



When (and how) to favor incumbents in optimal dynamic procurement auctions[☆]



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ABSTRACT

We consider the problem faced by a benevolent government agency that procures in each of $T > 1$ periods an indivisible good from one of $N > 1$ firms. The procurement process is complicated by the superior information possessed by firms about their time-varying production costs and efficiency-enhancing efforts. We fully characterize the optimal dynamic procurement. To reduce firms' informational rents, the government introduces distortions along two dimensions: when selecting from which firm to procure the good *and* when providing incentives toward efforts in cost reduction. Both distortions interact in a non-trivial way. Firms that draw lower cost parameters in the *first* period are favored in the selection process in *all* later periods, which allows for the provision of more powerful incentives.

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1. Introduction

This paper considers the problem faced by a benevolent government agency that procures in each of $T > 1$ periods an indivisible good from one of $N > 1$ firms. The procurement process is complicated by the superior information possessed by firms about their time-varying production costs and efficiency-enhancing efforts over multiple periods. The government agency is thus concerned with designing a dynamic procurement process that elicits private information from firms and provides them with incentives to exert costly effort.

Based on a dynamic variant of the model in Laffont and Tirole (1987) where the firms' source of private information – their cost types – evolves according to an AR(1) process, we characterize the optimal dynamic mechanism focusing on the interaction between (i) the static procurements conducted across time and (ii) the two stages of a static procurement conducted within a time period,

namely the *selection stage* and the *effort-recommending stage*. At the selection stage, the government chooses from which firm to procure the good, whereas at the effort-recommending stage, the government proposes the level of effort that the selected firm should spend in cost reduction.

Across time, the selection stage of the optimal dynamic procurement has many interesting features. In the first period, the government agency auctions a bundled good: the right to produce in the first period coupled with the tilting of future selection processes in favor of those who report lower costs. By linking selection decisions across time, the government reduces the amount of informational rents it has to leave to the firms and lowers the expected lifetime costs of procurement. The introduction of favoritism, in later periods, to firms that reported lower types in the first period is not without costs. After the first period, the government often procures from a firm despite it not being the most efficient producer at that time. The selection process is thus ex-post inefficient. This is a manifestation, in our dynamic environment, of the conflict between efficiency and rent-extraction that is common in the mechanism design literature.

The effort-recommending stage is also a source of interesting dynamics. From the start, effort is below the efficient level. Furthermore, to minimize the temporal allocation of informational rents to firms while preserving their incentives for both effort and information revelation, the optimal procurement prescribes that the power of incentives increases over time, gradually approaching

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first-best. This result derives from (i) the assumption that the effect of a firm's initial productivity on its future productivity declines over time – cost parameters evolve stochastically according to AR(1) processes – and (ii) the fact that productive firms derive more informational rents under a high-powered incentive scheme than under a low-powered one.

Apart from separately analyzing the two stages of the procurement process, we study how they interact in a static procurement, at a given date. We show that by favoring firms who report lower types in the first period at the selection stage, the mechanism designer alleviates the downward distortion in recommended effort levels. Hence there is a non-trivial interaction between both distortions that the government introduces to reduce firms' informational rents. Put differently, in a dynamic setting, the government agency introduces a distortion in the *selection stage* to make recommended effort levels closer to first best levels in the *effort-recommending stage*.

These results are in contrast to the solution of a full-information procurement problem that serves as a benchmark. If production costs are publicly known, the government never finds it optimal to favor one firm over another; at each period, it procures from the firm with the lowest cost parameter at that date. And, because effort is observable and contractible, the producing firm exerts first best levels of effort in cost reduction and earns zero profits. In sum, in a dynamic procurement process with full information there are no linkages between the static procurements conducted across time, nor between the two stages of a static procurement conducted at a given date.

The distortions introduced by the government agency at an optimal mechanism are shaped by the informational rents that must be left to the firms in an incentive compatible mechanism. We find that, for a fixed selection procedure, informational rents increase (i) with the likelihood that a firm draws a low cost parameter in the first period and (ii) with the degree of persistence of the process that describes the evolution of the firms' cost parameters. Hence, more persistent technologies lead to larger departures from first best effort levels. Moreover, except for the special case in which types follow a random walk with drift, distortions at the selection stage become less pronounced over time, eventually vanishing.

We also consider a simple variant of the baseline model in which the government initially contracts with only one firm, but a new entrant arrives over time. We show that on average the optimal selection procedure favors the incumbent over the new entrant. When designing the mechanism, the government anticipates the possible arrival of a new firm and specifies the contingencies under which it might contract with it. From an ex-ante perspective, the government finds it costlier to provide incentives to the new entrant than to the incumbent. Nevertheless, we show that there are instances in which, despite having larger costs than the incumbent, the entrant is favored by being selected to produce at a given period.

Literature review

First and foremost our work relates to [Laffont and Tirole \(1987\)](#) and [Riordan and Sappington \(1987\)](#), who study static monopoly franchise auctions. They derive optimal mechanisms that entail ex-post distortions – in effort provision in [Laffont and Tirole \(1987\)](#) and in production in [Riordan and Sappington \(1987\)](#) – but that prescribe that the principal always contracts with the most efficient agent. By contrast, we find that the principal distorts the selection procedure in all periods but the first, shunning the firm that is most efficient at the present in favor of firms that were more efficient in the first period. As we see it, our main contribution is to extend [Laffont and Tirole \(1987\)](#) to a dynamic environment

in which types evolve stochastically over time. By doing so, we show that their dichotomy result, according to which the selection and effort-recommending stages do not interact, does not hold. More generally, we are also able to fully derive the way by which the distortions at the selection stage interact with those in the production stage.

[Baron and Besanko \(1984\)](#) and [Besanko \(1985\)](#) also study dynamic principal-agent problems. We share with them the assumption that private information varies over time. We depart from their analysis by studying the case of a principal who, at each point in time, contracts with one among many privately informed agents.

[Cisternas and Figueroa \(2014\)](#) consider a two-period procurement model, where the firm that produces the good in the first period can invest to reduce the cost of production in the second period. They find that, to promote more competitive bidding ex-ante, the mechanism designer introduces ex-post distortions by tilting the second-period procurement in favor of the incumbent. We also find that the designer of the mechanism distorts the selection process, but in our model, those distortions play a different role; they allow for more powerful incentives toward effort provision.

In terms of methodology, we use the first order approach to dynamic design problems first developed by [Baron and Besanko \(1984\)](#) and [Besanko \(1985\)](#), and extended and generalized by [Kapička \(2013\)](#) and [Pavan et al. \(2014\)](#). Our paper has similarities with [Kakade et al. \(2013\)](#) given that the optimal mechanism we derive for the case of a fixed number of firms is what they define as a virtual pivot mechanism. Our paper, however, differs in many aspects from the applications considered in [Pavan et al. \(2014\)](#) and [Kakade et al. \(2013\)](#). They consider a multiarmed bandit problem, or more specifically, the optimal mechanism for the sale of an indivisible good to potentially many buyers whose valuations change stochastically upon consumption. In turn, we consider the case in which cost parameters change every period for all firms, not just the producing one. This leads the mechanism designer to maximize an objective function that is fully separable over time; so the optimal mechanism solves a sequence of static decision problems. Our paper also differs from [Pavan et al. \(2014\)](#) and [Kakade et al. \(2013\)](#) in that we consider an environment in which the principal is concerned with inducing effort toward cost reduction from the selected firm. Last, we extend the main model to allow for potential entry.

Our work is also related to the many recent papers in applied dynamic mechanism design. Some examples are [Courty and Li \(2000\)](#), [Battaglini \(2007\)](#), and [Board \(2008\)](#) for dynamic sales problems, [Esó and Szentes \(2007\)](#) for dynamic auctions, and [Garrett and Pavan \(2012a\)](#) for seniority based remuneration schemes. Among those papers, [Garrett and Pavan \(2012b\)](#) is the most similar to ours. They derive a firm's optimal firing and retention policy toward a CEO with privately known ability. In their setting, upon firing an incumbent CEO, the firm is randomly matched to a new one. From an ex-ante perspective, it is costlier to provide incentives to the replacement CEO, so the optimal mechanism entails excessive and inefficient retention of the incumbent. In our main model, because the government agency interacts with the same set of firms over time, the opposite holds: from an ex-ante perspective, informational rents are perceived as less costly regardless of the firm that is selected to produce. Therefore, the selection rule becomes closer to the efficient one as time unfolds. When we extend the model to allow for potential entry, we derive results that are similar to theirs: just as boards become more lenient regarding replacement decisions in their setup, in ours the government agency adopts a selection rule that is more lenient toward the incumbent.

Previous papers also study favoritism in procurement. [Branco \(1994\)](#) and [Vagstad \(1995\)](#) show that a government that

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