COST EFFICIENCY OF WASTE MANAGEMENT IN DUTCH MUNICIPALITIES

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Abstract

This paper analyses the cost efficiency of waste management of Dutch municipalities. For the first time stochastic frontier analysis is applied to Dutch data, employing recent multi-year data (2005-2008). The preliminary findings confirm earlier results on the importance for cost efficiency of urbanization levels and the mode of provision for cost efficiency. Contracting out seems to imply cost savings, but ownership of the suppliers (public or private) hardly matters. Economies of scale are essentially absent, except for the smallest municipalities. However, many of them indirectly benefit from economies of scale by contracting out to (large) public or private firms. More analysis is necessary to obtain robust results on the relative merits of public, private and mixed provision and on the organizational and managerial factors underlying waste management efficiency.

Introduction

Many governments currently are cutting budgets on an unprecedented scale after the world-wide financial and economic crisis. Reducing budgets and safeguarding the level of essential public services as much as possible, requires thorough knowledge of their efficiency or cost effectiveness. In the Netherlands, municipalities have to implement large budget cuts, as revenues from central government, such as lump sums and earmarked grants, will be substantially reduced in coming years. At the same time, empirical knowledge on local government efficiency in the Netherlands is hardly available. The relative large autonomy of individual municipalities and provinces in managing their own activities, despite a large financial dependence of central government, does not provide strong incentives for collecting comparable data, benchmarking and exchange of best practices. This paper is part of a larger research project, funded by the Dutch Ministry of Home Affairs and Kingdom Relation, aimed at gaining more insight on government efficiency and innovations to improve it.

In this paper we focus on a particular area of local public services, waste management. Not only substantial resources are spent on waste management, which in our definition comprises publicly mandated collection and disposal of waste from households (not firms), but municipalities organize these services quite differently. Some of them – in particular larger cities - have their own organizational units that collect waste, while others outsource waste collection to regional public corporations, other regional public entities or private firms. Disposing waste is taken care of both by private firms and public corporations. The impact of the mode of provision or production (private or public in different forms) on waste management costs has been the subject of much discussion in the recent literature (for an overview, see Bel and Warner, 2008). In our paper we use stochastic frontier analysis (SFA) as the main tool of analysis. Although a well know technique of efficiency analysis, it has not been applied before to Dutch waste management, whereas statistical cost functions have been used extensively (Dijkgraaf and Gradus, 2003, 2007, 2008). We use data of different years in order to detect any shifts in technology or other intertemporal developments. The analysis presented here can be considered as a first step to describe and explain detailed efficiency outcomes.

1 Model

Given largely exogenous supply of waste by citizens, we choose a standard stochastic frontier analysis (SFA) of the costs of local government waste management (Fried et al, 2008). The unit of analysis is the municipality. Local public managers are assumed to minimize costs of waste collection and waste disposal, given waste volumes and input prices for municipal labor and capital and - in the case of outsourcing – supplier prices. As wages in a small country as the Netherlands are nationally regulated (in the case of the public sector) or negotiated (in the case of the private sector) we neglect input price variations in the current analysis. We allow for variables that could affect waste management efficiency. Typical candidates, used in many other studies, are household density and household size. These variables are usually associated with higher efficiency because of network economies, although traffic congestion in larger cities works in the opposite direction. Dummies are included for the urbanization level - known to affect the technology of collection - and for the choice of the mode of collection: in-house municipal waste collection versus outsourcing collection to private or public companies or other public bodies. The latter variable indirectly incorporates possible price variation among types of suppliers. In the SFA we use a standard translog specification. Data on costs, waste volumes and household characteristics are available from Statistics Netherlands (CBS). Other sources (Agentschap NL) are used for the mode of waste collection used by individual municipalities.

Table 1 gives some descriptive statistics for the most important variables in the pooled sample for 4 years (2005-2008). Table 2 and 3 describe the municipal distribution of

urbanization levels and modes of waste collection respectively. Urbanization levels are based on a common Dutch classification based on the density of postal addresses. Note that the sample contains a large range of municipal population sizes: from about a thousand inhabitants to three quarters of a million. Table 3 shows that the most common mode of waste collection is outsourcing to private companies (about one third of municipalities), followed by outsourcing to public companies (slightly less than a third) and inhouse services (about a quarter). Not unexpectedly, smaller municipalities more often outsource waste collection, while the larger cities often have their own municipal service. We do not yet have reliable information on the costs of outsourcing to collaborating municipalities. This mode is chosen by about 13% of the total number of municipalities. They are not included in our sample.

Table 1: Descriptive statistics of the sample (N=1283)

Variable	*Mean*	*Min.*	*Max.*
Total costs (x1000 euro)	5,046	120	333,370
Waste volume (x1000 kg)	22,292	867	364,706
Population size	39,806	946	747,093
Density (Dwellings per km^2)	324	13	2,819
Household size	2.45	1.71	3.57
Costs per capita (euro)	99.40	45.8	656.2
Waste per capita (kg)	548.8	288	1,632

Table 2: Sample distribution of urbanization level

Urbanization level	
No urbanization	28.3%
Minor urbanization	36.2%
Modest urbanization	19.6%
Strong urbanization	13.2%
Very strong urbanization	2.7%

Table 3: Sample distribution of collection mode

Inzamelorganisatievorm	
Municipal service	23.5%
Neighbouring municipality	2.7%
Public Company	30.7%
Private Company	39.6%
Other	3.5%

2 Estimation results

Table 4 gives the estimation results of the SFA analysis of waste management costs for municipalities. We use the flexible translog cost function (Christensen et al, 1973). Note that the reference category for the year dummy is 2005; for urbanization the reference category is 'Very strong urbanization' and for collection mode the reference category is 'Municipal service'. All variables are normalized through division by their sample mean in 2005.

Tabel 4: Estimation results translog SFA-model (N=1238)

Dependent variable: Log Total costs	*Coefficient*	*t-value*
Constant	**8,39**	**130,40**
Log(Waste)	**1,00**	**70,30**
Log(Density)	0,03	1,95
Log(Household size)	-0,18	-1,80
Log(Waste)*Log(Waste)	**0,05**	**5,87**
Log(Density)*Log*(Waste)	0,00	0,19
Log(Household size)*Log (Waste)	0,13	1,00
Log(Density)*Log(Density)	**-0,02**	**-2,86**
Log(Density)*Log(Household size)	0,04	0,50
Log (Household size)*Log(Household size)	**2,00**	**4,52**
Dummy(2006)	**0,03**	**2,05**
Dummy(2007)	0,00	0,16
Dummy(2008)	**0,04**	**2,19**
Dummy(Strong urbanization)	**-0,26**	**-5,07**
Dummy(Modest urbanization)	**-0,31**	**-4,77**
Dummy(Minor urbanization)	**-0,34**	**-4,77**
Dummy(No urbanization)	**-0,37**	**-4,95**
Dummy(Neighboring municipality)	0,00	-0,07
Dummy(Public company)	**-0,10**	**-6,20**
Dummy(Private company)	**-0,17**	**-10,74**
Dummy(Other)	**-0,09**	**-2,46**
Sigma	3,54	33,21
Lambda	1,86	10,34

As table 4 shows, costs are significantly and positively related to waste volumes. The coefficient of the linear term is 1, and that of the quadratic term relatively small, implying no economies of scale at the sample mean (corresponding with a population size around 40,000), and only small (dis)economies of scale for smaller (higher) waste volumes. This is a typical outcome of the recent literature as well (see Bel and Warner, 2008). In particular the dummy variables for urbanization and mode of collection have a large impact on costs. The most rural areas show 37 percent lower costs compared with the very strong urbanized areas (the largest cities), everything else being equal. Outsourcing waste collection to public or private companies decreases costs with 10 respectively 17 percent. This finding is in line with other results for the Netherlands for earlier years obtained by Dijkgraaf and Gradus (2003), using a Cobb-Douglas statistical cost function

approach. They find a 13% decrease in costs for external collection (which in their definition also includes disposal of waste), whether by private or public firms. However, in a later dynamic multi-year analysis, cost savings of contracting out seem to diminish over time and are confined to private collection (Dijkgraaf and Gradus, 2008). They partly explain this from an increasing lack of competition in the Dutch waste collection market. Note that the choice for outsourcing may not be independent of structural characteristics such as population size or level of urbanization, i.e. smaller municipalities could inherently benefit more from outsourcing - using the economies of scale of external suppliers - than larger ones and in fact are already practising that. Policy recommendations on outsourcing therefore cannot easily be derived from our preliminary estimation results.

Figure 1 depicts individual efficiency scores that can be calculated for each municipality. The average efficiency score is relatively high, around 86%, but 10 percent of municipalities has an efficiency score below 77% and 5 percent an efficiency score below 65%, indicating room for efficiency improvement. Table 5 shows the average efficiency scores for some subgroups of municipalities. Apparently the smallest municipalities are able to operate relatively efficient, despite their inability to benefit from economics of scale in their own operations. Note, however, that more than 90% of these municipalities outsource more than 90% to a public or private firm, while only 7% operates its own municipal collection service. Other subgroup averages are not significantly different from the sample average, although larger municipalities seem to be less efficient, given their scale. Note that the frontier already incorporates the effects of urbanization level and collection mode in the current specification. In future analysis we plan to include additional variables that can explain efficiency.

Figure 1: Efficiency scores of municipalities

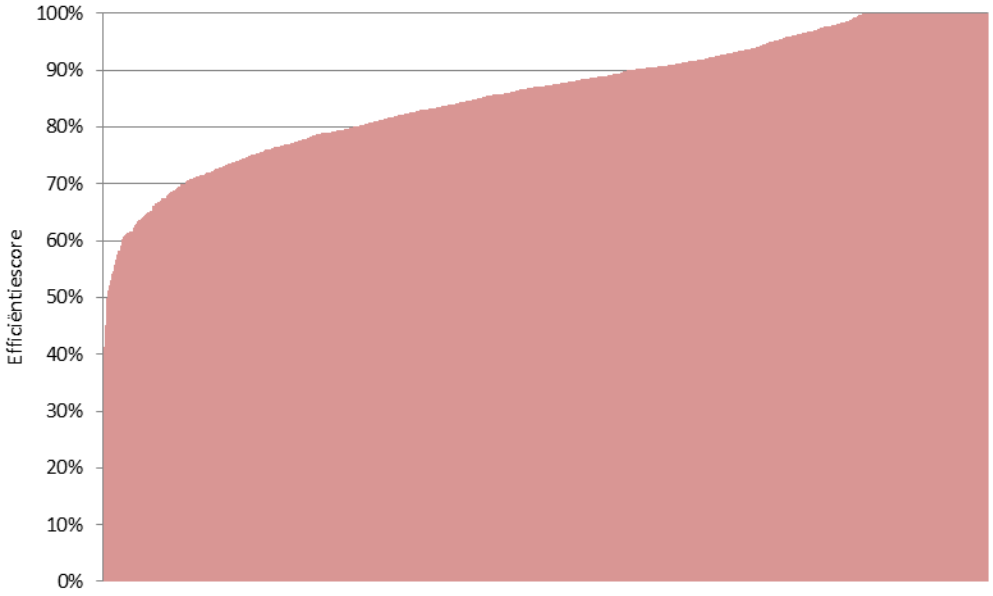

Table 5: Efficiencyscores for subgroups of municipalities

Subgroup description	*Mean*	*Min*	*Max*
Full sample	0,857	0,392	1
Urbanization level			
Very strong urbanization	0,835	0,392	1
Strong urbanization	0,855	0,412	1
Modest urbanization	0,864	0,512	1
Minor urbanization	0,857	0,404	1
No urbanization	0,857	0,450	1
Collection mode			
Municipal service	0,852	0,392	1
Neighbouring municipality	0,863	0,613	1
Public Company	0,862	0,567	1
Private Company	0,855	0,404	1
Other	0,866	0,559	1
Population size			
Less than 10,000	0,889*	0,868	1
10,000-20,000	0,857	0,847	1
20,000-50,000	0,854	0,845	1
50,000-100,000	0,849	0,833	1
100,000-150,000	0,841	0,807	1
More than 150,000	0,840	0,792	1

* = significantly different from full sample mean at 95% level

3 Summary and discussion

Public sector cost-effectiveness and efficiency are key topics in public policy. In particular in the aftermath of the financial crisis and worldwide cutbacks on public expenditures, policy makers urgently need more of that type of performance information. Econometric analysis can be used to model and calculate cost efficiency. As an empirical example, we studied the cost efficiency of waste management by Dutch municipalities. For the first time with Dutch data, stochastic frontier analysis has been used. The results confirm the absence of economics of scale except for the smallest municipalities. They can benefit from intermunicipal cooperation or outsourcing to (larger) public or private firms. Recent research challenges the potential cost savings of contracting out or full privatization. Our preliminary analysis seems to indicate that cost savings are possible by contracting out, but that ownership of the contracted party (public or private) does hardly matter. However, further analysis of the determinants of the efficiency scores is warranted to draw more robust conclusions. Recent literature (for an overview, see Bel and Warner, 2008) illustrates the need for more in-depth analysis of the contracting process moving beyond the ownership issue. Also, promising technology and social changes, such as a larger role of citizens in separating waste and bringing waste to fewer collection points, have been shown to contribute to higher efficiency in waste management (Dijkgraaf and Gradus, 2008). In future analysis we plan to include more variables, relevant for the technology applied by service producers and citizens, the organization and monitoring of contracts by municipalities and possible other determinants of efficiency.

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