research should try to distinguish among the effects of these different bases for non-commitment. In the following discussion, we simply assume that the

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[24]Creating a central authority with discretion about how to enforce contracts can be costly, even if all these conditions are met: see Milgrom [1988].

parties cannot commit.

7.3 Dynamics without commitment.

We follow in this section Freixas-Guesnerie-Tirole [1985] who assume that the firm's private information is perfectly correlated over time and that the planner can only commit to one-period contracts. The firm may be of low or high productivity ($\underline{C}(q) > \bar{C}(q)$ in terms of cost of producing a quantity q, and $\underline{C}' \geq \bar{C}'$), and the planner has a prior ν_1 that the firm has a low productivity. The firm produces a public good and the planner faces a cost of public funds. The planner observes only the firm's output. A static mechanism associates with any announcement of productivity a pair output-subsidy, i.e., either $(\bar{t},\bar{q})$ or $(\underline{t},\underline{q})$.

In the static framework we can characterize the optimal incentive scheme $IS(\nu_1)$:

(i) The individual rationality constraint of the low productivity firm (LP firm) is binding.

(ii) The high productivity firm (HP firm) is indifferent between both announcements. With the optimal scheme $IS(\nu_1)$, the HP firm gets a rent $\bar{u}(\nu_1)$ (the LP firm has no rent). Note that we explicitly describe the dependence of the informational rent on the prior beliefs.

(iii) The HP firm's social marginal cost equals the social value of the public good.

(iv) The LP firm's social marginal cost is lower than the social value of the public good.

In a two-period framework with commitment, we already know that the optimal dynamic scheme is the repeated static scheme.

In a two-period framework without commitment, the planner designs a first-period scheme $IS_1(\nu_1)$; the firm announces a productivity level and the scheme is implemented; then the planner updates his beliefs $(\nu_2,(1-\nu_2))$ and designs a second period scheme $IS_2(\nu_2)$. The firm is free to accept or reject any incentive scheme in any period. In this two-period two-player game, the concept of perfect Bayesian equilibrium (Selten [1975], Kreps-Wilson [1982]) is appropriate. Let us proceed by backward induction as usual.

As the game ends in period 2, it is clear that the second period optimal scheme is the static optimal one, given the planner's beliefs in period 2: $IS_2(\nu_2) \equiv IS(\nu_2)$. Therefore in period 1, the LP firm knows its future profits will be zero. Assume that the incentive schemes are constrained to be linear in output. The slope of an incentive scheme is called a bonus. In the first period, the LP firm maximizes its current profit: it claims it is LP. But the HP firm has to trade-off. If it reveals it is HP in period 1, ν_2 will then be zero and it will earn zero profit in period 2; on the contrary, it may lie either systematically or randomly. When it actually lies, it earns $\bar{u}(\nu_2)$ in period 2, where ν_2 is positive, but gives up a gain of Δ in the first period, where $\Delta \equiv \bar{t}-\bar{C}(\bar{q})-(\underline{t}-\bar{C}(\underline{q}))$. Δ is a measure of the HP firm's incentive to separate. The planner's beliefs being updated in a Bayesian way, we can describe three types of equilibria:

- separating equilibria: if $\Delta > \delta\bar{u}(1)$, firms reveal their true productivity in period 1. In that case, the first-period separation gain exceeds the most optimistic second-period profit from the firm's point of view (obtained when the planner is certain the firm has a low productivity).

■ pooling equilibria:[25] if $\Delta < \delta\bar{u}(\nu_1)$; an argument similar to the previous one shows that the HP firm pools with the LP firm so that the planner does not extract any information in period 1.

■ semi-separating equilibria: in the intermediate case where $\delta\bar{u}(\nu_1) < \Delta < \delta\bar{u}(1)$, it can be shown that the HP firm actually plays a mixed strategy and sometimes reveals its true productivity; thus, $\nu_1 < \nu_2 < 1$.

Three conclusions for the first period can be emphasized.

(i) As in the static scheme LP firms earn a zero profit.

(ii) If the static optimal bonus is separating, it is also the optimal first-period dynamic one. It is clear that if both the optimal dynamic bonus in the first period and the static bonus are separating then they should be equal: the static bonus gives higher first-period social welfare than any other separating bonus and has equal informational value. However, the next step -- to show that when the static bonus is separating the dynamic optimal bonus also is -- does not follow easily. Pooling in the first period (or semi-separation) is not open in the static problem but might be an interesting option from the viewpoint of the first-period social welfare. Some more work is needed to demonstrate that it is not so favorable.

(iii) In the case termed "well-behaved," i.e., Δ increases with the bonus, the optimal dynamic (first-period) bonus is always greater than or equal to (whatever the optimal regime) the static bonus. In that case, when

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[25] Pooling must be distiguished from "bunching." Bunching is perfectly consistent with truthful revelation, while pooling involves "lying." More generally, the problem that is considered here belongs to a category of incentives problems which can be characterized by the fact that the revelation principle does not hold.

the bonus increases, the regime switches from pooling to semi-separating and finally, to separating, i.e., there is no reswitching. Thus, there is a sense in which the search for information leads the planner to be more generous in the first period.

With a continuum of types, it can be shown that no separating equilibrium is feasible, let alone desirable (see Laffont-Tirole [1988], which proves this property in the general non-linear case).

The study of fully non-linear schemes is somewhat more difficult. Since high transfers may be required to induce the HP firm to separate, the LP firm may want to pretend in the first period it is highly productive and quit in the second period to get its individual rationality level (this feature differs from the static analysis where, under assumption $A2^+$, the LP firm prefers to announce it has a low productivity if the transfers are such that the HP firm is indifferent between the two announcements). This strategy consists of "taking the money and running."

Laffont-Tirole [1988] examines cost observation and moral hazard in a dynamic non-commitment version of the model presented in Section 5. Under commitment, the firm's effort is suboptimal, but without commitment this result does not necessarily hold. Imagine that, for the optimal policy, the high productivity firm pools with the low productivity one, i.e., produces at the same cost. If the latter already expends a suboptimal level of effort, the former *a fortiori* expends a very low level of effort. It may then be worth forcing the low productivity firm to work very hard, so that the pooling behavior of the high productivity firm does not lead it to shirk too much.

We should also mention the work of Baron and Besanko [1987] who impose a "fairness condition" on the planner's second-period incentive scheme.[26]

8. Hierarchies and conclusion.

To conclude, we mention two crucial and more radical departures from the lines of research we have described.

(a) All along we identified the firm with a (group of) dominant agent(s). In general, however, there may be conflicts among the different parties that compose a firm that cannot be resolved because of, say, asymmetric information between these parties. Opening the "black box" that characterizes the firm will be crucial to understanding how incentives trickle down within the organization. Two strands of research make some progress in this direction. The first, directly inspired by operations research problem, looks at the optimal organization of information flows when information is truthfully but imperfectly or costly transmitted (Simon [1976], Nelson-Winter [1982], Geanakoplos-Milgrom [1985], Sah-Stiglitz [1985], Cremer [1986]). The second looks at hierarchies from an incentive point of view and describes organizations as overlapping incentive relationships (Williamson [1967], Mirrlees [1975], Calvo-Wellisz [1978], Tirole [1986b]).

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[26] There exists an abundant literature on dynamics in moral hazard and/or adverse selection problems, or in mixed problems. This work (Radner [1981] [1985], Rubinstein-Yaari [1982], Rogerson [1985], Roberts [1982], Lambert [1983], Henriet-Rochet [1984], Holmstrom-Milgrom [1987], Fudenberg-Maskin [1986], Fudenberg-Holmstrom-Milgrom [1987], Allen [1985], Rey-Salanié [1986], Malcomson-Spinnewyn [1985], has made more precise the way in which repetition alleviates the moral hazard problem.

(b) While it is desirable to study intra-firm incentives, it is also crucial for our purposes to study the control mechanism. A fundamentalist approach ought to presume that the parties within a firm have the same tastes whatever the structure of outside control. In particular, there is no *a priori* reason why employees in a public or regulated firm should differ from their private sector's counterparts.[27]

The sociological and economic theory of bureaucracy (von Mises [1946], Weber [1947], Williamson [1964], Downs [1965, 1967], Niskanen [1971], Fionina-Noll [1978], Olson [1965] and Tullock [1965]) emphasizes the idea that public control involves one more layer: the shareholder/firm structure is replaced by the consumers/government agency/firm one. In other words, supervisor and principal are no longer identical.[28]

This extra layer introduces some extra inefficiency. The public supervisors must be given incentives to exert supervisory effort (as in Williamson, Mirrlees and Calvo-Wellisz), and not to collude with the regulated firms (as in Tirole. For the theory of regulatory capture, see, e.g., Posner

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[27] To some extent our survey of regulation theory applies as well to the control of private firms by their shareholders. There is no *a priori* reason why public supervisors of a <u>given</u> firm should have less information than their private counterparts. Note, however, that the public portfolio of firms is biased toward natural monopolies, which are harder to monitor because of the lack of information about similar firms or market pressure.

[28] In the private case, one can of course hardly think of a single supervisor. See the vast literature on shareholders' free-riding and takeover bids.

[1974] and Stigler [1971]).[29]

The hierarchical approaches may shed some light on the debate about the efficiency of public firms. While public production in the absence of informational problems is superior to private production (because it corrects monopoly biases or externalities for instance), it introduces a problem of delegation of control. As the empirical debate is far from being settled, we do not think that economists have yet brought a convincing and definite analysis of the relative advantages of public and private production.

[29]Public supervisors can offer firms slack, perks, job stability (perhaps not higher wages, as these can be more easily monitored by the consumers). Regulated firms can offer government agencies votes, jobs, the absence of strikes or complaints and so forth..

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