Agronomy Research **16**(3), 806–820, 2018
https://doi.org/10.15159/AR.18.125

Performance evaluation of rural areas: the case of Estonian rural municipalities before the administrative reform

H. Luik-Lindsaar*, R. Põldaru, A. Põder and J. Roots

Estonian University of Life Sciences, Institute of Economics and Social Sciences, Kreutzwaldi 1, EE51014 Tartu Estonia
*Correspondence: helis.luik@emu.ee

Abstract. Estonian municipalities have recently passed an administrative reform that has resulted in the reorganisation of municipal management and decreased the number of municipalities. Unfortunately, no thorough scientific research has been done to find out whether the emerging helps to increase the efficiency. The aim of this paper is to estimate the efficiency of Estonian rural municipalities and to identify the factors that influence their efficiency. In this study we use a two stage analysis. In the first stage, we use the DEA Slacks-Based Model's (SBM) output-oriented approach. In the second stage, we use the Fractional Regression Model (FRM) to determine relevant exogenous factors that are associated with efficiency. 170 Estonian rural municipalities have been analysed. According to the DEA results, 28% of municipalities (48) are efficient, the average efficiency of municipalities is 0.762. The analysis implies that there are considerable differences between smaller and larger rural municipalities. FRM results revealed that larger share of subsidies characterize inefficient municipalities. The weaker the municipality, the more state support the municipality must receive. A larger share of people with a higher education increases the efficiency, it is related to higher salaries and therefore higher revenue to the municipality. Elderly residents in the population increases the efficiency, however it isn't sustainable in the long-run because more inputs are needed to offer various public services. The results indicate that the further away a municipality is from the capital, the more inefficient the municipality becomes.

Key words: technical efficiency, rural municipalities, DEA, FRM.

INTRODUCTION

Municipalities manage public money, which is collected and distributed by the government. More than half on local municipalities' revenue comes from income tax (Statistics Estonia, 2016). Therefore, local residents expect high quality services which contribute to the functioning and development of local life.

Municipalities have to provide and ensure services to local residents. As any other organisations, municipalities must follow the theory of the firm: the provision of services must be cost-efficient and at the same time, they have to ensure high quality of services. A limited budget complicates the provision of high quality services and often becomes the decisive factor in calculating the volume of services and outlining the list of required services.

Some municipalities are managing public money better than others, which means that these municipalities are more efficient. We can measure the efficiency in input-output context. The services that municipalities provide are considered as inputs and the population and area describing the output volumes.

Assessing the efficiency of municipalities in respect of the provision of certain services is fully valid since municipalities operating within the same political and economic context and cultural space should provide services in a relatively homogenous way. Benchmarking and identifying the reasons of efficiency at local level provides necessary information to reorganise services in those municipalities that experience problems with the provision of services.

Previous literature shows that efficiency studies differ in terms of methodological approaches, as well as by results. DEA (data envelopment analysis) and SFA (stochastic frontier analysis) are quite extensively used techniques for efficiency analysis (Afonso & Fernandes, 2008; Cuadrado-Ballesteros, et al., 2013; Charles & Zagarra, 2014; Cruz & Marques, 2014; Doumpos & Cohen 2014; Asatryan & De Witte, 2015; Drew et al., 2015; Horta et al., 2016; Storto, 2016; D'Inverno et al., 2018). The performance of municipalities is estimated against a frontier consisting of the observation of the best practices. The municipalities with the best practices, which use resources effectively, serve as references for inefficient municipalities, and can be used as guidance for the future.

It is common to assess the efficiency of the following services which are in the area of responsibility of municipalities: education (Seroa da Motta & Moreira, 2009); environmental protection, and housing and communal services (Rogge & De Jaeger, 2012; Alper et al., 2015), healthcare (Valeira et al., 2010), social security (Iparraquirre & Ma, 2015), leisure and culture (De Witte & Geys, 2011). Some studies have focused on the size (population) and the merger of municipalities with the aim to make conclusions about the occurrence of the scale effect across different services provided in larger municipalities (Slack & Bird, 2013a).

In less populated municipalities, it is difficult to offer services as efficiently as in densely populated municipalities. Sparsely populated municipalities are often situated in the periphery, which are struggling due to urbanisation and outmigration. Owing to the marginalisation process, creation of new jobs is very limited in these municipalities, which leads to both short and long term decrease of the revenue base. The government has provided considerable subsidies for municipalities which have a low revenue base. Since Estonia's population is aging and municipalities are facing a situation where the revenue base is decreasing whilst the number of people who need social assistance is increasing, the state is looking for solutions that would ensure residents significant public services within their own municipalities. The state considers that the merger of municipalities is one of the options, in order to achieve greater efficiency through the scale effect. The merger of municipalities, their efficiency and the optimal size of a municipality have been the focus of increasingly heated public debate in Estonia. Many countries have gone through similar processes of considerable reform of municipal structures and mergers in the recent decades (Bönish et al., 2011). A number of studies have been carried out on the effect that the merger of municipalities has on financial sustainability in the context of providing public services (Nakazawa, 2013; Slack & Bird, 2013b; Allers & Geertsema, 2014).

This research uses a two-stage approach to assess the efficiency of Estonian rural municipalities as many authors have done previously in other countries (Balaguer-Colla et al., 2007; Afonso & Fernandes, 2008; Doumpos & Cohen, 2014; Storto, 2016). In the first stage, the efficiency of municipalities is assessed using the DEA method, followed by identifying efficient and inefficient municipalities. In the second stage, the FRM (fractional regression model) is used to assess the effect that exogenous variables have on efficiency, whereas the DEA model's efficiency score is the dependent variable.

Overview of Estonian municipalities

Estonia is located in the Baltic Sea on the shores of the Gulf of Finland, bordering with Russia in the east and Latvia in the south. With an area of 45,227 km^2 and a population of 1.3 million, it is one of the smallest EU countries. Estonia is territorially divided into 15 counties. It was subdivided into 213 municipalities, including 30 cities and 183 parishes until 1st July of 2017 (Statistics Estonia, 2015).

Due to urbanisation, more populated parishes are mainly situated in North Estonia, around the capital Tallinn. Harju county has 575,000 residents (a remarkable 43% of the total population), with 407,000 of them living in the capital Tallinn. Urbanisation of the population can also be observed elsewhere in Estonia, particularly in suburban parishes. Less populated parishes are situated in West, East and Southeast Estonia.

The single-level municipal system has been in force in Estonia since 1993. Municipalities make decisions and organise all aspects of local life independently (Ministry of Finance, 2016b). The state can only assign obligations to them based upon the law or upon an agreement with the municipality (The parliament of Estonia, 1993). The cornerstone of modern democratic organisation is the principle of subsidiarity, according to which functions must be exercised at a public administration level as close as possible to the citizen. One of the main tasks of the local council is to make the most important decisions that affect local life, and to guide the development of the municipality (The parliament of Estonia, 1993).

Municipalities must provide social assistance and services, housing and communal services, water supply and waste disposal, spatial planning, public transport, maintenance of municipal public roads and city streets, offer primary level healthcare services, organise the upkeep of local preschool childcare institutions, schools, libraries, community centres and other local institutions, and also ensure public order and surveillance. (The parliament of Estonia, 1993)

Municipalities can exercise the functions assigned by the state, using the financial resources at their disposal. Estonian municipality revenues include taxes, sales of goods and services, sales of tangible and intangible property, revenue from property, government subsidies, and other income. Government subsidies refer to central government's grants to local municipalities to guarantee financial resources for carrying out their tasks and for equalizing the disparities in per capita income (Reiljan, 2004, Ministry of Finance, 2016b).

The municipal income analysis shows that in 2013 the largest part of income in municipal budgets comes from personal income tax proceeds (49%), and another part is constituted by government subsidies (34%). A relatively small part is made up by the sales revenue of goods and services (10%) and by land tax (4%). The largest share of expenses are education costs (42%), followed by economic, defence and security costs

(17%), costs related to culture and sport (13%), and environmental protection and communal service costs (10%). (Statistics Estonia, 2016)

The quality of public services can differ between Estonian municipalities. The functions of all municipalities are the same by the law, however, the size of municipalities varies from capital with over 400,000 inhabitants to small island municipalities with less than 100 inhabitants (European Commission, 2013). So municipalities with very different capacities have to provide same kind of broad range of services (Friedrich et al., 2010). Uudelepp et al. (2009) pointed out that problems are caused by the delegation of tasks which are unaffordable to municipalities, and by the insufficient revenue base of municipalities, especially sparsely populated and peripheral ones. Insufficient public services create a multifaceted problem, possibly limiting people's quality of life (lacking social services) and opportunities (lacking educational services). Estonian administrative organisation is often referred to and highlighted as problematic. (Uudelepp et al., 2009)

An analysis of Estonian administrative organisation demonstrates that considering the number of residents and the area of Estonia, there was a lot of municipalities compared to other Nordic countries. In Estonia, the average surface area of a municipality was 212.3 km^2, whereas it is 1,067.6 km^2 in Finland, and 1,512.3 km^2 in Sweden. The average number of residents in Estonian municipalities was 6,165.6, compared to Finland's 17,261.1, and Sweden's 33,577.8 residents (Eurostat, 2015; Eurostat, 2016). Most of local municipalities appeared to be too small to deliver everyone the services they are required to provide by law (European Commission, 2012).

In order to reduce the number of municipalities, the parliament of Estonia passed the Promotion of Local Government Merger Act in 2004, stipulating that the state encourages and supports the merger of municipalities at their own initiative in order to create municipalities with a larger territory and more inhabitants (The parliament of Estonia, 2004). Regardless of the state support, municipalities have not merged extensively. From 2004 to 2016, the number of municipalities decreased only from 241 to 213. In 2016 there was many municipalities (142) fewer than 3,000 inhabitants (Statistics Estonia, 2016). The dissent over the reduction of the number of public servants after the mergers, local communities' fears about marginalization, political and economic future have also contributed to the slow progress of mergers (Olle & Merusk, 2013).

Given that municipalities in Estonia were small and not interested in merging voluntarily, the government decided to enforce an administrative reform to create stronger (administratively more efficient) municipalities that would develop local life as a whole and ensure better accessible and higher quality public services for people. Having a bigger budget would make it possible to hire better qualified staff and public servants, improve the quality and regularity of public transport thanks to a larger territory being involved, contributes to the growth of municipal budgets, thus enabling to draw up and carry out larger projects (Ministry of Finance, 2016a). By the end of 2017, local municipalities in Estonia were either voluntarily and forcedly merged in to 79 municipalities (Ministry of Finance, 2016a).

In theory, one can claim that the merger of municipalities will lead to the anticipated benefits. Nevertheless, research has shown that this is not the case when it comes to forced mergers. Hanes & Wikström (2010) analysed whether voluntary mergers are more efficient compared to forced mergers, as well as the impacts mergers have on the

local population and income growth in Sweden. The main finding was that municipalities formed on a voluntary basis had higher population growth, therefore the conclusion could be that local opinions are important to consider when forming a new municipal structure.

There are practically no scientific articles on the administrative technical efficiency of Estonian municipalities, however, the quality of life in Estonian counties has been studied using the DEA-PCA method (Põldaru & Roots, 2014). Reiljan et al. (2013) have studied the impact of merging municipalities and cities to their financial sustainability. Põldnurk (2015) has worked with municipal waste management optimisation in rural areas. The consultancy and training centre Geomedia has studied the capability of municipalities in 2016 (Noorkõiv & Ristmäe), and the Praxis Centre for Policy Studies has assessed the quality of public services (Uudelepp et al., 2009).

Since the efficiency of Estonian municipalities has not been assessed, there is a need to analyse and identify the factors that affect the efficiency of municipalities. On one hand, this is necessary for the better operation of inefficient municipalities in the future by learning from the municipalities with the best practice performances, and on the other hand, policy makers can acquire information that is important to help underdeveloped municipalities.

MATERIALS AND METHODS

Data Envelopment Analysis and fractional regression model

DEA method has many advantages to evaluate the efficiency, therefore it is widely used. There are a lot of different DEA models and model's developments (Cooper et al., 2007). The basic concept is the benchmarking study, where the units to be evaluated (decision making units - DMU) are evaluated against each other. The DEA model returns the efficiency scores (reported as the scalar ρ) for DMU's between in the interval 0 (worst result) to 1 (best result). The DMU is equal to 1 if and only if the DMU is on the efficient frontier without any slacks. The slacks represent input surplus or output scarcity of the DMU. Tone (2001) introduced a slacks-based measure of efficiency (SBM model) which deals with the input excesses and the output shortfalls, the model has some important properties: it is units-invariant and the measure is monotone decreasing in each input and output slack.

We will use the output-oriented approach, which allows assessing how much output could actually be produced with the available inputs, e.g. how many residents could be served using the incurred expenses in municipalities. We will deal with n DMUs ($j = 1,\dots,n$) each using m inputs ($i = 1,\dots,m$) to produce s outputs ($r = 1,\dots,s$). The input and output vectors are $x_o \in R^m$ and $y_o \in R^s$, respectively. For each DMU the input and output matrices are denoted as $X = (x_1,\dots,x_n) \in R^{m\times n}$ and $Y = (y_1,\dots,y_n) \in R^{s\times n}$, respectively. The vector s^+ indicates output shortfall, and it is called slack.

The output-oriented SBM model (1) with the variable returns to scale is formulated as (Tone, 2001; Cooper et al., 2007):

$$\rho_o = \min_{\lambda,s^+} \frac{1}{1 + \frac{1}{s}\sum_{r=1}^{s} s_r^+ / y_{ro}} \qquad (1)$$

subject to

$x_o \geq X\lambda;\ y_o = Y\lambda - s^+;\ \lambda = 1;\ \ s^+ \geq 0\, \frac{1}{s}\sum_{r=1}^{s} s_r^+ / y_{ro}$ is the mean expansion rate of outputs and λ is an intensity vector (Tone, 2001).

We use the fractional regression model (FRM) in the second-stage analysis as suggested by Papke & Wooldridge (1996), and Ramalho et al. (2010). The DEA estimates the technical efficiency scores are in the interval [0, 1]. The advantage of the FRM is that it allows accumulation of non-trivial probability mass at one end of the distribution, which is often the case in the DEA analyses. In addition, the FRM enables to analyse one- and two-part models, which is useful if the probability of observing a DEA score of unity is relatively large or if the sources of technical efficiency may differ from those of inefficiency (Ramalho & Ramalho, 2011).

In our analysis, the DEA score 1.000 was observed in 28% of cases. The first stage of the FRM uses a binary choice model, where the binary indicator has values 0 for inefficient and values one for efficient (TE score = 1.000) municipalities. The second stage of the model is the fractional section that is estimated using only the sub-sample of inefficient municipalities (TE score < 1.000).

Data

The inputs and outputs have differed considerably in previous DEA studies, which is fully justified. The selection of indicators for DEA analysis is crucial because selecting wrong indicators could lead to wrong results. Therefore, the indicators must characterize municipalities and their operation. The inputs must characterize the contribution that municipalities make to serve local residents, whereas the outputs must characterize the value created directly or indirectly by municipalities.

Several studies have used expenses as input – both the total expenditures (Loikkanen & Susiluoto, 2005; Afonso & Fernandes, 2008; Geys & Moesen, 2009) and expenses by offered services (Balaguer-Colla et al., 2007; Storto, 2016). Using expenses by offered services as inputs is common if the aim is to assess the efficiency of a specific offered service (healthcare, education, etc). In such cases, the chosen inputs could be for instance healthcare costs, education costs, environmental protection and communal service costs, public transport and road maintenance costs (Loikkanen & Susiluoto, 2005; Rogge & De Jaeger, 2012). Additonally, in DEA models have used the quantities of specific services: the number of teachers, children's day care centres, comprehensive schools, the length of roads, the number of parks and recreation areas, the amount of waste water, the number of households with central drinking water and sewage (Loikkanen & Susiluoto, 2005; Valeira et al., 2010; Rogge & De Jaeger, 2012).

Studies that focus on assessing the efficiency of a municipality as a whole often use the total cost as a input, and the number of residents and the surface of the municipality as outputs (Cruz & Marques, 2014; Storto, 2016). It is important to note that in this study, expenses made by the municipality are equalized with the amount of services. The outputs describe values indirectly created by the municipality. Four inputs and two outputs have been selected for DEA model (Table 1). Inputs include expenditures to significant public services per annum in euros: education costs (X1), environmental protection and housing and communal service costs (X2), social security costs (X3), leisure, culture and religious costs (X4). Output variables are: number of residents (Y1) and surface area of the municipality (Y2).

Table 1. Summary statistics of inputs and outputs in DEA and variables in FRM to evaluate Estonian rural municipalities

Variables	Name	Avg.	St. Dev.	Min	Max
Inputs in DEA					
X1 – Spending on education (€)	SPEDU	1,301,882	1,296,522	177,556	8,613,914
X2 – Spending on environmental protection (€)	SPENV	71,134	139,230	0,000	999,795
X3 – Spending on social care (€)	SPSC	234,803	246,249	19,551	2,359,321
X4 – Spending on culture, recreational activities and sport (€)	SPCAS	331,603	392,148	19,413	2,630,354
Outputs in DEA					
Y1 – Population (inhabitants) of municipality	POP	2,485	2,347	457	14,373
Y2 – Surface area of the municipality territory (km2)	AREA	232.1	133.5	12.0	871.3
Dependent variable in FRM					
Technical efficiency (score)	PTE	0.762	0.204	0.101	1.000
Independent variables in FRM					
Z1 – Population with higher education (%)	HEDU	0.2	0.0	0.1	0.3
Z2 – Roads (km)	ROAD	204.0	127.2	9.6	828.1
Z3 – Agricultural land (ha)	AGR	5,250	3,621	195	19,512
Z4 – Subsidies (% of total income)	SUB	0.4	0.1	0.1	0.7
Z5 – Distance from capital (km)	DCAP	154.0	70.4	0.0	290.9
Z6 – Quality of land (points)	QOL	41.0	5.3	29.0	53.0
Z7 – Elderly people (%)	ELD	21.0	4.2	9.5	32.1
Z8 – Wage (€)	WAGE	815.6	82.1	634.3	1,244

The technical efficiency score characterizing the efficiency of a municipality is the dependent variable in FRM, and the factors that potentially affect efficiency are independent variables (Z1–Z8). The FRM is used to assess the effect of exogenous variables on Estonian rural municipalities.

As there is not yet data available on the merged municipalities, the present analysis uses the statistical data from the period before the mergers in 2017. The dataset consists of municipalities' annual expenses and other relevant variables from 2013. All the information for the DEA and FRM comes from Statistics Estonia (2016), except for the indicator characterizing the quality of land, which is from the Estonian University of Life Sciences. To obtain outliers before the DEA analysis, we used the DEA super-efficiency model (Cooper et al., 2007) and expert opinions. 27 of the initial 197 rural municipalities have been excluded from the survey. Outliers were the municipalities with a very big or a very small population. Therefore, 170 municipalities are in the analysis.

Based on previous studies (Afonso & Fernandes, 2005; Bönish et al., 2011; Nakazawa, 2013; Doumpos & Cohen, 2014; Drew et al., 2015; Storto, 2016), we can claim that the following factors affect the efficiency of municipalities: the share of residents with higher education (HEDU), the length of roads (ROAD), the size of agricultural land (AGR), the share of subsidies in the municipal budget (SUB), distance from the capital (DCAP), the quality of land (QOL), the share of elderly residents (ELD), wage (WAGE). The effect of size of agricultural land on the efficiency is important because this study focuses on Estonian rural municipalities. In our analysis, the bigger

size of agricultural land could refer to the municipality's location in the periphery and therefore it could affect the efficiency negatively. The distance from capital could affect the efficiency negatively. The share of subsidies are presumably bigger in inefficient municipalities. The length of roads describes the municipality on several ways, it refers to the size of municipality, higher costs for road maintenance and also better infrastructure.

RESULTS AND DISCUSSION

Results of DEA

The analysis consisted of 170 Estonian rural municipalities. According to DEA results the number of efficient municipalities is 48 (28%), their pure technical efficiency (PTE) is equal to 1,000. The average technical efficiency of municipalities is 0.762 points. In other words, their average efficiency is 76.2%, which means that municipalities could serve 23.8% more population and area using the same amount of expenses they have used for services. Municipalities with low efficiency (PTE lower than 0.600) are the most problematic, the number of such municipalities is 46 (27.1%), these municipalities should serve at the same level of inputs (expenses) 40% more inhabitants and area.

For a more detailed analysis, municipalities have been divided into five groups based on efficiency score: PTE = 1.000 (Group I); $0.803 \leq$ PTE < 1.000 (Group II); $0.659 \leq$ PTE < 0.803 (Group III); $0.553 \leq$ PTE < 0.659 (Group IV); PTE < 0.553 (Group V). The difference between groups is statistically significant ($P < 0.05$).

Fig. 1 gives an overview of local rural municipalities ($n = 170$) based on efficiency scores (Group I being the most efficient). The figure highlights various efficient municipalities in North and Central Estonia, and inefficient ones in South Estonia. To generalize, it can be said that municipalities situated closer to the capital are relatively more efficient.

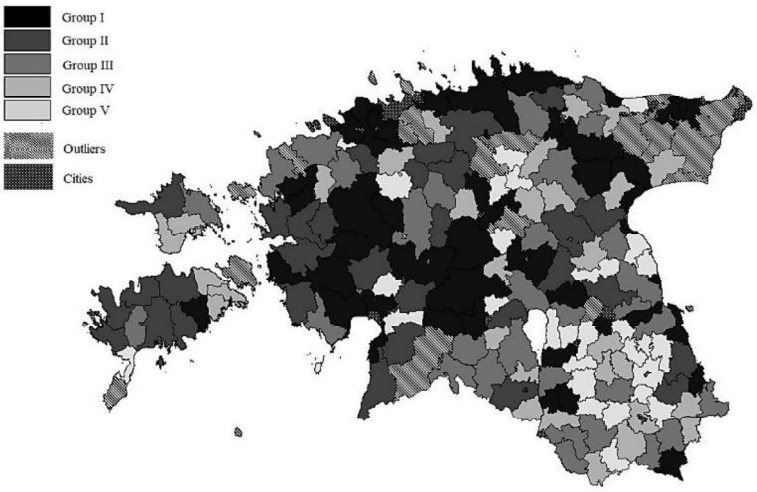

Figure 1. Classification of municipalities based on efficiency scores.

In order to analyse the efficiency of Estonian municipalities from different angles, municipalities have been divided into five groups based on the number of residents (P – population size). Each group contains 34 municipalities. The size groups are: $P < 955$ (Group 1); $955 \leq P < 1{,}318$ (Group 2); $1{,}318 \leq P < 1{,}886$ (Group 3); $1{,}886 \leq P < 3{,}729$ (Group 4); $P \geq 3{,}729$ (Group 5).

Comparing the expenses per resident, it appears that as the number of residents in municipalities grows, the average costs per resident decrease (Table 2). In small municipalities (Groups 1 and 2), average costs per resident are € 1,195–1,219. In large municipalities, expenses per resident are considerably lower. In municipalities with the most residents (Group 5), the average costs per resident were € 1,052. Municipalities with more residents are relatively more efficient, on average their expenses are 14% lower. Efficient municipalities spend less per resident (on average € 1,088), and less efficient municipalities spend considerably more – € 1,121 (Group I compared to Group V). Larger municipalities are hence more efficient since they spend considerably less per resident than small municipalities. Doumpos & Cohen (2014) have reached the same conclusion that smaller municipalities tend to be more inefficient. It appears that expenses are significant factor shaping the efficiency of a municipality.

Table 2. Costs per resident (€) by municipality's size and efficiency

Population of local municipality	Efficiency groups					
	I	II	III	IV	V	Average
Group 1	1,166	1,207	1,301	1,193	1,526	1,219
Group 2	1,085	1,282	1,370	1,171	1,116	1,195
Group 3	0,940	1,020	1,109	1,207	1,083	1,070
Group 4	1,127	1,050	1,059	1,283	1,080	1,101
Group 5	1,078	1,090	0,991	0,979	1,024	1,052
Average	1,088	1,110	1,175	1,168	1,121	1,128

An analysis of the average income by size and efficiency groups shows that average income is 11.8% bigger in large municipalities (Group 5) than in small municipalities (Group 1) (Table 3). As efficiency decreases, so do salaries. Residents of efficient and large municipalities (Group 5, I) have the highest salaries. To keep the workforce, it is important to ensure a competitive salary.

Table 3. Average monthly salaries (€) of local residents by municipality's size and efficiency

Population of local municipality	Efficiency groups					
	I	II	III	IV	V	Average
Group 1	775	810	801	780	831	790
Group 2	748	885	792	832	779	796
Group 3	800	804	800	802	798	801
Group 4	827	803	780	813	821	808
Group 5	917	836	841	861	873	883
Average	834	819	799	813	803	816

The share of subsidies in efficient and less efficient municipalities varies from 37.0% to 43.2% on average (Table 4). In smaller municipalities (Group 1), subsidies make up a larger share, an average of 40.4%, whereas in larger municipalities (Group 5), subsidies constitute 34.7%. The share of subsidies is larger in less efficient municipalities. The

weaker the municipality, the more state support the municipality must receive. Doumpos & Cohen (2014) reached a similar conclusion, pointing out that independence from state subsidies improves the efficiency of municipalities.

Table 4. The share of subsidies (%) by municipality's size and efficiency

Population of local municipality	Efficiency groups					
	I	II	III	IV	V	Average
Group 1	42.6	34.0	42.1	40.0	47.9	40.4
Group 2	46.1	39.1	44.4	34.2	44.1	42.3
Group 3	29.9	36.0	41.0	41.4	46.1	39.0
Group 4	36.5	39.7	43.0	44.5	39.8	40.3
Group 5	33.6	36.7	37.4	33.3	35.2	34.7
Average	37.0	37.1	42.0	38.6	43.2	39.3

An analysis of the size and efficiency of municipalities shows that there are significant differences within the groups regarding the following indicators: total cost per resident, average income, and the share of subsidies out of total revenue. In larger municipalities, efficiency is higher mainly thanks to having lower costs per resident. Therefore, we can say that based on the analysis, the dependence of analysed indicators on the size of the municipality and efficiency score is in accordance with economic theory and practice.

Results of fractional regression analysis

The results of the fractional regression analysis are presented in Table 5. The efficiency scores of municipalities obtained in the first stage using the DEA analysis are the dependent variables in the FRM analysis, and 8 factors that may affect the efficiency of a municipal unit serve as independent variables. In the one-part model, 4 factors resulted statistically significant. The share of subsidies (SUB), the share of population with higher education (HEDU), and the share of elderly people (ELD) are the most significant one ($P < 0.05$). The size of agricultural land is also statistically significant ($P < 0.1$).

A positive regression coefficient shows that as the impact factor increases, so does the efficiency of the municipal unit, whereas a negative one denotes an unfavourable association. As the share of people with higher education (HEDU) increases, so does the efficiency of a municipality, which is in compliance with the practice and also demonstrating that more efficient municipalities attract more educated population. As far as the share of people with higher education affects municipalities efficiency positively, it should be kept in mind and bring up in the future. Hopefully, the opportunity to get free higher education will be the case in the future and helps to increase the efficiency at municipal level and also in the state level.

Increase in the number of the elderly people (ELD) has a positive effect on the efficiency of a municipality. Just like other parts of Europe, Estonia is also characterized by aging population. This leads to increased costs (Nakazawa, 2013). The increase of costs combined with the decrease of tax revenue per person should in theory result in the decrease of efficiency in municipalities. The latter should occur in the long run. According to FRM results however, the increase of the share of the elderly increases efficiency. Various leading municipal researchers have reached the same conclusion

(Bönish et al., 2011). We should bear in mind that this correlation exists in the short run, and other tendencies occur in the long run. If the share of elderly people increases the tax revenue will decrease and the amount of social services will increase. The authors of this study agree with Cruz and Marques (2014) that the share of the elderly people and the surface area of the municipality are indicators that the government must consider when distributing resources between municipal budgets, and that state investments must also be made in more sparsely populated areas in order to guarantee the sustainability of these areas.

A negative indicator of the share of subsidies (SUB) is in accordance with economic practices. Based on studies, we can claim that independence from state subsidies improves efficiency in some countries (Bönish et al., 2011; Doumpos & Cohen, 2014; Drew et al., 2015) and reduces it in others (Balaguer-Colla et al., 2007; Cruz & Marques, 2014). The impact of subsidies on efficiency thus primarily depends on the specifics and the policies of the assessed country. The example of Estonian rural municipalities allows us to argue that independence from subsidies increases efficiency.

Increase in the agricultural land (AGR) has a positive effect to the efficiency.

There are some differences in significant variables in the two-part FRM models compared to the one-part FRM model. In the first part of the two-part model, the factors affecting efficiency negatively are: distance from capital (DCAP), wage (WAGE). It means that peripheral municipalities with lower local income levels are less efficient. The share of people with higher education has a positive effect to the efficiency.

In the second part of the two-part model we consider only these municipalities with lower efficiency (PTE < 1). The results of the 2nd part of the two-part model reveal that it bears resemblance to the one-part model. The three exogenous factors that are significant in the one-part model are also significant in the two-part model (AGR, SUB, ELD). In the 2nd part of the model, the importance of the share of higherly educated people did not appear to have significant effect on efficiency, but quality of land appears to be significant factor. Increase in the quality of land (QOL) has a negative effect to the efficiency. The negative effect of quality of land on efficiency could be explained by the fact that municipalities with a better rating on the quality of land are rural municipalities in which the agriculture dominates local economy. Lack of economic diversification has contributed to higher loss of population in recent decades and thus those municipalities have less inhabitants, which is in significant and negative correlation with efficiency.

From DEA results revealed that municipalities with bigger population are more cost-efficient and it might refer to the positive effect of emergization. Policy makers hope that units with a larger surface area and a higher number of inhabitants will be more efficient, referring to the occurrence of the scale effect. The study by Slack and Bird (2013b) showed that scale effect does not occur when it comes to providing services, but it can occur when providing a physical infrastructure to a higher number of users. Nakazawa's (2013) study demonstrated that merging municipalities results in the increase of administrative costs, although one would assume that these decrease as a result of a merger through the reduction of administrative staff at municipalities. Drew et al. (2015) have noted that the number of inhabitants is a factor that does not increase the efficiency of municipalities.

Table 5. Results of cauchit fractional regression models

	One-part model					Two-part model									
						1st part					2nd part				
	Estimate	SE	t-value	P(> |t|)		Estimate	SE	t-value	P(> |t|)		Estimate	SE	t-value	P(> |t|)	
INTERCEPT	2.8846	3.3744	0.8550	0.3930		5.4426	5.4775	0.9940	0.3200		1.4168	2.0423	0.6940	0.4880	
HEDU	8.0947	3.9352	2.0570	0.0400	**	24.7238	8.7152	2.8370	0.0050	***	-2.8721	2.3188	-1.2390	0.2150	
ROAD	0.0008	0.0012	0.6820	0.4950		0.0002	0.0016	0.1030	0.9180		0.0006	0.0005	1.1050	0.2690	
AGR	0.0001	0.0000	1.8020	0.0710	*	0.0000	0.0001	0.3920	0.6950		0.0001	0.0000	4.0910	0.0000	***
SUB	-2.7662	1.3031	-2.1230	0.0340	**	-2.0432	2.8695	-0.7120	0.4760		-2.0668	0.8846	-2.3360	0.0190	**
DCAP	-0.0040	0.0025	-1.5620	0.1180		-0.0115	0.0047	-2.4140	0.0160	**	-0.0008	0.0014	-0.5740	0.5660	
QOL	-0.0437	0.0280	-1.5620	0.1180		-0.0455	0.0561	-0.8110	0.4180		-0.0445	0.0169	-2.6270	0.0090	***
ELD	0.0728	0.0337	2.1600	0.0310	**	0.0428	0.0618	0.6920	0.4890		0.0323	0.0175	1.8480	0.0650	*
WAGE	-0.0019	0.0025	-0.7890	0.4300		-0.0088	0.0048	-1.8180	0.0690	*	0.0012	0.0015	0.8040	0.4220	
	Number of obs. 170					Number of obs. 170					Number of obs. 122				
	R-squared: 0.159					R-squared: 0.149					R-squared: 0.295				

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

CONCLUSIONS

We used the two-stage analysis to evaluate the efficiency of Estonian rural municipalities. In the first stage, we used the DEA and in the second stage the FRM model. The DEA model was an output-oriented SBM with 4 inputs and 2 outputs. In FRM, we evaluated the effect of 8 exogenous variables on efficiency. The dataset consisted of 170 rural municipalities in 2013. According to the DEA model, 48 rural municipalities (28%) are efficient, the average efficiency of municipalities is 0.762, which means that on average 23.8% more outputs should municipalities provide with a given set of inputs.

The analyse showed that there are differences between the size and the efficiency of groups, but on average, smaller units are more likely to be inefficient. To get more information about the effect of exogenous factors on the efficiency of rural municipalities, we used the FRM model. It revealed that the share of subsidies (SUB) affects negatively efficiency, the share of population with higher education (HEDU) increases the efficiency, and also the share of elderly people (ELD) and the size of agricultural land (AGR).

Policy makers must acknowledge that the more elderly residents and the larger their share in the population, the more inputs are needed to offer different public services. In the meanwhile, they must not forget that population aging results in a decrease of tax revenue. Therefore, it is important to review the current arrangement of distributing revenues to municipal budgets. Policy makers must additionally take into consideration the fact that rural municipalities with greater surface areas need more inputs because they have relatively higher fixed costs for maintaining their infrastructure.

Taking the latter into consideration, the authors of this study consider it an important next step to analyse whether the merger of municipalities and the formation of larger units would result in increased efficiency that policy makers hope for and promised people. This is especially the case since the efficiency of rural municipalities has been assessed and the factors affecting their efficiency have been identified.

REFERENCES

Afonso, A. & Fernandes, S. 2005. Assessing and explaining the relative efficiency of local government: Evidence for Portuguese Municipalities. In: *ISEG Economics Working Paper*.

Afonso, A. & Fernandes, S. 2008. Assessing and explaining the relative efficiency of local government. *The Journal of Socio-Economics* **37**, 1946–1979.

Allers, M. & Geertsema, B. 2014. The effects of local government amalgamation on public spending and service levels: Evidence from 15 years of municipal boundary reform Groningen: University of Groningen. In: *SOM Research Reports 14019-EEF*

Alper, D., Sinuany-Stern, Z. & Shinar, D. 2015. Evaluating the efficiency of local municipalities in providing traffic safety using the Data Envelopment Analysis. *Accident Analysis & Prevention* **78**, 39–50.

Asatryan, Z. & De Witte, K. 2015. Direct democracy and local government efficiency. *European Journal of Political Economy* **39**, 58–66.

Balaguer-Colla, M.T., Priorb, D. & Tortosa-Ausina, E. 2007. On the determinants of local government performance: A two-stage nonparametric approach. *European Economic Review* **51**, 425–451.

Bönish, P., Haug, P., Illy, A. & Schreier, L. 2011. Municipality size and efficiency of local public services: Do size matter? In: *IWH Discussion Paper* **18**, 1–39.
Charles, V. & Zagarra, L. 2014. Measuring regional competitiveness through Data Envelopment Analysis: A Peruvian case. *Expert Systems with Applications* **41**, 5371–5381.
Cooper, W., Seiford, L. & Tone, K. 2007. *Data envelopment analysis: a comprehensive text with models, applications, references and DEA Solver Software*. Springer. New York.
Cruz, N. & Marques, R. 2014. Revisiting the determinants of local government performance. *Omega* **44**, 91–103.
Cuadrado-Ballesteros, G.S, Garcia-Sanchez, I.B. & Prado-Lorenzo, J.M. 2013. Effect of modes of public services delivery on the efficiency of local governments: A two-stage approach. *Utility Policy* **26**, 23–35.
De Witte, K. & Geys, B. 2011. Evaluating efficient public good provision: Theory and evidence from a generalized conditional efficiency model for public libraries. *Journal of Urban Economics* **69**, 319–327.
D'Inverno, G., Carosi, L. & Ravagli, L. 2018. Global public spending efficiency in Tuscan municipalities. *Socio-Economic Planning Sciences* **61**, 102–113.
Doumpos, M. & Cohen, S. 2014. Applying data envelopment analysis on accounting data to assess and optimize the efficiency of Greek local governments. *Omega* **46**, 74–85.
Drew, J., Kortt, M. & Dollery, B. 2015. What determines efficiency in local government? A DEA analysis of NSW local government. In: *Economic Papers,* pp. 243–256.
European Commission. 2012. Assessment of the 2012 national reform programme and stability programme for Estonia. In: *Commission staff working document.* Brussels. *http://ec.europa.eu/europe2020/pdf/nd/swd2012_estonia_en.pdf.* Accessed 26.03.16.
European Commission. 2013. Local government & administration in Estonia. *https://ec.europa.eu/europeaid/decentralisation-and-regional-local-government-administration-estonia_en.* Accessed 30.01.16.
Eurostat. 2015. LAU 2 – NUTS 2013, EU-28. *http://ec.europa.eu/eurostat/web/nuts/local-administrative-units*. Accessed 30.01.16.
Eurostat. 2016. Land cover overview. *http://ec.europa.eu/eurostat/web/lucas/data/database.* Accessed 30.01.16.
Friedrich, P., Reiljan, J. & Nam, C.W. 2010. The need of municipal fiscal equalization reform in Estonia. In: *Raudjärv M, Mäeltsemees S, Reiljan J. (Ed.). Eesti majanduspoliitilised väitlused* XVIII. Berlin - Tallinn: Berliner Wissenchafts-Verlag, Mattimar, pp. 52−73.
Geys, B. & Moesen, W. 2009. Measuring local government technical (in)efficiency: an application and comparison of FDH, DEA and econometric approaches. In: *Public Performance and Management Review* **32**, 489–504.
Hanes, N. & Wikström, M. 2010. Amalgamation impacts on local growth: Are voluntary municipal amalgamation more efficient? *Canadian Journal of Regional Science* **33**, 57–70.
Horta, I., Camanho, A. & Dias, T. 2016. Residential building resource consumption: A comparison of Portuguese municipalities' performance. *Cities* **50**, 54–61.
Iparraquirre, J.L. & Ma, R. 2015. Efficiency in the provision of social care for older people. A three-stage Data Envelopment Analysis using self-reported quality of life. *Socio-Economic Planning Science* **49**, 33–46.
Loikkanen, H.A. & Susiluoto, I. 2005. Cost Efficiency of Finnish Municipalities in Basic Service Provision 1994–2002. In: *Urban Public Economics Review* **4**, 39–63.
Ministry of Finance. 2016a. Administrative reform. *http://www.fin.ee/haldusreform.* Accessed 01.03.18.
Ministry of Finance. 2016b. Local Government Finances. *http://www.fin.ee/local-government-finances* Accessed 30.01.17.
Nakazawa, K. 2013. Cost Inefficiency of Municipalities after Amalgamation. *Procedia Economics and Finance* **5**, 581–588.

Noorkõiv, R. & Ristmäe, K. 2016. Kohaliku omavalitsuse üksuste võimekuse indeks. Tartu: Geomedia. *http://geomedia.ee/tehtud-tood/.* Accessed 30.01.16. (in Estonian)

Olle, V. & Merusk, K. 2013. Problems of Estonian Local Government in 2013 and Co-operation as an Instrument of Their Resolution. In: *Juridica International: Law Review of University of Tartu,* pp. 160–168.

Papke, L. & Wooldridge, J. 1996. Econometric methods for fractional response variables with an application to 401 (K) plan participation rates. *Journal of Applied Econometrics* **11**, 619–632.

Põldaru, R. & Roots, J. 2014. A PCA-DEA approach to measure the quality of life in Estonian counties. *Socio-Economic Planning Sciences* **48**, 65–73.

Põldnurk, J. 2015. Optimisation of the economic, environmental and administrative efficiency of the municipal waste management model in rural areas. *Resources, Conservation and Recycling* **97**, 55–65.

Ramalho, E., Ramalho, J. & Henriques, P. 2010. Fractional regression models for second stage DEA efficiency analyses. *Journal of Production Analysis* **34**, 239–255.

Ramalho, E. & Ramalho, J. 2011. Alternative estimating and testing empirical strategies for fractional regression models. *Journal of Economic Surveys* **25**, 19–68.

Reiljan, J., Andresson, K. & Ukrainski, K. 2004. The consequences of attempting to equalize the income of local governments in Estonia. In: *Eesti majanduspoliitilised perspektiivid Euroopa Liidus: XII teadus- ja koolituskonverentsi ettekanded-artiklid: Tartu - Värska, 1.-3. juuli 2004. Berlin, Tallinn: Berliner Wissenschafts-Verlag*, pp. 364–381.

Reiljan, J., Jaansoo, A. & Ülper, A. 2013. The Impact of Amalgamation on the Financial Sustainability of Municipalities in Estonia. *Public Finance and Management* **13**, 167–194.

Rogge, N. & De Jaeger, S. 2012. Evaluating the efficiency of municipalities in collecting and processing municipal solid waste: A shared input DEA-model. *Waste Management* **10**, 1968–1978.

Seroa da Motta, R. & Moreira, A. 2009. Political factors and the efficiency of municipal expenditure in Brazil. *Economia Aplicada* **13**, 353–371.

Slack, E. & Bird, R. 2013a. Does Municipal Amalgamation Strengthen the Financial Viability of Local Government? A Canadian Example. In: *International Centre for Public Policy Working Paper Series* **12**, 1–23.

Slack, E. & Bird, R. 2013b. Merging Municipalities: Is Bigger Better? University of Toronto Institute on Municipal Finance and Governance. In: *IMFG Papers* **14**.

Statistics Estonia. 2015. Minifacts about Estonia. *http://www.stat.ee/90745*. Accessed 30.01.16.

Statistics Estonia. Tallinn. *http://www.stat.ee* Accessed 30.01.16.

Storto, C. 2016. The trade-off between cost efficiency and public service quality: A non-parametric frontier analysis of Italian major municipalities. *Cities* **51**, 52–63.

The parliament of Estonia. 1993. Local Government Organisation Act. Riigi Teataja. *https://www.riigiteataja.ee/en/eli/509012014003/consolide.* Accessed 30.01.16.

The parliament of Estonia. 2004. Promotion of Local Government Merger Act. Riigi Teataja *https://www.riigiteataja.ee/en/eli/513112013014/consolide.* Accessed 30.01.16.

Tone, K. 2001. A slacks-based measure of efficiency in data envelopment analysis. *European Journal of Operational Research* **130**, 498–509.

Uudelepp, A., Uus, M. & Ender, J. 2009. Kuidas arendada kohalikke avalikke teenuseid omavalitsuste ja kodanikeühenduste koostöös? Praxis. *http://www.praxis.ee.* Accessed 30.03.16. (in Estonian)

Valeira, P., Martins, G.A. & Fávero, L.P. 2010. Production efficiency and financing of public health: an analysis of small municipalities in the state of São Paulo – Brazil. *Health Care Management Science* **13**, 112–23.