Chapter 2
Cost Savings of Contracting Out Refuse Collection in The Netherlands

E. Dijkgraaf and R.H.J.M. Gradus

Abstract This chapter discusses the possible cost savings of contracting out refuse collection in the Netherlands. Our findings indicate that similar to foreign econometric studies cost savings of approximately 15–20% apply to the Netherlands. Moreover, compared with the existing literature we show that different production technologies apply to internal municipal waste collection units and external refuse collection firms. Different cost functions have to be estimated for the sub-samples. 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 entities are exempted. Thus, the fiscal system hinders a more pronounced role for private refuse collection firms.

Keywords Collection · cost estimation · chow stability test · pooling · VAT

2.1 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 much 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 an overview article Domberger and Jensen (1997) show that contracting out suggests cost savings in order of twenty percent without sacrificing the quality of service provided for a number of government services.

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In this chapter, 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. Pommorehne and Frey (1977) study refuse collection in Switzerland and again the private sector comes up with lower costs that amounted to 20%. 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 savings 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 database. Ohlsson (1998) reports comparable efficiency gains of contracting out for Sweden. Bosch, Predaja, and Suárez-Pandiello (2000) analyze Spanish data for 73 municipalities in Catalonia. They pointed out that the framework for which the service is provided is more relevant than the public private dichotomy. In a recent contribution Reeves and Barrow (2000) pointed out cost savings of around 45% in Ireland.

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, with the exception of Stevens (1978) all cited studies pool observations of waste collection units with respect to institutional forms 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, Papanastasiou, and Velentzas (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.

[1] Some studies only compare the average cost for private versus public collection on the basis of ratio analysis, see e.g. Savas (1977, 1981) and McDavid (1985) or Data Envelopment Analysis, see e.g. Cubbin, Domberger, and Meadowcroft (1987). However, these methods fail to account for the effects in changes of other variables. By estimating a cost function, institutional effects but also other factors as the frequency of collection and density of the infrastructure can be taken into account. Therefore, we rely on this method in this chapter.

A priori it is not sure whether external refuse collection firms (outside firms) apply the same waste collection technology as internal municipal waste collection units (inside firms). Outside firms handle the collection process from a different perspective while organizational goals also 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 production 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. 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 tax-neutral toward contracting outside or inside. Thus, the current fiscal system in the Netherlands renounces the role for private collection firms.

2.2 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, 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 stability test is applied in the next section.

2.2.1 Method

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

$$C = \alpha_1 Q + \alpha_2 I + \alpha_3 D + \alpha_4 F + \alpha_5 G + \alpha_6 P + \alpha_7 V + \alpha_8 O + \alpha_9 \quad (2.1)$$

The driving forces behind the (logarithm of) 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

[2] Based on a Cobb-Douglas production technique and minimization 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.

unit has to make by the number of stops. Secondly, the time spent at the pick-up stop (more bags or bins) can determine total cost. The number of inhabitants per pick-up point (I) approximates these costs. A third driving force is the time to arrive at the different pick-up points. The density variable, surface per pick-up point (D), approximates this. Fourth, the frequency of collection (F) is expected to have influence on total collection cost and is therefore included. Furthermore, the percentage of glass (G), paper (P) and vegetable, fruit and garden waste (V) separately collected is included in the estimations.

Furthermore, we include a dummy for the institutional form in which waste is collected (O). Main difference of the institutional form is whether waste is collected by the municipality itself or outside. Within this category we can discriminate between two types on the basis of ownership, i.e. public and private. Public outside collectors are a combination of municipalities for which waste is collected by an other municipality and municipalities that formed an independent public organization. Given the division of institutional forms, the basic model is tested whether the ownership of the outside collection service does matter.

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.

2.2.2 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, a response rate of 71%.[4] 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 key answers.

Of the 85 municipalities 41 collect their waste not inside, but trough an outside organization (see Table 2.1). Of the 41 outside firms, 13 were public independent organizations while 3 municipalities collect the waste through an other municipality. The remaining 25 municipalities collected the waste through a private 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).

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[4] In 1996 four municipalities were absorbed by another, 31 municipalities did not participate in this inquiry.

Table 2.1 Data description

	Average	Maximum	Minimum	St.dev.
Total cost (million euro)	1.6	20.5	0.1	2.5
Pick-up points (number)	16,386	267,000	400	3,0618
Inhabitants (per pick-up point)	4.0	64.7	1.6	8.1
Density (km^2 per pick-up point)	11	93	1	15
Frequency (>1 per 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 (%)[a]	28.4	47.4	0.0	9.9
Outside collection (dummy)	0.48	1.00	0.00	0.50
Private outside collection (dummy)	0.29	1.00	0.00	0.46
Public outside collection (dummy)	0.19	1.00	0.00	0.39

Note: [a] VFG = vegetable, fruit and garden waste

2.2.3 Fiscal Aspects

A lot of attention has been drawn to the distortionary aspects of taxation for all kind of commodities (see Atkinson and Stiglitz, 1980). For the central question in this chapter taxation can also be crucial. The fiscal regime distorts the decision process in the Netherlands with respect to public versus private waste collection (see Wassenaar, 2001). Private refuse collection is faced with a VAT rate of 19%, while public organizations are exempted from VAT. Therefore, a municipality in the Netherlands is biased toward inside production, because then refuse collection is exempted from VAT.

A possibility to resolve this inequality could be to assess public refuse collection as a business activity and thus tax them with VAT. This policy has been introduced to public companies such as telecommunications. However, taxing refuse collection by municipalities is not allowed according to EU laws. The other extreme, introducing a VAT exemption for enterprises is also not allowed.

The ministry of Finance has been working on a system to create a VAT compensation fund for public waste collectors (Wassenaar and Gradus, 2001). In line with a system already working in United Kingdom, all VAT a municipality has to pay will be refunded. In that case a municipality that decides to contract out the waste collection to a VAT liable firm will be compensated for the VAT the firm has to pay. Thus, contracting out decisions by a municipality are no longer distorted by the VAT difference between public and private firms.

The difference in fiscal treatment cannot be neglected for the Dutch data set for a proper analysis. The municipality cost for private companies are 19% higher compared to public companies. However, the costs for a private company are 19% lower and in this respect the cost data are corrected.[5] Thus, the VAT component is subtracted from the total cost for private firms.

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[5] A the cost data are for the fiscal year 1996, the VAT correction is based on the tariff of that year (17.5%).

2.2.4 Results

Results for the basis model are presented in the first column of Table 2.2. The F-statistic shows that the equation is significant, while the high (adjusted) R^2 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 95% 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 Reeves and Barrow (2000), 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 Bosch, Predaja, and Suárez-Pandiello (2000) and 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 95% confidence.

Table 2.2 Estimation results cost functions

		Dummy for outside collection	Dummy for outside and private outside collection
Pick-up points	ln	1.052	1.052
		(20.90)	(20.81)
Inhabitants per point	ln	1.004	1.007
		(12.34)	(12.29)
Density (km^2 per point)	ln	0.009	0.010
		(0.23)	(0.24)
Frequency	dummy	0.174	0.177
		(2.07)	(2.10)
Glass	%	0.019	0.018
		(1.41)	(1.36)
Paper	%	−0.008	−0.007
		(−1.40)	(−1.25)
VFG	%	−0.010	−0.010
		(−2.26)	(−2.06)
Private and public outside	dummy	−0.163	−0.134
		(−2.18)	(−1.44)
Private outside	dummy	–	−0.051
			(−0.50)
Constant		4.13	4.10
		(6.96)	(6.84)
R^2		0.93	0.93
F-value		132.30	116.48
Log likelihood		−11.36	−11.22
White (prob. Homoscedasticity)		0.41	0.40
Number of observations		85	85

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

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% 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.

The dummy for outside collection is significant. On average outside provision leads to 15% lower total cost.[6] In the second column the hypothesis is tested whether private outside collection does have an effect on total cost above that of outside provision. The negative coefficient implies that on average private collection is 5% cheaper than public collection. However, the basic model, without an ownership dummy, is not rejected on the basis of a Log-likelihood-ratio test (test statistic is 0.28). Furthermore, the dummy for ownership is not significant, while the coefficient for outside provision in the extended model does not differ from the basic model (using a Wald-test). Thus, we can conclude that the choice between outside and inside provision is more important than the ownership of the collection service. Competition seems to have more effects than the ownership issue. This is consistent with the literature (see Domberger and Jensen, 1997).

Compared to Domberger et al. (1986) and Szymanski (1996) 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. Three firms with only some small local private collection firms dominate private collection in the Netherlands.

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.[7] Tendering to a private firm will not result in significant effects on tariffs paid by households. Dutch local governments are free to decide either to collect the waste by themselves or to tender the job. However, from January 2003 a VAT compensation fund is present for public waste collectors. According to our results this initiative will lead to a decrease in social cost of waste collection.

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[6] Calculated as e^x-1, where x is the value of the estimation for the dummy for outside provision.

[7] 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 outside firm.

2.3 Robustness of Results

As Ganley and Grahl (1988) make clear the results for institutional dummies can be influence by specific observations that perform much better or worse than expected. Therefore, we tested whether our result for the outside dummy remains robust when we skip municipalities with much lower or higher cost than expected. By iteration we excluded municipalities with a higher deviation of predicted to real cost than 30%. The outside dummy remains significant (but now even at 99%), while the coefficient remains robust.

An other point to investigate is whether the estimations depend on extreme small or big municipalities. Therefore, we tested whether a dummy for very big or small municipalities should be added to our basic model. Using a Log-likelihood-ratio test the basic model is not rejected.

Szymanski and Wilkins (1993) test for sample selection bias. They have two reasons to suspect that sample selection bias could be a problem for their estimations. First, they estimate 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 suspect 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 crucial problem. Furthermore, Szymanski and Wilkins (1993) found that there model without corrections for sample selection bias is not rejected.

Stevens (1978) tested for the validity of pooling the different municipalities in one sample. She concludes 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), emphasize to make a difference between urban and rural municipalities. Domberger, Meadowcroft, and Thompson, (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 Fischer, 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.[8]

Testing for the hypothesis that breakpoints exist with respect to small, mid-size and large municipalities reveal that this hypothesis cannot be rejected

[8] 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.

Table 2.3 Chow breakpoint test cost function Netherlands

Breakpoint between rest versus:	No breakpoint hypothesis		
	F-statistic	Probability	Conclusion
Public and private outside collection	2.98	0.01	breakpoint
Private outside collection	1.93	0.07	no breakpoint
Public versus private outside 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

(see Table 2.3). 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.[9] Moreover, a breakpoint hypothesis with respect to the different institutional forms cannot be rejected. The probability that no breakpoints exist for all three organization forms is less than 5%.[10] 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.

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 nonparametric methods to estimate the effect of institutional form on cost.

Table 2.4 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, inside, public and private outside waste collectors have a different production technology. These results give an indication that outside firms can make more use of economies of scale. This is not surprising as municipal waste collectors are bounded on their borders. Outside waste collection firms are more flexible as they can combine the collection of different municipalities. The number of inhabitants per pick-up point is significant in the 'inside' equation, while they have no significant effect on the cost of the different outside firms. This applies also for the relative part of vegetable, fruit and garden refuse in total waste.

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

[10] Although a breakpoint is rejected at the 95% level for private collection versus other institutional forms, a breakpoint between private outside collection, public outside collection and inside collection could not be rejected.

Table 2.4 Estimation results cost function, different institutional forms

		Inside	Private outside	Public outside
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 homoscedasticity)		0.22	0.55	0.66
Number of observations		44	25	16

Note: Below coefficients are t-statistics. VFG = vegetable, fruit and garden 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 2.5 summarizes 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 outside and inside 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 outside 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. Nonparametric 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

Table 2.5 Chow breakpoint test cost function, institutional sample

Estimation:	Inhabitants:	Maximal F-statistic	Probability (no breakpoint)
Private outside	19,000	2.17	0.13
Public outside[a]	na	na	na
Inside	27,500	1.70	0.14

[a] Breakpoint test is not available due to low number of observations

Table 2.6 Estimated cost increases and institutional change (% total cost)

From outside	to	inside	17.2
From private outside	to	inside	19.3
From public outside	to	inside	14.0
From inside	to	private outside	−14.8
From public outside	to	private outside	3.4
From inside + public outside	to	private outside	−9.9
From inside	to	public outside	−13.9

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 confirm the cost decrease effect of changing the institutional form to a more market related direction. Contracting out the inside collection to a private firm would yield an average cost decrease of 14.8% (see Table 2.6). This is almost exactly what we found with the pooled estimation for the basic model. If the institutional form of inside waste collectors is changed to public outside the estimated cost decrease is 13.9%, only 1% lower than we found earlier. Of interest is the prediction for bringing outside firms inside. Apparently municipalities that collect waste by means of contracting outside have a very good reason for doing that as the predicted average cost increase is large.

2.4 Conclusions

While empirical research on the effects of changes in institutional form on the waste collection market for the Netherlands is missing, this chapter fills in the gap. Our results confirm the results of earlier studies, i.e. contracting out refuse collection results in lower cost of 15–20%. Moreover, we can conclude that the choice between outside and inside provision is more important than the ownership of the collection service. Competition seems to have more effects than the ownership issue.

The statistical analysis indicates that waste collectors in smaller, medium and big municipalities have different production technologies. This also applies for different institutional forms. As more flexibility exist with respect to combining the collection of different municipalities, outside firms can make more use of economies of scale.

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 VAT compensation fund would further stimulate the role of private waste collection. The current actions taken by the Ministry of Finance to correct the VAT difference between public and private firms are necessary to stimulate a fair choice between the real advantages and disadvantages of contracting out.

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References List

Apergis, N., Papanastasiou, J., & Velentzas K (1997). The credibility of policy announcements: Greek evidence. *Applied Economics, 29,* 699–705.

Atkinson, A. B., & Stiglitz, J. E. (1980). *Lectures on public economics*. London: McGraw-Hill.

Bosch, N., Predaja, F., & Suárez-Pandiello, J. (2000). Measuring the efficiency of Spanish municipal refuse collection services. *Local Government Studies*, 26, 71–90

Chow, G. C. (1960). Tests of equality between sets of coefficients in two linear regressions. *Econometrica*, 28, 591–605

Collins, J. N., & Downes, B. T. (1977). The effects of size on the provision of public services: The case of solid waste collection in smaller cities. *Urban Affairs Quarterly,* 12, 333–347.

Cubbin, J., Domberger, S., Meadowcroft, S. (1987). Competitive tendering and refuse collection: Identifying the sources of efficiency gains. *Fiscal Studies*, 8, 49–58.

Diewert, W. E. (1987). Cost functions. In: J. Eatwell, M. Milgate, & P. Newman (Eds.), *The new Palgrave, a dictionary of economics* (pp. 690–696). London: MacMillan.

Domberger, S., & Jensen, P. (1997). Contracting out by the public sector: theory, evidence and prospects. *Oxford Review of Economic Policy,* 4, 67–78.

Domberger, S., Meadowcroft, S., & Thompson, D. (1986). Competitive tendering and efficiency: The case of refuse collection. *Fiscal Studies*, 7, 69–87.

Domberger, S., Meadowcroft, S., & Thompson, D. (1988) Competition and efficiency in refuse collection: A reply. *Fiscal Studies*, 9, 86–90.

Fisher, F. M. (1970). Tests of equality between sets of coefficients in two linear regressions: An expository note. *Econometrica*, 38, 361–366.

Ganley, J., & Grahl, J. (1988). Competition and efficiency in refuse collection: A critical comment. *Fiscal Studies*, 9, 80–85.

Hirsch, W. Z. (1965, February) Cost functions of an urban government service: refuse collection. *Review of Economics and Statistics*, 47, 87–92.

Kitchen, H. M. (1976). A statistical estimation of an operating cost function for municipal refuse collection. *Public Finance Quarterly*, 4, 43–72.

Lai, C. C. (1994) Market structure and inter-industry profit differences in Taiwan. *Pakistan Development Review*, 33, 147–163.

Loomis, J. B. (1989). Test-retest reliability of the contingent valuation method: A comparison of general population and visitor responses. *American Journal of Agricultural Economics*, 71, 76–84.

McDavid, J. (1985, Sept/Oct). The Canadian experience with privatising residential solid waste collection services. *Public Administration Review*, 45, 602–608.

Ohlsson, H. (1998). Ownership and Production Costs: Choosing between Public Production and Contracting Out. Uppsala University working paper 6.

Pindyck, R. S., & Rubinfeld, D. L. (1991). *Econometric models & economic forecasts*. New-York: McGraw-Hill.

Pommorehne, W. W., & Frey, B. S. (1977). Public versus private production efficiency in Switzerland: A theoretical and empirical comparison. *Urban Affairs Annual Review*, 12, 221–241.

Reeves, E., & Barrow, M. (2000). The impact of contracting out on the costs of refuse collection services: The case of Ireland. *Economic and Social Review*, 31, 129–150.

Savas, E. (1977). Policy analysis for local government: Public vs. private refuse collection. *Policy Analysis*, 3, 49–74.

Savas, E. (1981). Intracity competition between public and private delivery. *Public Administration Review*, 41, 46–52.

Schmidt, P., & Sickles, R. (1977). Some further evidence on the use of the Chow test under heteroscedasticity. *Econometrica*, 45, 1293–1298.

Stevens, B. J. (1978). Scale, market structure and the cost of refuse collection. *Review of Economics and Statistics*, 60, 438–448.

Szymanski, S., & Wilkins, S. (1993). Cheap rubbish? Competitive tendering and contracting out in refuse collection – 1981–1988. *Fiscal Studies*, 14, 109–130.

Szymanski, S. (1996). The impact of compulsory competitive tendering on refuse collection services. *Fiscal Studies*, 17, 1–19.

Thursby, J. G. (1992). A comparison of several exact and approximate tests for structural shift under heteroscedasticity. *Journal of Econometrics*, 53, 363–386.

Toyoda, T. (1974). Use of the Chow test under heteroscedasticity. *Econometrica*, 42, 601–608.

Wassenaar, M. C., & Gradus, R. H. J. M. (2001). *Contracting out: the importance of a level playing field* (Research Memorandum 0108). Erasmus University Rotterdam.

White, H. (1980). A heteroskedasticity-consistent covariance estimator and a direct test for heteroskedasticity. *Econometrica*, 48, 817–838