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EFFICIENCY POTENTIAL AND DETERMINANTS OF EFFICIENCY: AN ANALYSIS OF THE CARE FOR THE ELDERLY SECTOR IN NORWAY

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Efficiency potential and determinants of efficiency: An analysis of the care for the elderly sector in Norway*

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Abstract The paper provides an analysis of efficiency in the care for the elderly sector in Norway. In a first step we perform DEA analysis to calculate the degree of efficiency in each municipality and the national level efficiency potential. The analysis reveals substantial variation in efficiency across municipalities, and the national level efficiency potential is calculated to 10%. Tobit regressions and recently developed bootstrap methods are applied in a second stage to explain the variation in efficiency. The second stage analyses indicate that high fiscal capacity, a low degree of user charge financing, and a fragmented local council are associated with low efficiency.

Keywords Efficiency · Care for the elderly · Data envelopment analysis · Determinants of efficiency · Bootstrap

JEL classification H75 · I12

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1 Introduction

In the next decades the number of elderly people will increase sharply in most West European countries due to increased longevity and the large cohorts born in the years after WWII. This wave of the elderly puts pressure on public budgets, and pension reforms are heavily debated in most countries. The wave of the elderly will also increase the demand and need for health services and elderly care. Since the pressure on care for the elderly will come 10-15 years later than the pressure on pensions, the debate regarding the future organization and financing of elderly care has hardly started. However, efficiency is likely to be a key issue when the future organization and financing are to be discussed.

There are several contributions in the literature that calculates the efficiency potential in the care for the elderly sector, and in particular nursing homes. Among these are the Dutch analysis by Kooreman (1994), the Swiss studies by Fillippini (2001) and Crivelli et al. (2002), the Danish study by Hougaard et al. (2004), and the Finnish study by Laine et al. (2005). In the US literature the focus has been on efficiency differences between for-profit and not-for-profit organizations, e.g. Nyman and Bricker (1989) and Vitaliano and Toren (1994).

The first contribution of this paper is to add an efficiency analysis of the care for the elderly sector in Norway to the international literature.[1] As in the other Scandinavian countries, care for the elderly is a municipal responsibility, and the DEA analysis is carried out at the municipal level and includes both home based care and nursing homes. The analysis reveals substantial variation in efficiency across municipalities, and the national level efficiency potential is calculated to 10%. A possible objection to these interpretations is that it is hard to capture all aspects of output, and in particular service quality is hard to measure. For a sub-sample of the municipalities we have access to a novel data set on service quality, and there is no evidence that high calculated efficiency is associated with low quality.

Our second contribution is to provide an extensive analysis of variation in efficiency across municipalities. The international literature has emphasized the roles of ownership (public versus private) and objective (for-profit versus not-for-profit), but such factors are of little relevance in the Scandinavian context where care for the elderly is a municipal responsibility

[1] Earlier Norwegian contributions include Edvardsen et al. (2000) and Kalseth (2003).

and there are few private providers. We analyze efficiency as a municipal decision involving local democracy, and focus on the fiscal capacity of the municipality, the degree of user charge financing of the care for the elderly sector, as well as political institutions. The variation in efficiency is analyzed using Tobit regressions and bootstrap procedures developed by Simar and Wilson (2007). The second stage analyses indicate that high fiscal capacity, a low degree of user charge financing, and a high degree of party fragmentation are associated with low efficiency. It is an interesting finding that user charge financing may reduce the pressure on public budgets in two ways, by replacing public funds and by reducing inefficiencies. The impact of user charge financing is robust to use of instruments.

The rest of the paper is organized as follows. The principles of DEA analysis are discussed in Sect. 2, while Sect. 3 provides institutional background and specifies the production function. The results are presented in Sect. 4 (DEA) and Sect. 5 (determinants of efficiency). Concluding remarks are offered in Sect. 6.

2 Data envelopment analysis (DEA)

We analyze efficiency in the care for the elderly sector using data envelopment analysis (DEA). This nonparametric method is based on Farrel (1957) and extensions of his work by Charnes et al. (1978). Within the DEA approach, the technical efficiency of a production unit is measured relative to a best practice reference frontier, which is calculated from the data. Efficient units are located on the frontier, while inefficient units are located inside the frontier. The DEA method easily handles multiple outputs and inputs and does not require information on neither inputs nor outputs prices, and is for these reasons widely applied to analyses of public services.

The principles of the DEA method are illustrated in Figure 1, where a single output is produced by a single input. The four units of production are labeled A, B, C, and K. The location of the frontier depends on whether we assume constant returns to scale (CRS) or allow for variable returns to scale (VRS). With constant returns to scale the best practice reference frontier is represented by the line OO’ that runs through the origin and observation B, the unit which has the highest output-input ratio. Unit B is located on the frontier and is fully efficient, whereas the other observations are inefficient since they are located below the frontier. Given the CRS frontier, unit K can reduce its input use from n to e without reducing output. The input oriented efficiency score (e_I) is calculated as hi/hK, and the efficiency score is lower the longer the distance from the observation to the frontier. The interpretation of the efficiency score is that if unit K was fully efficient, input could be reduced by $(1-e_I)100\%$ without reducing production. Alternatively, an output oriented efficiency score (e_O) can be calculated as nK/nq. In this case the interpretation is that production can be increased by $[(1-e_O)/e_O]100\%$ without increasing the use of inputs.

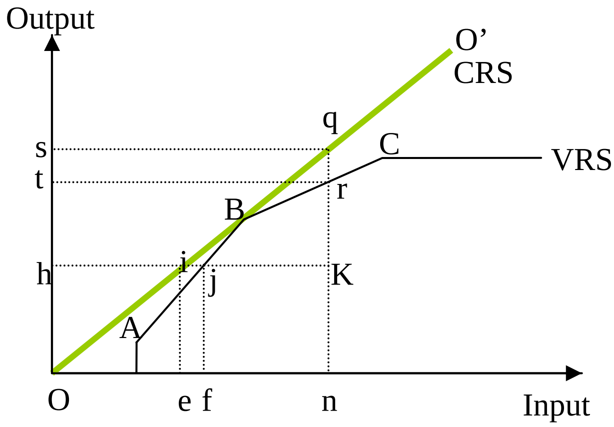

Fig. 1. The best practice reference frontier under constant and variable returns to scale

When variable returns to scale is allowed, the best practice reference frontier is given by the piecewise linear curve passing through the observations A, B, and C. Now units A, B, and C are characterized as technically efficient since they are located on the frontier, while unit K is still inefficient.[2] However, the input oriented efficiency score of unit K increases to hj/HK and the output oriented efficiency score to nK/nr. These differences between CRS and VRS hold in general. By assuming VRS, both the number of efficient units and the average efficiency score increases compared to CRS.

In the DEA analyses carried out in this paper we rely on VRS[3] technology for two reasons. First, there is substantial variation in the scale of operation across Norwegian municipalities due to variation in population size. The population size varies from a few hundred inhabitants

[2] With VRS one can separate between two types of efficiency, technical efficiency and scale efficiency. We use the term efficiency synonymous to technical efficiency. Strictly speaking, A and C are technically efficient, but not scale efficient.
[3] This VRS model is also known as the DEA-BCC model in the terminology of Banker et al. (1984).

in the smallest rural communities to more than 500,000 in the capital Oslo. Economies of scale is clearly of relevance for the smallest municipalities, and the largest ones may experience diseconomies of scale. Second, VRS is preferable in the second stage analysis where we aim at explaining variations in efficiency across municipalities. In that context we do not want to characterize municipalities as inefficient simply because they do not operate on an efficient scale due to low population size. It is the variation in technical efficiency that we attempt to explain in the second stage analysis.

There are several limitations to the use of DEA. First, the number of efficient units and the calculated efficiency potential depend on the number of inputs and outputs relative to the sample size. For a given sample size an increase in the number of inputs and/or outputs will increase the number of efficient units and reduce the calculated efficiency potential (Zhang and Bartels 1998; Perelman and Santín 2008). It is important to formulate a proper model specification since an overspecified model (with many outputs and inputs) may underestimate the efficiency potential, whereas an underspecified model (with few outputs and inputs) may overestimate the efficiency potential. Second, the DEA method is sensitive to measurement errors and outliers that tend to overestimate the efficiency potential. The reason is that outliers with high levels of output and/or low input use will affect the position of the frontier and thereby reduce the efficiency score of other units. Outliers with low levels of output and/or high input use will only have a minor impact since they only affect average efficiency by making themselves less efficient. In the empirical analysis we perform Jackknifing to investigate whether the results are sensitive to outliers and measurement errors. We also perform a test of the model specification in the second stage analysis.

3 Institutional context, users, and specification of the production function

In the Scandinavian countries, and also in Norway, care for the elderly is primarily a municipal responsibility.[4] The municipalities operate nursing homes and provide home based care, and do also determine the type of service and amount of care for individual users. Private alternatives are few, and most private providers operate on contract for municipalities. The municipalities are multi-purpose authorities, and the care for the elderly sector ‘competes’ with other sectors over the municipal budget. In addition to care for the elderly,

[4] Assous (2001) discusses the organization of care for the elderly in a comparative perspective.

the municipalities are responsible for welfare services like child care, primary health care, and primary and lower secondary education. Other important tasks are culture and infrastructure. As the largest service sector, care for the elderly amounts to more than ¼ of the total municipal budget and nearly 3% of GDP.

The main revenue sources for Norwegian local governments are taxes (45% of current revenue), grants (35%), and user charges (15%). Interest and other revenue account for the rest. Compared to most other countries, the system of financing is quite centralized. Around 95% of local taxes are income and wealth taxes where effective tax limits have been in place for the last 25 years. The opportunity to influence current revenues is limited to property tax and user charges.

Within the care for the elderly sector it is common to separate between two types of users, those who receive care in their own home (or a specially adapted dwelling)[5] and residents in nursing homes. Residents in nursing homes are on average older and less capable of functioning than users of home based services. In 2003, the year under study, 80% of the users received home based care and 20% were patients in nursing homes. Home based care and nursing homes are highly integrated, and it is difficult to split the resource use on the two activities. The appropriate level of analysis is therefore the care for the elderly sector in total, i.e. both home based care and nursing homes. Our study is in this respect similar to the Danish study by Hougaard et al. (2004), but differs from the vast majority of international studies that analyze nursing homes only.

The main challenge for efficiency analyses of care for the elderly is to measure output. The ideal indicators of output would capture improvements in health status and improved functioning in daily life, but they are obviously difficult to measure. The practical solution in the literature is to measure output based on the number of users, and to divide the users into groups with homogenous treatment within groups and heterogeneous treatment across groups (e.g. Nyman and Bricker 1989; Kooreman 1994; Vitaliano and Toren 1994; Hougaard et al. 2004).

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[5] Specially adapted dwelling is a recent phenomenon, and has the advantage that it offers great flexibility with respect to the amount of care. The level of care varies from a level similar to private homes to around the clock services as in institutions.

In home based care the users are divided into three groups on the basis of the type of service they receive. The first group consists of users that receive practical help (34%), the second group of users that receive home nursing care (29%), and the third group of users that receive both practical help and home nursing care (37%). We expect the third group (both practical help and nursing) to have the greatest resource requirements.

Residents in nursing homes receive around the clock services, and there is currently no information on the type of services each individual patient receives. We have chosen to separate the residents on the basis of the length of stay, i.e. whether they are on permanent stay (86%) or short-term stay (14%).[6] Residents on short-term stay are younger and more vigorous than those on permanent stay, and may therefore require fewer resources than residents on long-term stay. On the other hand, residents on short-term stay often need treatment or rehabilitation before they can move back to their home. An advantage by the DEA procedure is that we do not need to determine a priori which group that has the greatest resource requirements. The weights of the different user groups are endogenously determined as part of the DEA analysis.

Our specification of the production function in the care for the elderly sector includes seven outputs. Five of these are the user groups discussed above (three in home based care and two in nursing homes). In addition we include the share of single rooms in nursing homes as an indicator of quality. We also include the share of mentally handicapped to take into account that this group has substantially resource requirements.

A possible objection to our specification of the output vector is that it does not explicitly take into account that the need for care increases with age. However, age is implicitly taken into account because the age composition varies systematically across the groups. Long-term residents in nursing homes are older than those on short-term stay. And within home based care the average age is significantly higher in the group of users that receives both practical help and nursing than in the two other groups. The remaining question is whether age is important after type of service is controlled for. We leave this issue for the second stage analysis where we investigate whether the variation in efficiency scores is related to the age composition of the users.

[6] Short-term stays are defined by having limited duration. Typically, stay that last less than three months are classified as short-term.

Table 1 Descriptive statistics of outputs and inputs

Variable	Mean	St.dev.	Min	Max
Output				
Nursing homes, permanent residents	83.2	253.6	0	4,411
Nursing homes, short-term residents	13.5	42.8	0	769
Nursing homes, single bed rooms	84.3	246.8	0	4,400
Home based care, practical help	129.2	427.6	0	7,474
Home based care, nursing	109.6	212.0	0	2,915
Home based care, practical help and nursing	140.9	333.4	0	5,354
Number of mentally handicapped	44.5	70.1	0	931
Input				
Current expenditures	100,475	244,686	5,135	4083,731

Current expenditures are measured in Norwegian kroner (NOK) 1,000.

The production of care for the elderly is labor intensive, and it would be desirable to measure input by man years in different categories. But since data for man years are considered unreliable, we have chosen to use current expenditures as measure of input. The use of expenditures as input implies that the DEA analysis strictly speaking provides a mix between technical efficiency (quantities of labor) and prices (cost of labor).

The inputs and outputs in the DEA analysis is summarized in Table 1 along with some descriptive statistics. Data are from 2003 and were available for 420 of the 434 municipalities.

4 The results of the DEA analysis

Descriptive statistics for the efficiency scores calculated from the DEA model are reported in Table 2. Mean input oriented technical efficiency is 0.844 when all municipalities are given equal weight. This means that the average municipality could reduce expenditures by 15.6% without reducing measured output. If we rather rely on the output oriented efficiency scores, the average municipality could increase production by nearly 17.6% without increasing expenditures.

The mean efficiency score is line with earlier Norwegian studies. Edvardsen et al. (2000), who (as us) analyze both home based care and institutions, calculate the mean efficiency potential to be 14%. Kalseth (2003), analyzing nursing homes only, report mean efficiency scores in the range 0.75-0.84 depending on model specification. Moreover, the Danish study by Hougaard et al. (2004) report an improvement potential of 20%, while the Finnish study by Laine et al. (2005) report a mean inefficiency of 16%. Beyond the Scandinavian countries, the efficiency potential is calculated to 11% for nursing homes in Wisconsin (Nyman and Bricker 1989), to 29% for nursing homes in the New York State (Vitaliano and Toren 1994), to 6% for Dutch nursing homes (Kooreman 1994), and to 15% for Swiss nursing homes (Crivelli et al. 2002).

Table 2 Descriptive statistics for the efficiency scores

	# of effective units	Mean (unweighted)	Mean (weighted)	Min	Q_1	Q_3
Input oriented	72	0.844	0.895	0.525	0.758	0.940
Output oriented	72	0.850	0.904	0.506	0.769	0.945

Technical efficiency based on VRS technology. Population size is used as weight in the calculation of the weighted mean. The Q's are respectively 1st and 3rd quartile.

It is the weighted mean of the efficiency scores that reflects the national efficiency potential. The weighted average of the input oriented efficiency score is 0.895, which yields an efficiency potential of 10.5%. The calculated efficiency potential reflects substantial variation in efficiency across municipalities. The efficiency score varies from 0.52 in the municipality with lowest efficiency, to 1 in the 72 municipalities that come out as fully efficient. There is also substantial variation among the middle half of the municipalities, nearly 20 percentage points. The distribution of the input oriented efficiency scores is illustrated in Figure 2. With output oriented efficiency the national efficiency potential is calculated to 10.6%.

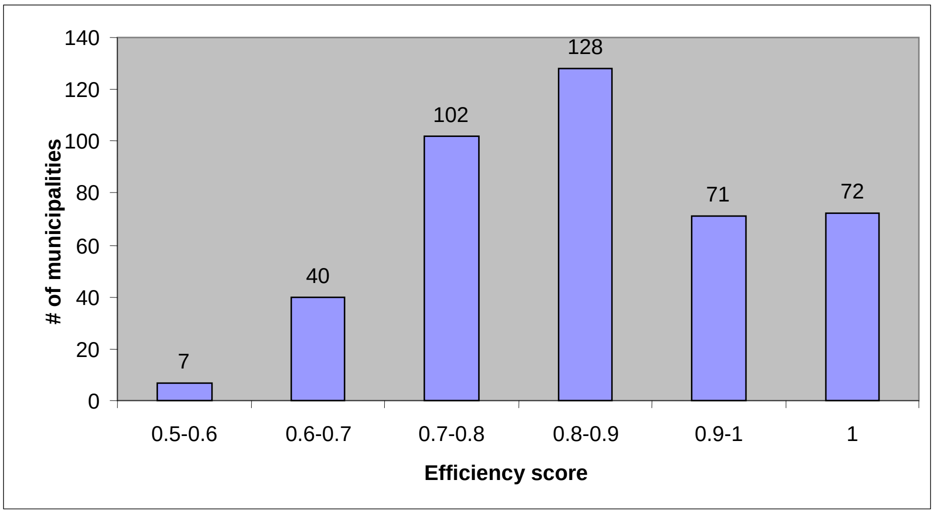

Fig. 2. The distribution of input oriented efficiency scores

Input and output oriented efficiency scores yield strikingly similar results in Table 2, but this is not sufficient to conclude that the two measures are highly correlated. The two measures could be weakly correlated, but still have a similar distribution. In our case however, they are highly correlated. The rank correlation is above 0.99. In the rest of this section we rely on input oriented efficiency scores in order to simplify the presentation.

As discussed in Sect. 2, the calculated efficiency scores may be sensitive to measurement errors and outliers. We perform Jackknifing to investigate whether this is a problem in our case. Jackknifing means that we leave out each efficient municipality one at a time. In our case with 72 efficient municipalities, 72 additional DEA analyses are conducted. When one efficient unit is left out, the mean efficiency score of the remaining units will generally increase.[7] The efficiency scores are considered to be robust if the increase is small and if the ranking of the municipalities is similar to the original ranking. In our case the maximum increase in efficiency is 0.3 percentage points and the lowest rank correlation is 0.992, indicating that the results are robust to measurement errors and outliers.

Table 3 User and service composition and resource use

	Efficient units	10 pct. least efficient	25 pct. least efficient	Sample mean
Output nursing homes				
Share of residents on permanent stay	0.843	0.882	0.887	0.860
Share of single rooms	0.843	0.888	0.908	0.871
Output home based care				
Share of user receiving practical help	0.382	0.327	0.324	0.340
Share of users receiving nursing care	0.257	0.282	0.280	0.289
Share of users receiving both practical help and nursing	0.361	0.392	0.396	0.371
Output general				
Share of users in nursing homes	0.210	0.195	0.200	0.203
Share of mentally handicapped users	0.103	0.110	0.104	0.104
Input				
Current expenditures per user	192.6	267.9	249.4	210.9
# of observations	72	43	106	420

The grouping of municipalities is based on input oriented efficiency scores assuming VRS technology. Current expenditures per user are measured in Norwegian kroner (NOK) 1,000.

[7] Mean efficiency score for the remaining units is unaffected if the unit that is left out is not a reference for any ineffective unit.

As a first step to characterize efficient and inefficient municipalities Table 3 reports some information on service composition and resource use in the care for the elderly sector. It is a tendency that the efficient municipalities have a user composition with lower resource requirements than the least efficient ones. In home based care the efficient municipalities have a lower share of users receiving both practical help and nursing, and in institutions they have a lower share of permanent residents and a lower share of single rooms. However, these differences in user and service composition are small compared to the difference in resource use. The efficient municipalities have expenditures per user 28% below the 10% least efficient, and 23% below the 25% least efficient.

Since the efficient municipalities are characterized by low expenditures per user and most output measures are based on the number of users, it can be objected that the efficient municipalities come out as efficient simply because each user receives less services and/or services of lower quality. The opportunity to investigate this objection is limited. If better output data were available for most municipalities, they would have been included in the DEA analysis in the first place. However, we have access to a survey conducted by the Norwegian Board of Health Supervision (*Helsetilsynet*) in a sample of 73 municipalities. The survey contains detailed information about all users of home based care that receives both practical help and nursing. We utilize two types of information from the survey. The first is information about the number of visits and lengths of visits to each individual user on a weekly basis.[8] On the basis of this information we can calculate average hours of assistance per user for each municipality in the sample. The second type of information is an evaluation of nursing and doctoral supervision for each user, which is given on a 1-4 scale where increasing value means better supervision. If the objection is of importance, we will expect municipalities with high efficiency scores to have fewer hours of assistance per week and lower supervision quality compared to municipalities with low efficiency scores.

[8] For nursing the survey separates between visits below 15 minutes, visits between 15 minutes and 1 hour, and visits above 1 hour. In the calculations we assume that the average length is respectively 10 minutes, 35 minutes, and 1 hour and 15 minutes. For practical help we have information on the exact length of visits.

Of the 73 municipalities included in the survey, 65 are included in the DEA analysis.[9] In Table 4 these 65 municipalities are divided into groups according to efficiency score. Four groups are defined by the quartiles of the sample of 420 municipalities included in the DEA analysis, and in addition we report separate figures for fully efficient municipalities and the sub-sample of 65. The reported figures are mean values for hours of assistance and supervision quality for each group. A first and important observation is that there is no tendency that a high efficiency score is associated with few hours of assistance, neither for practical help nor nursing. If anything, the relationship goes in the opposite direction. If we focus on the aggregate of practical help and nursing, the fully efficient municipalities provide 17% more assistance than the sample average. And the municipalities with below median efficiency (the two lower groups) are on average 13% below the sample mean. When it comes to supervision quality, there is some tendency that higher efficiency scores are associated with lower nursing supervision quality, but the difference is small in relation to the 1-4 scale. For doctoral supervision the most efficient municipalities are on the sample mean, while the least efficient group has slightly lower quality than the rest.

Table 4 Hours of assistance per week and evaluation of supervision

	Below Q_1	Between Q_1 and Q_2	Between Q_2 and Q_3	Above Q_3	Fully efficient	Sub-sample	Corr.
Hours per week							
Practical help	2.57	2.65	4.81	4.28	4.60	3.44	0.250 (0.04)
Nursing	4.48	4.80	5.62	4.81	5.04	4.84	0.012 (0.92)
Total	7.04	7.45	10.43	9.09	9.65	8.28	0.143 (0.26)
Supervision							
Nursing	2.91	2.89	2.88	2.82	2.77	2.87	-0.151 (0.23)
Doctoral	2.82	2.90	2.93	2.88	2.86	2.87	0.103 (0.41)
# of observations	18	18	10	19	15	65	65

The Q's refer to the quartiles in the distribution of input oriented efficiency scores in the original sample of 420 municipalities. The quality of nursing and doctoral supervision is measured on a 1-4 scale. The last column reports Spearman's rank correlations between the efficiency scores and hours of assistance/ evaluation of supervision, p-values in parentheses.

[9] In terms of efficiency score the 65 municipalities are quite representative of the 420 municipalities in the original sample. The minimum input oriented efficiency score is 0.57, mean efficiency score is 0.84, and 23% come out as fully efficient. This comes close to the corresponding figures in Table 2.

The most right column in Table 4 reports statistical tests of the relationship between the efficiency score and hours of assistance per week/ evaluation of supervision. Most correlations are insignificant and indicate that there is no systematic relationship between the efficiency score and the indicators of service level and service quality. The only significant correlation points towards a positive relationship between the efficiency score and hours of practical help. Nursing supervision quality is the only indicator that is negatively correlated with the efficiency score, but the correlation is weak and far from significant.

It is our interpretation that the complementary analysis in Table 4 provides little or no support for the hypothesis that the efficient municipalities come out as efficient simply because they provide less services and/or lower service quality. This understanding is in line with Nyman and Bricker (1989) who document that there among not-for profit nursing homes is a positive relationship between efficiency score and quality (measured by Medicaid certification code violations). Their interpretation is that managerial incompetence leads to both low efficiency score and low quality. Moreover, Kooreman (1994) find only weak evidence that a high efficiency score is associated with low quality (measured by procedures and restrictions on visiting hours).

5 Explaining variations in efficiency

We now turn to the issue of how to explain the variation in efficiency documented in Sect. 4. Why do some municipalities come out with low efficiency scores, while others are characterized as efficient? US contributions (e.g Nyman and Bricker 1989; Vitaliano and Toren 1994) have focused on the role of ownership on efficiency in nursing homes, and tend to find that for-profit private homes are more efficient than public and not-for profit private homes. On the other hand, the Swiss study by Crivelli et al. (2002) finds no significant effect of ownership and regulatory settings. In the Scandinavian context, where care for the elderly is a municipal responsibility and with only few private providers, ownership can not account for the variations in efficiency. The issue must be addressed as part of the municipal decision making, and following earlier Norwegian studies of efficiency in the local public sector we focus on the roles of fiscal capacity, user charge financing, and political institutions. In the background inefficiency is understood as a principal agent problem as originally formulated by Niskanen (1975).

The fiscal capacity of the municipality is an important economic factor that may affect efficiency. Increased fiscal capacity increases the demand for services for the elderly, and the service producing agencies may be able to take advantage of the increased demand to enjoy more budgetary slack and thereby reduce efficiency. As indicator of fiscal capacity we use a "real" per capita revenue measure published annually by the Ministry of Local Government. The starting point is the sum of block grants and tax revenues taken from the municipal accounts. Since high per capita revenue to some extent is compensation for unfavorable cost conditions, the revenues must be "deflated" in order to capture the real differences across municipalities. The cost index from the spending needs equalization system is used as deflator. It captures unfavorable cost conditions related to population size, settlement pattern, the age composition of the population, and social factors. The calculation of the cost index is documented in Ministry of Local Government (2006).

As a second economic variable we include the degree of user charge financing. In an analysis of cost efficiency in the municipal sewage industry, Borge and Rattsø (2005) find that a high degree of user charge financing contributes to lower costs. The underlying theoretical argument is developed within a sponsor-bureau model where user charge financing (combined with net budgeting) makes slack more costly for the bureau. It is of interest to investigate whether user charge financing has a similar effect on efficiency in the care for the elderly sector. The degree of user charge financing is measured as user charge revenue as share of current expenditures.

With regard to political institutions, several studies of Norwegian municipalities have emphasized the impact of political strength. Political strength is shown to reduce administrative spending (Kalseth and Rattsø 1998) and to increase efficiency (Kalseth 2003; Borge and Naper 2006; Borge et al. 2008). A strong political leadership may have an advantage in imposing a hard budget constraint on the service producing agencies, and may also have more power in bargains with public sector unions regarding implementation of incentive schemes and other means to increase performance. A traditional Herfindahl-

Hirschman index has been the most widely used indicator of political strength.[10] The index is calculated as

$$HHI = \sum_{p=1}^{P} SH_p^2 \qquad (1)$$

where SH_p is the share of representatives from party *p*. The index takes the maximum value of 1 when a single party holds all the seats in the local council, while the minimum value of 1/*P* is attained when the seats are equally divided among the *P* parties. The index can be interpreted as the probability that two randomly drawn members of the council belong to the same party. Alternatively, we can say that it captures the number of parties in the local council and the distribution of seats among them. The value of the index is reduced (fragmentation increases) when the number of parties increases and when the seats are more equally divided among a given number of parties.

In Norway the socialist camp is dominated by the Labour party, while the non-socialist camp is more fragmented. As a consequence, there is a positive correlation between the Herfindahl-Hirschman index and the share of socialists in the local council. Since we cannot rule out that socialist influence has an impact on efficiency, one could argue that the share of socialists should be included in the analysis to get an unbiased estimate of the Herfindahl-Hirschman index. A more substantive argument is that earlier studies have found that a high share of socialists is associated with high administrative spending (Kalseth and Rattsø 1998), low efficiency in nursing homes (Kalseth 2003), and low educational efficiency (Borge and Naper 2006). A possible interpretation of these findings is that it may be harder for socialists to impose a hard budget constraint on service providers because they are more concerned about service quality.

The standard approach in the literature is to analyze the determinants of efficiency using Tobit regressions. Tobit is supposed to be an appropriate method since the dependent variable, the calculated efficiency scores from the DEA analysis, is censored at 1. However, recent contributions (e.g. Xue and Harker 1999; Simar and Wilson 2007) have emphasized two

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[10] The index was originally developed to measure the degree of concentration in an industry, see Hirschman (1945, 1964) and Herfindahl (1950).

possible problems by applying Tobit in this context. First, the efficiency scores are not independent observations since the calculation of the efficiency score for one municipality necessarily involves all other municipalities in the sample. As a consequence, the error term in the Tobit model will be serially correlated and standard inference is not valid. The second problem is that the efficiency scores may be biased in finite samples. Simar and Wilson (2007) have developed bootstrap procedures to deal with these problems. The bootstrap procedures are applied by Afonso and St. Aubyn (2006) and Latruffe et al. (2008). In both studies the bootstrap results were similar to the results from standard methods. We have chosen to start out by presenting results from Tobit regressions. In addition we perform bootstrapping as a robustness check.

Table 5 The determinants of efficiency

	A	B	C	D	E
Municipal revenue	-0.099	-0.097	-0.100	-0.097	-0.058
	(-2.59)	(-2.52)	(-2.62)	(-2.54)	(-1.92)
User charge financing	1.658	1.582	1.642	1.706	2.021
	(5.69)	(5.44)	(5.40)	(5.97)	(3.23)
Herfindahl-Hirschman index of inverse party fragmentation	0.188	0.156	0.180	0.197	0.130
	(2.28)	(1.99)	(2.25)	(2.56)	(2.09)
Share of socialists	-0.002				
	(-0.05)				
Share of the population in rural areas	0.027				
	(0.91)				
Population size (in 10,000)	0.026	0.023	0.023	0.023	0.016
	(4.21)	(4.40)	(4.22)	(4.38)	(3.44)
Share of residents in nursing homes 90 years and above		-0.032			
		(-0.41)			
Share of users of home based care 90 years and above		-0.080			
		(-0.64)			
Share of population 0-5 years			-1.480		
			(-1.96)		
Share of population 6-15 years			0.630		
			(1.21)		
Share of population 80 years and above			-0.049		
			(-0.09)		
Estimation method	Tobit	Tobit	Tobit	Tobit	Tobit IV
Log likelihood	159.8	165.3	161.5	159.3	1380.6
# of observations	419	411	419	419	419

Tobit estimates with t-values in parentheses. The dependent variable is input oriented efficiency scores assuming VRS technology. In model E the share of elderly 80 years and above is used as instrument for the degree of user charge financing.

In the regressions presented in Table 5 the dependent variable is the input oriented efficiency scores.[11] Model A is the baseline specification. In addition to the four variables discussed above, it controls for the two structural characteristics population size and settlement pattern. The two economic variables come out as significant and with expected signs. A high level of revenue contributes to lower efficiency, while a high degree of user charge financing has the opposite effect. Among the political variables, only the Herfindahl-Hirscman index is significant. The interpretation of the positive coefficient is that a more fragmented local council leads to lower efficiency.

The findings that high fiscal capacity and a high degree of party fragmentation are associated with low efficiency is in line with earlier studies of efficiency in Norwegian municipalities, e.g. Kalseth (2003) analyzing nursing homes, Borge and Naper (2006) analyzing the educational sector, and Borge et al. (2008) analyzing all service sector simultaneously. A negative relationship between efficiency and fiscal capacity is also a robust finding in the international literature on municipal efficiency, see e.g. the survey by De Borger and Kerstens (2000). The evidence on party fragmentation is scarcer, but a recent Belgian study by Ashworth et al. (2006) reports similar results as us.

Population size seems to be an important background factor to explain the variation in efficiency, and larger municipalities have higher efficiency scores. However, the impact of population size does not reflect economies of scale since variable returns to scale is allowed for in the underlying DEA analysis. It rather reflects that the variation in efficiency scores across municipalities is related to population size, and more precisely that the variation is larger among small municipalities. The share of the population living in rural areas comes out as statistically insignificant, which indicates that the settlement pattern is of little importance. The two insignificant variables, the share of the population living in rural areas and the share of socialists in the local council, are not included in the additional equations reported in Table 5.

The definition of user groups in the DEA analysis is based on type of service, and does not take account of age. In model B we control for the age composition of the users by including the share of user 90 years and above (separate variables for home based care and nursing

[11] Descriptive statistics for the explanatory variables are reported in Table A1 in the appendix.

homes). The negative coefficients for the two variables are consistent with the hypothesis that elderly users are more resource demanding, but the effects are far from being statistically significant.[12] The quantitative effects are also modest. A one standard deviation increase in the share of users 90 years and above is associated with a reduction in the efficiency score of 0.3 percentage points (nursing homes) and 0.5 percentage points (home based care). The lack of significance of the age composition of the users yields support to our specification of the production function. Moreover, the impacts of fiscal capacity, user charge financing, and party fragmentation are robust to the control for the age composition of the users.

The age composition of the population is important for the demand for welfare services like child care, education, and care for the elderly, see e.g. Borge and Rattsø (1995). These services make up a large share of the total budget, and increases in the relevant age groups represent fiscal pressure that may promote efficiency. In model C we control for the share of the population eligible for child care (0-5 years of age), primary and lower secondary education (6-15 years of age), as well as the main target group for elderly care (the share of the population 80 years and above). The share of children 0-5 years of age is the only variable that comes out as significant, but the negative sign is inconsistent with the fiscal pressure hypothesis. Again, signs and significance of fiscal capacity, user charge financing, and party fragmentation are robust to the modification of the model.

In model D we report the results from a parsimonious specification including party fragmentation, municipal revenue, the degree of user charge financing, and population size. We use the parsimonious specification in model D to illustrate the quantitative effects of the key variables. Efficiency will be reduced by nearly 1 percentage point if municipal revenue increases by 10 percentage points, whereas efficiency will increase by 1.7 percentage points if user charge financing increases by 1 percentage point. An increase in party fragmentation by one standard deviation is predicted to reduce the efficiency score by 1.7 percentage points. Finally, an increase in the population size by 10,000 is predicted to increase the efficiency score by 2.3 percentage points.

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[12] One might suspect that multicollinearity is a problem here, but also the joint significance of the two variables is clearly rejected. The F statistic (with 2 and 405 degrees of freedom) is 0.36 and the corresponding p-value is 0.70.

It is an interesting result that a high degree of user charge financing is associated with high efficiency. It indicates that more user charge financing may reduce the pressure on public budgets in two ways, a direct effect of replacing public funds and an indirect effect through increased efficiency. However, it could be objected that the estimated effect is due to a mechanical relationship between efficiency and the degree of user charge financing. The point is that municipalities with high levels of expenditures tend both to be less efficient (see Table 3) and to have a low degree of user charge financing (through the definition of the variable). This issue is addressed in model E in Table 5 where we instrument the degree of user charge financing. As instrument we use the share of the population 80 years and above. This is a valid instrument in the sense that it is highly correlated with the degree of user charge financing[13] and it satisfies the exclusion restriction (see model C). The degree of user charge financing comes out with a positive effect on efficiency also when it is instrumented. Contrary to the concern expressed above, the quantitative effect increases. And although the coefficient is less precisely estimated, it is still highly significant.

In Table 6 we report additional robustness tests using the parsimonious specification (reproduced as model A) as point of departure. The first robustness test (model B) is to use output oriented efficiency scores as dependent variable instead of the input oriented efficiency scores. Given the high correlation between the two efficiency measures (see Sect. 4), it is not surprising that sign and significance of the four variables are unaffected by this modification.

The next step is to apply the bootstrap procedures developed by Simar and Wilson (2007).[14] They introduce two procedures, a single bootstrap and a double bootstrap. Both procedures are based on a coherent data-generating process, which leads to a truncated regression model, rather than a Tobit model, in the second stage. The truncated regression model is more general than the Tobit model and only utilizes the uncensored observations (the inefficient municipalities) when estimating the coefficients of interest.

The first stage of the bootstrapping procedures is to estimate a DEA model as in Sect. 4 of this paper. The second stage is to estimate a truncated regression model with the efficiency scores from the first stage as dependent variable and the determinants of efficiency as explanatory

[13] In the first stage regression the estimated coefficient is 0.553 with a t-value of 8.33.

[14] In the following we provide a brief description of the bootstrapping procedures. The reader is referred to Simar and Wilson (2007) for a more thorough description.

variables. The truncated regression model has the same potential problems as the Tobit model, i.e. the efficiency scores are serially correlated and the estimates are biased in finite samples. The single bootstrap is designed to tackle the serial correlation problem and to improve on inference. The estimates are those obtained in the second stage, but bootstrapping is applied to obtain an empirical distribution for the estimates. The bootstrapping is performed by conducting L drawings of residuals from a truncated normal distribution, and then reestimate the truncated regression model for each drawing.

The double bootstrap procedure is designed to tackle both the inference problem and the bias problem. After the two first stages described above, L_1 drawings of residuals from a truncated normal distribution is performed to estimate bias-corrected efficiency scores. These bias-corrected efficiency scores are obtained by performing L_1 additional DEA analyses (one for each drawing). Then the double bootstrap estimates are obtained by estimating a truncated regression model with the bias-corrected efficiency scores as dependent variable and the determinants of efficiency as explanatory variables. Finally, empirical distributions for the double bootstrap estimates are obtained in the same way as in the final step of the single bootstrap procedure. The number of drawings in the final step is denoted L_2.

Table 6 Robustness tests

	A	B	C	D	E
Municipal revenue	-0.097	-0.111	0.189	0.182	0.455
	(-2.54)	(-2.96)	(3.27)	(2.47)	(2.97)
User charge financing	1.706	1.616	-2.507	-3.802	-10.811
	(5.97)	(5.75)	(-5.79)	(-5.58)	(-7.87)
Herfindahl-Hirschman index of	0.197	0.153	-0.222	-0.253	-0.881
inverse party fragmentation	(2.28)	(2.01)	(-1.90)	(-1.53)	(-2.62)
Population size (in 10,000)	0.023	0.025	-0.038	-0.074	-0.229
	(4.38)	(4.74)	(-4.61)	(-3.70)	(-5.53)
Dependent variable/Efficiency score	Input	Output	1/Output	1/Output	1/Output
Estimation method	Tobit	Tobit	Tobit	Single bootstrap	Double bootstrap

T-values in parentheses.

We have performed single and double bootstrap using the algorithms provided by Simar and Wilson (2007). These algorithms are based on a measure of technical inefficiency defined as the inverse of the output increasing efficiency score (Shephard's output distance function). We use the same algorithms, and for comparison we first reestimate the Tobit model with this measure of technical inefficiency as dependent variable (model C in Table 6). As expected, the main consequence is that coefficients take on opposite signs compared to model B.

The results from the single and double bootstrap procedures are reported as respectively model D and model E. Regarding the number of bootstrapping replications, we follow Simar and Wilson (2007) and set $L=L_2$=2,000 and L_1=100. It turns out that the bootstrapping procedures yields similar results as Tobit in terms of sign and significance of the coefficients. The only modification is that the Herfindahl-Hirschman index loses significance with the single bootstrap procedure. In terms of quantitative effects however, the double bootstrap estimates are substantially larger than the single bootstrap and Tobit estimates.[15]

6 Concluding remarks

The purpose of the paper was to calculate the efficiency potential in the care for the elderly sector in Norway and to analyze variation in efficiency across municipalities. In the first stage DEA analysis the national efficiency potential is calculated to 10%. The efficiency potential is robust to outliers, and a complementary analysis, covering a sub-sample of the municipalities, yields little support to the hypothesis that high efficiency simply reflects low quality. It should be noted that the calculated efficiency potential is based on VRS technology and do not take account of scale inefficiencies. Allowing for cooperation in services provision or consolidation of municipalities would increase the efficiency potential.

In a second stage analysis we performed Tobit regressions and recently developed bootstrap procedures in order to explain the variation in efficiency scores across municipalities. The qualitative effects are very robust across estimation methods, and the main findings are that high fiscal capacity, a low degree of user charge financing, and a fragmented local council are associated with low efficiency. The results indicate that user charges may reduce the pressure on public budgets in two ways, directly by replacing public funds and indirectly by increasing efficiency. The impact of user charges also is significant when the variable is instrumented.

[15] Simar and Wilson (2007) and Latruffe et al. (2008) also estimate much stronger quantitative effects with double bootstrap compared to single bootstrap.

Appendix

Table A1 Descriptive statistics for the explanatory variables in the second stage

Variable	Description	Mean (st.dev.)
Municipal revenue	The sum of local taxes and block grants from the central government. Measured per capita and adjusted for spending needs. Index where the national average equals 1.	1.033 (0.173)
User charge financing	User charges in care for the elderly as share of current expenditures	0.086 (0.022)
Herfindahl-Hirschman index	The inverse of the party fragmentation in the local council, based on the election period 1999-2003.	0.264 (0.087)
Share of socialists	The share of socialists in the local council, based on the election period 1999-2003.	0.365 (0.140)
Share of the population living in rural areas	The share of the population living in rural areas, based on Census data from 2001.	0.486 (0.268)
Population size	Total population, January 1.	10694 (30441)
Share of residents in nursing homes 90 years and above	Residents 90 years and above as share of the total number of residents.	0.260 (0.082)
Share of users of home based care 90 years and above	Users 90 years and above as share of the total number of users	0.118 (0.051)
Share of population 0-5 years	The share of the population 0-5 years of age, January 1.	0.074 (0.011)
Share of population 6-15 years	The share of the population 6-15 years of age, January 1.	0.139 (0.014)
Share of population 80 years and above	The share of the population 80 years and above, January 1.	0.053 (0.016)

Unweighted means.

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