Note

Robustness of simple menus of contracts in cost-based procurement ☆

Daniel F. Garrett

Toulouse School of Economics, 21 allee de Brienne, 31015 Toulouse Cedex 6, France

A B S T R A C T

We consider a model of cost-based procurement in which the principal faces Knightian uncertainty about the agent's preferences for cost reduction. We show that a particularly simple incentive scheme—a menu comprising a fixed-price contract and a cost-reimbursement contract—minimizes the maximum expected payment, where this maximum is taken over the set of possible agent preferences. For some parameters of the problem, a range of alternative incentive schemes also satisfy this criterion. We show that the simple incentive scheme is not weakly dominated by any of the alternatives: there does not exist an alternative mechanism for which the expected payment is no higher for all realizations of the agent's preferences and strictly lower for some realization.

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1. Introduction

Laffont and Tirole (1986) study a principal who wants to procure a good or service from an agent. The parties can contract directly on the production cost but not on any of the agent's actions which affect it. The solution to the principal's problem is a payment schedule which is a non-linear function of the production cost; alternatively, it is a menu of infinitely many linear payment schemes. Both solutions seem more complex than the contractual offers we usually see in practice. One set of explanations for this rests on the principal's lack of information about agent technologies and preferences. This paper provides some support for the use of a simple kind of procurement contract, giving a sense in which it is optimal for a principal who lacks relevant information.

Laffont and Tirole are motivated by the idea that incentives are important whenever the agent can influence the production cost. They capture the role of incentives by allowing the agent to exert "effort" to reduce the production cost, where such effort is privately costly.[1] The agent's preferences over production costs are determined by his "innate cost", the production cost that he realizes without effort, and by a function which specifies the agent's disutility for each level of effort.

In Laffont and Tirole's model, the principal has a specified prior over the agent's innate costs and knows the agent's disutility function exactly. In this paper, the principal instead lacks precise information about the disutility function. The principal *cannot know* this information and so faces uncertainty as described by Knight (1921). The only available

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[1] "Effort" might more generally be interpreted as any action that reduces the accounting cost of the project, such as reducing the level of perquisites taken by the agent while on the job.

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information pertains to the difference between the innate cost and the lowest price the agent will accept to produce the good. This difference is the *available cost saving* from incentives. Our assumption is in the spirit of comments by Rogerson (2003, p. 929). Rogerson argues that the information requirements of Laffont and Tirole's model are unrealistic and that "A much more modest goal would be to hope that the contracting officer might be able to suggest the distribution of [innate costs] and to suggest what the size of the efficiencies from fixed-price contracting would be." We suppose here that the principal knows the distribution of innate costs and the *minimum possible* size of the efficiencies from fixed-price contracting (i.e., the minimum "available cost savings"), but nothing more.

We consider the performance of a simple incentive scheme that is analyzed by Rogerson. In what he terms a Fixed-Price Cost-Reimbursement (FPCR) menu, the agent is offered two contracts between which he can choose: a fixed-price contract and a cost-reimbursement contract. What we are able to show is that the FPCR menu is a "robust" choice of incentive scheme given only the available information.

We consider two criteria for robustness: first that the incentive scheme solve the problem of minimizing the principal's maximum expected payment (the minimax problem); and second, that the scheme not be weakly dominated—i.e., that there be no other scheme which performs better for some realization of the principal's uncertainty, and no worse for all others. The reason for considering non-Bayesian criteria is simply the absence of any basis for forming a prior over possible disutility functions and the need to nevertheless propose a choice among incentive schemes.

The minimax criterion is of particular interest because it is consistent with the kind of conservative decision making that seems appropriate in regulatory settings and in public procurement, where contracting officers are caretakers of public funds.[2] Another advantage is that it is easy to understand and, perhaps for this reason, has been quite a popular alternative to the Bayesian framework.

Our second robustness criterion—requiring the incentive scheme not to be weakly dominated—seems uncontroversial. This criterion needs only be considered when there is a multiplicity of solutions to the minimax problem. Whether multiple solutions exist depends on the parameters of the problem and can be neatly characterized: if there is a unique FPCR solution, then this is the unique solution among all possible incentive schemes if and only if it always induces the agent to exert effort.

The finding of robustness supports the use of an incentive scheme which has seen some use in practice. Rogerson (2003) reviews the use of FPCR menus in regulation and has recommended their use in procurement contracts at the U.S. Department of Defense. FPCR menus may also be consistent with contracts that on the face of it are fixed-price contracts, but where there is an implicit guarantee that the provider will receive no less than a reasonable return for his efforts.

In the rest of this section, we provide a brief overview of related literature. Section 2 then introduces the model, Section 3 provides the analysis and results, and Section 4 concludes. Formal proofs are given in Appendix A.

1.1. Relationship to the literature

Several papers have analyzed solutions to Laffont and Tirole's model that are constrained to be simple. Reichelstein (1992) calculates the optimal menu of linear contracts when the number of contracts in the menu is limited. More recently, Rogerson (2003) and Chu and Sappington (2007) compare the performance of simple two-contract menus to the unconstrained solution. They suggest that simple menus may be preferable because the additional complexity of the unconstrained solution yields only small improvements, at least for a broad range of model parameters.[3] Whilst this provides one rationale for using simple schemes, the key contribution of this paper is to provide a rationale based instead on *fully-optimal* worst-case decision making.

There is also an empirical literature on cost-based procurement and regulation; see, e.g., Wolak (1994), Gasmi et al. (1997), Gagnepain and Ivaldi (2002) and Perrigne and Vuong (2011) and Abito (2012). Take, for example, Gagnepain and Ivaldi's study of the regulation of the French urban transport industry. Their study estimates the optimal regulatory policy as well as the gains from implementing this policy instead of the policies actually implemented by the local authorities. Derivation of the optimal policy relies on data on past performance and on functional form assumptions about preferences. The present work is probably best thought of as relating instead to an environment where good data on the agent's past performance is unavailable and where the contract designer is unwilling or unable to take a view on the functional form of the agent's preferences. Our results suggest that, in such environments, simple contracts may be preferable.

The FPCR incentive scheme can be viewed as a kind of "debt contract", since the agent becomes the residual claimant in case he is sufficiently successful at reducing the cost, and is effectively indemnified (i.e., has costs reimbursed) otherwise. There are other rationalizations of debt contracts in the literature, such as Innes (1990) who finds that debt contracts are optimal in the canonical moral hazard problem if the agent has limited liability and if the principal must be provided with incentives not to sabotage output. The present paper provides an alternative explanation why this kind of contractual form may arise based on worst-case decision making.

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[2] Indeed, public managers are often thought more likely to avoid risk than their private-sector counterparts (Boyne, 2002, reviews the empirical evidence).

[3] These kinds of comparisons can clearly be a useful tool in evaluating the "cost of simplicity" when designing incentive schemes in a range of settings. Another example is Bose et al. (2011), who, in a different environment, evaluate the cost of using linear piece-rate schemes compared to the fully-optimal non-linear schemes. These approaches, however, do not explicitly account for the uncertainty that may be inherent in contracting environments.