Collusion in the Dutch waste collection market

31 January 2005

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

Abstract:

In this paper we analyse whether collusion exists in the Dutch waste collection market, which shows a high degree of concentration. Although scale effects might be in accordance with this market outcome, the question is whether this concentration is in fact a result of fair competition. Using data for (nearly) all Dutch municipalities we estimate whether collusion exists and what the impact is on tariffs for waste collection. The results indicate that high concentration increases prices and therefore (partly) offsets the advantage of contracting out. The presence of competing public firms might be essential to ensure more and fair competition.

Keywords: Waste collection, collusion, public-private firms, contracting out

JEL-codes: D 43, L 33, R 51

*SEOR-ECRi and Rotterdam School of Economics, Erasmus University Rotterdam, Room H 6-21, P.O. Box 1738, 3000 DR Rotterdam, The Netherlands,

Tel: +31 10 4082590 Fax: +31 10 4089650

Email: dijkgraaf@few.eur.nl Web: www.ecri.nl

**Vrije Universiteit Amsterdam, ECRi (Erasmus University Rotterdam) and Ministry of Social Affairs and Employment

Acknowledgements: We thank M. Allers and G. Bel for comments on an earlier version.

I. 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 seems 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. However, contracting out does not come without costs, the most important being transaction costs (Domberger and Jensen [1997]). Nevertheless, for refuse collection these costs seem manageable, because the asset specificity is low and quality is easily measurable. Therefore, Domberger and Jensen [1997] conclude that contracting out refuse collection suggests cost savings in order of twenty percent without sacrificing the quality of service.

Recently, we investigated the effects of changes in institutional form on the waste collection market for the Netherlands (Dijkgraaf and Gradus [2003]). Based on data for 85 municipalities, 15% lower costs are found if waste collection is contracted out, which is in line with the literature. Moreover, we found proof that collection by a public firm results in costs comparable to private collection. From this perspective, contracting out to a public or private organisation seems more important than the ownership issue.

Due to the large costs advantages the use of private collectors seems relatively scarce. In the United Kingdom, 30 percent of the contracts for municipal refuse collection are placed privately (Szymanski [1996]). In the Netherlands, 37 percent of the municipalities in 2002 use private firms. However, because Dutch private collectors are especially active in small villages, only 26 percent of total tonnage is in private hands. For Sweden and Ireland similar pictures can be given (e.g. for Sweden Ohlsson [2003] and for Ireland Reeves and Barrow [2000]). Therefore, in recent years political-economy papers have empirically studied the factors that induce or deter privatisation for services

as refuse collection (see for example Lopez-de-Silanes et al. [1997] for the United States, Bel and Miralles [2003] for Spain, Dijkgraaf et al. [2003] for the Netherlands, Ohlsson [2003] for Sweden and Christoffersen and Paldam [2003] for Denmark)). A more general finding of this political-economy literature is that there seem not much ideological biases influencing politician's decision, so that the decision of the municipality is pragmatic and not ideological.

Moreover, some politicians are reluctant to privatisation simply because they do not foresee relevant cost savings. A possible explanation is that initial savings given by privatisation are disappearing over time; this seems especially to be true for small municipalities (e.g. Ballard and Warner [2000]). Another more important explanation could be that the market place for refuse collection is likely to become monopolised. For this thesis there is some evidence for the United States. In his seminal IO-textbook Shepherd [1997, p. 342] stresses that as a result of the high market share of BFI and WMX "effective competition in it may simple not be viable". Bel and Costas [2004] show the market share of the leading private firms in Catalonia is above fifty percent. Moreover, Reimer [1999] finds a tendency to concentration in this service in the UK. Therefore, Warner and Hebdon [2001] emphasise the idea that privatisation is just one of the tools the local politicians has in order to face a demand for a more efficient government. Hence, more attention should be paid to the ability to reform public units that produce services.

In order to evaluate the issues described above, the Dutch market for refuse collection is analysed in this paper. It is shown that a high degree of market concentration may weaken competition and, therefore, makes it difficult for some local governments to effectively obtain benefits from contracting out. Therefore, it is worthwhile to investigate empirically whether involving public firms competing for tendering is a proper tool for taking profit of potential scale economics and reduce costs in low-population mu-

nicipalities. Also inter-municipal cooperation is examined. It will empirically turn out that public firms are appropriate alternative for privatisation and there is less evidence for inter-municipal cooperation.

This article is organised as follows. In the second paragraph we calculate the concentration rates and the Herfindahl index for the Dutch refuse market on a provincial level. It is shown that the tendency for concentration is high. Moreover, based on the earlier literature we discuss whether scale effects are available. In the third paragraph we discuss the methodology and data. In the fourth paragraph estimations are discussed. Results points out that a high degree of market concentration may weaken competition. Moreover, it is shown that involving public firms competing for a tender in the concentrated provinces reduce costs. Finally, in the fifth paragraph some conclusions are drawn.

II. The Dutch market for refuse collection

Dutch municipalities have a legal obligation to provide a waste collection infrastructure for municipal waste. They are free to choose whether to provide this task themselves or to contract out waste collection to outside firms (public or private). In 2002 183 municipalities have contracted out waste collection to a private firm[1] and 85 to a public firm (see also Table I.). A third group of municipalities (95) collect the waste by a municipal service in cooperation with neighbouring municipalities. The other municipalities (133) collect the waste themselves.

[Place Table I approximately here.]

Contrary to the UK, in the Netherlands contracting out refuse collection is not com-

pulsory. However, there are attempts to promote efficiency through competitive tendering. Nevertheless, these attempts can be weakened by concentration. The Dutch waste collection market is highly concentrated with respect to competition between private firms (see Table II.). Based on a national market the Herfindahl index is 0.27.[2] Compared with a value of 0.18 used by the US-regulators to indicated concentrated markets, the national market is concentrated indeed. If the relevant market is the province, concentration is even higher (see Table II.).[3] However, the concentration is not evenly spread over the country. Some provinces do not have private collection firms at all (Flevoland and Friesland), while others have a high incidence of private collection. The concentration index C3, on a national scale equal to 0.76, further points in the direction of a high concentrated market (compare Shepherd, [1997, p. 92]).[4]

However, if municipalities decide to contract out waste collection not only private firms are available as a potential contractor. Public firms behave more and more as competitors for private firms. The righthandside of Table II. calculates the Herfindahl index and C3 ratio again when private and public firms compete with each other. On a national scale the Herfindahl index is now only 11% suggesting a competitive market. Still concentration might be available at a provincial level as for a number of provinces the Herfindahl index is still very high. For Gelderland, Utrecht, Noord-Brabant, Zeeland, Limburg, Zuid-Holland and Noord-Holland, the concentration rates and/or the Herfindahl index are substantially lower if public firms are included. Only for Drenthe and Groningen these indices do not change. When public firms are the main supplier of refuse collection services, the indices might even rise. This is the case for Overijssel. The C3 ratio indicates still a moderate concentrated market with a value of 0.5 if both private and public firms are included.

[Place Table II approximately here.]

High concentration may result from cost minimising (or profit maximising) behaviour if increasing returns to scale exist. Cost functions of refuse collection have been studied at length in the literature. From this literature it follows in general that the production of refuse collection services exhibits constant returns to scale (cf. Domberger et al. [1986]). For the Netherlands Dijkgraaf and Gradus [2003] found also constant returns to scale for the whole sample. However, for those studies disaggregating the sample into low-, medium- and high-populated municipalities, especially for low-populated municipalities economies of scale are found (e.g. Pommerehne and Frey [1977], Stevens [1978], Dubin and Navarro [1988] and Bel and Costas [2004]). From Dijkgraaf and Gradus [2003] we can conclude that for the Netherlands economies of scale are present in refuse collection in municipalities with population of less than 20,000 (scale coefficient is 0.93 for this group) and that constant returns to scale are present for municipalities with 50,000 inhabitants. So for small municipalities there is a strong incentive for contracting out allowing only the company which already serves in the same zone. This means that there are serious entry barriers for new entrants in the refuse collection market. Inter-municipal cooperation is another way to deal with these economies of scale. However, there are weak incentives for efficiency improvement as the provision is still organised by municipalities themselves, while no explicit confrontation with potential competitors takes place.

Some studies stresses out that contracting out refuse collection is a dynamic process typically converging from a competitive market structure to a monopolistic one. Although bidding process may have been competitive enough, the market becomes a bilateral monopoly just after awarding the contract and contracted firms will try to

keep control over the contract by means of anticompetitive behaviour against rivals. Szymanski [1996] shows some evidence that the cost reductions of contracting out will not sustain over time. A study by Gómez-Lobo and Szymanski [2001] also shows for the UK that in many biddings the number of bidders is too small for competitive efficiency.

III. Methodology and data

In this section we estimate the influence of private firm collusion on waste collection costs. We do this by estimating:

$$TC = f(Q, T, S, U, G, P, V, I_i, O_S, O_I, O_P, C_I, C_P) \qquad \text{(III..1)}$$

where variables, if possible, are measured in log's.

Comparison of total cost (TC) between municipalities is only possible when a correction is made for all differences in exogenous factors. The factors we use in equation III..1 follow directly from the literature that estimate cost functions for waste collection (see for the Netherlands Dijkgraaf and Gradus [2003]). Total costs will change if:[5]

- the number of stops made by the collection vehicle increases (Q is the number of pickup-points, measured as the number of households);
- the time spent at the pick-up stop (more bags or bins) increases (T is the number of inhabitants per pick-up point);
- the time to arrive at the different pick-up points increases (S is the surface per pick-up point);

- the quantity of unsorted waste (U) and separately collected glass (G), paper (P) and vegetable, fruit and garden waste (V) increases;
- the waste treatment costs change (I_i is a dummy with value 1 if the municipality uses waste incineration plant i to treat the collected waste)[6];
- the institutional form in which waste is collected changes (O_S is a dummy with value 1 for municipalities that collect the waste in cooperation with other (neighbouring) municipalities, O_I is a dummy with value 1 for municipalities that use a public company, while O_P is a dummy with value 1 for municipalities that use a private waste collection firm). Note that all these dummies should be significant and negative if municipalities choose this institutional form from a cost minimising perspective, possibly as a result of scale and efficiency effects.

After correction for these variables the non-collusion prior is that we will find no significant relationship between provincial concentration and costs of municipalities using private firms. The previous section showed that concentration of private firms might be in accordance with an efficient market outcome if this results from scale effects and a competitive market. In that case no significant relationship should be found between variables measuring market concentration and waste collection costs of municipalities using private firms. The concentration is under these circumstances not the result of collusion, but stems from market mechanisms to decrease costs by increasing the scale of collection. However, if collusion exists private firms are able to ask higher tariffs than would be necessary from a cost perspective. In other words, if provincial markets are created in explicit or implicit consultation between private companies markets with a higher degree of concentration will show higher waste collection tariffs. Private companies compete not only with each other, but also with public companies. More and more these companies behave as entrepreneurs

and participate actively in public tendering. Four alternative sets of variables are used to test the role of regional concentration and competition:

- First, we include Herfindahl indices measuring provincial concentration. As public companies compete with private companies both private and public companies are included in this variable ($Herf_{I+P}$*O_P).[7]

- Second, we include C3 ratios which are defined accordingly to the Herfindahl indices with $C3_{I+P}$*O_P based on the three larges public and private companies.

- Third, we include variables for local private competition (C_P) and public competition (C_I). These variables measure the presence of competitors in the neighbourhood of municipalities which use private collection firms. For municipalities that use a private waste collection firm this variable is measured by:

$$C_P^i = \sum_j \left(O_P^{jl} * \frac{lnh^j}{D_{(i,j)}} \right) \qquad \text{(III..2)}$$

with C_P^i the private competition index for municipality i, O_P^{ik} a dummy with value 1 if municipality i uses private collection firm k and O_P^{jl} a dummy with value 1 for the neighbourhood municipality j that uses another private company (l). For the municipalities with private collection, C_P^i increases if (i) there are more municipalities that use another private collection company, (ii) these municipalities have more inhabitants (lnh_j), and (iii) are within shorter distance ($D_{(i,j)}$).[8] For municipalities that do not use a private waste collection firm C_P^i is zero.

The variable for public competition is defined in the same way. For municipalities that use a private collection firm:

$$C_I^i = \sum_j \left(O_I^j * \frac{lnh^j}{D_{(i,j)}} \right) \qquad \text{(III..3)}$$

where O_I^j is a dummy with value 1 for the neigborhood municipality that uses a public company. For municipalities that do not use a private waste collection firm C_I^j is zero.

- Fourth, as an alternative to the third measure, we construct two dummies (DC_P and DC_I) which are one if C_P or C_I are above average and zero otherwise.

We test the presence of collusion by significance tests on the coefficients of these variables. If the actual provincial availability of private and/or public competitors does not influence waste collection costs of municipalities using private firms the coefficients should be insignificant.

Data for Q, T, S, U, G, P and V are from the Dutch Bureau of Statistics (CBS). Data for O, I_j and concentration variables come from the Dutch Waste Management Council (AOO). TC is calculated per municipality by multiplying the average cost per household with the number of households.[9] Furthermore, we correct for differences in VAT as public waste collection companies and private collection companies have to pay VAT, while other institutional forms are exempted.[10] Distances between municipalities are based on data from a standard routeplanner. Table III. gives the descriptive statistics. All data are for 2002. In total we have 453 observations as for 43 municipalities data are missing.

[Place Table III approximately here.]

IV. Results

Table IV. shows the estimation results of the specifications described above. The results for most variables are in line with results found by Dijkgraaf and Gradus [2003].[11]

A Wald test of coefficient restrictions does not falsify the constant returns to scale hypothesis, although the coefficient of Q is somewhat lower than 1. This result confirms earlier results found in the literature. As discussed before, this does not mean, however, that returns to scale does not play a role in the collection industry. Constant returns to scale might be the result of scale optimising behaviour. If small municipalities work together with each other or contract out waste collection to public firms or private firms, they can make use of scale economies.

[Place Table IV approximately here.]

The coefficients for inhabitants per pickup-point and density are not significant. This is also the case for the coefficients of the quantity of glass and vegetable, fruit and garden waste. A higher quantity of unsorted waste does result in higher costs, while a higher quantity of paper collected results in lower costs. This last result probably stems from the fact that in many municipalities a free kerbside collection programme for recyclable paper is organised by local associations. The data include the waste collected by these associations. If more paper is collected, this saves collection and treatment costs for unsorted waste.

According to the first estimation, private collection is 17% cheaper than collection by municipalities.[12] This result is consistent with the literature (see Domberger and Jensen [1997] for an overview). Collection by a public firm is 14% cheaper than collection by municipalities. Although the coefficient for private firm collection is somewhat higher than for public firms, a Wald test does not reject the hypothesis that they have the same size. This result is in accordance with earlier results found bij Dijkgraaf and Gradus [2003]. Apparently, the most important factor influencing collection costs is not ownership in the first place. Professionalism and cost consciousness, stimulated

by the contracting process, plays a much larger role. Moreover, the difference between collection by an intermunicipal cooperation (O_S) and collection by the own municipality is positive, but very small and insignificant. It seems that for the Netherlands public firms appear to be a proper tool for taking profit of potential scale economies and is effectively used as an alternative to privatisation. This is contrary to Bel and Costas [2004] where intermunicipal cooperation is found to be the privatisation alternative.

The second estimation shows that the Herfindahl index is significant at 90%. This means that the lower costs of private provision is dependent on the regional concentration. At the average value of the Herfindahl index , i.e. 0.39, the net effect of private provision on collection costs is now -18%. When a monopoly is present (implying a Herfindahl index of 1) total costs even increase (with 8%) compared with municipal collection. From this estimates it follows that private provision is only beneficial when the Herfindahl index is lower than 0.80. At the other hand, the results imply that the cost advantage of private collection might be much higher if enough competition is present as a Herfindahl index of zero results in an estimated cost decrease of nearly 30%. This is interesting as this result might give an explanation why studies differ with respect to the effect of private provision. In the literature on contracting out of refuse collection most studies point out a cost decrease between 10 and 30 percent.

The results for the third estimation are in line with the results for the Herfindahl index. The coefficient for the C3 ratio is significant at 95% and again indicates that the cost advantage of private provision depends on regional concentration. At the average value for the C3 ratio the cost advantage of private provision is now 16%. Note that for low values of the C3 ratio, i.e. 0.5 for Gelderland, the cost advantage of private provision is 35%. The high standard error, however, shows that these values are within the ranges generated with the second estimation. A C3 ratio of 1, i.e. monopoly, results in a cost decrease of 6%.

The results of the second and third estimation indicate that collusion on a regional scale is present in the Dutch waste collection market. Although higher tariffs could in general result from Cournot competition if the number of competitors is low (Tirole [1997, p. 220]), in our case the number of competitors is endogenous. A priori enough potential competitors are present that operate on a national scale. In this case higher tariffs when markets are provincially concentrated ex post are consistent with a situation where implicit or explict collusion takes place.

Interestingly, the fourth and fifth estimations show that the presence of public companies might be especially important. The coefficients for the availability of private competitors are insignificant, while the coefficients for the presence of public firms are significant and negative. This means that when public firms are present the costs of neighbouring municipalities using private firms are lower. These results indicate that private companies might show collusive behaviour in regions where not enough public competitors are present as their absence apparently enable them to raise tariffs. This is interesting as this suggests that the simultaneous presence of public and private companies is an effective instrument to contest collusion.[13] Estimation of separate models for small and large municipalities (defined by an under and above average number of households), reveals that collusion especially exists in larger municipalities. For instance, the coefficient for C_l is significant and negative at 99% for large municipalities and insignificant for small municipalities.

One important robustness test is necessary. If local decision makers look closely at the costs of neighbouring municipalities before they make decisions on their own costs, the costs of neighbouring municipalities are interrelated. The found collusion effects might then in fact result from this information process. Furthermore, in this case the standard errors presented in Table IV. are biased. Fortunately, the literature provides robust measures to test for spatial autocorrelation. Bivand and Szymanski [2000] for

instance use Moran's I to show that for the UK spatial autocorrelation was present in the waste collection market before compulsory competitive tendering. Moran's I measures the correlation of the costs of municipalities with the average costs of neighbours and lies between -1 and 1. If Moran's I is zero no spatial autocorrelation is present.

Using software described in Ferstl [2004] we calculate Moran's I for different samples. Table V. summarizes the results. Only for all municipalities a significant and positive I is found. However, the magnitude is very small. More important, Moran's I is insignificant for all subsamples.[14] Even the public and private firms that have positive collusion variables do not show a positive or negative spatial autocorrelation. Our conclusion about the collusive effects seems therefore not the result of general spatial autocorrelation.

[Place Table V approximately here.]

V. Conclusions

In this article we show that the Dutch market place for refuse collection is highly concentrated in 2002. Both the concentration rates and the Herfindahl index are high on a provincial level. Moreover, it is shown that in highly concentrated provinces competition is weak, which results in barriers for local governments to effectively obtain benefits from contracting-out. However, in low concentrated provinces where public firms are active competition is strengthened. Involving public firms competing for tendering can be a proper tool for reducing costs in potentially concentrated markets. There is less evidence that inter-municipal cooperation will reduce costs and it seems

that costs consciousness stimulated by the contracting out process is important. Furthermore, there are no indications for spatial autocorrelation.

Although our results are promising they should be interpreted with caution, because data are only available for one year. Nevertheless, it is interesting to notice that the efficiency range we found envelops the range of the literature. Our estimations show that an explanation for the range is that concentration offsets the advantage of contracting out. To justify this conclusion more studies in other countries should be done. Nevertheless, our results strongly advocate that there is a clear role for the government in promoting anti-trust policies and give public firms a chance to enter the markets as well.

An important topic for future research is contracting out dynamics. There are some indications in the literature that the effects of a special mode of production will change over time. Szymanski [1996] and Bel and Costas [2004] stress out that the advantage of privatisation of refuse collection disappears due to a tendency towards monopoly. Because a lack of data it is not possible to investigate this topic in this article. Nevertheless, it is important to study this topic in future research and, moreover, to investigate whether a transformation of a local government division into public-owned private-law cooperation can offset this tendency dynamically. Finally, an important topic for future research is the relevant market. There are some indications that the relevant market for refuse collection is the province and this assumption is used in the empirical part of this paper. Till recently the market was regulated on a provincial level and, therefore, the waste market was organised regionally (Dijkgraaf [2004]). However, current legislation is more on a national scale and in some cases even on an international scale. This stimulates cooperation between regions in different provinces. It would be worthwhile in future research to analyse whether other relevant markets are feasible.

References

Ballard, M.J. and Warmer, M.E., 2000, 'Taking the high road: local government restructuring and the quest for quality', *Cornell University Working Paper*, Ithaca (NY).

Bel, G. and Costas, A., 2004, 'Do public sector reforms get rusty? An empirical analysis on privatization of solid waste collection', *Universitat de Barcelona Working Paper*.

Bel, G. and Miralles, A., 2003, 'Factors influencing privatization of urban solid waste collection in Spain', *Urban Studies*, 40, pp. 1323-1334.

Bivand, R. and Szymanski, S., 2000, 'Modelling the spatial impact of the introduction of Compulsory Competitive Tendering', *Regional Science and Urban Economics*, 30, pp. 203-219.

Bosch N., Predaja, F. and Suárez-Pandiello, J., 2000, 'Measuring the efficiency of Spanish municipal refuse collection services', *Local Government Studies*, 26, pp. 71-90.

Collins, J.N. and 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, pp. 333-347.

Christoffersen, H. and Paldam, M., 2003, 'Markets and municipalities: A study of the behaviour of Danish municipalities', *Public Choice*, 114, pp. 79-102.

Dijkgraaf, E., 2004, 'Regulating the Dutch waste market', *PhD-thesis*, Erasmus University Rotterdam.

Dijkgraaf, E. and Gradus, R.H.J.M., 2003, 'Cost savings of contracting out refuse collection', *Empirica*, 30, pp. 149-161.

Dijkgraaf, E., Gradus, R.H.J.M. and Melenberg, B., 2003, 'Contracting out refuse collection', *Empirical Economics*, 28, pp. 553-570.

Domberger, S., Meadowcroft, S. and Thompson, D., 1986, 'Competitive tendering and efficiency: the case of refuse collection', *Fiscal Studies*, 7, pp. 69-87.

Dubin, J.A. and Navarro, P., 1988, 'How markets for impure public goods organize: The case of household refuse collection', *Journal of Law, Economics and Organization*, 4, pp. 217-241.

Ferstl, R., 2004, 'Werkzeuge zur Analyse räumlicher Daten: eine Softwareimplementation in EViews und MATLAB', *Wirtschafsuniversität Wien*.

Gómez-Lobo, A. and Szymanski, S., 2001, 'A law of large numbers: Bidding and compulsory competitive tendering for refuse collection contracts', *Review of Industrial Organization*, 18, pp. 105-113.

Hirsch, W.Z., 1965, 'Cost functions of an urban government service: Refuse collection', *Review of Economics and Statistics*, 47, pp. 87-92.

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

Ohlsson, H., 2003, 'Ownership and production costs: Choosing between public production and contracting-out in the case of Swedish refuse collection', *Fiscal Studies*, 24, pp. 451-476.

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

Reeves, E. and Barrow, M., 2000, 'The impact of contracting out on the costs of

refuse collection services: The case of Ireland', *Economic and Social Review*, 31, pp. 29-150.

Reimer, S., 1999, 'Contract service firms in local authorities: evolving geographies of activity', *Regional Studies*, 13, pp. 121-130.

Shepherd, W., 1997, *The Economics of Industrial Organization*, Prentice-Hall, New Jersey (NY).

Stevens, B.J., 1978, 'Scale, market structure and the cost of refuse collection', *Review of Economics and Statistics*, 60, pp. 438-448.

Szymanski, S., 1996, 'The impact of compulsory competitive tendering on refuse collection services', *Fiscal Studies*, 17, pp. 1-19.

Tirole, J., 1997, *The theory of industrial organization*, MIT Press, Cambridge.

Warmer, M.E. and R. Hebdon (2001), Local government restructuring: privatisation and its alternatives, *Journal of Policy Analysis and Management*, 20, pp. 315-336.

Wassenaar, M.C. and Gradus, R.H.J.M. (2004), 'Contracting out: The importance of a level playing field', *CESifo Economic Studies*, 50, pp. 377-396.

Tables

Table I.: Waste collection in the Netherlands in 2002

Collection by:	Number	% Municipalities	% Inhabitants
- private firm	183	37	26
- public firm	85	17	22
- municipal (cooperation with neighbour(s))	95	19	13
- municipal services (only own municipality)	133	26	38

Table II.: Herfindahl and concentration indices per province

	Only private firms				Private and public firms			
	Munic.	Inhab.	Herf.	C3	Munic.	Inhab.	Herf.	C3
Drenthe	6	33	1.00	1.00	6	33	1.00	1.00
Friesland	0	0	n.a.	n.a.	13	52	1.00	1.00
Flevoland	0	0	n.a.	n.a.	4	42	0.85	1.00
Groningen	12	26	0.72	1.00	12	26	0.72	1.00
Limburg	29	55	0.53	1.00	30	56	0.50	1.00
Zuid-Holland	13	7	0.43	0.95	34	39	0.35	0.85
Zeeland	3	12	0.58	1.00	4	18	0.34	1.00
Utrecht	19	27	0.57	0.96	21	40	0.32	0.86
Noord-Holland	13	8	0.46	1.00	19	14	0.32	0.92
Overijssel	6	21	0.23	0.70	21	88	0.31	0.86
Noord-Brabant	38	46	0.28	0.86	49	62	0.20	0.67
Gelderland	42	54	0.28	0.79	55	79	0.16	0.57
Netherlands	183	26	0.27	0.76	268	46	0.11	0.50

Table III.: Descriptive statistics

		Mean	Max.	Min.	Std. Dev.
Municipal collection costs (mln euro)	TC	3.3	95.3	0.1	7.0
Pickup-points (households)	Q	14,290	405,359	520	29,372
Inhabitants per point	T	2.52	3.65	1.75	0.21
Density (hectares per household)	S	0.01	0.37	0.00	0.03
Unsorted waste (kg per household)	U	222	529	78	59
Glass (kg per household)	G	23	116	10	9
Paper (kg per household)	P	73	156	21	16
Vegetable, fruit and garden waste (kg/hh)	V	112	275	10	44
Collection by public firm	O_I	0.17	1	0	0.38
Collection by private firm	O_P	0.37	1	0	0.49
Collection with neighbouring munic.	O_S	0.19	1	0	0.39
Herfindahl (private and public)	$Herf_{I+P}$	0.39	1	0.16	0.24
C3-ratio (private and public)	$C3_{I+P}$	0.84	1	0.57	0.15
Competition variable (private)	C_P	1,701	41,107	0	4,641
Competition variable (public)	C_I	1,404	53,024	0	4,683
Competition dummy (private)	DC_P	0.21	1	0	0.40
Competition dummy (public)	DC_I	0.21	1	0	0.41

Table IV.: Estimation results

	Basis	Herfindahl	C3-ratio	Competition level	Competition dummy
Q	0.99***	0.99***	0.99***	0.99***	0.99***
	0.02	0.02	0.02	0.02	0.02
T	0.17#	0.20#	0.23#	0.18#	0.16#
	0.15	0.15	0.15	0.15	0.15
S	-0.02#	-0.02*	-0.02*	-0.02#	-0.02#
	0.01	0.01	0.01	0.01	0.01
U	0.24***	0.24***	0.25***	0.24***	0.24***
	0.04	0.04	0.04	0.04	0.04
G	0.03#	0.04#	0.03#	0.04#	0.04#
	0.04	0.04	0.04	0.04	0.04
P	-0.15***	-0.15***	-0.15***	-0.16***	-0.15***
	0.05	0.05	0.05	0.06	0.05
V	-0.02#	-0.01#	-0.01#	-0.01#	-0.01#
	0.02	0.02	0.02	0.02	0.02
O_S	0.04#	0.04#	0.04#	0.04#	0.04#
	0.03	0.03	0.03	0.03	0.03
O_I	-0.06**	-0.06**	-0.06**	-0.06**	-0.06**
	0.03	0.03	0.03	0.03	0.03
O_P	-0.07***	-0.13***	-0.28***	-0.06**	-0.05#
	0.03	0.04	0.09	0.03	0.03
$Herf_{I+P}$		0.16*			
		0.09			
$C3_{I+P}$			0.26**		
			0.10		
C_P				1.90#	
				2.38	
C_I				-3.62*	
				2.19	
DC_P					0.02#
					0.03
DC_I					-0.05*
					0.03
R^2-adj.	0.96	0.96	0.96	0.96	0.96

Notes: Standard errors between brackets. Coefficients with */**/*** are significant at the 90/95/99% level and for coefficients with # which denotes non-significance at the usual the usual levels. Results for I_i are available upon request.

Table V.: Moran's I

Collection by:	Moran's I: 15 miles		Moran's I: 25 miles	
- all municipalities	0.06	(0.02)	0.03	(0.01)
- municipal services	0.01	(0.04)	0.01	(0.02)
- public and private firms	0.01	(0.03)	0.00	(0.02)
- idem with positive collusion variables	0.00	(0.04)	0.00	(0.02)

Note: Standard deviation between brackets.

Notes

[1]In Dijkgraaf et al. [2003], where we use data for 1998, 42% of all municipalities use private firms. Because some small villages have merged and due to the fact that private collectors are especially active in small villages the number in 2002 is comparable with the number in 1998.

[2]We define the Herfindahl index as sum of the squared market shares of private (and, if applicable, public) companies in a province. Thus the index lies between zero and 1.

[3]There are twelve provinces in the Netherlands. Due to (past) Dutch legislation there is some evidence that the relevant market is the province.

[4]The C3 ratio is defined by the sum of the market shares of the three largest private (and, if applicable, public) companies in a province.

[5]Price variables for the different inputs are not included as no reason exists ex ante why factor prices would differ between municipalities. Wage bargaining takes place at a national level.

[6]There are 11 plants in the Netherlands. Note that in 2002 in the Netherlands none of the municipalities use another form of treatment, like landfilling.

[7]We multiply the Herfindahl indices and C3 ratios by the private ownership dummy as we are interested in the effects of concentrated markets on the behaviour of private firms.

[8]As a starting point we include only municipalities within a distance of 15 miles. Substituting this distance for 25 miles does not influence the conclusions.

[9]The AOO presents figures for actual tariffs and for the extent for which these tariffs cover total costs. If actual tariffs do not cover total costs, we use the coverage factors to calculate cost covering tariffs.

[10]As total collection costs are about 40% of TC (Dijkgraaf [2004]) and the VAT is

19%, we diminish TC with 7.6% for O_I and O_P. If input VAT is taken into account the correction might be slighly (1%-point) lower, but this will not influence the conclusions. Results are available upon request. See also Wassenaar and Gradus [2004].

[11]Due to data availability the specifications are somewhat different, while we can use a more extensive dataset in this paper.

[12]As the estimations are in logs the effect can be calculated using e^x-1. Note that this effect has to be multiplied by 2.5 as collection costs are on average 40% of TC.

[13]Note that an alternative interpretation could be that private firms have to lower prices if public firms are present in their neighbourhood if these public firms have lower tariffs for example resulting from different firm goals or circumstances (like profit maximisation or not). However, the first estimation shows that in general tariffs are comparable between public and private firms.

[14]We calculated Moran's I including all neighbouring municipalities within a distance of 15 or 25 miles. Alternatives with smaller or larger distances lead to comparable results.