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COST SAVINGS OF CONTRACTING OUT REFUSE COLLECTION

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Abstract

The article discusses the possible cost savings of contracting out refuse collection in the Netherlands. According to foreign econometric studies, contracting out refuse collection leads to cost savings of approximately 20%. Our findings indicate that similar cost savings apply to the Netherlands.

However, different production technologies apply to internal or external refuse collection. The Chow test, which examines whether the estimated coefficients on the explanatory variables are the same, reveals that different cost functions have to be estimated for the sub-samples. We show that the postulated cost savings can even be larger, when taking account of effects of different production technologies.

Though significant cost savings exist on contracting out waste collection, households will not experience these cost savings on a one to one basis. Private refuse collection firms must pay VAT while public firms are exempted. At present the Dutch fiscal system hinders a more pronounced role for private refuse collection firms.

1. INTRODUCTION

Contracting out tasks like refuse collection, building cleaning, catering and vehicle maintenance has become an important measure to improve efficiency within the public sector. There is more and more evidence that contracting out certain public services can imply an efficient provision of services well adapted to needs and reduces the costs to tax payers.

In this article, we focus on the effects of contracting out refuse collection. A number of empirical studies are published on the effects of different institutional forms on performance in the waste collection market. The studies estimate the effects of private collection (or contracting out) by estimating a cost function. Generally, these studies show considerable cost savings, if refuse collection is contracted out[1].

Kitchen (1976) estimates a cost decrease of $ 2.23 per capita when private firms collect household waste with data for 48 Canadian municipalities. Observations of 340 public and private firms in the USA, Stevens (1978) indicate a cost decrease of 7% to 30% due to contracting out. The magnitude of the effect depends on the size of the municipality. Domberger *et al.* (1986) published a study on the effects of contracting out household refuse collection in the United Kingdom. Making use of a data set with 610 observations for 305 municipalities, they concluded that there are cost saving of 22% for contracting out to private companies and 17% for contracting in-house. Szymanski and Wilkins (1993) and Szymanski (1996) have confirmed the results, based on an extension (in years) of this UK database.

Though studies are performed for different countries, a study in the Netherlands is missing. We try to fill the gap and show that results of other studies are confirmed if we use comparable estimation techniques. Furthermore, we extend these studies in two directions. First, all cited studies pool observations of waste collection units to estimate the effects of contracting out. With this pooled data set a cost function is estimated and the coefficient of the included institutional dummy reveals the effect of different institutional forms. It is, however, questionable if this pooling is acceptable. Chow (1960) states that: “Often there is no economic rationale in assuming that two relationships are completely the same” (p. 591). In other areas of economics Chow stability tests are used frequently, see e.g. Apergis *et al.* (1997), Lai (1994) and Loomis (1989). The most important application of the Chow stability test is to check for the Lucas critique in time-series. However, checking for different types of models with cross-sectional databases can be important as well.

A priori it is not sure if external firms apply the same waste collection technology as internal firms. External firms handle the collection process from a different perspective while organisational goals differ. Moreover, differences in municipality size can lead to

different collection techniques. For instance, bigger cities have more opportunities to make use of scale economies. If collection techniques are not identical, pooling can lead to biased coefficients. Therefore, if pooling is not justified, different cost functions have to be estimated for each sub-sample. The omission of the checks on the validity of pooling in the mentioned studies may lead to biased estimated effects of contracting out on performance as we will show for the Dutch data. From a policy perspective, it is important that estimations of possible cost savings are accurate.

Secondly, compared with previous studies more emphasis is put on the fiscal system. Due to the Dutch fiscal system there is a disincentive for contracting out. Even though we can estimate significant cost savings when waste collection is contracted out, households will not experience these cost savings on a one to one basis. In the Netherlands private collection firms have to pay VAT while public firms are exempt. Countries such as the United Kingdom and Denmark have a compensating system, in that local authorities are neutral towards contracting out or in-house production. Thus, the current fiscal system in the Netherlands renounce the role for private collection firms.

2. Effects of tendering: Estimations for the Netherlands

Although many foreign econometric studies on effects of contracting out refuse collection have been published, such estimations are not available in the Netherlands. This section is an attempt to fill this gap by estimating a cost function for the Netherlands, making use of a representative data set for Dutch municipalities. To make the results comparable the applied technique in this section corresponds with the studies cited in the previous section. The Chow approach is applied in the next section.

2.1 Procedure

On the basis of previous research (see e.g. Stevens, 1978) the following standard equation is estimated[2]:

$$\ln C = c_1 \ln Q + c_2 \ln I + c_3 \ln D + c_4 F + c_5 G + c_6 P + c_7 V + c_8 E_i + c_9 \qquad (1)$$

The driving forces behind the total collection cost per municipality (C), include a number of variables[3]. First, the number of pick-up points (Q) is expected to determine part of the total cost. This reflects on the cost which a collection unit has to make by the number of stops. Secondly, the time spent at the pick-up stop (more sacks or bins) can determine total cost. These cost are approximated by the number of inhabitants per pick-up point (I). A third driving force is the time to arrive at the different pick-up points. This is approximated by the density variable, surface per pick-up point (D). Fourth, the

frequency of collection (F) is expected to have influence on total collection cost. Furthermore, the percentage of glass (G), paper (P) and vegetable, fruit and garden waste (V) separately collected is included in the estimations.

Last, but not least we included a dummy for the institutional form in which waste is collected (E_i). Main difference of the institutional form is whether waste is collected by the municipality itself or by an external organisation. Within this category we can discriminate between two types on the basis of ownership, i.e. public and private. Public external collectors are a combination of municipalities for which waste is collected by an other municipality and municipalities that formed an independent public organisation. Given the division of institutional forms, three estimations are made for the whole sample; one with a dummy for external collection, one with a dummy for private external collection and one with a dummy for public external collection.

Expected signs are positive for the number of pick-up points, inhabitants per pick-up point, surface per pick-up point and collection frequency and negative for the institutional dummy's, while signs of the coefficients for the percentage collected glass, paper and vegetable, fruit and garden waste are undetermined a priori.

2.2 *Data*

To collect data 120 municipalities were approached in the period November 1996-April 1997. These municipalities were selected at random from 646 Dutch municipalities. A total of 85 municipalities have responded to this inquiry[4], a response rate of 71%. The 85 municipalities responded to an inquiry on the collection of waste in 1996. The resulting database was checked on consistency of answers and the reliability was checked by spot checks on some key answers.

Of the 85 municipalities 41 collect their waste through an external organisation (see table 1). Of the 41 external firms, 13 were public independent organisations while 3 municipalities collect the waste through an other municipality. The remaining 25 municipalities waste collected the waste through a private collection firm. The data are representative for the Netherlands in general. Some 30% of the 218 municipalities have a contract with a private waste collection firm.

Total cost per municipality is measured by multiplying the refuse collection rate(s) by the total number of households. Total cost is diminished by handling cost by multiplying cost per ton with tons recycled (glass and paper), composted (vegetable, fruit and garden waste) and disposed (incineration and dumping).

Table 1. Data estimation cost function, 1996

	Average	Maximum	Minimum	Standard deviation
Total cost (mln. guilders)	3.5	45.1	0.2	5.6
Pick-up points (number)	16386	267000	400	30618
Inhabitants (per pick-up point)	4.0	64.7	1.6	8.1
Density (km^2 p. pick-up point)	11	93	1	15
Frequency (>1/week, dummy)	0.19	1.00	0.00	0.39
Glass (%)	3.2	11.1	0.0	3.0
Paper (%)	6.6	29.7	0.0	7.5
VFG (%)	28.4	47.4	0.0	9.9
External (dummy)	0.48	1.00	0.00	0.50
Private external (dummy)	0.29	1.00	0.00	0.46
Public external (dummy)	0.19	1.00	0.00	0.39

VFG = vegetable, fruit and garden waste.

2.3 Fiscal aspects

A lot of attention has been drawn to the distortionary aspects of taxation (see Atkinson and Stiglitz, 1980). For the central question in this article taxation can be crucial. The present fiscal regime distorts the decision process in the Netherlands with respect to public versus private waste collection. Reason for the distortion is the exemption of VAT for the public sector and non-profit institutions. Private refuse collection is faced with a VAT rate of 17,5%, while public organisations are exempted from VAT. Therefore, a municipality in the Netherlands is biased towards in-house production.

A possibility to resolve this inequality could be to asses public refuse collection as a business activity and thus tax them with VAT. This policy has been introduced to enterprise agencies and public utilities such as telecommunications. An other possibility to alleviate the burden is make provisions to local companies for refuse collection. Since 1972 such a system has been introduced in the United Kingdom. Local authorities that make any taxable supplies in the course for the furtherance of business are liable to be

registered for VAT whatever the business of its supplies. For administrative reasons the list of exempted activities is not exhaustive. Due to this system there is a level playing field between private and public refuse collectors. From a welfare point of view there seems to be good reasons to have such a system, because the tax system is neutral. Denmark has a budgetary system to correct the tax distortion. In the United States this distortion is not important, because the sales tax is usually levied at the retail level (Davis and Meyer, 1983). Therefore, this point has not been raised in the reviewed literature in the previous section.

The difference in fiscal treatment can not be neglected for the Dutch data set for a proper analysis. In general the municipality cost for private companies are 17,5% higher compared to public companies. However, the cost for a private company are 17,5% lower and in this respect the data set has been corrected.

2.4 Results

Results are presented in table 2. The F-statistic shows that all the estimated equations are significant, while high (adjusted) R^2's indicate that the explained variation is high. All coefficients have the expected sign. T-statistics are not corrected for heteroscedasticity as the White test (White, 1980) could not reject the homoscedasticity hypothesis for all estimations with 5% confidence.

The number of pick-up points has a significant impact on the total collection cost. A Wald test of coefficient restrictions (Pindyck and Rubinfeld, 1991) does not falsify the constant returns to scale hypothesis. This result confirms earlier results from Collins and Downes (1977) and Hirsch (1965), while Stevens (1978) found also constant returns to scale for the large cities. Decreasing returns to scale were found by Domberger *et al.* (1986) and increasing returns to scale in Szymanski and Wilkins (1993), but coefficients were very close to one. Kitchen's (1976) inverted U-shaped average cost curve result was not confirmed since inclusion of a quadratic term was falsified with an F-test on 1% confidence.

The number of inhabitants per pick-up point, the pick-up frequency and the percentage of collected vegetable, fruit and garden waste have a significant impact on total cost. If the number of inhabitants per pick-up points increases with 1%, the total cost will rise with the same percentage. A higher pick-up frequency leads to 19-22% higher cost. Total cost decrease if more vegetable, fruit and garden waste are collected. It may be due to a scale effect as vegetable, fruit and garden waste is collected on a one bin per household while the number of bins per household is fixed.

Table 2. Estimation results Cost functions, 1996

		Public and private external	Private external	Public external
Pick-up points	ln	1.052	1.073	1.080
		(20.90)	(21.91)	(21.57)
Inhabitants per point	ln	1.004	1.034	1.037
		(12.34)	(12.87)	(12.55)
Density (km^2 per point)	ln	0.009	0.016	0.019
		(0.23)	(0.39)	(0.46)
Frequency	dummy	0.174	0.198	0.191
		(2.07)	(2.35)	(2.22)
Glass	%	0.019	0.018	0.020
		(1.41)	(1.29)	(1.46)
Paper	%	-0.008	-0.006	-0.009
		(-1.40)	(-1.14)	(-1.59)
VFG	%	-0.010	-0.010	-0.013
		(-2.26)	(-2.10)	(-2.84)
Private and public external	dummy	-0.163	-	-
		(-2.18)		
Private external	dummy	-	-0.136	-
			(-1.69)	
Public external	dummy	-	-	-0.057
				(-0.65)
Constant		4.13	3.84	3.84
		(6.96)	(6.67)	(6.39)
R^2		0.93	0.92	0.92
F-value		132.30	128.98	124.71
White (probability homoskedasticity)		0.41	0.21	0.46

Below coefficients are t-statistics. VFG = vegetable, fruit and garden waste.

The results for the different institutional forms are of interest. External collection leads to a 15% lower total cost. A striking result is that private collection is somewhat more expensive with total cost some 13% lower on average. Given the standard errors both results are not significant different. However, the other institutional form, collection by a public external organisation, has no significant influence on total cost. This indicates that total cost are lower for private compared to other external institutional forms.

Compared to Domberger *et al.* (1986) and Szymanski (1993) effects of changing institutional forms are somewhat lower but of the same order. Maybe competition in the Netherlands is somewhat less stringent since the private firms are not numerous. Private collection in the Netherlands is controlled by three firms only with some small local private collection firms.

An important result from our findings is that the difference in fiscal treatment between private and public 'firms' hampers tendering on the waste collection market[5]. Tendering to a private firm will not result in significant effects on tariffs paid by households. Currently, local governments are free to decide either to collect the waste by themselves or to tender the job. Incentives to local politicians will therefore not automatically result in a possible decrease in social cost of waste collection.

3. ROBUSTNESS OF RESULTS

Szymanski and Wilkins (1993) adopted a two-stage approach to control for sample selection bias. They had two reasons to suspect that sample selection bias could be a problem for their estimations. First, they estimated a cost function for a data set including different years while the response rate in 1988 was significant lower than in other years. This may be due to the introduction of compulsory competitive tendering in that year. Moreover, they suspected that authorities which performed a successful competitive tender were certainly keen to report, whereas an inefficient controlled authority did not likely to report (p. 117). As we do not have an indication that comparable problems exist in the Netherlands, we assume that sample selection bias is not a problem for our estimations.

Stevens (1978) tested for the validity of pooling the different municipalities in one sample. She concluded that different estimations have to be made for a few municipality size classes, but that pooling of the private and public collection firms was valid. Also Ganley and Grahl (1988), in a reaction to Domberger *et al.* (1986), emphasise to make a difference between urban and rural municipalities, without funding this on econometrics. Domberger *et al.* (1988) state in their reply that the included dummy for rural versus urban municipalities solves this problem. However, they did not check explicitly the

validity of pooling the observations.

Chow (1960) made clear that testing for the validity of pooling observations is possible (see also Fisher, 1970). As unjust pooling of observations can lead to biased estimated coefficients this validity check is also necessary. Therefore, we checked the validity of pooling the observations for the Dutch data set with respect to municipality size and the different institutional forms, making use of the Chow test[6].

Testing for the hypothesis that breakpoints exist with respect to small, mid-size and large municipalities reveal that this hypothesis can not be rejected (see table 3). The impossibility to reject the breakpoint hypothesis with respect to municipality size could be due to the relative inflexible Cobb-Douglas form of the production function. However, testing for size breakpoints with a more flexible translog form holds the same conclusions[7]. Moreover, a breakpoint hypothesis with respect to the different institutional forms can not be rejected. The probability that no breakpoints exist for all three organisation forms is less than 5%[8]. This means that different cost functions must be estimated for the three institutional forms. For reasons of both types of breakpoints, our estimates in the previous section could be biased.

Table 3. Chow breakpoint test cost function Netherlands, 1996

	No breakpoint hypothesis		
Breakpoint between rest versus:	F-statistic	Probability	Conclusion
Public and private external collection	2.98	0.01	breakpoint
Private external collection	1.93	0.07	no breakpoint
Public versus private external collection	1.98	0.03	breakpoints
< 20,000 inhabitants	3.58	0.00	breakpoint
< 40,000 inhabitants	0.30	0.96	no breakpoint
> 20,000 and < 40,000 inhabitants	2.02	0.03	breakpoints

Combination of the two different breakpoint tests results in 6 sub-sample estimations. As our sample includes only 85 municipalities the estimations would become meaningless. Therefore, we follow a three-step approach. First, we take into account the effects of pooling the three sub-samples related to institutional form by estimating three equations. Secondly, we test these equations for the validity of pooling the observations with respect to municipality size. Third, we make some calculations based on non-parametric methods to estimate the effect of institutional form on cost.

Table 4 reveals the effects of sub-sampling on the basis of the different institutional forms. Comparing the coefficients for the estimated equations clearly reveals that they are significantly different. Apparently, internal, public and private external waste collectors have a different production technology. Though coefficients for the number of pick-up points are not significantly different, for all three institutional forms the constant returns to scale hypothesis could not be rejected, these results indicate that external firms make more use of economies of scale. This is not surprising as municipal waste collectors are bounded on their borders. The number of inhabitants per pick-up point is significant in the 'internal' equation, while they have no significant effect on the cost of the different external firms. This applies also for the relative part of vegetable, fruit and garden refuse in total waste.

We tested the three estimated equations for the validity of pooling the observations with respect to municipality size, again with a Chow test. Table 5 summarises the results. Each equation was tested for breakpoints, the number of tests only limited by the number of observations. Reported is the maximal F-statistic found per equation. For the equations for private external and internal waste collectors the Chow breakpoint test reveals that the no-breakpoint hypothesis could not be rejected. Therefore, we conclude that pooling with respect to municipality size was valid for these cases. Due to the low number of observations, the equation for public external collectors could not be tested for breakpoints.

While the samples are now homogenous for institutional form, it is not possible to include a dummy for this variable in the estimations. Non-parametric comparison however can give an indication of possible cost differences between the samples. The estimated equations can be used to predict the development of cost when the institutional form is changed. Total cost for municipal collectors if they are contracted out can be predicted with the estimated equation for private collectors, making use of the known variables for municipal collectors.

Predictions using the estimated equations based on sub-samples confirms the cost decrease effect of changing the institutional form to a more market related direction. Contracting out would yield an average cost decrease of 14.8% (see table 6). This indicates that invalid pooling could underestimate the effect of private collection by 2%. The underestimation is much greater if we look at the predicted cost decrease if the institutional form of internal waste collectors is changed to public external. In that case the estimated cost decrease was 5.5%, while our prediction is 13.9%. Of interest is the prediction for internalising external firms. Apparently municipalities that collect waste by means of contracting out have a very good reason for doing that as the predicted average cost increase is large.

Table 4. Estimation results cost functions, different institutional forms, 1996

		Public Internal	Private external	Public external
Pick-up points	ln	1.103	1.044	0.964
		(15.86)	(8.28)	(12.21)
Inhabitants per point	ln	1.100	-1.333	-2.047
		(12.49)	(-0.47)	(-1.94)
Density (km^2 per point)	ln	-0.000	0.109	-0.015
		(-0.00)	(0.87)	(-0.16)
Frequency	dummy	0.137	0.209	0.109
		(1.50)	(1.03)	(0.34)
Glass	%	0.014	-0.017	0.015
		(0.67)	(-0.64)	(0.54)
Paper	%	-0.004	-0.010	0.002
		(-0.49)	(-0.96)	(0.28)
VFG	%	-0.012	-0.010	0.004
		(-2.13)	(-0.91)	(0.37)
Constant		3.593	5.265	7.259
		(4.59)	(3.65)	(4.54)
R^2		0.91	0.80	0.98
F-value		61.78	14.52	109.55
White (probability homoskedasticity)		0.22	0.55	0.66
Number of observations		44	25	16

Below coefficients are t-statistics. VFG = vegetable, fruit and garden waste.

The essential assumption behind the forecasting procedure is that estimated coefficients can still be used as the sample is expanded. If municipalities have characteristics that are very different, predictions can be biased. Therefore, we include also predictions which take into account that large deviations between predicted and current cost can be caused by deviating characteristics[9]. The general picture is not

Table 5. Chow breakpoint test cost function, institutional sample, 1996

Estimation:	Inhabitants:	Maximal F - statistic	Probability (no breakpoint)
Private external	19,000	2.17	0.13
Public external	n.a.	n.a.	n.a.
Internal	27,500	1.70	0.14

n.a. Breakpoint test not avaibable for public external collection due to the low number of observations.

Table 6. Estimated cost increases and institutional change

		Average cost increase in percentage total cost		Percentage of observations with cost increases	
		All	Excluding deviations more than 40%	All	Excluding deviations more than 40%
External	→ Internal	17.2	2.0	61.0	51.7
Private	→ Internal	19.3	3.7	64.0	55.6
Public	→ Internal	14.0	-0.7	56.3	45.5
Internal	→ Private	-14.8	-9.3	25.0	26.5
Public	→ Private	3.4	-5.5	37.5	25.0
Internal + public	→ Private	-9.9	-8.3	28.3	26.1
Internal	→ Public	-13.9	-8.5	31.8	31.3

changing in that case, although not surprisingly, the magnitude of the effects is different. Especially the prediction for internalising is dominated by some observations with high cost increases. Of interest is the result for internalising public collection firms, since the sign of the prediction changes. However, it may be due to the low number of observations in this sub-sample.

4. Conclusions

While empirical research on the effects of changes in institutional form on the waste collection market for the Netherlands is missing, this paper fills in the gap. Our results, based on generally used techniques, confirm the results of earlier studies, i.e. contracting out refuse collection results in lower cost.

However, estimations based on the whole sample can be biased. Testing for breakpoints reveals that waste collectors in smaller, medium and big municipalities have different production technologies. This also applies for different institutional forms. The use of the different estimated equations for the sub-samples based on institutional form reveals that contracting out could have a stronger effect on total cost as presently assumed in literature. The generally applied techniques therefore underestimates the effect of contracting out waste collection on cost. In view of the relative low number of observations, it would be interesting to test these conclusions on a more extensive database.

The fiscal system in the Netherlands hinders a more profound role for private waste collection as households will not benefit of the possible cost decreases. The burden of higher taxes for private firms counteracts the efficiency improvements. A level playing field would further stimulate the role of private waste collection.

Notes

1. Some studies only compare the average cost for private versus public collection on the basis of ratio analysis, see e.g. Savas (1977 and 1981) and McDavid (1985) or Data Envelopment Analysis, see e.g. Cubbin *et al.* (1987). However, these methods are too simple, because they fail to account for the effects in changes in other variables. By estimating a cost function, institutional effects but also other factors as the frequencies of collection, density and the distance to the nearest disposal site can be taken into account. Therefore, we rely on this method in this article.

2. Based on a Cobb-Douglas production technique and minimisation of a total cost function.

3. No price variables for the different inputs are included, because no reason exists ex ante why factor prices would differ between municipalities.

4. In 1996 four municipalities were absorbed by another, 31 municipalities refused to participate or did not meet the time-schedule.

5. The corrections made because of the difference in tax treatment (17.5%) could be too high as public collectors can not deduct paid VAT on inputs. This paid VAT is part of the price consumers pay for the collection of waste. However, inputs with a VAT obligation are very low in total cost. For example total cost for collection trucks are only about 10% of total collection cost. This would result in a 1.75% point lower difference in effective VAT rates between public and private waste collectors. Moreover, the obligation for private firms to pay profit tax would diminish this difference as capital cost rise.
   Regressions with a 1% point lower effective VAT rate for private firms show only very small differences in coefficients for the institutional dummy's. Even a 10% point lower effective VAT rate for private firms results in a significant cost decrease if waste is collected by an external firm.

6. Toyoda (1974) and Schmidt and Sickles (1977) showed that the Chow test for equality of regression coefficients is not robust to heteroscedasticity. Then other tests can be applied (see e.g. Thursby, 1992) Fortunately, the homoscedasticity hypothesis is not rejected for our

estimations.

7. The translog cost function has exactly the number of parameters required for a flexible functional form, see e.g. Diewert (1987).

8. Although a breakpoint is rejected at the 5% level for private collection versus other institutional forms, a breakpoint between private collection, public collection and internal collection could not be rejected.

9. Note that Domberger *et al.* (1988) also found very large deviations in cost between public and private collectors.

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