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ABSTRACT

We take issue with the fundamental privatization theorem of Sappington and Stiglitz, which asserts that a government contracting-out auction can be -- and by implication, should be -- designed to maximize output while simultaneously extracting all contractor rent. We demonstrate through a model that accepts the possibility of contractor deception that welfare can be enhanced by permitting the contractor to retain some of the rent.

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The incentive contracts literature takes off from an admitted principal-agent conflict resulting from asymmetric information, opportunistic behavior, and monitoring costs (see, for example, Sappington, 1991). It searches for an efficient incentive structure, defined as one that will maximize output while simultaneously extracting the agent's rent. This thesis, applied by Sappington and Stiglitz (1987; henceforth S-S) to the government contracting out scenario as "the fundamental privatization theorem," asserts that, at least conceptually, an efficient auction process can be designed that will be analogous to an efficient incentive structure. Admittedly, this auction process breaks down in reality for numerous reasons (Sappington and Stiglitz, 1987: 570f; Sappington, 1991: 48-49): Contractors are risk-averse, the parties have asymmetric reactions to gains versus losses, some information gaps are unanticipated and unresolvable, and the presence of principal-agent conflicts that are internal to both the government authority and the contracting firm.

We take issue with this fundamental theorem by constructing a scenario in which the government can choose among contractors. We prove that choosing the lowest-cost supplier but permitting the contractor to earn some rent benefits the contractee as well as the contractor. We follow Toma and Toma (1992) in allowing agent deception: The contractor may produce less than called for. But our point is not that the fundamental S-S theorem assumes zero monitoring costs. Instead and in contrast to the incentive contract literature and S-S, we suggest that in the presence of uniform monitoring costs, not extracting the last penny of rent is welfare-enhancing. Our objectives are two: (1) to formulate contracting-out decision rules under conditions of uncertainty that explicitly take into account monitoring costs, and (2) to demonstrate via the contracting criteria the truth of our proposition.

A government agency, now producing a given service, must decide whether to continue in-house supply or to contract out.[1] We seek to determine its decision rule under the following assumptions:

1. *The contractor is more risk-averse than the contract writer.* Typically the contract writer is a public entity or a business firm and therefore we shall assume with no loss of generality that it is risk-neutral.

2. *The contractor will receive a fixed payment (α) per unit, which may have been determined by auction or negotiated among the parties, for an agreed-upon quantity of output (y).* This assumption of a linear payment function come to simplify the definition of a contract as a set of three fixed parameters (y, α, t).[2]

3. *The contractor produces y at a lower per-unit cost (c) than does the government (g).* A fundamental assumption of this paper is that production and monitoring costs can be easily separated in the case of contracting out, but cannot be distinguished when the service or the product is provided by the government. Hence even though the government's fixed marginal cost of production, g, might include such costs as self-monitoring, the contractor's fixed marginal cost of production, c, are purely production costs. This distinction stems from a simple institutional fact: In the case of contracting out, the functions of production and monitoring are handled by two different parties, while under government production, one authority is responsible for both functions.

4. *The government, however, realizes the possibility of opportunistic contractor behavior, and so undertakes monitoring costs (m) to reduce the possibility of cheating.* With p to denote the probability of discovering cheating, we assume that m(p) is a

[1] The use of the government as the contractee is a matter of convenience. The analysis applies equally well to a private firm considering contracting out one of the products or services it presently produces.

[2] The parameter t is defined below in 5.

monotonic increasing function of p with increasing rates and m(0) = 0.[3]

5. In addition, *a penalty administration mechanism with costs, k, will impose a penalty rate (t) should deception be detected.* These costs and fines are determined by government and known in advance by the contractor. We assume the conventional assumptions that k is a monotonic increasing function of t with increasing rates and k(0) = 0. The penalty rate is proportional to the discrepancy between contracted output and actual output (x). Here again, linearity of the penalty function is assumed for simplicity.

Some restrictions have to be imposed on the parameters of the model in order to develop a meaningful and non-trivial criterion for contracting out. The following inequalities will be assumed to hold:

a. $1 > g > \alpha > c > 0$

b. $1 > t > c > pt > 0$

Some of these inequalities have a straightforward interpretation and some will be clear during the following analysis. For instance, no contractor will undertake a government project if he or she can't cover the production expenses by suitable compensation, i.e. if $c > \alpha$. If $g < \alpha$, then contracting out is less efficient even if $x = y$. If $t < c$, the penalty has no deterrent effect.

We begin with a given contract (y, α, t). For given costs (g, c), and for a given probability of identifing cheating (p), the government will contract out if and only if the following inequality holds:

[3] Bruno Frey (1993) has observed that increased monitoring may be perceived as distrust and hence may engender an inverse, "crowding out" effort by the agent. Our monitoring costs, m, capture this effect as well.

$$(1-p)[x-\alpha y-m(p)-k(t)]+p[x-\alpha y-m(p)-k(t)+t(y-x)] \quad > \quad y(1-g)\ . \tag{1}$$

In other words, government production leads to a net benefit of y(1 - g), the difference between its desired output and its total cost. When it contracts out, on the other hand, it faces a contractor who may deliver a lesser quantity or quality, x, instead of y and who may not be detected. Hence, the costs of inducing contractor compliance, m and k, must also be taken into account when calculating the desirability of contracting out. In short, the government must balance its higher production cost against the uncertainty and so the costs of obtaining similar output quantity and quality from a contractor.

With some manipulation, (1) can also be written as:

$$y(g - \alpha) > m(p) + k(t) + (y - x)(1 - pt) \tag{2}$$

In other words, the government will contract out if and only if its production savings [the LHS of (2)] sufficiently overwhelms its deterrent costs (m + k) and the anticipated loss of production through undetected contract violation [(y - x)(1 - pt)].

Turn first to a contractor, who is offered a contract with specific parameters (y, α, t) and is presumed to maximize expected utility w.r.t. x, where

$$\pi = (1 - p)U(\alpha y - cx) + pU[\alpha y - cx - t(y - x)]\ . \tag{3}$$

The FOC of optimizing (3) w.r.t. x is:

$$\frac{d\pi}{dx} = (1 - p)U'(\alpha y - cx)(-c) + pU'[\alpha y - cx - t(y - x)](t - c) = 0 \ . \quad \textbf{(4)}$$

The first term on the RHS of (4) is negative and the second term, by assumption b, is positive. Hence we assume the existence of a unique regular interior solution, x^*, such that $0 < x^* < y$.

x^* is a function of p and t. The reaction function of the contractor, $x^*(p, t)$ is assumed to be taken into account by the government when offering the contract. Now, if the government anticipates an honest contractor, so that $x = y$, then it would incur no monitoring outlays nor will it collect any penalties. When $p = t = 0$, the LHS of (1) equals $y(1 - \alpha)$, and by assumption (a), the government benefits by contracting out. Alternatively, the RHS of (2) equals zero and by assumption (a), the LHS of (2) is positive. If these expectations are borne out, then $\pi = U[y(\alpha - c)]$. (Note that by assumption (a), $y(\alpha - c)$ is positive.)

When the contractor is risk-averse, the SOC holds globally, i.e.,

$$\frac{d^2\pi}{dx^2} = (1-p)U''(\alpha y - cx)(-c)^2 + pU''[\alpha y - cx - t(y-x)](t-c)^2 < 0 \ . \quad \textbf{(5)}$$

Moreover, it turns out that the contractor's risk aversion in the neighborhood of x^* is a necessary property for the optimality of an interior solution.

Now we turn to comparative statics analysis of x^* w.r.t. p and t. Denote $V = d\pi/dx$. Since by (4), dV/dx is negative and since $\partial x/\partial z = -(\partial V/\partial z)/(dV/dx)$, then: sign $\partial x/\partial z$ = sign $\partial V/\partial z$.

$$\frac{\partial V}{\partial p} = U'(\alpha y - cx)c + U'[\alpha y - cx - t(y - x)](t - c) \tag{6}$$

$$\frac{\partial V}{\partial t} = pU'[\alpha y - cx - t(y - x)] - pU''[\alpha y - cx - t(y - x)](t - c)(y - x) \quad . \tag{7}$$

By assumption (b), (6) is positive and thus $\partial x/\partial p > 0$. Since $U'' < 0$, $\partial V/\partial t > 0$ and thus also $\partial x/\partial t > 0$. These results assure that the penalty rate, t, and the probability of detecting a cheater (p) really serve as deterrents.

Now given its expectations of the contractor actions, the objective of the government is to optimize

$$\underset{p,t}{\text{Max}} \quad (1-p)[x - \alpha y - m(p) - k(t)] + p[x - \alpha y - m(p) - k(t) + t(y-x)] \tag{8}$$

s.t. $x \in \text{argmax}\ \pi$. More compactly,

$$\underset{p,t}{\text{Max}} \quad [x^*(p, t) - \alpha y - m(p) - k(t)] + pt[y - x^*(p, t)] \quad . \tag{9}$$

The FOCs yield

$$\frac{\partial x^*}{\partial p}(1 - pt) + t(y - x^*) = \frac{dm}{dp} \tag{10}$$

$$\frac{\partial x^*}{\partial t}(1 - pt) + p(y - x^*) = \frac{dk}{dt} \tag{11}$$

The RHS and the LHS of (10) and (11) are respectively the marginal costs and the marginal revenues of the deterrents, p and t. The inequalities

$$\frac{\partial^2 x}{\partial p^2} < 0, \quad \frac{\partial^2 x}{\partial t^2} < 0, \quad \frac{d^2 m}{dp^2} > 0, \quad \text{and} \quad \frac{d^2 k}{dt^2} > 0$$

are necessary conditions for the SOCs to hold.

The optimal deterrent means the p* and t* chosen by the government are solved from (10) and (11) and inserted into x*(p, t), the optimal solution derived from (4). Then all the values p*, t* and x*(p*, t*) are substituted into criterion (1) or (2) to determine whether or not to contract out. In order to better illustrate this decision process and in order to express (2) in more explicit terms, we shall use now the following Taylor approximation:

$$f(z) \approx f(z - \theta) + \theta f'(z - \theta) \quad . \tag{12}$$

Letting $f = U'$, $z = \alpha y - cx$, and $\theta = t(y - x)$, rewrite (4) as

$$\frac{d\pi}{dx} = (1 - p)f(z)(-c) + pf(z - \theta)(t - c)$$

$$= -cf(z) + ptf(z - \theta) + cp[f(z) - f(z - \theta)] \; .$$

Use (12) to find that

$$\frac{d\pi}{dx} \approx (-c)f(z - \theta) - c\theta f'(z - \theta) + ptf(z - \theta) + cp\theta f'(z - \theta)$$

$$= (pt - c)f(z - \theta) - c\theta(1 - p)f'(z - \theta)$$

$$= f(z - \theta)\left\{\frac{-f'(z - \theta)c\theta(1 - p)}{f(z - \theta)} - (c - pt)\right\} = 0 \; .$$

Note that

$$R = -\frac{f'(z - \theta)}{f(z - \theta)} = -\frac{U''[\alpha y - cx - t(y - x)]}{U'[\alpha y - cx - t(y - x)]}$$

is the Arrow-Pratt measure of absolute risk aversion.

Thus, the FOC yields: $Rct(y - x)(1 - p) = c - pt$ or

$$y - x^* = \frac{c - pt}{Rct(1 - p)} \; . \qquad \textbf{(13)}$$

$c > pt$ is a necessary condition for x^* to be an interior solution.

It is easy to discover that $\partial(y - x^*)/\partial p < 0$, $\partial(y - x^*)/\partial t < 0$, and $\partial(y - x^*)/\partial R <$

0. Substitute $\partial x^*/\partial p = (t - c)/[Rct(1 - p)^2]$ and $\partial x^*/\partial t = 1/[Rtz(1 - p)]$ in (10) and (11) to discover

$$p^2t^2 - c(1 - t) + t(1 - 2p) = Rct(1 - p)^2\frac{dm}{dp} \tag{10'}$$

$$-p^2t^2 + c = Rct(1 - p)\frac{dk}{dt} \tag{11'}$$

For specific functions m(p), k(t) one can solve for p* and t*.

Now substitute (13) into (2) to find that the condition for the government opting to contract out becomes

$$y(g - \alpha) > m(p^*) + k(t^*) + \frac{(c - p^*t^*)(1 - p^*t^*)}{Rct^*(1 - p^*)} > 0 . \tag{14}$$

In short, the government opts to contract out only when its production savings, $y(g - \alpha)$, exceed its optimal monitoring expenses (m) plus its optimal fine collection costs (k) plus the expected loss stemming from undetected cheating, taking into account the risk aversion of the contractor. The advantage of (14) over (2) lies in its explicitly demonstrating the vital role played by the contractor's attitude toward risk, R.

That, itself, is a conclusion that needs to be emphasized. Privatization advocates continually stress the greater efficiency of private sector production over public sector supply. But given opportunism, which presumably is significantly less under government production than under private sector supply, and hence the need for government to introduce prophylactic measures against deceptive contractor actions, these costs must be added when balancing out public versus private production.

To return to our initial point, however, namely, that government should not extract the last iota of rent from the contractor even when such a possibility exists, consider again (14). Note that $[\partial(y - x^*)/\partial c] > 0$. Now a more efficient contractor ($dc < 0$) is also one less inclined to shirk ($dx^* > 0$), since its profits are greater and its potential loss from being detected are correspondingly greater. Removing that prospective gain by devising a more confiscatory auction scheme, however, simultaneously reduces the contractor's incentive to be more honest.

This point can be emphasized by rewriting (2), the contracting-out criterion:

$$y(g - \alpha) > m(p^*) + k(t^*) + (y - x^*)(1 - p^* t^*) \quad . \tag{15}$$

The derivative of the RHS of (15) w.r.t. c yields

$$\frac{\partial(y - x^*)}{\partial c}(1 - p^* t^*) > 0 \quad .$$

Hence, if c is smaller, then even if α remains the same, the incentive to contract out increases.

This argument also justifies a practice that is more common among private contracting arrangements than among public outsourcing, where transparency plays a more critical role. (Prager, 1992). Public authorities are often mandated to accept the lowest bid unless evidence of inadequate or illegal past performance is produced. Our model suggests that reputation and R, the risk aversion propensity of the contractor, which might be detected by experience and track record, should play a role in the contracting out decision. Awarding a project to a contractor with an unknown track record but with lower costs is not necessarily more efficient than granting the contractor to a firm with higher costs but a more solid record of past performance.

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