REDUCING GOVERNMENT SPENDING WITH PRIVATIZATION COMPETITIONS: A STUDY OF THE DEPARTMENT OF DEFENSE EXPERIENCE

Christopher M. Snyder, Robert P. Trost, and R. Derek Trunkey*

Abstract—In a privatization competition, private contractors bid against an in-house team to perform a governmental function that is currently performed by the in-house team. The Department of Defense initiated 3,500 privatization competitions from 1978 to 1994, generating estimated annual savings of $1.46 billion. We estimate a reduced-form model of the savings from these competitions that takes into account the premature cancellation of some competitions and the censoring of the in-house bid at current cost. The Department of Defense maintains a list of candidates for future privatization competitions. Using our model, we forecast annual savings of $5.74 billion if privatization competitions were completed for all functions on this list.

I. Introduction

THE theoretical literature provides two approaches to reducing the cost of the government provision of goods and services. One approach (Rose-Ackerman, 1986; Tirole, 1994) is to implement incentive systems, eliciting greater effort from existing government employees by rewarding superior performance. Another approach (Hart, Shleifer, & Vishny, 1997; Laffont & Tirole, 1993; Schmidt, 1996) is to privatize some of the agency's functions, an approach which would be particularly successful if private ownership exhibited inherent organizational advantages. A third approach, involving what we will refer to as a *privatization competition,* has received little attention in the theoretical literature, although it potentially combines the benefits of incentives and privatization. In a privatization competition, the supply of goods or services to the government by an in-house team (that is, consisting of government workers) is opened up for competition with outside contractors. It differs from straight privatization in that the in-house team also participates in the bidding. The supply of the good or service is privatized if an outside contractor submits a lower bid than the in-house team. Even if the in-house team wins the bid, although there is no privatization, the potential for cost savings still exists because the in-house team's bid may be lower than its previous cost of provision.

In this paper, we provide an analysis of privatization competitions undertaken by the Department of Defense (DoD) as part of its participation in a larger federal government initiative. Our data consists of the entire set of privatization competitions initiated by the DoD: more than 3,500 during the period 1978–1994, involving 145,000 personnel, resulting in estimated annual savings of $1.46 billion. (All figures are in FY 1996 dollars.) Constructing a reduced-form model of the determinants of savings is complicated by a censoring problem (the requirement that the in-house team not use the competition as an opportunity to bid more than its current cost means that savings was censored at zero) and a selection problem (some competitions were canceled prior to completion). We address these problems by building a reduced-form model with multiple nested levels.

We find evidence of scale economies in that the elasticity of savings with respect to the size of the competed function is significantly greater than unity. In spite of this, the probability of the premature cancellation of a competition is increasing in size, suggesting that the parties responsible for the cancellation decision may have taken factors besides savings into account, such as the social cost of job displacements. The same pattern occurs with some other explanatory variables as well.

The more than 3,500 functions that constitute our data set are a fraction of the inventory of functions maintained by the DoD as candidates for future privatization competitions. Over 13,000 functions were in this inventory as of 1995, employing over 380,000 military and civilian personnel. Using the estimates from our empirical model, we forecast that completing privatization competitions for all of these functions would generate $5.74 billion of annual savings for the DoD.

There is a growing empirical literature on the relative efficiency of public versus private firms in a variety of industries.[1] Although the existing evidence on the benefits of privatization is mixed,[2] we find large savings from privatization competitions, due in part to the fact that a

Received for publication July 29, 1997. Revision accepted for publication February 9, 2000.

* George Washington University, George Washington University, and The CNA Corporation, respectively.

We are grateful to G. S. Maddala, David Ribar, the editor Robert Pindyck, and two anonymous referees for helpful comments. We are grateful to Christine Baxter, Jane DeWinter, Angela King, Rachel Lee-Leviten, and Kevin Shaw for research assistance. The conclusions expressed herein do not necessarily represent the views of the CNA Corporation. We retain responsibility for errors.

[1] Teeples and Glyer (1987) and Bhattacharyya, Parker, and Raffiee (1994) analyze water distribution; Hollas and Stansell (1994) analyze natural gas distribution; Kwoka (1996) and Kumbhakar and Hjalmarsson (1998) analyze electricity distribution; Kwoka (1993) and de Boer and Evans (1996) analyze telecommunications; Eckel, Eckel, and Singal (1997) and Erlich et al. (1994) analyze airlines; and Savage (1993) analyzes local buses. Borcherding, Pommerehne, and Schneider (1982), Boardman and Vining (1989), and Vickers and Yarrow (1991) analyze a cross section of industries and countries.

[2] Some studies provide evidence in favor of public ownership: for example, Kwoka (1996) finds that cost levels are lower with municipally owned rather than investor-owned electric utilities. Teeples and Glyer (1987) find no significant cost differences between public and private systems for water delivery and suggest that the preferred ownership type may depend on regional characteristics. Other studies provide evidence in favor of private firms: for example, Erlich et al. (1994) find that the productivity growth for privately owned international airlines is faster than for state-owned ones.

The Review of Economics and Statistics, February 2001, 83(1): 108–117

privatization competition is not simply a mechanism for changing a supplier's ownership. It has the additional effect of enhancing the incentives of the in-house team (our analogy to the publicly owned firm) even if the in-house team turns out to be the most efficient supplier. Privatization competitions are particularly useful for the type of function that is studied in the present paper (namely functions that are similar to work done in the private sector by outside contractors) because they are likely to generate highly competitive bidding. Bidding may be less competitive for functions that require large sunk investments that are specific to the transaction, which is characteristic of many of the functions analyzed in the studies cited in footnote 1. Even with these, however, privatization competitions may be more efficient than either maintaining public ownership or straight privatization.

We are aware of only one other analysis of privatization competitions (Carrick, 1988). His sample includes 1,700 privatization competitions in various nondefense agencies of the U.S. government. His analysis is largely descriptive, whereas one of our main focuses is the development of an econometric model that is useful for forecasting savings from future competitions.

II. A-76 Competitions

In 1955, the Office of Management and Budget implemented the Commercial Activities (CA) program to encourage private provision of certain government functions. The program evolved over time and by the 1970s involved privatization competitions in which outside contractors bid against the government agency's in-house team to supply the agency with a good or service, rather than straight privatization. The privatization competitions have come to be called *A-76 competitions* after the publication containing the rules for conducting them (*OMB Circular A-76*).

As part of its participation in the CA program, the DoD annually constructs a list of those functions that could potentially be subject to A-76 competitions. In 1995, this list, or *CA inventory,* contained more than 13,000 functions. Between 1978 and 1994, the DoD initiated A-76 competitions for a small subset (4,311) of its CA inventory, 2,195 of which were carried through to completion. According to the competitions' rules, bids from the in-house team and private contractors were compared on a cost basis alone (with no allowance, for example, for contractor reputation or expectations regarding service quality), and the in-house team was afforded a 10% bidding advantage.[3]

We are interested in determining the savings due to an A-76 competition, that is, the difference between the baseline cost of the function involved (the cost of performing the function in-house prior to the competition), C^0, and the winning bid, C^*. Unfortunately, C^0 is not recorded in the DoD's data. The DoD does record *baseline billets*—the number of personnel, both military and civilian, employed in the function by the in-house team prior to the competition—denoted L^0. As part of its bid, the in-house team submits both the cost at which it will perform the function if it wins, C^I, and the number of billets it will employ, L^I. Both are recorded by the DoD. Assuming that the in-house team's costs are proportional to the number of personnel employed in the function, $C^0/C^I = L^0/L^I$. Rearranging produces our estimate of baseline cost: $\hat{C}^0 \equiv C^I L^0/L^I$.

The proportionality assumption is justified if the production function for the good or service is Leontief. Otherwise, $\hat{C}^0$ will be an imperfect proxy for the true baseline cost. In practice, in an effort to preserve personnel while cutting cost, the in-house team may reduce the capital it uses, substituting greater effort from each of the retained employees. If so, $C^0/C^I > L^0/L^I$, which implies that $\hat{C}^0 < C^0$, which in turn implies that our proxy of cost savings, $S \equiv \hat{C}^0 - C^*$, would be a conservative bound on true cost savings, $C^0 - C^*$.

The data set that we employ in the remainder of this paper is a cleaned version of the DoD's records of the A-76 competitions that were conducted between 1978 and 1994. The final data set has 3,548 competitions, of which 2,126 were completed and 1,422 were cancelled.[4] Although the completed competitions in the data set represent only a fraction of the larger CA inventory, they still were economically significant, involving nearly 80,000 billets.

Table 1 presents summary statistics for the data set. Because the contracts involved in the A-76 competitions were multiyear (usually five years, but with some variation), we express savings on an annual basis, dividing the savings that result from a competition by the contract length. We use the DoD price deflator (described in *National Defense Budget Estimates for FY 1996*) to express savings (and all other monetary values) in FY 1996 dollars. The last row of the table shows that the DoD has experienced $1.46 billion in annual savings from the completed A-76 competitions in our data set. This is an average savings of 31% of the baseline cost ($\hat{C}^0$) of performing the functions involved in the competitions. Approximately 60% of the initiated competitions were completed. The average completed competition involved 38 billets, 22% of which were military. Half of

[3] Williamson (1976) provides an efficiency rationale for an incumbent bidding advantage involving the protection of its specific investments. Laffont and Tirole (1993) show that this conclusion depends on whether the incumbent's investment is transferable. In practice, other reasons for offering an incumbent bidding advantage might include lessening government workers' opposition to the CA program or avoiding transition costs for small savings.

[4] Of the 4,311 initiated competitions, we dropped 457 that were rebundled (that is, either consolidated with other functions or "broken out" into a number of separate ones) and returned to the inventory to be subjected to an A-76 competition later. We dropped 91 observations labeled "in progress" at the end of 1994, 260 observations missing vital data, 65 observations involving an expansion beyond the baseline function (as evidenced by L^I exceeding L^0), three observations having an outside contractor winning with a higher bid than the in-house team (which is impossible according to the A-76 rules), and one observation having an obvious typographical error.

TABLE 1.—SUMMARY STATISTICS FOR A-76 COMPETITIONS

	Full Sample of Initiated Competitions			Subsample of Completed Competitions						
	Number	Total Billets	Percentage Military	Number	Percentage Won In House	Percentage with No Savings	Total Billets	Percentage Military	Total Savings	Percentage of Baseline
By size (number of billets)										
1–10	1,379	7,539	12.7	857	62.1	58.3	4,764	11.0	76.4	22.8
11–50	1,554	36,339	13.2	936	60.2	42.5	21,549	11.2	380.6	29.5
51–100	292	20,196	12.2	178	61.0	47.2	12,370	13.3	191.9	29.4
101–150	122	14,675	16.2	56	45.9	53.6	6,638	17.0	125.2	30.1
151–200	65	11,357	13.5	33	50.8	54.5	5,778	11.8	103.9	29.5
More than 200	136	55,024	28.7	66	48.5	33.3	28,564	38.2	583.7	36.2
By function type										
Installation Services	968	44,496	10.1	673	69.5	54.1	28,119	10.1	515.0	30.1
Social Services	376	14,163	11.9	234	62.2	20.5	4,245	12.4	68.2	36.6
Health Services	114	2,595	26.8	31	27.2	77.4	518	19.5	4.1	14.9
Intermediate Maintenance	245	28,433	35.7	162	66.1	41.4	15,731	45.7	285.2	33.3
Depot Maintenance	29	2,067	0.1	9	31.0	100.0	555	0.0	4.8	14.6
Real Property Maintenance	444	16,921	6.0	320	72.1	45.9	10,715	8.3	209.2	29.5
Research Support	29	1,759	50.9	12	41.4	25.0	984	76.2	68.0	46.5
Training	56	3,229	66.8	8	14.3	50.0	1,232	91.9	21.4	36.9
Data Processing	265	6,762	12.5	95	35.8	56.8	2,153	14.3	22.9	25.2
Other Nonmanufacturing	1,022	24,705	24.2	585	57.2	57.0	15,411	22.9	258.1	31.2
Total	3,548	145,130	19.2	2,126	59.9	49.5	79,663	21.7	1,456.9	31.4

Percentage military is the percentage of billets in the category that are military rather than civilian. Savings, estimated as stated in the text, is measured in millions of FY1996 dollars annually. Percentage of baseline is the savings as a percentage of baseline cost.

the completed competitions were won in-house, and more than three quarters resulted in positive savings.

The summary statistics by size category—wherein the size of a competition is the number of baseline billets—show that the completion rate declined with size, although, conditional on completion, the percentage with positive savings increased with size. Outside contractors were more likely to win the largest competitions. The summary statistics by function type exhibit large differences in both savings and completion rates across types.

Before turning to the formal econometric model in the next section, we can use the raw data to disentangle the sources of savings from A-76 competitions. If the competition is won by a private contractor, savings from privatization are generated. Privatization can generate savings to the extent that private provision is inherently more efficient than is public. Even if private contractors draw their technology from the same distribution as the in-house team, the fact that the winning contractor bid is the minimum of a number of bids may produce savings. If the competition is won by the in-house team, savings may still be generated in the form of savings from competition. The threat of losing to private contractors may lead the in-house team to submit a lower bid than baseline cost, and cost reductions can come from elimination of waste, innovation, or diminished quality.

Our measure of the realized savings from competition is computed by adding up the savings from competitions won by the in-house team and dividing by total savings from all completed competitions. By this measure, 24% of the savings can be attributed to competition and the rest, 76%, to privatization. This measure may understate potential savings from competition, by which we mean the thought experiment of having all parties bid as if the in-house team could lose the function to private contractors, yet the function is retained in-house regardless of the ranking of the bids. Defined in this way, potential savings from competition can be computed by summing the difference between baseline cost and the in-house bid for all completed competitions. By this measure, 64% of the total can be attributed to the potential savings from competition.[5]

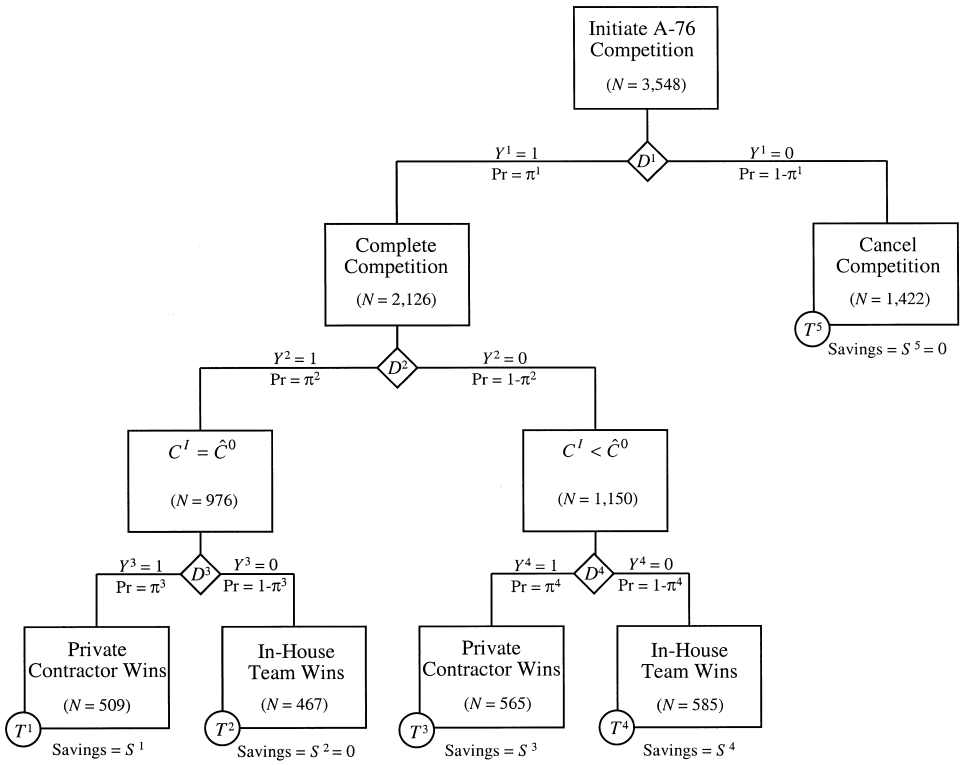
III. Model

One feature of the data that requires careful modeling is that 40% of the 3,548 initiated competitions are canceled prior to completion. We are interested in characterizing the cancellation/completion decision so that we can estimate the extent to which savings is reduced by cancellation. We are also interested in determining whether cancellation imparts a selection bias in regressions run on the 2,216 completed competitions alone.

A second feature of the data is that savings is censored at zero for completed competitions. The censoring is due to the A-76 rule constraining the in-house team to bid no more than its baseline cost, a rule which precludes negative

[5] The residual, 36%, does not necessarily measure the potential savings from privatization—the savings experienced if the in-house team were removed from the bidding process entirely—because the two potential savings figures need not sum to 100%. To calculate the potential savings from privatization, one would begin by taking the difference between baseline cost and the minimum private contractor bid. The result would be an overestimate because the presence of the in-house team causes private contractors to bid more competitively than they would in its absence, although one cannot tell how much of an overestimate from the raw data alone.

FIGURE 1.—MODEL OF A-76 COMPETITION SAVINGS



savings. The censoring problem is more complicated than usual because two conditions must jointly be met in order to produce zero savings: the in-house team's unconstrained bid must exceed baseline cost, and the private contractors must bid so high that they lose to the in-house team. A savings equation that does not account for this censoring problem will be biased whether it is run on the whole sample of 2,216 completed competitions or if it is run on the subsample of 1,659 competitions producing positive savings.

We address these two data problems by estimating the nested model depicted in figure 1. The diamonds (D^j, $j = 1, \ldots, 4$) are referred to loosely as "decision nodes" and the boxes marked with circles (T^j, $j = 1, \ldots, 5$) as "terminal nodes." Node D^1 represents the decision to cancel or complete the competition for a given function i. If the competition is completed, node D^2 is reached. If the competition is cancelled, terminal node T^5 is reached. Obviously, zero savings is produced in that event. Node D^2 represents the decision of the in-house team to bid at baseline cost ($C_i^I = \hat{C}_i^0$) or below it ($C_i^I < \hat{C}_i^0$). Depending on the outcome at node D^2, either node D^3 or D^4 is reached. In either event, there are two possibilities: the private contractor wins the competition, or the in-house team does. This leads to the four terminal nodes T^1, T^2, T^3, and T^4. Conditional on completion, zero savings is realized only at node T^2, where the in-house team bids its baseline cost and the in-house team wins the competition. Savings are positive for the other terminal nodes T^1, T^3, and T^4.

Our estimation strategy is to estimate independent probits for the decision nodes D^1, D^2, D^3, and D^4 and independent savings regressions for nodes T^1, T^3, and T^4. A potential problem in using this strategy is that the completion/cancellation decision may impart a selection bias in the savings equations. Suppose, for example, that the objective of the party making the completion/cancellation decision were to cut costs. Then, any unobservable factors (that is, unobservable to the econometrician) that lead the competition to generate high savings would make the decision-maker more likely to complete the competition. Conversely, if the decision-maker sought to minimize the job displacements caused by A-76 competitions, a completed competition would have been less likely to generate savings due to unobservable factors. To address this problem, we estimated a probit equation for the completion/cancellation decision jointly with a tobit savings equation.[6] This allowed us to estimate ρ, the correlation between the errors in the completion/cancellation equation and the savings equation, a measure of the selection bias due to cancellation. Our estimate $\rho = 0.095$ was not significantly different from zero at any conventional level. Therefore, the hypothesis of no selection bias cannot be rejected, so we proceed with the estimation strategy involving independent probits and savings regressions.

[6] The full set of results, omitted for space considerations, is available upon request from the authors.

Consider, first, the probit at nodes D^j, $j = 1, \ldots, 4$. Let $\tilde{Y}_i^j$ be a latent variable determining Y_i^j, the outcome of the decision for competition i. Assume

$$\tilde{Y}_i^j = z_i\alpha_i^j + \epsilon_i^j, \tag{1}$$

where z_i is a vector of explanatory variables, ϵ_i^j is a standard normal error, and

$$Y_i^j = \begin{cases} 0 & \text{if } \tilde{Y}_i^j \leq 0 \\ 1 & \text{if } \tilde{Y}_i^j > 0. \end{cases} \tag{2}$$

Consider, second, the savings regressions at the terminal nodes. By definition, savings are zero at terminal nodes T^2 and T^5. At terminal nodes T^j, $j = 1, 3, 4$, assume savings for competition i is given by

$$\ln S_i^j = z_i\beta^j + \nu_i^j, \tag{3}$$

where ν_i^j is a normal error. The log form for savings ensures that predicted savings will always be strictly positive for any values of z_i, required by definition for terminal nodes T^j, $j = 1, 3, 4$.

For tractibility—and as justified by the finding discussed above that ρ is not significantly different from zero—we assume that the errors ϵ_i^j and ν_i^j are independently distributed. The independence assumption simplifies the computation of expected savings. Let $\hat{\pi}_i^j$ be the predicted probability of moving left at decision node D^j conditional on the observables; that is, $\hat{\pi}_i^j \equiv E(Y_i^j|z_i)$. Given independent standard normal errors, $\hat{\pi}_i^j = \Phi(z_i\hat{\alpha}^j)$, where $\hat{\alpha}^j$ is a vector of coefficient estimates and Φ is the standard normal distribution function. Let $\hat{S}_i^j$ be the expected savings conditional on reaching terminal node T^j. Inverting the log in equation (3),

$$\hat{S}_i^j = \exp(z_i\hat{\beta}^j)\,\exp\left[\frac{1}{2}(\hat{\sigma}^j)^2\right]. \tag{4}$$

The second factor in equation (4), which is a function of $\hat{\sigma}^j$, the standard deviation of the residuals ν_i^j, adjusts for the fact that we are taking the expectation of the inverse of a logarithm, which is a concave function (See Greene (1990), p. 168.) Expected savings for an arbitrary function that is selected for an A-76 competition then is

$$\begin{aligned} E[S_i|z_i] = {} & \hat{\pi}_i^1\hat{\pi}_i^2\hat{\pi}_i^3\hat{S}_i^1 + \hat{\pi}_i^1(1 - \hat{\pi}_i^2)\hat{\pi}_i^4\hat{S}_i^3 \\ & + \hat{\pi}_i^1(1 - \hat{\pi}_i^2)(1 - \hat{\pi}_i^4)\hat{S}_i^4. \end{aligned} \tag{5}$$

The expectation in equation (5) incorporates the possibility that competition i may be canceled according to the historical pattern (and thus may produce no savings). We will also be interested in calculating the expected savings assuming no competitions are cancelled. This figure might be a better forecast of savings if the DoD decides to tighten the rules for cancellation (for example, by denying base commanders the discretion to cancel competitions). The expected savings for competition i conditional on its being completed is

$$\begin{aligned} E[S_i|z_i,\, Y_i^1 = 1] = {} & \hat{\pi}_i^2\hat{\pi}_i^3\hat{S}_i^1 + (1 - \hat{\pi}_i^2)\hat{\pi}_i^4\hat{S}_i^3 \\ & + (1 - \hat{\pi}_i^2)(1 - \hat{\pi}_i^4)\hat{S}_i^4, \end{aligned} \tag{6}$$

or, equivalently,

$$E[S_i|z_i,\, Y_i^1 = 1] = \frac{E[S_i|z_i]}{\hat{\pi}_i^1}. \tag{7}$$

Although there is a structure to our model as depicted in figure 1, the structure is designed to capture properties of the reduced-form savings variable rather than to estimate the distribution of primitive technological and preference parameters as in, for example, Laffont, Ossard, and Vuong (1995). Our reduced-form approach thus has several limitations. One cannot determine the mechanism through which the determinants of savings operate: a finding of scale effects, for example, would not indicate whether large competitions induce the participation of more bidders or more-intense bidding among given participants. More generally, one cannot determine the intensity of competition among private contractors in the form of estimated Lerner indices or conduct parameters. Further, one cannot forecast savings in the presence of structural shifts (for instance, entry of private contractors or changes in the A-76 competition rules). Yet, our approach allows us to derive robust estimates of the determinants of savings and robust forecasts of savings from future competitions under the null of no structural shifts—robust in that we do not need data on the number of bidders and their bids, homogeneity among the functions to be procured, or the correct specification of the in-house team's objective function.

IV. Estimation Results

Table 2 and 3 present the estimation results. The explanatory variables include a quadratic function of the number of billets (denoted previously as L^0), the number of military billets, a time trend, and fixed effects for service branches and function types.[7] We have included the unemployment rate and mean family income to proxy for local economic conditions, which might affect the productivity and costs of the bidding parties. We use 1990 Census data at the county level for these variables.[8]

[7] The fit in the savings regressions was much better with billets and military billets entering in log form, and we have adopted this functional form. The time trend ranges from one (if the function was proposed for competition in 1978) to seventeen (if proposed in 1994).

[8] We use the FIPS code area in which the relevant installation is located or the nearest area if the installation is located outside a FIPS code area. The unemployment rate is a fraction less than 1 and mean income is in thousands.

TABLE 2.—PROBIT RESULTS

	Node D^1		Node D^2		Node D^3		Node D^4	
	Coeff.	(Std. Err.)	Coeff.	(Std. Err.)	Coeff.	(Std. Err.)	Coeff.	(Std. Err.)
Constant	2.295**	(0.260)	1.568**	(0.322)	0.410	(0.446)	−0.661	(0.440)
Billets ($\times 10^2$)	−0.216**	(0.055)	1.320**	(0.113)	0.769**	(0.231)	0.245**	(0.089)
Billets^2 ($\times 10^4$)	0.018**	(0.007)	0.140**	(0.013)	−0.073*	(0.038)	−0.036**	(0.012)
Military Billets ($\times 10^2$)	0.089	(0.067)	−0.416**	(0.147)	0.993	(0.719)	0.313**	(0.102)
Time Trend	−0.125**	(0.007)	−0.095**	(0.010)	−0.019	(0.015)	−0.032**	(0.013)
Unemployment	−0.028**	(0.014)	−0.024	(0.018)	−0.022	(0.025)	0.011	(0.024)
Mean Income	−0.019**	(0.005)	−0.007	(0.006)	−0.008	(0.008)	0.008	(0.008)
Function-type dummies								
Social Services	0.317**	(0.097)	0.417**	(0.113)	0.670**	(0.149)	1.615**	(0.210)
Health Services	−0.876**	(0.145)	0.197	(0.243)	−1.027**	(0.382)	−0.417	(0.360)
Intermediate Maintenance	0.003	(0.105)	−0.031	(0.124)	−0.298*	(0.183)	0.522**	(0.163)
Depot Maintenance	−1.028**	(0.243)	−0.287	(0.501)	*a*		*a*	
Real Property Maintenance	0.094	(0.084)	−0.151	(0.098)	−0.013	(0.146)	0.137	(0.124)
Research Support	−0.366	(0.257)	−0.624	(0.463)	−0.413	(0.929)	0.721	(0.473)
Training	−1.731**	(0.230)	−0.676	(0.537)	*a*		−0.362	(0.619)
Data Processing	−0.922**	(0.097)	0.008	(0.149)	−0.144	(0.188)	0.121	(0.218)
Other Nonmanufacturing	−0.428**	(0.063)	−0.399**	(0.079)	−0.192*	(0.117)	0.021	(0.100)
N	3,548		2,126		971		1,144	
Percentage correctly predicted	72.3		68.4		64.1		61.8	
Log likelihood	−1,945		−1,249		−616		−720	

Omitted function-type dummy is Installation Services. Service dummies included but not reported.
[a] Predicted dependent variable perfectly, so omitted. As a result, five observations were dropped from the probit for node D^3 and six from the probit for node D^4.
* Significantly different from 0 at the 10% level.
** Significantly different from 0 at the 5% level.

A. *Completion/Cancellation Decision*

There is independent interest in analyzing the estimates from the probit for the completion/cancellation decision (node D^1) because the coefficients are readily interpretable and their estimates can be used to shed light on theories of privatization. (The estimates are given in the first column of table 2.)

The effect of an increase in the function's size (as measured by billets) on the probability of completion is decreasing over much of the relevant size range. The probability does not bottom out and begin to increase until a function employs more than 600 billets; fewer than 1% of the observations in the sample are this large. If the objective of the decision-maker were to realize large savings, we would expect larger competitions to be more likely to be completed. The result suggests, therefore, that the decision-maker's objective was not purely to maximize savings but perhaps included avoiding job displacement or keeping large, mission-critical functions in-house.

TABLE 3.—REGRESSION RESULTS

	Node T^1		Node T^3		Node T^4	
	Coeff.	(Std. Err.)	Coeff.	(Std. Err.)	Coeff.	(Std. Err.)
Constant	2.518**	(0.362)	3.437**	(0.527)	2.235**	(0.459)
Ln(Billets)	1.022**	(0.097)	0.545**	(0.164)	0.611**	(0.138)
Ln(Billets)^2 ($\times 10^1$)	−0.231	(0.177)	0.423*	(0.225)	0.422**	(0.205)
Ln(Military Billets)	0.081*	(0.044)	0.047	(0.033)	0.013	(0.035)
Time Trend	−0.016	(0.011)	0.000	(0.013)	−0.001	(0.012)
Unemployment	−0.002	(0.019)	−0.007	(0.025)	0.044**	(0.022)
Mean Income	0.005	(0.006)	0.015*	(0.008)	0.018**	(0.007)
Function-type dummies						
Social Services	0.037	(0.098)	−0.108	(0.159)	−0.369	(0.262)
Health Services	−0.093	(0.437)	−0.394	(0.472)	−0.675**	(0.268)
Intermediate Maintenance	−0.205	(0.151)	−0.004	(0.147)	0.029	(0.169)
Depot Maintenance	*a*		*a*		0.230	(0.367)
Real Property Maintenance	0.329**	(0.114)	0.126	(0.132)	0.025	(0.116)
Research Support	−0.028	(0.751)	−0.078	(0.345)	0.110	(0.611)
Training	−0.455	(0.527)	−0.615	(0.673)	−0.258	(0.437)
Data Processing	−0.725**	(0.167)	−0.390	(0.243)	−0.481**	(0.191)
Other Nonmanufacturing	−0.531**	(0.100)	−0.290**	(0.113)	−0.222**	(0.089)
N	509		565		585	
R^2	0.688		0.573		0.636	

Dependent variable is the natural log of savings, measured in thousands of FY1996 dollars on an annual basis. Omitted function-type dummy is Installation Services. Service branch dummies included but not reported.
[a] Dummy dropped because no observation fits category.
* Significantly different from 0 at the 10% level.
** Significantly different from 0 at the 5% level.

An increase in military billets increases the completion rate. This result is expected. On the one hand, assume that the decision-maker is interested in cutting measured costs. Note that military personnel are often shifted around among many functions during the course of their careers and may not have the skills of a civilian employee who specializes in that function. If so, large apparent savings might be produced if civilian billets are substituted for military as a result of a privatization competition, especially if savings are measured as we have here, namely, in proportion to number of billets.[9] This would incline the decision-maker to complete the competition for functions with a large percentage of military billets. On the other hand, assume that the decision-maker is interested in minimizing job displacement for government employees. The decision-maker might be more inclined to expose functions with a large percentage of military to A-76 competitions, knowing that the military employees will be guaranteed jobs elsewhere in government, whereas civilian employees might be forced out of government. Alternatively, in-house teams with a large civilian component might protest the completion of a competition more vigorously.

A competition's vintage, as measured by the time trend, strongly decreased its probability of completion. This result is indicative of the political climate surrounding the A-76, which became increasingly hostile by the end of the 1978–1994 period. Base commanders were given complete discretion over the cancellation decision, and those commanders who were not in favor of privatization competitions began cancelling competitions under their control. Congress introduced several provisions that evinced its waning enthusiasm for the competitions.[10]

The unemployment rate and mean income significantly decreased the probability of completion. As we will see, these results are at odds with later findings from the savings regressions: high levels of unemployment and mean income are associated with high savings, providing additional evidence that the party making the cancellation decision may have had objectives besides pure savings maximization. One explanation for the unemployment result along these lines is that unmeasured social costs of job displacements may be higher the higher is the local unemployment rate. One explanation for the mean income result along these lines is that workers in high mean income areas can exert greater political pressure to preserve jobs by cancelling competitions.

The coefficients on the function-type dummies show an interesting pattern. Installation Services (the omitted function-type dummy), Social Services, Intermediate Maintenance, and Real Property Maintenance have significantly higher completion rates than do Health Services, Depot Maintenance, Research Support, Training, Data Processing, and Other Nonmanufacturing. We will see later that this pattern is consistent with the savings results: function types exhibiting high completion rates also exhibit high savings. One explanation of the observed pattern of these coefficients is that the completion and savings rates are greater for functions that are commercial in nature rather than being specialized for military or combat purposes.[11] The more specialized the function for military or combat purposes, the more the military establishment might regard the function as essential and be reluctant to have a private contractor provide it. Furthermore, it is likely that private contractors would be less-competitive bidders the more specialized the function is for military purposes. This explanation is consistent with the fact that Installation Services and Real Property Management (categories which include such commercial functions as mowing and painting) and Social Services (which includes the operation of grocery stores and hotels) have higher completion rates than do Depot Maintenance and Training (which includes training in military skills). It is inconsistent with several other results, namely that Intermediate Maintenance (which includes maintenance of military equipment such as fighter planes) has a higher completion rate than do Health Services or Data Processing.

Hart, Shleifer, and Vishny's theory (1997) of the costs and benefits of privatization provides another explanation of the coefficients on the function-type dummies. Their theory suggests that the best candidates for privatization are functions whose nature can be easily specified in a contract. If noncontractible contingencies arise, the government and the agent providing the function are forced to renegotiate, which leaves both parties vulnerable to possible expropriation. This leads a private contractor to underinvest in quality and overinvest in cost reduction relative to the in-house team: the private contractor realizes gains from cost savings automatically but must negotiate with the government for a higher fee if it is to realize gains from quality improvement, leaving the private contractor's investment in quality improvement subject to expropriation.[12] According to this theory, the various maintenance functions, Installation Services, and Social Services should be good candidates for A-76 competitions, whereas functions whose output is harder to quantify (such as Health Services, Research Support, and Training) might not be. This might lead to a lower probability of completion for the latter function types.

[9] It should be emphasized that these savings might only be apparent because the opportunity cost might be lower for military than for civilian billets (true, for example, if military billets are temporary assignments between tours of duty).

[10] One specified that competitions must be cancelled if they could not be completed in a timely manner (within two years). The second was the moratorium on new competitions in the FY 1993 DoD Authorization Act.

[11] Because all functions must be classified as commercial to be subjected to A-76 competitions, the terms *commercial, military,* and *combat* in the preceding sentence are relative.

[12] An illustration of the difficulties of contracting, even for seemingly simple tasks, is provided by Marcus (1993): "Learning to write the specifications for the awards and penalties takes practice . . . at one base, a custodial contractor figured out that it was cheaper to pay the penalty than to take the time to clean window sills."

TABLE 4.—MARGINAL EFFECTS ON EXPECTED SAVINGS

Variable	No Cancellation		Historical Cancellation Rate	
	Marginal Effect	(Std. Err.)	Marginal Effect	(Std. Err.)
Continuous Variables (marginal effect = elasticity)				
Civilian Billets[a]	1.08**	(0.04)	1.05**	(0.04)
Military Billets[b]	1.43**	(0.10)	1.41**	(0.10)
Time Trend	0.08	(0.08)	−0.37**	(0.09)
Unemployment	0.12	(0.11)	0.04	(0.12)
Mean Income	0.54**	(0.19)	0.25	(0.20)
Dummy Variables for Function Type (marginal effect = percent change)				
Social Services	18.3	(12.7)	32.9**	(14.7)
Health Services	−57.9**	(14.2)	−76.8**	(8.7)
Intermediate Maintenance	3.0	(12.7)	3.1	(13.3)
Depot Maintenance	−17.0	(42.1)	−60.7**	(22.6)
Real Property Maintenance	22.9**	(10.2)	27.8**	(11.1)
Research Support	28.1	(48.6)	5.5	(44.0)
Training	−20.8	(32.1)	−85.2**	(9.2)
Data Processing	−39.6**	(9.6)	−68.1**	(5.8)
Other Nonmanufacturing	−19.9**	(5.7)	−36.1**	(5.0)

For the continuous variables, marginal effect is the percentage increase in savings from a 1% increase in the variable starting from the baseline (all continuous variables set at their means in the sample of 3,548 initiated competitions, service set to Navy, function type set to Installation Services).

For the dummy variables, marginal effect is the percentage increase in savings when the indicated dummy is set equal to one starting from the baseline case.

Standard errors computed by taking 1,000 draws from the joint distribution of coefficients, simulating the marginal effects for each draw, and calculating the standard deviation of the simulated marginal effects.

[a,b] To facilitate comparison, these marginal effects are computed as the percentage increase in savings from a 1% increase in total billets given that all additional billets are assumed to be civilian in case *a* and military in case *b*.

* Significantly different from 0 at the 10% level.

** Significantly different from 0 at the 5% level.

B. Results on Savings

Given the complexity of the nested model, it is difficult to read the effect of a variable savings directly from table 2 and 3. To facilitate the interpretation of the results, table 4 presents the marginal effect of an increase in various explanatory variables on expected savings, considering all estimated equations simultaneously.

Table 4 shows that savings are elastic with respect to the size of the function (size measured by employment). A 1% increase in billets, assuming the increase is purely civilian, leads to a 1.08% increase in savings, a figure which can be shown to be significantly greater than unity at the 5% level. If the 1% increase in billets is assumed to be purely military, the savings increase is much higher, 1.43%. These results show that there is a scale effect of size on savings: savings rises more than proportionately with size. In the previous subsection, we found that large competitions were more likely to be cancelled, which provides further evidence that the party making the cancellation decision may have had objectives besides maximizing savings from the privatization competitions. The results also show that larger savings are realized the higher the percentage of billets that are military prior to the competition's initiation. Military personnel might be less productive than civilian if their rotation from function to function at various bases deprives them of the opportunity to specialize in a function for which they have an aptitude. With either civilian or military billets, accounting for cancellation reduces the savings elasticity.

The time trend has little effect on savings, unless the prospect of cancellation is taken into account. There is no evidence, therefore, of the phenomenon of "cherry picking," wherein the candidates that generate the highest savings are selected for competition first, and increasingly poor candidates are left to be subjected for privatization competitions in later years. Cherry picking would be associated with a significantly negative marginal effect of the time trend. Once the prospect of cancellation is taken into account, there is a significantly negative marginal effect of the time trend: a 1% increase in the time trend reduces savings by 0.37%. Recasting this result in more-intuitive units, a one-year increase in the time trend from the mean reduces savings by 4.43%, which is entirely due to increased cancellation.

The marginal effects for the function-type dummies follow the pattern described above: readily contractible functions have higher completion and savings rates than others. Consider the last set of columns in table 4, which combine the savings and cancellation effects. Installation Services, Social Services, Intermediate Maintenance, and Real Property Maintenance—classes suggested earlier as involving readily contractible tasks—have significantly higher marginal effects than do Health Services, Depot Maintenance, Training, Data Processing, and Other Nonmanufacturing—classes suggested earlier as involving less readily contractible tasks.[13] These findings are consistent with Hart, Shleifer, and Vishny's (1997) theory.

V. Predicted Savings for CA Inventory

In this section, we use the model to predict the savings from subjecting all functions in the DoD's CA inventory to A-76 competitions. The DoD is considering a policy along these lines, so the calculations are of substantial practical relevance. Table 5 presents summary statistics on the 1995 inventory by size class and function type. The CA inventory involves 13,328 functions, employing over 380,000 personnel, 63% of which are civilian. The average function in the CA inventory involves fewer billets and a greater percentage of military billets compared to the sample of initiated A-76 competitions in table 1. The distribution of function types is relatively more even in the CA inventory. As large as it is relative to the number of A-76 competitions, many DoD functions that are commercial in nature are still excluded from the CA inventory.

Using the formula in equation (6), we find that the DoD would save $5.74 billion annually from subjecting the entire CA inventory to privatization competitions, if they forbid cancellation of competitions. To account for the variance of the estimated coefficients, we adopt a simulation methodology to compute the standard error, 0.52, for the savings

[13] The standard error for the Research Support marginal effect is too large for any firm conclusions to be drawn.

TABLE 5.—SUMMARY STATISTICS FOR CA INVENTORY

	Number	Total Billets	Percent Military
By size (number of billets)			
1–10	7,896	31,197	29.8
11–50	3,896	90,947	34.7
51–100	923	64,560	38.3
101–150	265	32,544	38.9
151–200	113	19,378	59.8
More than 200	235	141,423	36.4
By function type			
Installation Services	3,619	90,950	30.9
Social Services	2,020	26,774	13.9
Health Services	1,369	64,852	63.3
Intermediate Maintenance	1,069	35,334	73.5
Depot Maintenance	139	43,869	1.7
Real Property Maintenance	917	18,367	8.2
Research Support	242	8,748	27.2
Training	618	24,253	81.0
Data Processing	706	14,505	14.7
Other Nonmanufacturing	2,629	52,397	30.5
Total	13,328	380,049	37.2

figure, implying a 95%-confidence interval around the savings estimate of (4.72, 6.76).[14]

Using the formula in equation (5), we find that savings would fall to $3.01 billion if the historical pattern of cancellations were continued for the CA inventory, with a standard error of 0.25 and a 95%-confidence interval of (2.52, 3.50). The savings with cancellation is only approximately half the savings without cancellation, implying that substantial savings could be realized if the cancellation policy were tightened with future privatization competitions.

VI. Conclusions

To summarize our findings, the DoD saved $1.46 billion from the privatization competitions that it conducted from 1978 to 1994, but the savings do not arise purely from switching to private suppliers that are inherently more efficient than the in-house teams (savings from privatization). The threat of losing to private contractors caused the in-house team to submit bids substantially lower than current costs (savings from competition). Our measures of the savings from competition range from 24% (for the realized savings measure) to 64% (for the potential savings measure) of the total.

We project that the DoD could save an additional $5.74 billion annually if it subjected its entire inventory of commercial activities to privatization competitions. The savings would be cut almost in half if the DoD allowed competitions to be cancelled according to the historical pattern.

The estimates indicate that savings tend to rise more than proportionately with size, where the size of a function is the number of billets employed. The greater the proportion of billets that are military, the greater is the savings potential. There do not appear to be strong effects of the vintage of the competition on savings, although the probability of cancellation of a competition increased significantly the later the competition was initiated in the 1978–1994 period. The pattern of completion rates across function types—with Social Services, Installation Services, Intermediate Maintenance, and Real Property Maintenance having high completion and savings rates—supports the implication of Hart, Sheifer, and Vishny (1997) that contractual completeness may make certain functions more desirable candidates for privatization.

Because we do not observe baseline cost directly, our savings measure is only a proxy of true savings. It is likely that our use of this measure rather than true savings causes us to underpredict savings and understate marginal effects. Policymakers should also consider other caveats before drawing policy conclusions from our analysis. First, our analysis is partial- rather than general-equilibrium. Our measure of savings rises if employees are shed from a certain function due to a privatization competition. If these employees are merely shifted to some other function within the DoD, then we may be overestimating the general-equilibrium effect of privatization competitions on the government's budget. Second, we are considering only the costs of—not the quality of—the goods or services provided. If quality declines as a result of privatization competitions (either because the in-house team wins but has fewer resources to continue performing the function or because the quality provided by private contractors is harder to control), this would argue against pursuing privatization competitions in the future, at least for the functions whose quality declines most markedly.[15]

[14] The simulated standard error is computed by taking 1,000 draws from the joint distribution of coefficients, estimating total savings for each draw, and taking the standard error of the 1,000 savings estimates.

[15] In a case study of three military bases at which thirty privatization competitions were conducted, Marcus (1993) found that administrators were generally satisfied with the performance of the private contractors. Each base had only one unsatisfactory experience, which each time involved outright contractor default.

REFERENCES

Bhattacharyya, Arunava, Eliott Parker, and Kambiz Raffiee, "An Examination of the Effect of Ownership on the Relative Efficiency of Public and Private Water Utilities" *Land Economics* 70(2) (1994), 197–209.

Boardman, A. E., and A. R. Vining, "Ownership and Performance in Competitive Environments: A Comparison of the Performance of Private, Mixed, and State-Owned Enterprises," *Journal of Law and Economics* 32(1) (1989), 1–33.

Borcherding, Thomas E., Werner W. Pommerehne, and Friedrich Schneider, "Comparing the Efficiency of Private and Public Production: The Evidence from Five Countries," *Zeitschrift Nationalökonomie* supplement 2 (1982), 127–156.

Carrick, Paul M., "New Evidence on Government Efficiency," *Journal of Policy Analysis and Management* 7(3) (1988), 518–528.

de Boer, David B., and Lewis Evans, "The Economic Efficiency of Telecommunications in a Deregulated Market: The Case of New Zealand," *Economic Record* 72(216) (1996), 24–35.

Eckel, Catherine, Doug Eckel, and Vijay Singal, "Privatization and Efficiency: Industry Effects of the Sale of British Airways," *Journal of Financial Economics* 43(2) (1997), 275–298.

Erlich, Issac, Georges Gallais-Hamonno, Zhiqiang Liu, and Randall Lutter, "Productivity Growth and Firm Ownership: An Analytical and Empirical Investigation," *Journal of Political Economy* 102(5) (1994), 1006–1038.

Greene, William H., *Econometric Analysis* (New York: Macmillan Publishing Company, 1990).

Hart, Oliver, Andrei Shleifer, and Robert W. Vishny, "The Proper Scope of Government: Theory and an Application to Prisons," *Quarterly Journal of Economics* 112(4) (1997), 1127–1161.

Hollas, Daniel R., and Stanley R. Stansell, "The Economic Efficiency of Public vs. Private Gas Distribution Utilities," *Annals of Public and Cooperative Economics* 65(2) (1994), 281–300.

Kumbhakar, Subal C., and Lennart Hjalmarsson, "Relative Performance of Public and Private Ownership under Yardstick Competition: Electricity Retail Distribution," *European Economic Review* 42(1) (1998), 97–122.

Kwoka, John E., Jr., "The Effects of Divestiture, Privatization, and Competition on Productivity in U.S. and U.K. Telecommunications," *Review of Industrial Organization* 8(1) (1993), 49–61.

———, *Power Structure: Ownership, Integration, and Competition in the U.S. Electricity Industry* (Boston: Kluwer Academic Publishers, 1996).

Laffont, Jean-Jacques, and Jean Tirole, *A Theory of Incentives in Procurement and Regulation* (Cambridge, MA: MIT Press, 1993).

Laffont, Jean-Jacques, Hervé Ossard, and Quang Vuong, "Econometrics of First-Price Auctions," *Econometrica* 63(4) (1995), 953–980.

Marcus, Alan J., "Analysis of the Navy's Commercial Activity Program," The CNA Corporation research memorandum no. 92-266 (1993).

OMB Circular A-76, Supplemental Handbook, Performance of Commercial Activities, Office of the President, Office of Management and Budget (1983).

National Defense Budget Estimates for FY 1996, Department of Defense, Office of the Undersecretary of Defense (1995).

Rose-Ackerman, Susan, "Reforming Public Bureaucracy through Economic Incentives?" *Journal of Law, Economics & Organization* 2(1) (1986), 131–161.

Savage, Ian, "Deregulation and Privatization of Britain's Local Bus Industry," *Journal of Regulatory Economics* 5(2) (1993), 143–158.

Schmidt, Klaus, "The Costs and Benefits of Privatization: An Incomplete Contracts Approach," *Journal of Law, Economics & Organization* 12(1) (1996), 1–24.

Teeples, R., and D. Glyer, "Cost of Water Delivery Systems: Specification and Ownership Effects," this REVIEW 69(3) (1987), 399–408.

Tirole, Jean, "The Internal Organization of Government," Oxford Economic Papers 46(1) (1999), 1–29.

Vickers, John, and George Yarrow, "Economic Perspectives on Privatization," *Journal of Economic Perspectives* 4(2) (1991), 111–132.

Williamson, Oliver E., "Franchise Bidding for Natural Monopolies—In General and with Respect to CATV," *Bell Journal of Economics* 7(1) (1976), 73–104.