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## Ownership and Production Costs - Choosing Between Public Production and Contracting Out

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# OWNERSHIP AND PRODUCTION COSTS\*

## Choosing between public production and contracting out

Henry Ohlsson

June 2003

### **Abstract**

Many comparisons of public and private firms use a public/private ownership dummy variable to capture cost differences. If, however, public and private firms use different production technologies, the dummy variable approach is misspecified. Data from public and private firms should not be pooled. Second, selectivity bias may arise making it more difficult to identify cost differentials that actually exist. Third, if data should be pooled the resulting empirical model may be logically inconsistent. I compare public and private firms using refuse collection costs of 170 firms in 115 Swedish municipalities. First, public production costs were 6 percent lower than private production costs. Second, cost differences did not affect producer choice. It is crucial to adjust for selectivity. Data for private and public firms should not be pooled. The dummy variable model is misspecified.

Keywords: public ownership, private ownership, contracting out, cost minimization, switching regression model with endogenous switching

JEL classifications: D24, E22, L32, L33

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# 1 Introduction

The public sector has expanded in all industrialized countries, the tax pressure has increased. These trends, together with ideological changes, have meant that the public activities during the last decades have been more and more questioned. There have been extensive privatizations in many countries in response to this.<sup>1</sup> Public ownership and the efficiency of public firms have been widely discussed.

There are, however, considerable methodological problems when studying the effects of ownership. The discussion about how to compare the performance of private and public firms clearly illustrates the difficulties to measure firm performance. The market structure and the degree of *competition* is one issue. The performance of public and private firms may not differ in a competitive environment. Without competition, however, firms will have the opportunity to extract monopoly rents.

Then the *objectives* of firms become essential. Private and public firms may differ in objectives. Public firms may not exploit their market position—instead they may, for example, maximize social welfare. Profit maximizing private firms, on the other hand, will exploit their market position if there is not enough competition.

Private and public firms may also differ in *corporate governance*. This may concern how managers are monitored or in the incentive structure of managers. Principal–agent considerations show that there are more complexities comparing firm performance. It is often conjectured that public firms are less efficient internally because public managers put less effort into reducing costs than private managers.

At the same time, some argue that the default risk of private firms result in higher capital costs than for public firms. By the same argument, it is conjectured that private firms also are more likely to pay more for inputs.

Costs and profits are the evaluation criteria most often used when empirically comparing the performance of private and public firms. However, profits measure efficiency poorly when there is lack of competition. This is an argument for using costs instead. Pestieau and Tulkens (1993) argue that it is impossible to sort out the ownership matter from the market structure and regulation matters. Instead they advocate that the performance of public firms should be measured and compared on the basis of productive efficiency only.<sup>2</sup>

There is a considerable empirical literature on these issues. Vining and Boardman (1992) survey the empirical literature on the effect of ownership

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<sup>1</sup>The literature on privatization is extensive, Vickers and Yarrow (1988) and Bös (1991) are two early contributions.

<sup>2</sup>More specifically, they argue for using a frontier approach, e.g., data envelopment analysis (DEA), for measuring productive efficiency.

on efficiency.<sup>3</sup> The survey includes, for example, previous studies on the costs of refuse collection. Vining and Boardman argue that ownership in itself has a role separate from the degree of competition in the output market. The position of Borchering et al. (1982), on the other hand, is that there are no ownership effects when controlling for competition. There are also studies focusing on contracting out in particular. Domberger and Jensen (1997) conclude that the evidence shows that contracting out may reduce costs considerably.

Many studies focus on the possible differences in costs between private and public firms. On the other hand, few focus on what determines the political decision makers' choice between private and public firms. To understand this choice is as important as understanding possible cost differences.

The starting point for this paper is that many previous studies of the performance of public and private firms use dummy variables to capture the effects of public/private ownership (or market organization in general) in cross sections.<sup>4</sup> When estimating cost functions, the dummy variables are intended to capture the cost difference between, e.g., public and private firms. The model has, however, nothing to say about producer choice. In addition, this approach raises three important empirical issues: pooling, selectivity, and logical consistency.

*Pooling.* If public and private firms use different production technologies, the dummy variable approach is simply misspecified. It is not possible to pool data from the different types of firms if production technologies differ.

*Selectivity.* A second potential problem arises because the type of producer is chosen by the public authorities. The choice is not random.<sup>5</sup> There is, therefore, a risk for selectivity bias when estimating cost functions. A consequence of this is that the cost differences may be overestimated. This will be a potential problem regardless of whether the dummy variable model or some other specification is used.

*Logical consistency.* Third, the dummy variable approach is logically inconsistent if private firms only have lower costs in the cases when private production is chosen.<sup>6</sup> If, on the other hand, private firms always produce at lower costs, why do we observe public production at all if costs matter for the choice of producer?<sup>7</sup>

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<sup>3</sup>Other surveys are Bennett and Johnson (1980), Pestieau and Tulkens (1993), and Tang (1997).

<sup>4</sup>Szymanski and Wilkins (1993) and Szymanski (1996) are exceptions. These studies use panel data.

<sup>5</sup>Marcinèin and van Wijnbergen (1997) show that it is crucial to take selection into account also when studying the effects of privatization.

<sup>6</sup>The terminology is from Maddala (1983), Heckman (1978) and Maddala and Lee (1976) also discuss this.

<sup>7</sup>Dubin and Navarro (1988, p. 219) ask: "...if private monopoly is the efficient, cost-minimizing alternative, why do over half of the local communities choose other forms of market organization?"

The dummy variable approach may be appropriate in an experimental situation, when the type of producer is randomly chosen. To my knowledge there are, however, no data available from experiments with random assignments of the type of producer. Instead, an empirical cost comparison fits well in the econometric framework of a switching regression model with endogenous switching. It takes producer choice into account and provides a unified framework to test pooling, selectivity, and logical consistency. The objective of the paper is to estimate a model of this kind using Swedish data.

In our case it turns out that it is crucial to adjust for selectivity and that it is not possible to pool data for private and public firms. The dummy variable model is misspecified. As data should not be pooled in this case, the problem of logical consistency does not arise. The two main results are:

1. The estimations suggest that public production, on average, was 6 percent cheaper than private production.
2. Cost differences did not affect producer choice. The municipalities, in other words, did not choose the least cost alternative.

Model selection is crucial. Suppose that we erroneously pool the data and do not correct for selectivity by using the dummy variable model. This gives the opposite qualitative result, costs in public firms are estimated to be 13 percent higher than in private firms. If instead we correct for selectivity but still erroneously pool the data, the public cost advantage is overestimated. Costs in public firms are estimated to be 36 percent lower than those in private firms.

The paper is organized as follows: The data and the decision making process are presented in section 2. In section 3, I discuss the potential problems with the dummy variable approach. I also specify the more general model and discuss how it should be estimated. Section 4 presents a theoretical framework for the choice of producer by local public authorities. The estimations of producer choice models and cost models can be found in section 5. Section 6 concludes.

## 2 Data and the decision making process

The data set comes from a survey made by the Swedish Competition Authority in 1989. It covers the refuse collection in 115 of Sweden's 284 municipalities. There were two major municipal boundary reforms in Sweden during the 1950s and 1960s. The number of municipalities in Sweden was reduced from 2,500 in 1952 to 278 in 1974. Since then there have been some municipal break-ups.

Since 1972, the Swedish municipalities have local monopolies by law in

the provision of refuse collection.<sup>8</sup> A municipality can choose to collect itself or it can decide to contract out the collection. In 1989, when the data were collected, procurement in almost all municipalities was made according to procurement guidelines suggested by Swedish Association of Local Authorities. These guidelines stressed that the municipalities should take advantage of existing possibilities of competition when procuring. The guidelines also stressed that procurement should be done in a businesslike manner and that all bids should be treated objectively. There was a recommendation to have competitive tendering using sealed bids. This was, however, not compulsory.<sup>9</sup>

The municipality can decide to procure refuse collection from different firms in different areas of the municipality. (Sometimes the collection areas correspond to the “old”, small, pre-amalgamation municipalities.) Several private firms may collect in different areas of the municipality. It may also be the case that the municipality collects itself in some areas while there is contracting out in other areas. There is, however, only one collector in each collection area.

In 56 municipalities, the collection was—completely (35) or partly (21)—done by the municipality. In the remaining 59 municipalities, private firms were the only collectors. All in all, 150 “firms” were involved, 55 public and 95 private. Some firms, however, operated in more than one municipality. The data for these firms are separated for each municipality so the number of firms on the municipality level is 170, 56 public and 114 private. Appendix A presents some more information about the variables I use. There are unfortunately many missing observations for some variables. The concerns the cost variables in particular.<sup>10</sup>

Table 1 reports the type of procurement that was used. It is clear from the table that competitive tendering with sealed bids only was used in one out of four cases. There was no difference between the cases when private and public firms were chosen. The most important other types of procurement were direct procurement and bargained procurement.

There is some information on the number of bids but unfortunately only in the cases when private firms were chosen. When procurement was done using sealed bids competitive tendering there were 2 – 6 bids in most cases.

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<sup>8</sup>Why should refuse collection should be compulsory and publicly provided? What is the market failure? Consumption of collection services is rival and exclusion is possible. The reasons are because of general health and sanitation. Externalities exist because individuals are jointly damaged by deteriorations in the environment when some individuals choose low (or no) levels of collection services. The deteriorations are characterized by indivisibilities and exclusion is difficult or impossible.

<sup>9</sup>Presently, public procurement must be done in accordance with the 1992 public procurement law that came in effect from 1994. This law is much stricter than the previous guidelines.

<sup>10</sup>In most estimations of cost functions I can only use 47 public firms and 75 private firms. As far as I can test, however, this sub-sample is representative of the full sample.

Table 1: Types of procurement, number of collection areas.

	private firm chosen	public firm chosen
competitive tendering, sealed bids	23	10
other types of procurement	77	43
missing	14	3

Table 2: Cost analysis, number of collection areas.

	cost analysis	no cost analysis
competitive tendering, sealed bids	22	11
other types of procurement	52	68

There is information on the number of bids for all 23 cases of sealed bids competitive tendering when a private firm is chosen. There was usually only one bid when the other types of procurement were used. There are, however, many missing observations for these cases.

In some cases the municipalities claimed that there were no private firms interested in providing the service. One way of increasing the competitive pressure when the number of firms giving bids is too small is to analyze the collection costs. Some procuring municipalities have, therefore, done a thorough analysis of the collection costs in particular collection areas. The objective is to create yardstick competition. The information collected in this way allows the municipalities to more easily identify the least cost alternative. Table 2 shows that such an analysis was made in 52 of the cases when competitive tendering with sealed bids was not used. A cost analysis also complement competitive tendering with sealed bids in many cases.

### 3 Models and estimation strategy

*How it usually has been done.* The most common empirical approach used when comparing public and private firm performance is to estimate a single cost function with production quantity and factor prices as explanatory variables, and simply adding a dummy variable for the type of ownership. In SPK (Swedish National Price and Cartel Office) (1991), the official government report using this data set, the total costs of private refuse collection

were estimated to be 25 percent lower than in public production.<sup>11</sup> Total costs include costs for labor, vehicles, offices, packing, and some minor cost items. Reestimating the equation, adding housing density as explanatory variable in one specification, I get the results reported in Table 3.<sup>12</sup>

There are four variables measuring different dimensions of produced output. These are the collected quantity, the number of places from which refuse has been picked up in relation to the collected quantity, the number of pick-ups in relation to the number of pick-up points, and the distances driven. Previous refuse collection studies have also used similar output variables.

All estimated parameters for the output variables are significant at the 5 percent level, except for pick-up frequency. Factor prices are borderline significant. I have also added housing density as this variable has been included in many previous studies. It is significant. Costs in private firms are 12–20 percent lower than in public firms depending on which other variables are included.<sup>13</sup> The reason why I do not replicate the estimations in the government report is that the agency did choose to impute many missing values whereas I do not use these imputed values. The private ownership dummy is significant in the estimation reported in column 3.

*Why it may be wrong.* There are several potential problems related to empirical estimations. A first problem is misspecification. Is it possible to pool data from private and public firms? Suppose that the cost functions are:

$$\text{private costs: } C_{pr} = \beta_{pr}X + u_{pr}, \quad (1a)$$

$$\text{public costs: } C_{pu} = \beta_{pu}X + u_{pu}, \quad (1b)$$

where  $C_{pr}$  and  $C_{pu}$  are costs, the vector  $X$  includes production quantity and factor prices, while  $u_{pr}$  and  $u_{pu}$  are error terms. The subindices  $pr$  and  $pu$  refer to private production and public production.<sup>14</sup> Suppose that the cost functions are the same for all firms ( $\beta_{pr} = \beta_{pu}$  for all  $X$ ). We can

<sup>11</sup>There are many papers studying ownership effects on refuse collection costs using the dummy variable approach. Among them are Hirsch (1965), Kemper and Quigley (1976), Kitchen (1976), Collins and Downes (1977), Pommerehne and Frey (1977), Stevens (1978), McDavid (1985), Domberger et al. (1986), Tickner and McDavid (1986), Dubin and Navarro (1988), Szymanski and Wilkins (1993), Szymanski (1996), Gradus and Dijkgraaf (1997), and Reeves and Barrow (2000). Edwards and Stevens (1978) use the dummy variable method to study refuse collection prices. There are also other studies of refuse collection. Cubbin et al. (1987) and Bosch et al. (2000) use DEA approaches to study productive efficiency. Some studies simply compare refuse collection costs or prices without controlling for other variables. Savas (1977b), Savas (1977a), Bennett and Johnson (1979), and Savas (1981) are among those.

<sup>12</sup>I have used the LIMDEP version 7.0 software package, see Greene (1995), and the Stata release 7.0 software package, see StataCorp (2001).

<sup>13</sup>Most of the previous studies using the dummy variable method also find that private production is cheaper. Collins and Downes (1977), however, report the opposite result.

<sup>14</sup>All explanatory variables may not have an influence in both equations. For some elements of  $X$  the  $\beta_{pr}$ - and  $\beta_{pu}$ -coefficient in the cost functions may be zero.

Table 3: Costs per ton, dummy variable models.

quantity	-0.11 (1.91)	-0.14 (2.63)	-0.22 (3.72)
pick-up points per ton	0.20 (2.83)	0.21 (3.30)	0.15 (2.46)
pick-up frequency	0.02 (0.19)	-0.02 (0.27)	-0.06 (0.68)
distance	0.15 (3.17)	0.13 (2.86)	0.14 (3.10)
wage rate		0.23 (1.90)	0.18 (1.55)
cost of capital		0.18 (1.78)	0.21 (2.14)
housing density			0.09 (2.93)
private ownership	-0.13 (1.28)	-0.12 (1.25)	-0.20 (2.10)
constant	-0.21 (0.55)	0.74 (1.60)	1.38 (2.78)
$R^2$	0.17	0.25	0.31
$SEE$	0.48	0.43	0.41
$RSS$	27.19	19.78	18.31
log likelihood	-81.54	-62.00	-57.53
number of observations	122	116	116

Notes. All variables are in logarithms, including the dependent variable, except the private ownership dummy. Absolute  $t$ -values within parentheses.

then pool the data and estimate a single cost function. Having the same production technologies imply that the cost functions are the same. But if the production technologies differ we must allow public and private firms to have different cost functions (different  $\beta$ s).

The second problem is selectivity. This may arise if the producer choice is not completely random. Suppose that producer choice is determined according to:

$$\text{producer choice: } Pr^* = \gamma Z + \delta(C_{pr} - C_{pu}) + v, \quad (2)$$

where  $Pr^*$  is a latent variable for private firms with the corresponding binary variable  $Pr$ ,  $Z$  is a vector of variables that influence producer choice, and  $v$  is an error term. The term  $C_{pr} - C_{pu}$  captures the cost difference between private and public production. Some, but not all of the variables in  $X$  may also appear in  $Z$ .

We will also have use for the reduced form of the choice equation. Here the cost difference is replaced by the determinants of costs according to (1a) and (1b). The reduced form is:

$$Pr^* = \gamma Z + \delta(\beta_{pr} - \beta_{pu})X + \delta(u_{pr} - u_{pu}) + v, \quad (3)$$

which can be given new parameters to become  $Pr^* = \tilde{\gamma}\tilde{Z} + \tilde{v}$ .

The potential selectivity problem can be illustrated by the following example: Suppose that firms differ in production costs partly because of differences in, for example, managerial ability. Furthermore, let us assume that there is no information available to us about this ability. Now suppose that we study a firm with higher managerial ability, and, therefore, lower production costs, than captured by the exogenous variables in the cost equation. This will give rise to a negative error term  $u_{pr}$  if it is a private firm and a negative error term  $u_{pu}$  if it is a public firm.

The procuring municipalities may, however, have learnt over time about the managerial ability of different firms. Suppose that this reputation about ability makes the municipality more likely to procure from high ability firms than captured by the explanatory variables in the producer choice equation. We will then have a positive error term  $v$  if it is a private firm (and a negative error term  $v$  if it is a public firm). And more importantly, there will exist a negative covariance,  $\sigma_{u_{pr}v}$ , between the error term in the private cost equation,  $u_{pr}$ , and the error term in the choice equation,  $v$ . There will also exist a positive covariance,  $\sigma_{u_{pu}v}$ , between the error term in the public cost equation,  $u_{pu}$ , and the error term in the choice equation,  $v$ . Because of reputation high ability firms are more likely to be chosen.

Suppose that these covariances indeed are nonzero. In general, the covariance  $\sigma_{u_{pr}v}$  can then be expected to be negative while  $\sigma_{u_{pu}v}$  can be expected to be positive. If we now estimate the cost equations without taking

the covariances into account, the estimation results will suffer from selectivity bias. Producer choice will give us more observations of firms with true cost error terms being negative than observations of firms with positive error terms. But empirical models that do not control for selectivity assume that there are as many positive error terms as negative. The estimated coefficients will, therefore, be biased.

The conditional expected costs are:

$$E(C_{pr}|Pr = 1) = \beta_{pr}X + \sigma_{u_{pr}v} \frac{\phi(\tilde{\gamma}\tilde{Z})}{\Phi(\tilde{\gamma}\tilde{Z})}, \quad (4a)$$

$$E(C_{pu}|Pr = 0) = \beta_{pu}X - \sigma_{u_{pu}v} \frac{\phi(\tilde{\gamma}\tilde{Z})}{1 - \Phi(\tilde{\gamma}\tilde{Z})}, \quad (4b)$$

where  $\phi(\tilde{\gamma}\tilde{Z})$  and  $\Phi(\tilde{\gamma}\tilde{Z})$  are the density function and the distribution function of the standard normal evaluated at  $\tilde{\gamma}\tilde{Z}$ . Including  $+\sigma_{u_{pr}v} \frac{\phi}{\Phi}$  and  $-\sigma_{u_{pu}v} \frac{\phi}{1-\Phi}$  when estimating the respective cost equation will control for selectivity and yield estimates of the covariances.

If we estimate the cost equations (1a) and (1b) without controlling for selectivity we will get biased estimates if the covariances are nonzero. Most probably, we will tend to overestimate the cost advantage of private ownership. This will also, in a second step, affect the estimation of the choice equation. Suppose that we have biased estimates of the coefficients of the cost equations and, therefore, a biased estimate of the cost difference. This will lead to biased estimates of the producer choice equation regardless of whether we estimate (2) using the expected cost difference as explanatory variable or (3) using the differences in estimated coefficients times the  $X$ -variables as explanatory variables.

A third potential problem is logical inconsistency. This problem may arise if we pool the data. Suppose that we capture the cost effect by a dummy variable when estimating the cost equation. The issue now is if this effect should be attributed to the type of firm ownership or to the particular area where the refuse is collected. If, on the one hand, it is connected to the area, all firms will have to bear these costs which are the same for all. In this case there will be no variation in costs across firms. Consequently, it is not possible to identify the impact of ownership when estimating a choice equation.

If, on the other hand, the cost difference should be attributed to ownership, there will be variation across firms. Private firms will have different costs than public. The model is:

$$\text{costs: } C = \beta X + \alpha Pr + u, \quad (5a)$$

$$\text{producer choice: } Pr^* = \gamma Z + \delta \alpha Pr + v, \quad (5b)$$

where  $\alpha$  is the ownership effect. The parameter  $\alpha < 0$  if private production

is cheaper. However, Maddala (1983, p. 118) presents the following lemma, I use the notation of (5a) and (5b):<sup>15</sup>

**Lemma 1.** *Suppose  $Pr^*$  is an unobserved variable, with the corresponding observed variable  $Pr = 1$  if  $Pr^* > 0$  and  $Pr = 0$  if  $Pr^* \leq 0$ . Then a model of the form  $Pr^* = \gamma Z + \delta \alpha Pr + v$ , where  $Z$  is a variable, and  $\gamma$  is a parameter, is logically inconsistent unless  $\delta \alpha = 0$ .*

The proof is as follows:  $P(I = 0) = 1 - F(\gamma Z)$  while  $P(I = 1) = F(\gamma Z + \delta \alpha)$ . The probabilities sum to one,  $1 - F(\gamma Z) + F(\gamma Z + \delta \alpha) = 1$ . But this holds only if  $\delta \alpha = 0$ .

Logical consistency requires that the cost difference plays no role for the producer choice, i.e.,  $\delta = 0$ . Alternatively, there should be no cost difference,  $\alpha = 0$ . Cost differences will then play no role for the choice to contract out. To simplify matters, suppose also that there are no other variables affecting choice ( $\gamma Z = 0$ ). The producer choice, or rather the assignment, is random according to  $v$ .

*How it could be done.* The cost equations (1a), (1b), and the choice equation (2) combined is a switching regression model with endogenous switching. We can use it to estimate if there are cost differences between private and public firms and if cost differences affect producer choice. At the same time, the model provides a unified framework for testing selectivity, pooling, and logical consistency. Some of the previous empirical studies of refuse collection have done parts of what could be done. But no study has done it all at the same time.

How do I test selectivity, pooling, and logical consistency? If the error covariances  $\hat{\sigma}_{u_{pr}v}$  and  $\hat{\sigma}_{u_{pu}v}$  are significant in the cost equations, we know that this correction for sample selection was indeed needed.

I test pooling in the following way. Maddala (1983) suggests an empirical specification where the expected cost is:

$$E(C) = \beta_{pu}X + (\beta_{pr} - \beta_{pu})X\Phi(\gamma Z) + (\sigma_{u_{pr}v} - \sigma_{u_{pu}v})\phi(\gamma Z). \quad (6)$$

The cost equation (6) can be estimated using a two-step procedure. Suppose that all  $(\beta_{pr} = \beta_{pu})$  for all  $X$  except the constant. This model is sometimes called the treatment effects model. It can be viewed as a restricted version of the selectivity controlled cost equations, in the sense that all the coefficients, except the constants, are the same. Equation (6) then collapses to:

$$E(C) = \beta X + \alpha \Phi(\gamma Z) + (\sigma_{u_{pr}v} - \sigma_{u_{pu}v})\phi(\gamma Z), \quad (7)$$

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<sup>15</sup>Heckman (1978, p. 936) also provides a proof of this proposition.

where  $\alpha$  equals the difference in  $\beta$ -coefficients for the constant. This captures the effect of ownership on the costs. Pooling for the whole model can be tested by a likelihood ratio test of the treatment effects model vs. the separate cost equations. If pooling for the whole model is rejected, we can then test pooling variable by variable by estimating (6). The impact of a variable will differ between private firms and public firms if the estimated coefficients ( $\beta_{pr} - \beta_{pu}$ ) are significant.

There will be no problem of logical inconsistency if pooling is rejected. If data should be pooled, consistency requires either that there is no cost difference,  $\alpha = 0$ , or that the cost difference does not affect producer choice,  $\delta = 0$ . In the pooling case, the estimation of the treatment effects model provides a test of  $\alpha = 0$  while the structural form probit gives us the test of  $\delta = 0$ .

## 4 Theoretical framework

Which variables form  $X$  and  $Z$ ? Cost functions usually follow directly from the assumption that the firm optimizes. Costs will then be a function of quantity produced and factor prices. The effects of factor prices can be identified empirically if factor prices vary between different collection areas. We can then compare public and private costs for a given quantity collected and given, exogenous, area-specific factor prices.

Suppose instead that factor prices vary between public and private firms. The comparison can then only be made for a given quantity as factor prices are endogenous (ownership-specific). There are systematic differences in the factor prices paid by public and private firms in this data set. In a previous study using the same survey, Ohlsson (1996), I found that private firms, controlling for other factors, pay 10–15 percent less for their trucks. As firms cannot be assumed to be price takers, factor prices should not be included in the cost functions. I will, therefore, assume that the  $X$ -vector only consists of variables capturing different dimensions of the quantity produced.

Gómez-Lobo and Szymanski (2001) find that more bids in compulsory competitive tendering are associated with lower costs for refuse collection. It is here not possible to test this when public firms are chosen because of lack of data. When testing if the number of bids affect costs I have, therefore, had to restrict the estimation to the cases when private firms have been chosen. I cannot, however, find any significant effects of the number of bids.<sup>16</sup>

*Transaction costs.* The production costs in private firms are not necessarily the same as the payment of the public sector when choosing to contract out. I will, however, assume that cost-plus contracts are used. I will also assume that there are no differences in the possibilities for the public sector to forecast the costs of own production and the costs when contracting out.

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<sup>16</sup>The results are available on request.

These are, of course, strong assumptions. Real resources will have to be spent both during and after the actual procurement. Borcharding (1988) and Wittman (1989) argue that, on one hand, observed cost differences can be attributed to cost-increasing behavior of public managers. Many empirical studies, on the other hand, implicitly assume that the transaction costs associated with contracting out are negligible. When total costs are considered, this may make public production more efficient.

There are also transaction costs associated with bargaining, monitoring, and enforcing when contracting out. The public firms, which are perceived to be inefficient, may actually be the least cost alternative when all things are considered. Contracting costs and contract failure are also discussed by Domberger and Jensen (1997).

*Producer choice.* Things are less clear for how (local) politicians choose the producer of publicly provided goods and services. de Silanes et al. (1997) discuss three types of determinants of producer choice: efficiency (social goals), political patronage, and ideology. Political patronage has to do with the fact that politicians get support from public employees when services are publicly produced. Politicians will, therefore, favor public production unless tax payers force them to do otherwise. Hoover and Peoples (2003) find that U.S. municipalities are more likely to use union refuse workers when a relatively large percentage of the residents in the municipality are union members.

Similar determinants have been suggested by other authors. Ferris (1986) writes that contracting out is more likely with greater cost savings. More stringent fiscal limits and less powerful public employees and public service constituency groups will also make contracting out more likely. Nelson (1997) adds that heterogenous citizen preferences may make contracting out less likely.<sup>17</sup>

To sum up, four different types of determinants of producer choice have been suggested in the literature:

- ideology
- cost differences (efficiency)
- the influence of pressure groups (tax payers, public employees, etc.)
- the pressure from legal constraints on fiscal behavior

## 5 Evidence: Costs and producer choice

*Representative sample.* There are many missing observations for the firm level variables while the municipality level data I use in the choice models

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<sup>17</sup>The determinants of producer choice are also discussed in Sonenblum et al. (1977), Dubin and Navarro (1988), Szymanski (1996), and Dijkgraaf et al. (2003).

are complete. There is, therefore, a potential problem that the sample is not representative. Table 4 reports some probit estimations that address this problem.

Table 4, column 1 is an ownership probit for the a sample of 153 firms. The loss of 17 firms compared to the full sample of 170 firms is caused by the inclusion of the dummy variables which indicate if the municipality has used sealed bids competitive tendering and if the municipality has done a cost analysis of its refuse collection. Column 2 is a corresponding probit for the sample of 122 firms for which cost data are available. The estimated coefficients do not differ considerably between the two estimations.

Running a probit on whether cost data are available does not give any particularly significant coefficients, see column 3. My conclusion is that the subsample with available cost data is not biased. A  $\chi^2$ -test of the restriction that the model only has a constant does not reject the restriction.

*Producer choice.* Unfortunately, there are few variables available that directly correspond the determinants of producer choice discussed in section 4. However,  $\chi^2$ -tests of the restriction that the models in Table 4, column 1 and column 2, only have a constant rejects the restriction in both cases. In this sense, the estimated models as such have explanatory power.

I have proxied ideology with a dummy variable for if the Social Democrats and the Left Party together had a majority in the municipality council. This dummy variable is, however, not significant.<sup>18</sup> It could be argued that the share of single family houses in the housing stock could proxy ideology. The idea is that there is a correlation between preferences for owning a single family house and more conservative political preferences. This variable has a significantly positive impact on the probability that a private firm is chosen.

Efficiency considerations are captured by two dummy variables. Using competitive tendering with sealed bids seems to make a choice of a private firm more likely. The estimated coefficients are, however, far from significant. Some procuring municipalities have analyzed the collection costs in the particular collection areas to create yardstick competition. The estimated coefficient is significant, cost analyses increase the probability that the procuring municipality chooses public production. This is the most important determinant of producer choice together with the share of single family houses.

I also have access to the variables average income, population, population density, and housing density. These variables may measure the influence of pressure groups. None of these variables does, however, have a significant impact on the probability of the municipality choosing a private firm.<sup>19</sup>

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<sup>18</sup>Bivand and Szymanski (2000) and Gómez-Lobo and Szymanski (2001), on the other hand, find political effects on costs using U.K. data. Local governments lead by the Conservatives have lower costs than those lead by Labour.

<sup>19</sup>I have tried several other variables capturing different aspects of the finances of the municipality without getting any significant result. Among the variables tried without

Table 4: Producer choice, test of representative sample, probit models.

	dependent variable:		
	private ownership = 1	private ownership = 1	cost data available = 1
sample	all firms	firms for which cost data are available	all firms
socialist	0.01 (0.06)	0.22 (0.77)	0.30 (1.10)
share of single family houses	2.51 (1.98)	2.86 (1.95)	-0.02 (0.02)
competitive tendering, sealed bids	0.24 (0.84)	0.41 (1.33)	0.16 (0.54)
cost analysis made by the procuring municipality	-0.54 (2.32)	-0.64 (2.46)	-0.15 (0.59)
average income	0.15 (0.07)	0.09 (0.03)	-1.85 (0.92)
population	-0.36 (0.68)	-0.47 (0.69)	0.43 (1.35)
population density	1.35 (0.23)	2.68 (0.38)	7.03 (1.08)
housing density	-0.29 (0.03)	-2.14 (0.16)	-13.5 (1.13)
constant	-0.93 (0.41)	-1.28 (0.48)	2.24 (1.11)
log likelihood	-88.0	-70.8	-75.0
average likelihood	0.56	0.56	0.61
$\chi^2$	21.5	21.1	4.13
significance level	0.006	0.007	0.845
number of observations	153	122	153

Notes. Absolute  $t$ -values within parentheses.

Dubin and Navarro (1988) actually estimate choice equations (Szymanski (1996) discusses the matter). They find that the probability of public ownership is lower if the share of votes on the Democratic Party is high and if the fraction of unionized collection workers is high while it is decreasing in per capita income.

*Cost functions.* Table 5 presents estimations of cost functions controlling for sample selection. The dependent variable is the logarithm of costs per ton. The probit in Table 4, column 3 is used to compute the sample selection term variables which equal  $\frac{\phi}{\Phi}$  for private firm costs and  $-\frac{\phi}{1-\Phi}$  for public firm costs. Davidson and MacKinnon (1993) write that 2SLS should be used to test for selectivity bias while maximum likelihood estimation should be used if selectivity bias cannot be rejected. Table 8 in Appendix B presents maximum likelihood estimations. The results are, in general, similar to those reported in Table 5.

The sample selection term is borderline significant in the private cost function. It also has the predicted sign. The sample selection term is significant in the maximum likelihood estimation reported in Appendix B. The public cost function, on the other hand, seems to be unaffected by the selection term.

This implies that there is a negative and significant covariance between the error term in the producer choice equation and the error term in the private firm cost function. Private firm that are chosen by municipalities, although they are not predicted to be chosen, have lower costs, controlling for the other variables in the cost function.<sup>20</sup>

Quantity and distance are the output variable with the highest  $t$ -statistics in the private cost function while pick-up points per ton is borderline significant, see Table 5, column 1.<sup>21</sup> In the public cost function, pick-up points per ton is the only significant output variable (column 2). These differences raise the question if it is possible to pool data from private and public firms.

The estimated cost functions can be used to predict and compare the costs of private and public production for each collection area. In other words, I compute  $(\hat{C}_{pr} - \hat{C}_{pu}) = (\hat{\beta}_{pr} - \hat{\beta}_{pu})X$ . This suggests that private production on average is 6 percent more costly than public production. The estimated mean of excess private costs, 0.064, has a standard error of 0.024 and is, therefore, significantly different from zero. This result is consistent with the finding, reported in Table 4, that municipalities that have used

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success are expenditure per capita, revenue per capita, central government grants per capita, tax base per capita, tax rate, tax revenue per capita, net worth per capita, and the share of the population reporting income.

<sup>20</sup>Dubin and Navarro (1988) also test for selectivity, but this is rejected in their case.

<sup>21</sup>I have tried the dummy variables for sealed bids competitive tendering and cost analysis in the cost functions. The estimated coefficients were not significant. I have also tried the number of bids on the cost function for private firms. The estimated coefficient was not significant. The estimation results are available on request.

Table 5: Cost functions, tests for selectivity and pooling, sample selection models.

	private firms	public firms	all
quantity	-0.13 (1.65)	-0.06 (1.23)	-0.09 (1.64)
pick-up points per ton	0.16 (1.78)	0.45 (5.49)	0.20 (2.88)
pick-up frequency	-0.01 (0.05)	0.22 (1.49)	0.01 (0.10)
distance	0.21 (3.09)	0.05 (1.46)	0.16 (3.41)
private ownership			0.36 (1.38)
selection term	-0.45 (1.82)	0.04 (0.33)	-0.34 (2.11)
constant	0.07 (0.14)	-1.06 (1.99)	-0.50 (1.24)
$\sigma_{u_i}$	0.55	0.23	0.46
$\rho$	-0.71	0.18	-0.64
$R^2$	0.20	0.52	0.21
$RSS$	20.50	2.08	24.53
log likelihood	-57.78	6.57	-75.26
number of observations	75	47	122

Notes. All output variables are in logarithms, including the dependent variable costs per ton. Absolute  $t$ -values within parentheses.

yardstick competition, in the sense that they have done cost analyses, are more likely to choose public production.

*Pooling.* I have calculated a likelihood ratio test of the hypothesis that the output coefficients are the same for private and public firms. Table 5, column 3 reports a dummy variable estimation for the whole sample, controlling for sample selection, with the restrictions on output coefficients and on the sample selection term coefficient imposed. The likelihood ratio test of the restrictions gives a  $\chi^2(5)$ -statistic with a value of 41.2, which corresponds to a significance level of 0.000. This test strongly rejects the pooling restrictions.

Which variables cause the pooling restriction to fail? The distance variable is significantly different in the private and public cost functions. Pickup points per ton is also borderline significantly different. In addition, the estimated coefficients for the selection terms imply different selection processes.<sup>22</sup>

There are examples in the previous refuse collection literature where separate cost functions are estimated and pooling tested. Gradus and Dijkgraaf (1997) estimate separate cost functions and test pooling. They reject pooling while Stevens (1978) cannot reject pooling. Pier et al. (1974) estimate separate cost functions.

*Logical consistency.* A consequence of the pooling tests is that the dummy variable specification is rejected. This implies that there is no problem of logical inconsistency for these data.

Even if the dummy variable model had passed the pooling tests, these data would still not give rise to a logically inconsistent model. The reason is that it turns out that cost differences do not matter for choice.

*Producer choice.* Table 6 suggests that cost differences do not matter for choice. Column 1 reports the estimation of a reduced form probit. The only significant output variable is quantity. I have computed excess private costs as previously described. A cost minimizing behavior would imply that excess private costs had a negative coefficient in the choice equation. Column 2 in Table 6, however, reports an insignificant (and positive) coefficient.

The result that municipalities that have analyzed costs are more likely to choose public production still holds in the structural probit. The share of single family houses continues to have a positive impact on the probability of private production in the structural probit.

I have also tried to simultaneously estimate the cost models and the choice equation assuming that lower costs matter for choice. The maximum likelihood estimations did not, however, converge or gave unreasonable results. I interpret this as that this model specification is not appropriate for the present data.

*Model selection.* Table 7 summarizes the different results reported on the

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<sup>22</sup>The estimations are available on request.

Table 6: Producer choice taking costs into account, test for cost minimization, probit models.

	reduced form	structural form
socialist	0.09 (0.28)	0.22 (0.77)
share of single family houses	1.96 (1.20)	2.87 (1.95)
competitive tendering, sealed bids	0.22 (0.63)	0.42 (1.33)
cost analysis made by the procuring municipality	-0.48 (1.64)	-0.64 (2.46)
average income	3.15 (1.07)	0.09 (0.04)
population	0.68 (0.74)	-0.48 (0.70)
population density	9.20 (0.97)	2.67 (0.38)
housing density	-16.8 (0.94)	-2.11 (0.16)
excess private costs		0.05 (0.10)
quantity	-1.07 (4.20)	
pick-up points per ton	-0.58 (2.00)	
pick-up frequency	-1.12 (1.54)	
distance	0.16 (0.98)	
constant	2.13 (0.58)	-1.29 (0.49)
log likelihood	-52.95	-70.79
average likelihood	0.65	0.56
$\chi^2$	56.74	21.06
significance level	0.000	0.012
number of observations	122	122

Notes. Absolute  $t$ -values within parentheses.

Table 7: Excess private costs, percent.

	separate cost models, no pooling	dummy variable model, pooling
correction for selectivity bias	6.4 <sup>a</sup>	35.9 <sup>b</sup>
no correction for selectivity bias	-13.9 <sup>c</sup>	-13.3 <sup>d</sup>

<sup>a</sup> Computed using the estimations reported in Table 5, column 1 and column 2.

<sup>b</sup> Table 5, column 3, reports the estimation.

<sup>c</sup> Estimations available on request.

<sup>d</sup> Table 3, column 1, reports the estimation.

effect of ownership. Model selection is crucial. Suppose that we erroneously pool the data and do not correct for selectivity by using the dummy variable model. This gives the opposite result compared to a correctly specified model. Costs in public firms are estimated to be 13 percent higher than in private firms. If we instead correct for selectivity but still erroneously pool the data, the public cost advantage is overestimated. Costs in public firms are estimated to be 36 percent lower than those in private firms. Pooling is less of a problem than not correcting for selectivity. Suppose that we correctly do not pool but erroneously do not correct for selectivity. We will get a result (14 percent excessive public costs) opposite to the true (6 percent excessive private costs).

## 6 Concluding remarks

There are many studies of the possible differences in costs between private and public firms. On the other hand, few studies focus on what determines the political decision makers' choice between private and public firms. To understand this is as important as understanding possible cost differences.

Many comparisons of the performance of public and private firms use a public/private ownership dummy variable to capture cost differences in cross section data. When estimating cost functions, the dummy variables are intended to capture the cost difference between, e.g., public and private firms. The model has, however, nothing to say about producer choice. In addition, this approach raises three important empirical issues: pooling, selectivity, and logical consistency.

If public and private firms use different production technologies, the dummy variable approach is misspecified. Second, selectivity bias may arise making it more difficult to identify cost differentials that actually exist. Third, if data should be pooled the resulting empirical model may be logically inconsistent.

I compare public and private firms using refuse collection costs in 115 Swedish municipalities. In some municipalities, several firms collect in different areas. The data cover 170 firms.

In our case it turns out that it is crucial to adjust for selectivity and that it is not possible to pool data for private and public firms. The dummy variable model is misspecified. As data should not be pooled in this case, the problem of logical consistency does not arise. The two main results are:

1. The estimations suggest that public production, on average, was 6 percent cheaper than private production.
2. Cost differences did not affect producer choice. The municipalities, in other words, did not choose the least cost alternative.

It is a main finding that policy makers do not minimize costs. This is consistent with what I found in Ohlsson (1996). Public firms pay more for their trucks. It is also consistent with the idea that private firms are likely to have higher capital costs than public firms. Private firms are also more likely to pay more for inputs. To select private firms, therefore, does not give the lowest costs. It is, finally, consistent with the argument that privatization, procurement, and contracting out force public sector managers and procurers to adopt commercial criteria.<sup>23</sup>

The important conclusion is, therefore, that the main problem was that public policy makers did not minimize costs, not that public firms were less efficient than private. They were not.

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<sup>23</sup>This argument is made by, among others, Haskel and Szymanski (1993).

## Appendix A. The data

### Municipality level data

Socialist = 1 if the Social Democrats and the Left Party together had a majority of the seats in the municipality council 1987. Source: Statistics Sweden, Yearbook for Swedish Municipalities 1987.

Share of single family houses, the number of single family houses divided by the total number of housing units 1985. Source: Statistics Sweden, The 1985 Census.

Average income, total factor income per inhabitant older than 20 years, 1987. Source: Statistics Sweden, Yearbook for Swedish Municipalities 1989.

Population, 1 January 1987. Source: Statistics Sweden, Yearbook for Swedish Municipalities 1987.

Population density, the number of inhabitants per square kilometer, 1 January 1987. Source: Statistics Sweden, Yearbook for Swedish Municipalities 1987.

Housing density, total number of housing units in the municipality 1985 divided by the area of the municipality. Sources: Statistics Sweden, The 1985 Census (housing units) and Yearbook for Swedish Municipalities 1987 (area).

### Firm level data

The firm level data come from the 1989 survey by the Swedish Competition Authority, formerly the Swedish National Price and Cartel Office, concerning 1987.

Competitive tendering, sealed bids. When collection in the area presently is done by a public firm, data are from Survey Form C, question 8. When the municipality presently contracts out the collection in the area to a private firm, data are from Survey Form C, question 11, column 6.

Cost analysis made by the procuring municipality. When collection in the area presently is done by a public firm, data are from Survey Form C, question 9. When the municipality presently contracts out the collection in the area to a private firm, data are from Survey Form C, question 11, column 9.

Quantity. Data are in tons and come from the answers to Survey Form E, question 2.

Pick-up points per ton. Data on pick-up points come the answers to Survey Form B, question 1. I have then divided the data with quantity.

Pick-up frequency. Data on number of pick-ups come the answers to Survey Form B, question 1. I have then divided the data with the number of pick-up points.

Distance. Data for distance driven are in kilometers and come from Survey Form B, question 7.

Costs. The sum of the costs for labor, vehicles, offices, packing, and some minor cost items. Data are in SEK per ton and come from Survey Form D, line 6–21 costs + line 22–24 depreciation - line 19 payments to contractors. Sometimes both the municipality and the firm has costs for collection within a certain area. In these cases I have added the costs, but payments to contractors should not be included.

Wage rate, wage costs divided by the number of employees. Wage cost data including payroll taxes are in SEK and come from Survey Form D, line 6 and line 7. Data on the number of employees (fulltime all year equivalents) are from Survey Form B, question 4.

Cost of capital, vehicle costs divided by the number of vehicles. Vehicle cost data are in SEK and come from Survey Form D, line 10 leasing costs, line 11 repairs and fuel, line 13 insurance, line 14 taxes, line 22 depreciation. Data on the number of vehicles are from Survey Form B, question 7.

Private ownership. Data are from the list of identification codes of firms and municipalities.

## Appendix B. Maximum likelihood estimations

Table 8: Cost functions, sample selection models.

	private ownership		public ownership		all	
quantity	-0.14	(1.80)	-0.07	(0.96)	-0.09	(1.67)
pick-up points per ton	0.16	(1.80)	0.46	(4.63)	0.21	(3.11)
pick-up frequency	-0.01	(0.07)	0.24	(1.05)	0.01	(0.14)
distance	0.22	(3.14)	0.05	(1.41)	0.16	(3.51)
private ownership constant	-1.47	(2.22)	-1.18	(1.81)	0.41	(2.48)
					-1.74	(3.20)
socialist share of single family houses	0.07	(0.27)	-0.31	(0.64)	-0.04	(0.18)
	2.48	(1.78)	3.35	(1.52)	1.52	(1.20)
competitive tendering, sealed bids	0.31	(1.03)	-0.42	(1.26)	0.21	(0.82)
cost analysis made by the procuring municipality	-0.50	(1.97)	0.64	(2.15)	-0.38	(1.74)
average income	0.73	(0.32)	0.12	(0.04)	0.63	(0.32)
population	-1.03	(1.46)	0.15	(0.11)	-1.49	(2.29)
population density	-0.82	(0.13)	-4.20	(0.45)	-2.94	(0.52)
housing density	5.67	(0.46)	5.80	(0.29)	10.8	(0.98)
constant	-1.47	(0.61)	1.51	(0.57)	-0.63	(0.29)
$\sigma_{u_i v}$	-0.60	(2.89)	-0.40	(0.25)	-0.71	(5.88)
$\sigma_{u_i}$	0.61	(8.95)	0.24	(2.44)	0.54	(10.7)
log likelihood	-131.65		-67.40		-147.64	
$\chi^2$	15.77		30.10		33.13	
significance level	0.003		0.000		0.000	
number of uncensored observations	75		47		122	
number of observations	122		122		122	

Notes. All output variables are in logarithms.

Absolute  $z$ -values within parentheses.

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