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Inter-municipal cooperation, economies of scale and cost efficiency: an application of stochastic frontier analysis to Dutch municipal tax departments

Thomas Niaounakis[a] and Jos Blank[a,b]

[a]Faculty of Technology, Policy and Management, Delft University of Technology, Delft, The Netherlands; [b]Department of Public Administration, Erasmus University, Rotterdam, The Netherlands

ABSTRACT

Inter-municipal cooperation is increasingly popular in European countries. Saving cost is a key motivation. This paper analyses the relation between inter-municipal cooperation and cost efficiency among Dutch municipal tax departments between 2005 and 2012. Motivated by the notion that cost savings are ascribed to scale economies, the relation between cooperation and cost is modelled explicitly through scale. The size of the cooperation is incorporated as a determinant of cost efficiency. The results indicate that inter-municipal cooperation can contribute to reducing cost and that the relation can be explained by scale. Municipalities or cooperations sized around 10,000 inhabitants are estimated up to 30% inefficient. At 60,000 inhabitants, the benefits of scaling are largely exhausted. Other than through scale, municipalities that cooperate are not estimated to operate significantly more or less efficient.

KEYWORDS Inter-municipal cooperation; scale economies; efficiency analysis; local government

1. Introduction

Municipalities aim at providing local public services in a cost-efficient manner. It is widely recognised that many local government services are subject to returns to scale (Lago-Peñas and Martinez-Vazquez 2013). Fixed cost may drive the average cost of small municipalities up, while large municipalities may, for example, require more managerial oversight (Drew, Kortt, and Dollery 2016).

A traditional approach to effectuate economies of scale is through the consolidation of municipalities (Bel and Warner 2015). Australia and the Netherlands are among the countries that have seen a substantial decrease in the number of municipalities since the 1990s. Yet, municipality consolidation is subject to several drawbacks. Most importantly, the current scientific consensus is that municipal consolidation has often not led to the

CONTACT Thomas Niaounakis t.k.niaounakis@tudelft.nl Faculty of Technology, Policy and Management, Delft University of Technology, Jaffalaan 5, Delft 2628 BX, The Netherlands

anticipated decrease in costs (Dollery and Johnson 2005; Drew, Kortt, and Dollery 2016; Fox and Gurley-Calvez 2006). A similar empirical view arises in the Netherlands (Allers and Geertsema 2016).

Second, since municipal services and tasks are rather heterogeneous, it is questionable whether the scaling of one municipality service is also beneficial for another municipality service. Scale effects may vary strongly between municipal services such as waste collection, civil affairs and tax collection. There may be no such thing as 'one size fits all'. The heterogeneity of municipality services also highlights the methodological difficulty that comes with the measurement of municipality output. Frequently, output is measured by some measure of population, which may be a rather poor proxy for overall output (Boyne 1996).

Inter-municipal cooperation is an alternative and relatively understudied reform (Bel and Warner 2015) through which municipalities can exploit economies of scale, and its popularity is on the rise in, amongst other countries, the Netherlands. Inter-municipal cooperation allows for the scaling of municipal services or back offices, benefiting from potential economies of scale and maintaining jurisdictional autonomy.

Based on these experiences, one might wonder whether inter-municipal cooperations are successful in exploiting economies of scale. An emerging literature on the matter indicates that cooperation can be effective in decreasing cost, but there are some contradictory results (for an extensive and recent overview, see Bel and Warner (2015)). As inter-municipal cooperation is often based around specific services or back offices, it is appropriate to analyse these separately. In the past, some authors have followed this research strategy. Most of the available studies concern waste collection (Bel and Costas 2006; Bel and Mur 2009; Bel, Fageda, and Mur 2014; Dijkgraaf and Gradus 2013; Sørensen 2008; Zafra-Gómez et al. 2013). Most empirical studies that investigate the relation between cooperation and cost are carried out in western European countries. This paper thus focuses on the cost-motivated form of cooperation as is popular there.

This paper analyses the relation between inter-municipal cooperation and cost efficiency among Dutch municipal tax departments. The aim of this paper is to analyse whether inter-municipal cooperation has contributed to reducing cost here and to analyse how the relation depends on scale. Motivated by the notion that cost effects of inter-municipal cooperation are generally ascribed to scale economies, this paper explicitly relates inter-municipal cooperation to cost through scale. The relation between inter-municipal cooperation and cost is allowed to vary with the size of the cooperation so that the assumption on economies of scale can be tested empirically. In contrast, the more common approach in literature is that the institutional form in which the activities are organised, such as cooperation, is included in the model e.g., through dummy variables. This approach boils down to the implicit assumption that cooperation influences cost by a constant percentage or amount.

The basic model used is a stochastic cost frontier in which costs are related to outputs and efficiency. Cooperation is assumed to affect cost through two key mechanisms. First, it is assumed that through scale, cooperation affects efficiency. A distinction is made between the *administrative* scale of the municipality tax department and the *actual* scale of production. For cooperating municipalities, the scale of production is determined by the size of their cooperation. For non-cooperating municipalities, there is no difference. The scale of production is then included in the model as a determinant of efficiency. Moreover, the model allows for a non-linear relationship between scale and cost. For example, it is expected that small municipalities can benefit more from scaling. Second, given some scale of production, cooperating municipalities may be more or less efficient. Cooperations may, for example, face coordination costs, decreased transparency or may not be able to materialise scale effects to their full extent. To test this hypothesis, a dummy variable is included as well.

The model is applied to an extensive panel data set covering 2005–2012, comprising data on the administrative cost of taxing and levying and detailed data on production. Municipal taxation in the Netherlands is a popular subject for inter-municipal cooperation. The number of municipalities levying taxes through a form of inter-municipal cooperation increased from 25 out of a total of 467 municipalities in 2005 to 124 out of 415 in 2012. In the context of the Netherlands, this specifically renders them as an interesting case for analysis.

This paper is organised as follows. Section 2 discusses the relevant literature. The methodology is presented in Section 3. Section 4 includes a description of the data. The results are presented in Section 5. Section 6 contains the discussion and concluding remarks.

2. Literature

This paper is related to literature on the organisation of local governments. First and foremost, this paper is related to the emerging literature that specifically addresses the relation between inter-municipal cooperation and cost. Second, there is a more general and well-developed strand of literature on the measurement scale economies in local governments.

2.1. *Inter-municipal cooperation and cost*

Bel and Warner (2015) provide an up-to-date and extensive discussion of potential theoretical effects of inter-municipal cooperation on cost and discuss the emerging evidence on the matter. Importantly, as they note, inter-municipal cooperation in EU countries differs from that in the US. Focus in research of inter-municipal cooperation in the EU is mostly on economic effects, whereas research on inter-municipal cooperation in the US is more concerned with regional coordination and externalities. This paper focuses on the way inter-municipal cooperation is designated in EU countries.

This paper directly links inter-municipal cooperation to scale. Many papers have suggested that inter-municipal cooperation may be an effective reform for exploiting economies of scale (Bish and Ostrom 1973; Parks and Oakerson 1993; Plata-Díaz et al. 2014). Indeed, scale economies appear to be the 'most important efficiency motivation for inter-municipal cooperation' (Bel and Warner 2015). Other recent papers confirm that from an economic perspective, economies of scale are the most important driver of inter-municipal cooperation (Plata-Díaz et al. 2014; Warner and Hefetz 2003; Warner 2006; Zullo 2009).

In addition to scale economies, inter-municipal cooperation may affect efficiency and cost through several additional mechanisms, such as economics of density and by addressing externalities. Moreover, inter-municipal cooperation may give rise to transaction and coordination costs (see, e.g., Brown and Potoski 2003; Feiock 2007). The degree to which each effect applies likely depends on the type of service, the scale of production and institutional design of the cooperative governance arrangement (Bel and Warner 2015).

Compared to privatisation, empirical evidence on the relation between inter-municipal cooperation and cost is still rather scarce (Bel and Warner 2015 discuss eight multivariate studies in detail, see p.61; Holzer and Fry 2011). In the past decade, several parametric empirical studies have emerged, most of them focusing on waste collection (Bel and Costas 2006; Bel and Mur 2009; Bel, Fageda, and Mur 2014; Dijkgraaf and Gradus 2013; Dijkgraaf and Gradus 2014; Perez-Lopez, Prior, and Zafra-Gómez 2015; Pérez-López et al. 2016; Sørensen 2008; Zafra-Gómez et al. 2013). Garrone, Grilli, and Rousseau (2013) are an exception in that they also study water, electricity and gas.

It is insightful to discuss some of these papers in more detail. In the context of Dutch municipalities, Dijkgraaf and Gradus (2013) study the effects of inter-municipal cooperation in Dutch waste collection on the total associated cost of municipalities. They find that cooperation leads to cost reduction, although the result is statistically insignificant. Their analysis is carried out at the level of the municipality. The effect of inter-municipal cooperation is modelled by including a dummy variable. In earlier work on the topic, Bel and Costas (2006) follow a comparable identification strategy. In their study on waste collection costs in Spanish municipalities, they find that inter-municipal cooperation is negatively related to costs. Bel and Mur

(2009) also use dummy variables to identify the effect of cooperation (among other aspects) on cost but estimate the model for different sub-samples by size and find that small Spanish municipalities decreased waste collection costs through inter-municipal cooperation. They note that in the regular cost function, *no evidence of scale economies is found because small municipalities have likely exploited them by means of inter-municipal cooperation*. In other words, the effect of cooperation is explicitly characterised by scale economies. It may thus be insightful to measure and include the scale of cooperation in the empirical framework to test the assumption on economies of scale. Bel and Warner (2015) discuss several other papers that focus on inter-municipal cooperation and cost, which follow comparable identification strategies (Sørensen 2008; Zafra-Gómez et al. 2013; Bel, Fageda, and Mur 2014).

An exception is the analysis of Garrone, Grilli, and Rousseau (2013) on the impact of inter-municipal joint ventures and other multi-government utilities on the efficiency of Italian municipal utilities. Interestingly, they find that scale benefits are outweighed by coordination costs. Garrone, Grilli, and Rousseau (2013) use multi-utility firms as the unit of observation instead of municipalities. Therefore, they also measure the actual scale of production. While their focus differs significantly from this paper (water, electricity, gas and waste), their analysis stresses the point that coordination costs may be an important drawback of cooperation.

Finally, Pérez-López et al. (2016) recently estimated the relation between efficiency and inter-municipal cooperation by means of a meta-frontier approach. Hence, they can estimate whether, for example, inter-municipal cooperation or privatisation is better for a certain group of municipalities. They find that in general, cooperation is the most suitable option, but for municipalities with over 20,000 inhabitants, contracting out leads to higher efficiency levels.

2.2. *Local governments and economies of scale*

It is widely recognised that many local governments are subject to returns to scale (Lago-Peñas and Martinez-Vazquez 2013) and there is a large number of studies that empirically addresses the relation between scale and (average) cost. An orthodox assumption is that the average cost curve is 'U-shaped' (Drew, Kortt, and Dollery 2016). Increasing output when it is still small may bring down the burden of fixed costs, but at some point, the increase in, for example, bureaucracy may overtake. These are just two out of many possible mechanisms driving scale effects. In general, labour-intensive services are relatively less likely to benefit from scaling up as opposed to capital intensive services and back office functions (Andrews and Boyne 2011; Drew, Kortt, and Dollery 2016). This particularly holds for labour-intensive services that are hard to standardise or where intensive client contacts are relevant.

Byrnes and Dollery (2002) provide an extensive discussion on many empirical studies concerning local governments in the UK and USA. As they note, most studies use population as a measure of scale. Remarkably, there are a large number of papers that only allows for a linear relationship between average cost and scale, that is, that assume that average cost is monotonically in- or decreasing with output.

Several recent studies that study the relation between average cost and scale allow for a quadratic or non-linear shape of the cost function. Through the estimation of a quadratic cost function, Drew, Kortt, and Dollery (2016) also provide evidence for a U-shaped cost curve in Queensland, Australia, with an optimum around 98,000 inhabitants. Geys, Heinemann, and Kalb (2007) find that German municipalities have significant economies of scale for municipalities up to 10,000 inhabitants. Solé-Ollé and Bosch (2005) estimate a piecewise linear function for municipalities in Spain and find that the optimal size lies around 5000 inhabitants. Bikker and van der Linde (2016) study scale economies in local public administration in the Netherlands using several non-linear functions and find that the optimum size increased from around 49,000 inhabitants in 2005 to 66,260 inhabitants in 2014.

Andrews and Boyne (2009) study administrative overheads of English local authorities and find that administrative cost monotonically decreases with size. As they note, it is important to control for local structure or heterogeneity by incorporating environmental characteristics into the analysis.

3. Empirical strategy

This paper estimates a stochastic cost frontier for Dutch municipalities between 2005 and 2012. The frontier identifies efficient municipalities that minimise cost given their output level and production environment. The regression representation of the stochastic cost frontier is given by

$$c = g(\mathbf{y}, \mathbf{w}, \mathbf{q}, \boldsymbol{\beta}) + v + u(\mathbf{z}, \boldsymbol{\delta}), u(\mathbf{z}, \boldsymbol{\delta}) \geq 0. \quad (1)$$

In the above equation, c is the log municipality cost of municipality tax departments, $\mathbf{y}$ is a vector of log outputs, $\mathbf{w}$ is a vector of log input prices, $\mathbf{q}$ is a vector of log environmental variables, v is an independent identically distributed random error term and u specifies cost inefficiency as a function of covariates $\mathbf{z}$ and parameters $\boldsymbol{\delta}$. The variables included in the model are discussed in Section 4. Furthermore, $g(\cdot)$ is some parametric function parameterised by $\boldsymbol{\beta}$. By choosing a flexible mathematical specification, a cost frontier approach allows for multiple outputs and can account for multiple environmental characteristics. Here, a translog specification is used, a more general function than the Cobb–Douglas specification.

The relation between inter-municipal cooperation, scale and cost is modelled as follows. Analysis is conducted at the level of the municipality. That is, the variables c and in $g(\cdot)$ correspond to the observed cost and output of individual municipalities. This corresponds to an analysis at the *administrative* scale level. The *actual* scale at which a municipality produces is incorporated as a z variable as a determinant of (in)efficiency. For municipalities that are active in an inter-municipal cooperation, this equals the sum of the total output of the cooperation. For single municipalities, this is equal to their individual output. Furthermore, to allow for a U-shaped relation between scale and inefficiency, **z** also includes a squared scale variable. Hence, output influences cost both through $g(\cdot)$ and $u(\mathbf{z}, \boldsymbol{\delta})$. The approach is completed by imposing constant returns to scale in the cost function $g(\cdot)$. Constant returns to scale imply that a 1% increase in the output of municipalities increases cost through $g(\cdot)$ by 1%. Scale effects are then isolated in the efficiency term, both for individual municipalities and those active within a cooperation. By also including a dummy variable for cooperating municipalities, the set-up furthermore allows us to analyse whether municipalities within inter-municipal cooperations are more or less efficient than individually operating municipalities, under a comparable scale of production.

An additional advantage of this approach is that analysis at the level of the Decision-Making Unit, the municipality, is preserved. An alternative method that incorporates the scale of actual production is to analyse at the level of the cooperation using aggregated municipality data. A disadvantage of this approach is that it sacrifices relevant information and requires the aggregation or averaging of included variables. Furthermore, one may also want to analyse how the effects on efficiency within an inter-municipal cooperation are dispersed among the different participants in the cooperation or incorporate individual municipality efficiency determinants unrelated to cooperation. Table 1 briefly summarises the

Table 1. Summary of three potential models.

	Model 1		Model 2	Model 3	
Unit of analysis:	Municipality		Cooperation	Municipality	
	Mun. 1	Mun. 2	Mun. 1 and 2	Mun. 1	Mun. 2
Cost (c)	C_1	C_2	C_{1+2}	C_1	C_2
Output (y)	y_1	y_2	y_{1+2}	y_1	y_2
Efficiency determinant (z)	y_{1+2}	y_{1+2}	–	–	–
	Scale and efficiency effects: captured through efficiency component $u(z)$, constant economies of scale assumed in $g(\cdot)$		Scale: captured through cost function $g(\cdot)$. Efficiency effects (non-scale): capture through moderation of cost function (e.g., by dummies)	Effects of cooperation: captured through moderation of cost function (e.g., by dummies)	

proposed model (1), the discussed alternative (2) and the more common approach (3), in case there are two cooperating municipalities.

Note that $u(\mathbf{z}, \boldsymbol{\delta})$ is not yet specified. The pioneering SFA models (Aigner, Lovell, and Schmidt 1977; Meeusen and Van den Broeck 1977) assumed that u was an independently distributed random variable. Early attempts to model u conditional on potential determinants z involved so-called *two-step* approaches in which estimates of u were regressed on z in a second stage. It is now widely recognised that this is bad practice leading to invalid inference (Wang and Schmidt 2002).

The alternative proposed here is to estimate (1) in a single-step procedure that is based on the so-called *scaling property* (Alvarez et al. 2006; Simar, Lovell, and Vanden Eeckaut 1994; Wang and Schmidt 2002). It is said that the model satisfies the scaling property if $u(\mathbf{z}, \boldsymbol{\delta})$ can be written as

$$u(\mathbf{z}, \boldsymbol{\delta}) = h(\mathbf{z}, \boldsymbol{\delta}) \cdot u^*,$$

where $h(\mathbf{z}, \boldsymbol{\delta}) \geq 0$ and $u^* \geq 0$ is a random variable which distribution does not depend on $\mathbf{z}$. The scaling property implies that the *shape* of the distribution of u does not depend on $\mathbf{z}$, but that the *scale* of the distribution of u is determined by the *scaling function* $h(\mathbf{z}, \boldsymbol{\delta})$. One convenient advantage of the scaling property is that in order to estimate the model, no distributional assumptions on the basic variable u^* are required, which normally is a common criticism of SFA models (see, e.g., Wang and Schmidt 2002; Schmidt 2011). It holds that

$$E(c|\mathbf{y}, \mathbf{w}, \mathbf{q}, \mathbf{z}) = g(\mathbf{y}, \mathbf{w}, \mathbf{q}, \boldsymbol{\beta}) + h(\mathbf{z}, \boldsymbol{\delta})\mu^* \tag{2}$$

where $\mu^* \equiv E(u^*)$. The parameters β, δ and μ^* can then be estimated using non-linear least squares (NLLS). Taking expectations of u gives

$$E(u) = h(\mathbf{z}, \boldsymbol{\delta}) \cdot E(\mu^*),$$

so that replacing $\boldsymbol{\delta}$ and μ^* by their estimates $\hat{\boldsymbol{\delta}}$ and $\widehat{\mu^*}$ gives the expected value of u. Note that inference cannot be conducted on the random (stochastic) part of inefficiency, that is, u^*, without imposing distributional assumptions. The model furthermore does not impose a structural time-varying trend on the efficiency component. If there is no intertemporal variation in the efficiency determinants for a municipality, inefficiency is assumed to remain constant.

An appealing candidate for the scaling function is the exponential function $h(\mathbf{z}, \boldsymbol{\delta}) = \exp(\mathbf{z}'\boldsymbol{\delta})$. This function always generates positive values (as it should). Here, the scaling function is defined as the sum of two exponential functions, one that incorporates the variables relating to scale, and one relating to the coordination costs that arise from cooperation:

$$h(\mathbf{z}, \boldsymbol{\delta}) = (\exp(\mathbf{z}'_1\boldsymbol{\delta}_1) + \exp(\mathbf{z}'_2\boldsymbol{\delta}_2))\mu^*. \tag{3}$$

In words, it is assumed that the relation between coordination and efficiency is independent of scale, that is, the loss in efficiency due to coordination is not related to scale. The motivation for this choice is that it seems reasonable to assume that coordination effects occur independent of scale.

4. Data

The main data used in this study are sourced from Statistics Netherlands, the national Dutch statistical agency. Information on municipal tax rates was obtained from the Centre for Research on Local Government Economics. Information on the composition of inter-municipal cooperations has been obtained from the Association of Dutch Municipalities, the Council of Real Estate Assessment (in Dutch: Waarderingskamer) and by inspection of cooperation agreements or inquiries.

The data cover the period 2005–2012. Dutch municipalities typically set up a designated department that performs tax-associated tasks, which operates reasonably independent from other municipality departments and services. Due to municipal consolidations, the number of municipalities in the Netherlands decreased from 467 in 2005 to 415 in 2012. In total, 3116 observations are included in the analysis. Municipalities with negative reported cost or worryingly high intertemporal variation were systematically dropped from the analysis. This resulted in the omission of approximately 250 observations. A statistical description of the data that are finally included in the model for the year 2012 is given in Table 2.

Table 2. Descriptive statistics, 2012 (*N* = 373).

Variable	Mean	Std. dev.	Minimum	Maximum
INPUT VARIABLE				
COST (IN MILLIONS OF EUROS)	0.96	3.07	0.04	49.28
OUTPUT VARIABLES				
HOUSING PROPERTIES	17,625	30,861	445	390,454
NON-HOUSING PROPERTIES	3099	4025	188	459,66
TAXED TOURIST NIGHTS (TOURIST TAX REVENUE/TOURIST TAX RATE)	249,686	629,067	1102	8,778,888
IMPOSED DOG TAXES (DOG TAX REVENUE/DOG TAX RATE)	2318	2981	194	29,180
ENVIRONMENTAL VARIABLES				
AVERAGE PROPERTY VALUE (IN EUROS)	251,078	63,884	133,000	630,000
PROPERTY TAX RATE (IN %)	2.62	0.63	1.06	4.98
SINGLE-PERSON HOUSEHOLDS/TOTAL HOUSEHOLDS	0.30	0.06	0.19	0.60
NET PROPERTY TAX RETURNS[a]	0.94	0.03	0.78	1.10
WELFARE RECIPIENTS	918	3262	10	40,870
EFFICIENCY DETERMINANTS				
ACTUAL SCALE OF PRODUCTION (BY NUMBER OF PROPERTIES)	45,825	66,508	1084	450,307
MUNICIPALITIES IN COOPERATION (%)	26			
COOPERATION WITH WATER AUTHORITY (%)	11			

[a]Some values exceed one due to using *predicted* tax returns and minor measurement errors.

4.1. *Tax departments and cooperations*

Dutch municipal tax departments carry out two primary tasks. First, municipalities impose and levy several taxes and fees. In terms of revenues, the main taxes are a real estate or property tax (43% of municipal tax revenues) and the waste collection and sewerage fees (41%). The remaining 16% are related to tourist taxes, dog taxes and other smaller taxes. Second, Dutch municipalities are obliged to perform an annual revaluation of all real estate properties. Valuation of real estate properties is generally based on property characteristics, market prices of recently listed properties in the vicinity and other possibly relevant demographic information. Municipalities inform property owners of the valuation assessment and the property value is then utilised as a basis for taxation. Note that the difference between taxes and fees is not important for the purpose of this analysis.

The number of municipalities that levy taxes through a form of inter-municipal cooperation increased from 25 out of a total of 467 municipalities in 2005 to 124 out of 415 in 2012, while the number of inter-municipal cooperations increased from 3 in 2005 to 29 in 2012. Between 2005 and 2012, the percentage of total cost incurred by cooperations increased from 1% to 35%. Inter-municipal cooperations differ in size. While the smallest consists of only two municipalities, the largest is composed of more than 20 municipalities. Figure 1 presents a geographic overview of the cooperations (panel a) and the actual scale of production per municipality (panel b) in 2012, measured by the number of properties.

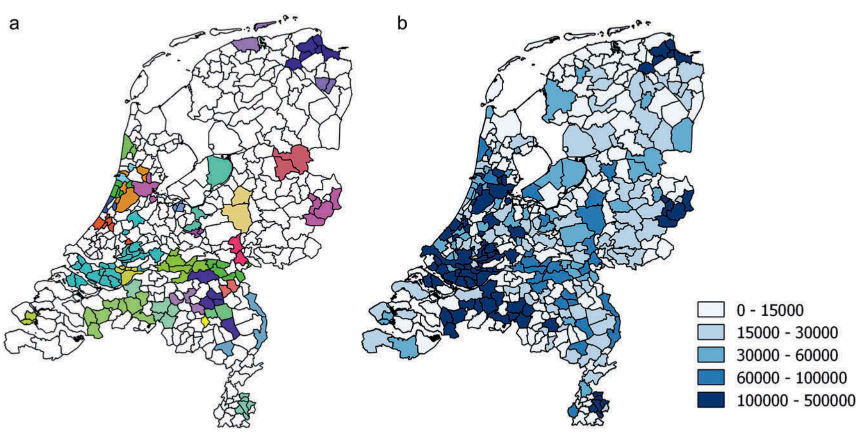

Figure 1. (a) Inter-municipal cooperations in 2012. (b) Actual scale of production per municipality in 2012.

4.2. *Cost and input price variables*

The dependent variable in the cost function analysis is the (log) cost level of municipality tax departments. Between 2005 and 2012, nominal costs increased from roughly 360 to 380 million euros. The costs are composed of mainly labour, IT and office supply costs. While municipal tax departments are a popular subject for inter-municipal cooperation, their relevance in terms of cost is limited (less than 1% of total municipality cost).

In terms of input prices, only the consumer price index is included. Dutch municipalities face largely equal input prices (Bikker and van der Linde 2016) as wages are collectively set and the purchase of other inputs such as office supplies is done on national markets. The cost of capital (e.g., housing) may vary but these are not relevant here, as municipalities report housing costs separately. In the analysis, costs are effectively deflated using the consumer price index, which is invariant between municipalities.

4.3. *Output measures*

The clear majority of local government studies measure output by population count. While there is a large strand of literature that carefully studies the methodological sensitivity in measuring scale economies (for a recent analysis, see Bikker and van der Linde 2016), it has proven difficult to find consistent better aggregate output measures of local government production (Andrews and Boyne 2009). Studies of specific municipality services or back offices typically have used more accurate measures of output. For example, analyses of waste collection services have seen output measures used such as the quantity of waste collected (e.g., Bel and Costas 2006; Zafra-Gómez et al. 2013) in addition to or as replacement of population measures.

For municipal tax departments, there is no comparable literature available to draw output measures from. Recall that Dutch tax departments carry out two primary tasks: the imposition and collection of several taxes and fees and the (re)assessment of all real estate property value. Finally, four output variables are included (1) the number of housing properties, (2) the number of non-housing properties, (3) the number of taxed tourist nights and (4) the number of imposed dog taxes. The motivation for these measures is discussed below.

Ideally, the output of the taxation task is defined as the number of the imposed and processed tax assessments, by type. There are however no data available that directly measure this. In terms of revenue, the most important are the real-estate tax (43%) and waste collection and sewerage fees (41%). Although revenues are known, they offer no suitable output measures as tariffs vary among municipalities. Higher tariffs lead to higher revenues but not to more administrative efforts. The number of real-estate properties is known at the municipality level, an accurate proxy for the number of levied real-estate taxes. The number of real-estate properties is also used to proxy the number of levied waste collection fees. Although these are usually levied at the level of households, these correlate strongly with properties.

The next two important taxes are the tourist tax and dog tax (together 3% of revenues). These may source some heterogeneity as not all municipalities levy tourist taxes and/or tourist fees and as tourism varies strongly between municipalities. Tourism is an often overlooked but important source of municipal heterogeneity (Bel and Costas (2006) discuss this in the context of waste collection). Dutch municipalities typically levy tourist taxes per tourist night. The tourist tax revenue is used as a proxy for the number of levied tourist taxes. The revenues are divided by the prevailing tax rate. This measure is equal to the number of taxed tourist nights. Following the same line of reasoning, the dog tax revenues are divided by the dog tax rate to proxy the number of levied dog taxes.

The second primary task of tax departments is the valuation of all real-estate properties. This output can also be measured by the number of properties. On average, it requires fewer resources to perform valuation of more common properties such as flat apartments than of more heterogeneous properties such as schools and hospitals. One distinction that is available in the data is between housing and non-housing properties. Both are included separately in the model. Finally, the first two output measures (housing and non-housing properties) then measure both the output of the valuation process and a part of the taxation process (real-estate tax).

4.4. *Variables in the efficiency component*

The cost efficiency component includes five variables that all relate to scale and cooperation characteristics. The first two and most important variables relate to scale: (1) the scale of services measured by the total number of properties and (2) the square of (1) to allow for an (inversely) U-shaped effect, that is, to allow for a shift from increasing to decreasing economies of scale at some point (and to allow for the existence of a tipping scale or optimum scale). These scale variables express the *actual* level of production. Thus, for municipalities in an inter-municipal cooperation, (1) is equal to the sum of total cooperation output, while for single municipalities, it equals the individual output of the municipality. The production (y) variables on the other hand always relate to the individual municipality output.

The third, fourth and fifth managerial variables are dummy variables that indicate (3) whether a municipality participates in the cooperation (coordination costs), (4) if a water authority is included in the cooperation (vertical integration eliminates the need for double administrative systems) and (5) whether it is a municipality's first year in a cooperation (transition or start-up costs).

Finally, recall that $h(\mathbf{z}, \boldsymbol{\delta}) = (\exp(\mathbf{z}'_1\boldsymbol{\delta}_1) + \exp(\mathbf{z}'_2\boldsymbol{\delta}_2))\mu^*$. The scale variables (1) and (2) make up $\mathbf{z}_1$ while (3), (4) and (5) are included in $\mathbf{z}_2$.

4.5. *Environmental variables*

Exogenous variables may influence the cost level through the production environment. The efforts to levy taxes may depend on the municipality's socio-economic, demographic or fiscal characteristics. Variables included are (1) the average value of properties; (2) the municipal property tax rate (in %), (3) the number of welfare benefit recipients, (4) the ratio of single households to the total number of households and (5) the net property tax returns (i.e., the percentage of the imposed property taxes that are successfully collected). As the literature on the economies of municipality tax collection agencies is rather scarce, not all variables are justified by literature but haven arisen from interviews held with civil servants employed in municipality tax departments.

Expensive properties are on average less homogeneous and thus require more effort to valuate. To control for this, the average value of properties is included as an additional measure (Bikker and van der Linde (2016) also include this to account for municipality heterogeneity).

As discussed in Section 4.2, the waste collection fee is typically collected per household. Although strongly correlated with the number of properties, in municipalities with a relatively high number of single-person households, this may lead to a bias. The relative number of single-person households to total households in the municipality is therefore included.

Inhabitants of a municipality may fail to pay some or all the imposed taxes. This requires municipalities to exert more effort to collect the taxes, for example, by engaging bailiffs. The degree to which a municipality succeeds in collecting the total property income (tax rate multiplied by total property value) can be interpreted as a measure of quality of the levying process. To control for this, the *net* property tax returns (in %), that is, the percentage of the total imposed property tax collected, are included. This percentage may also vary due to environmental variables, such as income level and other factors, for which a correction is made by a separate single OLS regression.

Also, the number of welfare recipients is included in the model, as low incomes are more likely to appeal for tax exemption. Also, municipalities will more likely have to send more repeated requests for payments or fines. It is expected that this drives average cost up.

A final potential important cost driver is the number of submitted appeals. Inhabitants may file an appeal if they disagree, for example, with the valuation report or the tax assessment, and the handling of such an objection is rather expensive. The returns of a successful appeal are higher if the property tax rate is higher. This motivates including the average property tax rate.

4.6. *Technological and institutional changes*

IT innovations play an important role in the administrative processes for taxation, as valuation is increasingly done with automatised software. Therefore, an annual trend parameter is included in the specification. The estimated parameter of the annual trend (2005–2012) reflects the average annual percentage change in cost due to these technological changes.

5. Results

5.1. *General*

The main results are presented in Table 3. The results are obtained by regressing the log cost of municipalities on output, environmental characteristics and inefficiency determinants, that is, by estimation of Equation (2) with NLLS. All (continuous) variables have been centred on their arithmetic mean. Panel-robust (White) standard errors are computed as the convoluted regression error is heteroskedastic by definition (Parmeter and Kumbhakar 2014).

The first-order output parameters (b_1, b_2, b_3, b_4) have plausible (positive) signs. The third parameter is estimated significant only at a 10% significance level and fourth output parameter (dog taxes) is not estimated significantly. The fourth output (dog tax) is small in magnitude and not as a big a source of heterogeneity. Note that most cross terms are estimated insignificant as well. A simpler Cobb–Douglas formulation with no cross terms is however rejected by a LR test. Note furthermore that constant returns to scale have been imposed: the first-order and second-order parameter sum to, respectively, one and zero.

One way to evaluate the plausibility of the estimates is to inspect the marginal cost with respect to every distinct product. The marginal costs are computed for the average (in terms of environmental characteristics) and cost-efficient municipality. These are reasonable: the marginal cost in euros equal 40 and 63 euros for levying taxes on and the valuation of, respectively, a housing and non-housing property, while the marginal cost of levying a tourist tax (per night) and dog tax equal, respectively, 0.11 and 13 euros.

Table 3. Model estimates (N = 3116).

Variable	Parameter	Estimate	Std. Error	T-value
HOUSING PROPERTIES	b_1	0.736	0.062	11.805***
NON-HOUSING PROPERTIES	b_2	0.203	0.058	3.483***
TAXED TOURIST NIGHTS	b_3	0.029	0.017	1.712*
IMPOSED DOG TAXES	b_4	0.032	0.029	1.102
HOUSING PROPERTIES × HOUSING PROPERTIES	b_{11}	0.136	0.126	1.076
HOUSING PROPERTIES × NON-HOUSING PROPERTIES	b_{12}	−0.128	0.131	−0.980
HOUSING PROPERTIES × TAXED TOURIST NIGHTS	b_{13}	−0.014	0.024	−0.596
HOUSING PROPERTIES × IMPOSED DOG TAXES	b_{14}	0.007	0.036	0.188
NON-HOUSING PROPERTIES × NON-HOUSING PROPERTIES	b_{22}	0.171	0.142	1.202
NON-HOUSING PROPERTIES × TAXED TOURIST NIGHTS	b_{23}	0.000	0.025	0.002
NON-HOUSING PROPERTIES × IMPOSED DOG TAXES	b_{24}	−0.043	0.036	−1.183
TAXED TOURIST NIGHTS × TAXED TOURIST NIGHTS	b_{33}	0.009	0.007	1.340
TAXED TOURIST NIGHTS × IMPOSED DOG TAXES	b_{34}	0.006	0.007	0.851
IMPOSED DOG TAXES × IMPOSED DOG TAXES	b_{44}	0.030	0.026	1.167
AUTONOMOUS COST GROWTH	g_0	−0.031	0.004	−7.064***
AVERAGE PROPERTY VALUE	g_1	0.390	0.079	4.935***
PROPERTY TAX RATE (IN %)	g_2	0.105	0.042	2.518**
SINGLE HOUSEHOLDS/TOTAL HOUSEHOLDS	g_3	0.113	0.107	1.058
NET PROPERTY TAX RETURNS	g_4	0.703	0.331	2.126**
WELFARE RECIPIENTS	g_5	0.095	0.029	3.320***
MEAN INEFFICIENCY PARAMETER	u^*	1.016	0.227	4.469***
FUNCTIONAL SCALE	d_1	−9.757	2.467	−3.955***
FUNCTIONAL SCALE × FUNCTIONAL SCALE	d_2	0.985	0.249	3.957***
DUMMY: IN COOPERATION	d_3	−0.052	0.057	0.905
DUMMY: IN COOPERATION WITH WATER AUTHORITY	d_4	−0.197	0.116	−1.695*
DUMMY: FIRST YEAR IN COOPERATION	d_5	0.239	0.077	3.118***
LOG LIKELIHOOD		−1552.42		
R^2		0.813		

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

5.2. *The relation between scale, efficiency and inter-municipal cooperation*

Next, consider the parameter estimates of the efficiency component u. A negative (positive) sign here implies a positive (negative) relationship with efficiency, as u denotes cost *in*efficiency. Recall that cooperation enters the model in two ways. First, the actual scale of production for cooperating municipalities, which is included as a determinant of efficiency, exceeds their administrative scale. Second, a dummy variable is included to test whether, *given* some scale, cooperations are significantly more or less efficient. There is evidence of economies of scale as the parameters of the actual scale of production and the squared actual scale of production variables are estimated significantly. Furthermore, the parameters indicate a U-shaped relation between inefficiency and scale, as the parameters are estimated positive and negative, respectively. The optimum scale is estimated at 226,961 $(\approx 9.757/(2 \cdot 0.985) \cdot 45,825)$ real-estate properties. This roughly corresponds to 450,000 inhabitants (on average, there are two inhabitants per property). Below (above) this point, production is characterised by (dis)economies of scale. In the Dutch context, this is rather large; as such, the estimate should be interpreted more as a careful indication than an accurate point estimate. The tipping point is extrapolated from mostly smaller municipalities; only a few in the sample exceed this size.

The most important point to take from the scale parameters is that scale effects are pronounced especially for municipalities or cooperations with less than roughly 30,000 properties; the decrease in cost efficiency after this point is virtually non-existent. Figure 2 graphs the estimated relation between expected efficiency and scale for under 50,000 properties. Hence, despite the estimated large optimum size, economies of scale are defined mainly for smaller municipalities.

Now consider the estimated dummy variable. Remarkably, other than through scale, cost efficiency is not significantly associated with cooperation. Hence, there is no evidence of significant coordination costs. The point estimate is even slightly negative (cooperation is associated with higher efficiency). Importantly, note that in case scale effects were persistent only for non-cooperating municipalities, this parameter would have taken a positive and larger value.

To illustrate the estimated relation between scale and cost, the parameter estimates can be used to predict cost levels. Table 4 presents some simulations of municipalities that decide to scale their production through inter-municipal cooperation. The simulations suggest that the cost-saving effects

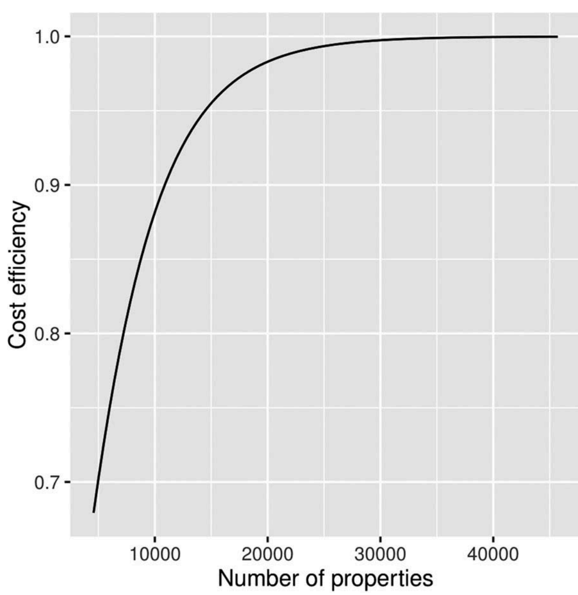

Figure 2. Estimated relation between scale and cost efficiency.

Table 4. Predicted scale effects.

Ex-ante scale of production (in properties)	Percentage of Dutch municipalities operating at a lower scale of production in 2012	Increase of actual scale of production towards	Estimated cost reduction (%)
5000	5	10,000	20.4
		20,000	28.9
		50,000	29.8
10,000	25	20,000	10.3
		50,000	11.8
		100,000	11.8
25,000	60	50,000	0.6
		75,000	0.7
		100,000	0.7

are more pronounced (percentagewise) for smaller municipalities. Two municipalities, each currently sized at 5000 properties, are estimated to save up to 20% by cooperating. Two larger municipalities, sized at 10,000 properties each, can expect to save 10% through cooperation. For average to larger municipalities, scale effects have exhausted.

Municipalities that collaborate with a water authority are estimated more efficient. Cooperation between municipalities and water authorities implies the discontinuation of some of the activities that were previously duplicated, such as administering duplicate address databases. Finally, the first year a municipality levies through inter-municipal cooperation is associated with a temporary loss in efficiency.

Finally, autonomous productivity growth is deduced from the change in costs over time, corrected for changes in production and all other control variables. Costs decreased by 3.1% a year on average. One plausible explanation is that the valuation of properties is becoming less and less expensive as more and more automated software is used.

6. Discussion and conclusion

This paper analysed the relation between inter-municipal cooperation, scale and cost efficiency in Dutch municipal tax departments. In the Netherlands, tax collection is a popular subject for inter-municipal cooperation. The results indicate that inter-municipal cooperation is related to lower cost and that the relation can be explained by scale. Economies of scale are particularly pronounced at small levels of production. A scale of 5000 properties (roughly 10,000 inhabitants) is associated with 30% cost inefficiency. The benefits diminish with scale and are largely exhausted at 30,000 properties (roughly 60,000 inhabitants).

Remarkably, no significant association between inter-municipal cooperation and cost efficiency was found other than through scale, for example, through coordination and transaction costs, except for a temporary downward shock of efficiency in the first year, a municipality is active in a cooperation. Although non-significant, cooperating municipalities are, surprisingly, associated with a slightly higher cost efficiency. One factor that may contribute here is that cooperations are not as susceptible to political inference from a single municipality. In addition, tax collection is a relatively low-complexity and standardised task, which may limit the required coordination between cooperating municipalities.

Municipalities do seem to incur extra cost for setting up or joining a cooperation initially. Work processes between different municipalities have to be integrated and personnel have to be relocated. Additionally, municipalities that cooperate with water authorities are more efficient. This is expected, as it removes the duplicate maintenance of rather similar administrative systems.

Inter-municipal cooperation is becoming an increasingly common phenomenon in European countries, and its popularity in the Netherlands is on the rise as well. In many western European countries, cooperation is motivated by cost savings. Often, cooperations focus on a specific municipal service, task or output, such as waste collection, road maintenance or social services. In the Netherlands, municipalities can be active in tens of different cooperations. From a scale perspective, inter-municipal cooperation then offers tailored scaling of services that may benefit from it. Existing literature on inter-municipal cooperation confirms that cooperation may contribute to reducing cost and, generally, the effects are ascribed to scale economies. So far, most empirical studies on EU inter-municipal cooperation and cost concern waste collection.

A practical implication of the results is that by scaling production, cooperation can be effective in decreasing cost, especially for smaller municipalities. It should be stressed however that the results do not easily generalise to other municipality services, as both scale and coordination effects likely vary. Further research on the relation between inter-municipal cooperation, scale and cost efficiency in other services may help in shed light on what factors determine the feasibility of inter-municipal cooperation to reduce cost. More generally, analysis of specific services may also be useful to decompose overall municipality scale effects. Examples of potential determinants that drive scale and coordination effects include the size of fixed cost, labour intensity, task complexity and the level of standardisation in the delivery of the service between municipalities (see also Bel and Warner 2015). In the case of Dutch tax departments, task complexity is low and there is a high degree of standardisation driven by legal requirements. Coordination requirements are therefore likely limited and scale effects are plausible.

Finally, it should be noted that inter-municipal cooperation has also been subject to criticism: cooperation goes at the expense of democratic legitimacy, and municipalities that are active in dozens of cooperations become less transparent, while they may also incur increased overall administrative burdens, for example, in overall municipality management. Such effects remain unclear when focusing on a single municipal service, as the costs of other services and general municipal management are not included. Moreover, little is still known about the relation between inter-municipal cooperation and the quality of service delivery. Future research on the relationship between flexible structures of inter-municipal cooperation, efficiency and the quality of service delivery is therefore desirable to uncover these relations in more detail.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Thomas Niaounakis is a PhD candidate at Delft University of Technology and a researcher at the Institute for Public Sector Efficiency Studies. He graduated in econometrics and economics from the Erasmus School of Economics. His research interests include the analysis of public sector efficiency and productivity. His PhD thesis focuses on the empirical measurement of scale efficiency in particular.

Jos Blank is a professor at Erasmus University Rotterdam, an associate professor at Delft University of Technology and Chair of the Institute for Public Sector Efficiency Studies. He graduated in econometrics and has had a long career in research on public sector productivity, on which he has published numerous books and articles. He also is an advisor for Dutch politicians and policy makers.

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