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Swedish Health Care Performance – Quantity versus Quality

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Swedish Health Care Performance – Quantity versus Quality

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Abstract

This paper investigates the relative efficiency of 21 Swedish county councils through two efficiency models; one focusing on a traditional productivity measure (activity model) in terms of the production of intermediate outputs, and the other on quality outputs in the form of health-related outcomes (outcome model). Efficiency is estimated using Data Envelopment Analysis (DEA) and the two models are used to test whether there are significantly different efficiency estimates among the councils. The efficiency concept used consists of technical efficiency, here measured as cost efficiency, where the relationship between inputs and outputs for each council is compared to a "best practice" consisting of a production frontier. A weak positive correlation is found between the two models, indicating that cost efficiency regarding activities and outcomes may foremost be seen as complements in the production process. In a second stage, the efficiency scores in both models are used as dependent variables in multiple regressions with several independent structural factors that may be used to explain differences in efficiency. The paper finds that councils which are net receivers in the equalization grant system have lower efficiency scores in both models.

Keywords: Productive efficiency, quality indicators, data envelopment analysis, Tobit regression, Sweden

JEL Classifications: C14, I11

1. Introduction

The Swedish health care system is characterized by its far-reaching decentralization, with 21 politically, economically and administratively independent county councils[1] responsible for financing, delivering and organizing health care for their citizens on the basis of need. This population responsibility is mostly fulfilled by own provision, but the councils are also free to buy health care from other councils. Thus, in order to accomplish the statutory responsibilities of high patient safety, good quality and cost efficiency, they need to act as both efficient purchasers and providers of health care (Health Care Act 1982). In this regard, they are comparable decision-making units in that they, as political organizations, play an organizing function, establishing the rules and conditions to which internal or external producers must adhere (Jacobs *et al.* 2006).

Most research on the production of health care has focused on production data on the volume of intermediate goods such as the number of treated patients in somatic care or the number of physician visits in open somatic or primary care (see Hollingsworth 1999 for a comprehensive review, Färe *et al.* 1995, Gerdtham *et al.* 1999, 1995). These measures may be seen as intermediate outputs of the health care sector and, in relation to the resources used, result in performance evaluations with a primary focus on efficiency in a quantitative sense, or alternatively expressed as productivity.

Measuring performance in terms of intermediate measures is an essential part of the efficiency concept but these indicators are not able to fully capture more extended objectives of health care. On a comprehensive level they are expressed as a qualitative health care for all in the 1982 Swedish Health Care Act (1982). Moreover, the society and individual consumers are ultimately interested in final goods such as health, improved health or health-related quality of life (Fishman *et al.* 2004). How these objectives are fulfilled in relation to the resources used may be seen as the societal goal of the health care sector and simultaneously represent a more correct efficiency concept. Consequently, it is important to augment activity counts with measures of the quality of outcome. Ideally these would encompass health gains, but problems of measurement makes us to rely on aspects that are believed, ceteris paribus, to be associated with improved levels of health outcome, or alternatively quality of care (Jacobs *et al.* 2006).

The possibilities for enlarged studies concerning both the quantity of performed activities and health-related outcomes have recently increased within the Swedish health care sector. More sophisticated measures of performed activities, such as DRGs (Diagnosis-related groups), or weighted patient contacts, which to a larger extent consider differences in patient characteristics and resources used, have been developed in primary and specialized somatic care. In addition, data on health-related outcomes in the population served by the councils have been publicized in different health areas. They offer a possibility of investigating county councils' efficiency in providing for their populations in terms of quality aspects and clinical effectiveness. It is, though, important to highlight that these measures are on a highly aggregated level and describe only some dimensions of relevant outcomes within the health care sector. Moreover, "quality of care is an elusive characteristic which is difficult to define, yet alone quantify" (Burgress &

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[1] The 21 health districts formally consist of 18 councils, two regions and one municipality with the same responsibility.

Carey 1999 p. 509), and there is no consensus concerning what constitutes relevant quality measures and how organizations producing multiple outcomes should be evaluated (Williams 1996). Adjustments for differences in patient characteristics and factors that work exogenously on county council performance are also needed in order to discern the proportion of a patient's outcome over which health care providers have control. However, the existence of clearly defined information of costs, performed activities and health-related outcomes, from a consumer perspective, enhances the possibilities for extended research on the performance of the county councils. Thus, an important aim in this paper is to investigate the relation between activities and outcomes. The ambition is consequently to widen the performance study and scrutinize potential links between an enlarged set of performance indicators of health care such as resource use, activities performed and health outcomes.

We consequently investigate the relative cost efficiency of the Swedish county councils through two efficiency models; one focusing on traditional efficiency measures in terms of the production of intermediate outputs (activity model) and the other focusing on aspects related to the final goods of the health care sector (outcome model). We hereby also include indicators related to health outcomes in different fields as a way to capture the quality aspect. What is, for instance, the relation between more traditional measures of efficiency among the county councils and indicators of survival/mortality rates in different specialties? Should cost efficiency in terms of performed activities and cost efficiency in terms of health-related outcomes be regarded as complements or substitutes in the production process (Pauly 2004)? Quantity and quality are in this regard considered to be separate products and different dimensions in the production possibility set (Newhouse 1970). If an increase in performed intermediate activities is achieved at the expense of quality of care, there exists a quantity and quality trade-off. This trade-off is also closely connected to the use of different reimbursement systems among the councils, because there is a potential risk that reimbursement systems that reward increased activities could cause resources to be placed in areas that contribute less to the overall health outcomes. The ambition is not to measure efficiency concerning health-related outcomes per se but instead to focus on the relation between different efficiency models.

Efficiency is estimated using Data Envelopment Analysis (DEA). The efficiency concept used consists of technical efficiency, here measured as cost efficiency, where the relationship between inputs and outputs for each council are compared to a "best practice" among councils consisting of a production frontier. We also test if the two models give significantly different efficiency estimates for the councils.

An important distinction when studying performance within the Swedish health care system consists in whether to apply a consumer or a producer perspective. We choose to study efficiency from a consumer perspective and consequently focus on health care delivered to the populations served by the councils, regardless if the care is provided by internal producers within the jurisdiction or by external producers. The rationale for this is the risk that councils with university hospitals otherwise would be disadvantaged due to the treatment of a larger share of more severe patients, which is not fully reflected in the intermediate production data (SALAR 2002).

The paper is ordered as follows. In the next section, the basic structure of the Swedish health care organization is described together with important characteristics of

the health care market. It is followed by a description of the DEA-methodology and an explanation of the content of both models concerning the selection of input and output measures. Thereafter, the results of both models are presented. In a second stage, the efficiency scores in both models are used as dependent variables in a multiple regressions used to explore differences in efficiency. Finally, these results are shown and followed by overall conclusions.

2. Organisation of the Swedish health care sector

The responsibility for health care in Sweden is shared by three independent government levels; the national government, the county councils and the municipalities. The municipalities are responsible for care at nursing homes for the elderly. All other health care is the responsibility of the county councils. It can be seen that the local governments receive their competence from the central government.

As local monopolies, the county councils are responsible for providing and financing health care for their residents on the basis of need (Anell 2005). Their central obligations are stated in the Health Care Act as a responsibility for offering "good health and medical services to persons living within its boundaries" and that they "shall promote the health of all residents" (Health Care Act 1982). The councils' responsibility to serve their own populations corresponds well with the Health maintenance organizations (HMOs) contractual responsibility to assure the delivery of a range of medical services to an enrolled population. However, the element of competition is only of marginal character since the only way to change a health plan (council) is to vote with one's feet (exit).

The councils are also responsible for the effective integration of different parts of the health care system, mainly consisting of three organizational levels. The foundation of the sector is primary care that consists of public or private care centers serving local districts within the councils, together with a smaller segment of district, family and private practitioners. The second part belongs to county care at the specialized somatic care level. The patient is here either referred from primary care to a specialist within or outside hospitals or seeks care directly at the hospitals. Finally, rare or more complicated cases, frequently of an emergency character, are treated mostly at university hospitals at the regional care level (Ds 2003). The patients are also allowed to seek care outside their health care district or county, but in practice cross border care is not encouraged by the councils (Anell 2005).

The decentralized form of decision-making brings relatively large freedom for the councils in structuring their own organizations. They may choose to supply the services in-house, use competitive tendering with either publicly owned assets or employ privatization.[2] However, the councils are still overall accountable for the providers as long as there is public ownership, together with a planning and control responsibility for privatized services. Historically, a number of reforms concerning organizational aspects have in varying degrees been implemented in the councils. The most apparent was the

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[2] There are, on the other hand, legal restrictions concerning privatization of emergency care hospitals .This restriction was introduced in 2001 but did not affect existing private hospitals (Health Care Act 1982).

introduction of market-oriented reforms during the early 1990s with the purchaser/provider split as the main characteristic. This caused an increased focus on contractual arrangements between purchasing departments within the councils and either internal or external providers. Contracts between the councils concerning reimbursement and delivery of services also exist, mostly at the regional level. At this level the councils are organized into six regional care districts and the contracts encompass highly specialized care in councils with university hospitals (Ds 2003).[3]

Another important characteristic is the system of central government grants. This is mainly in the form of equalization grants aiming at securing equal conditions in the delivery of health services, regardless of varying county council tax bases and different factors considered to have an exogenous influence on the cost structure. The equalization of costs is aimed at securing equal conditions for an average service level and can be described as a form of capitation system including three models. The most important part covers differences in patient characteristics with the aim of describing the expected health care need in the councils. Another part equalizes cost differentials due to rural location. Finally, small councils receive adjustments. Thus, any differences in quality and the level of service delivery may reflect differences in efficiency (SOU 2003).

3. Characteristics of the Swedish health care market

The production of health care diverges in many respects from the conditions that surround most markets and absence of the usual market signal causes increased demand for alternative performance evaluations. Moreover, the decision to offer or demand medical services is not made by sovereign providers or patients. Neither are they fully financially responsible for their decisions. Instead, financing is to a large extent delivered by the councils as a third party, causing lack of incentives concerning cost efficiency from both patients and providers. This can be described as a principal-agent problem, and lack of comparable cost information on certain procedures and activities cause difficulties for the principal (council) in determining how efficient the agent (provider) is. It is, further, not usually feasible for a purchaser to specify in advance the precise levels for all the many aspects of the quality in the delivery of services. Consequently, the providers have an informational advantage compared to both purchasers and patients concerning the quality and their cost reducing effort. The third party payment system, i.e. the existence of incomplete contracts together with asymmetries of information between the actors, causes intricate difficulties with regard to both cost efficiency and efficient monitoring of quality aspects. Moreover, the asymmetry of information between the consumer and producer causes additional phenomena such as supplier-induced demand and moral hazard (Dravone & Satterthwaite 2000)

A way to manage the principal-agent problem within the councils has traditionally been reimbursement by global budgets, where the hospital managers have been given decentralized responsibility to make economic priorities and ensure quality control. Around 1990 different studies and anecdotal evidence pointed at recent productivity

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[3] Contracts outside these districts also occur, mostly at particular clinics within certain specialties such as cardiac care centers for children (Ds 2003).

downturns, causing pressure to implement incentives to increase health care output, commonly not present in the fixed budget system. Market-oriented reforms, with the purchaser/provider split as the main characteristic, were thus implemented to various degrees in the councils. However, most of the councils kept the integrated model, with only some market-oriented elements (Anell 2005).

An essential part of the market oriented reforms was the implementation of various output-related reimbursement systems (fee for service or fee per diagnosis). There is, though, a potential risk that increased elements of prospective payments also generate dysfunctional incentives in the form of different selection mechanisms or under-provision of services to high severity patients (Ellis 1998, Ma 1994). However, several empirical studies on Swedish data have found no clear indication of different forms of quality deterioration as a consequence of market-oriented reforms (Dalhström & Ramström 1995, Garelius & Svensson 1994). The prevalence of these effects has, for example, also been extensively investigated since the introduction of prospective payment within Medicare. In this regard, the Rand Corporation studies show on an overall level, no significant declines in quality of care for five diagnoses, but increases in the number of patients discharged in an unstable condition (Rogers *et al.* 1990). Other studies show a decrease in non-surgical procedures or a lowering of the length of hospitalisation after the introduction, suggesting some deteriorating of the quality of care (Sloan *et al.* 1998, Fitzgerald 1987). The level of competition for patients among providers will also influence the workings of prospective payment systems (Ellis 1998). Even though consumer choice was encouraged during the reforms, this aspect is, in large, lacking in the Swedish health care sector (Anell 2005).

Without supply restrictions or effective elements of yardstick competition forcing providers to reach their efficient cost level, there is a risk that overall cost control is weakened in output-related reimbursement systems. Thus, relatively weak incentives were introduced and the general tendency is a return to more traditional forms of reimbursement. Global budgets and capitation are also today the most dominant form of payment in health care (Anell 2005). Structural reforms and increased focus on cooperation between different health entities are instead the most characterizing part of development. Ad hoc forms of cost containment have also been frequent due to financial distress in different areas (Olsson & Thorling 2005).

Another related, and thoroughly researched, question concerns the impact of ownership status on health care efficiency. From a property right perspective, private or for-profit organizational forms have traditionally be seen as more efficient than public provisions, due to the high-powered incentives based on the presence of well defined residual claimants with legally enforceable property rights (Kessler & McClellan 2002). However, theories on contractual incompleteness have also shown that private contracting, in relation to in-house production, may cause too strong incentives in cost-reduction effort due to ignorance of adverse effects on non-contractible quality (Hart *et al.* 1996). For-profit organizations may, in this regard, have incentives and opportunities to take advantage of consumers by under-provision of services. Not-for-profit status has consequently been seen as a more advantageous organizational form, because the absence of pure profit maximization objectives softens cost reduction incentives, which in turn might mitigate the effects of contractual failures (Arrow 1963, Hansman 1996). Other theoretical work has, however, shown that nonprofit provision might not be preferable

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from an efficiency perspective (Newhouse 1970). The empirical evidence, mostly concerning the impact of hospital ownership on these aspects, is also mixed. A vast empirical literature shows that for-profit either achieves greater productivity or has higher costs. Other researchers are instead unable to identify the most socially preferable ownership status, in terms of both cost and quality perspectives (Kessler & McClellan 2002).

The tendency of soft budget constraints, especially from an efficiency perspective, is another complicating factor within the public sector. Furthermore, the problem has been exacerbated to the extent that expenditures are not financed by own tax bases, but from general governments grants or equalization grants. There is a risk that councils shift costs for the chosen level of ambition to citizens in other councils. Balanced budget requirements have been introduced in order to prevent this behaviour, but there is still lack of sanctions, insufficient borrowing restrictions and overuse of targeted grants (Petterson-Lindholm & Wiklund 2002).

4. Methodology

The most frequently used techniques for measuring cost efficiency in the health care sector are accomplished by applying parametric stochastic frontier analysis (SFA) or nonparametric data envelopment analysis (DEA). Parametric stochastic frontier estimation needs a behavioural assumption regarding cost minimization and this causes difficulties in interpreting to which degree inefficiency could be rooted in potential misspecifications of the functional form (Linna *et al.* 2006). DEA, instead, hinges on no assumptions regarding the functional form. Therefore, cost minimizing behaviour, which is not the regular case in this sector, does not have to be assumed. The DEA-method is also easier to handle in organizations with multiple outputs and inputs (Jacobs *et al.* 2006).

4.1. The DEA-method
We use nonparametric DEA in order to investigate if this method can offer a guide to performance in the councils. DEA arises from the pioneering work of Farell (1957). In DEA-analysis a central concept is technical efficiency, which refers to producing the maximum amount of output from a given amount of input. We use an input-oriented approach. This method keeps outputs fixed and investigates the proportional reductions in input usage that are possible. The method proceeds in two steps. By using linear programming techniques the observations with the highest ratio of output to input, are to start with, joined into a most efficient production frontier. Second, each organization's output/input ratio is assigned an efficiency score in relation to the radial distance to the efficient frontier. Efficiency is thus measured in relation to the most technical efficient form of production.
The method can be visualized in an example where the county councils produce one output y by the use of two inputs, x_1 *and* x_2. Under the assumption of constant returns to scale and diminishing marginal productivity, we could represent the efficient production frontier by the curve ZZ'. All efficient county councils lie on the production frontier. If a council produces a given amount of output at the point *A,* the technical inefficiency of

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this council may be represented by the distance *AB*, which is the amount by which all inputs could be proportionately reduced without a reduction in output. The technical efficiency is usually expressed as the radial distance measured by the ratio:

$$TE_{IN} = \frac{OB}{OA} \tag{1}$$

which is equal to the distance 1 – *BA/OA*. This value is between 0 and 1 and a value of 1 indicates that a council is fully efficient. If we know the input price ratio, measured by the line SS′, we may also calculate the allocative efficiency of the council measured by the distance *OC/OB*.
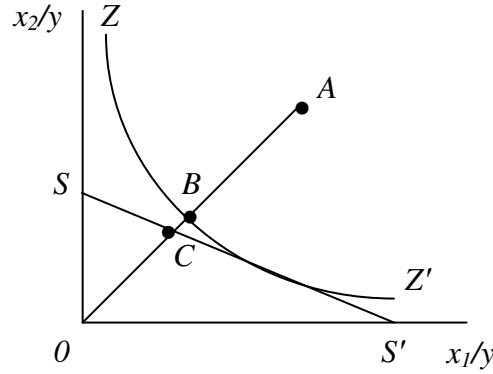
Fig. 1. Illustration of the DEA-method.

More formally, for the $j = 1,...,n$ county councils in the sample the technical efficiency score may be described as the following ratio formulation:

$$\max_{u,v} \left(\frac{\sum\limits_{r=1}^{p} u_r y_{r0}}{\sum\limits_{i=1}^{m} v_i x_{i0}} \right)$$

$$s.t.$$

$$\frac{\sum\limits_{r=1}^{p} u_r y_{rj}}{\sum\limits_{i=1}^{m} v_i x_{ij}} \leq 1, \ \ j = 1,...,n \tag{2}$$

$$u_r > 0, \ \ r = 1,...,p$$

$$v_i > 0, \ \ i = 1,...,m$$

Where y_{r0} and x_{i0} are the quantity of output r and input i for county council zero respectively, and u_r and v_i are the weights attached to output r and input i respectively. Thus, efficiency is calculated by forming the ratio of a weighted sum of outputs to a weighted sum of inputs, where the weights are selected in order to represent the county

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councils in the most favourable light and under the constraint that– when the weights are applied to all councils – none can have a relative efficiency score greater than unity (Hollingsworth *et al.* 1999, Jacobs *et al.* 2006)

This ratio problem has an infinite number of solutions, but it may be translated into a solvable linear programming problem by imposing the additional constraint that either the nominator or the denominator of the efficiency ratio be equal to one. The dual to this problem is easier to solve and more interpretable. For the county council zero the dual problem is:

$$\min_{\theta,\lambda} \theta_0$$

$$s.t.$$

$$\sum_{j=1}^{n} x_{ij}\lambda_j \leq x_{i0}\theta, \quad j=1,...,n$$

(3)

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0}, \quad j=1,...,n$$

$$\lambda_j \geq 0, \quad j=1,...,n$$

Lambda is here the weights of the councils sought to form an efficient frontier to which the council under evaluation is compared. The objective of the linear program is to seek the minimum θ that reduces the amount of inputs used while achieving at least the output level y_r. If there is no need to reduce the amount of inputs, θ is equal to 1. Thus, the value of θ is the efficient score and a value of 1 indicates a point on the frontier and there is no council or combination of councils that outperforms it. If $\theta<1$ the council is technically inefficient. The linear programming problem must be solved separately for each council in order to obtain a value of θ for each council (Coelli *et al.* 1998). Simar and Wilson (1998) show that θ is a consistent estimator during assumption of identically and independently distributed random variables. For a more thorough discussion of DEA see also Färe, Grosskpof and Lovell (1994).

4.2. Deficiencies with the DEA-estimator
Smith *et al.* (2006) point to some important drawbacks to consider in DEA- applications. It is problematic that no stochastic elements are included due to the deterministic nature of the methodology. The estimator is also biased, since the frontier is only defined relative to the best practice observations in the sample. However, this bias does not exist in the present study, because the efficient frontier is constructed from the entire population of councils. The bootstrap approach developed by Simar & Wilson (1998), in order to correct for this bias and incorporate a stochastic element, is consequently not appropriate in this setting. The traditional DEA-method is also sensitive to variable selection. However, the potential bias is less when including an extraneous variable than by omitting a relevant, but the more variables that are included, the less discriminating the model is. As a rule of thumb Banker *et al.* (1989) suggest that the number of DMUs should be at least three times the number of factors but there is no analytical support for this rule. Measurement error is also a potential source of bias because the method is based on outlier observations.

5. Earlier related studies

There are only a few frontier-based studies of efficiency in the Swedish health care sector and they have mainly focused on productivity developments. By using a Malmquist productivity index Färe *et al.* (1995) estimated the productivity development from 1970 to 1985 whereas Tambourg (1997) looks at 20 ophthalmology departments from 1988 to 1993. Hesmati (2002) studies the productivity growth in gynecology and obstetrics departments by measuring the total factor productivity with stochastic frontier models assuming a Cobb-Douglas production frontier. A more related study is by Gerdtham *et al.* (1999, 1995) using a stochastic ray production function to examine the technical efficiency of the county councils from 1989 to 1995. In a second stage, they estimate the effects of organizational reforms consisting of a purchaser/provider split combined with output-related reimbursement systems on the councils during this period. Technical efficiency is studied from a production perspective and they use intermediate outputs in the form of the number of operations, number of discharges and number of visits to physicians for all medical and surgical departments in somatic care. They find significant cost savings by introducing output-related reimbursement but they are not able to reject the hypotheses of constant returns to scale.

6. Model specification and data

We study two separate models, in order to investigate the relation between cost efficiency regarding performed activities and efficiency concerning health-related outcomes. The main differences consist of the use of various outputs. The first model aims at capturing the traditional efficiency aspect of the health care sector by using two resource-weighted intermediate outputs measuring activities performed in both primary and specialized somatic care; this is termed the activity model. In the second model, we instead use comparable measures concerning health-related outcomes as outputs; this is termed the outcome model. The outputs also represent a consumer perspective as the information is based on council residence and not the provider council. Due to the fact that the output variables in the outcome model consist of ratio measures, instead of absolute numbers, any information about the size of the scale of operations in the county councils is removed.[4] In order to accomplish comparability, ratio measures of all variables concerning inputs and outputs are used in both models. The DEA analysis is conducted under the assumption of constant returns to scale.

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[4] This is, for example, the case in outputs such as mortality rates or proportion of patients fulfilling goals for blood sugar value.

Table 1. Descriptive statistics.

Indicators	Activity model	Outcome model	Mean	Standard deviation
Inputs				
Average cost per inhabitant in primary and specialized somatic care, 2002-2004	X	X	11595	762
Outputs				
Average consumed DRG-points per inhabitant in specialised somatic care, 2002-2004	X		0.225	0.009
Average weighted patient contacts per inhabitant in primary care, 2002-2004	X		2.27	0.4
Avoidable mortality, health care related, 2002-2003		X	32.5	5.3
Number of deaths per 100 000 inhabitants				
Five year survival rate with cancer disease, 1998-2004		X		
Large intestine cancer			57.7	4
Rectum cancer			59.2	3.2
Breast cancer			87	1.6
Diabetes care, 2004-2005		X		
Share of patients fulfilling goal for Hba1c			56	3.5
Stroke care		X		
Mortality rate within 28-days, 2001-2003			23.3	2.1
Share of patients with low functional status (ADL-dependent), 2004			23.4	4.7
Delivery care, 2002-2004		X		
Perinatal mortality per 1000 births			3.5	0.9
Neonatal mortality within 28-days per 1000 births			2.3	0.5
Proportion of perineal ruptures in vaginal childbirth			3.8	0.8
Share of births with low Apgar score			1.2	0.2
Cardiac care, 2002-2003		X		
AMI mortality rate within 28-days			32.8	2.4

6.1 Data

The data is taken from official Swedish data sources (SALAR & NBHW 2006). The activity model encompasses data covering 2002 to 2004, while the outcome model includes information on medical results from 1998 to 2005 and is based on the publication of 35 quality indicators by the Swedish health authorities. Moreover, in public policy the indicators are seen as established, valid, relevant, interpretable and possible to influence. They include measures of clinical results regarding the consequences of care for the patient and the population, indicators focusing on health processes concerning different treatments and the degree of coverage in respect of vaccinations etc. They are also grouped into 10 health areas capturing different dimensions of the health care delivery such as cardiac care, cancer care and stroke care (SALAR & NBHW 2006).

6.2. Input

We use net cost in primary and specialized somatic care per inhabitant as an input measure in both models.[5] This cost measure focuses on the council's responsibility to assist its population, as costs for bought care from other councils are included. Moreover, costs of psychiatric care are excluded, due to the loss of output measures in this sector, together with the costs of home-based nursing care, because this responsibility is to varying degrees fulfilled by the councils. We also assume that the county councils are free to deploy both capital and labour inputs efficiently.

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[5] Due to lack of data on costs in primary care for one Council (Uppsala) in 2002 we for this year use the average deflated costs for 2003 and 2004 in this council.

Overall costs are used because these are clearly defined in relation to the utilized output measures and are essential from an accountability perspective. They also offer a way to adjust for differences in environmental factors. We accordingly adjust the net cost used in the two models with different parts of the equalization grant system in order to control for differences in patient mix and structural factors that constitute exogenous influences on the cost structure.

6.3. Output – activity model

We use consumed - by inhabitants in the county councils - DRG-points in closed and open somatic care at hospitals together with weighted patient contacts in primary care as outputs. In the case of consumed DRG-points, each patient contact is weighted according to age, diagnosis, state of illness and relative use of resources. Because all patient contacts are grouped into diagnosis-related groups of homogenous resource use, it is possible to take into account the patient-mix and performed activities through estimating the consumption of equivalent DRG-points.[6] It is, though, important to emphasize that patients classified as having the same basic diagnoses may differ in the severity of their conditions, leading to differences among councils regarding the proportion of more or less expensive cases (Chakley & Malcomson 2000). The output measure used in primary care consists of weighted patient contacts, due to differences in consumed resources when seeing various staff categories. Seeing staff categories other than physicians is assumed to be equivalent to 40 percent of the resources used for a physician visit and a telephone contact is assumed to consume a third of the resources used for a reception visit (SALAR 2002). No adjustments according to diagnoses or severity are made within this indicator.

Adjustment for rural location

We adjust for differences concerning rural location because this factor is assumed to have an exogenous effect on the cost level. The adjustment is based on a special model of the equalization grant system where the amount of net allowance received, or contribution made per inhabitant is subtracted from/added to the cost measure.[7] The model includes five cost areas; hospital, primary and ambulatory care, health care travels, and the number of sleeping accommodations at primary care centers. No adjustment is made, though, for the equalization of differences in expected health care need in the councils. The

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[6] In Sweden Nord-DRG is used as a classification scheme and different combinations of treatments and diagnoses are grouped into approximately 500 distinct DRG-groups.

[7] Assume that county council *A* receives 500 in rural equalization grant (eq_i) per inhabitant in order to adjust for the total health care expenses that amounts to 12500 per inhabitant (C_i). County council *B* is instead making a contribution to this grant by paying 200 per inhabitant ($-eq_i$) and has a total health care cost of 11800. If no adjustments of the costs per inhabitant are made, *B* is estimated as relatively more efficient than *A,* given both *A* and *B* produce the same amount of intermediate activities per inhabitant. This causes biased relative efficiency comparisons because the different cost structures reflect diverse exogenous rural conditions. The net cost of 12000 for both councils after adjustment for rural location is consequently used in the comparison. Due to the fact that costs in primary and specialized somatic care (c_i) are only a subset of the overall health care responsibility, we adjust the net cost variable by these sectors share of the total health care costs (costs for the political governance is excluded). The following adjustment is made: $c_i – eq_i * (c_i/C_i)$.

adjustment for differences in patient-mix is otherwise made twice.[8] Finally, we use the average cost and performed intermediate activities between 2002 and 2004 and the adjustment for rural location is done on a yearly basis.

6.4. Output - outcome model

To decide what measures to use in a performance study of health-related outcomes is challenging. Health care is a complex activity and the county councils are responsible for producing multiple outcomes of heterogeneous products. Moreover, there is no agreed set of indicators to use in evaluations of health-related outcomes among health care organizations in Sweden. This question is also closely linked to quality assurance and quality measurement within the health care sector. There are a lot of alternative definitions concerning what constitutes quality of care, either generic or disaggregated. An often cited example of a generic definition is the U.S Institute of Medicines (IOM 1994 p.11) that defines quality of care as the "degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge". Even though it has a focus on the clinical effectiveness of health services it clearly illustrates the complexity of the concept and how to proceed in its evaluation.

A classical example of a disaggregated description of quality assessment in health care is Donabedians' (2003) multidimensional construct with structure, process and outcome-specific components. Structural measures concern the conditions under which care is provided and encompass material resources, human resources and organizational characteristics such as patient volume and cooperation. These can also be seen as enabling factors influencing health providers to provide high quality care. Process measures describe the content of care in the form of activities such as screening, diagnoses, pharmacotherapy, surgery, rehabilitation and prevention. Outcomes refer to measures attributable to health care and encompass mortality, morbidity, functional status and pain as well as patient-related knowledge and satisfaction. A further question concerns the differences between clinical quality and the quality of health care experience of the patients (Reinhart 1998).

Another example of a disaggregated approach that recognizes that quality is complex and multidimensional is the Swedish health authorities' regulation of the factors that are associated with "good care". They define six comprehensive quality areas as fundamental in the delivery of health services: health care shall be evidence-based and appropriate, safe, patient-focused, efficient, equal and accessible (NBHW 2006). The publication of 35 quality comparable indicators for the councils is in line with this regulation, as they are based on several of these dimensions.

Selection of output indicators

The starting point for the selection of indicators is the 35 quality indicators published by the Swedish health authorities (SALAR & NBHW 2006). Moreover, in order to limit the study we focus on indicators that according to Donabedians' classification are seen as outcomes measures, that is output changes within populations that can be attributed to health care. Within this restriction, our aim is to include a large set of relevant indicators

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[8] No adjustment is made for small councils as this factor is shown not to be related to costs (SOU 2003).

in order to put as much information into the model as possible. Moreover, the included indicators can be described as objective measures of clinical outcomes, mostly covering mortality/fatality rates within different specialties (Williams 1996). A concentration on outcomes is also found in an earlier study of quality improvement in the Swedish health care between 1960 and 1992 (Ds 1994). Outcome measures can also be seen as the bottom line representing what really matters for the patient. Romano and Mutter (2004) mention that they may represent a measure of the whole chain of valuable actions by health care providers.[9] Furthermore, we include only indicators that have a natural preference ordering by virtually everyone in terms of the desirable direction of a characteristic. The AMI mortality rate within cardiac care is one example. We also exclude indicators that do not timely overlap the activity model. The final selection consists of 12 indicators ordered within the same six groups as in the original publication.[10] The chosen indicators comprise large patient groups that consume essential parts of the resources devoted to health care.

The first indicator is avoidable mortality, focusing on mortality that is possible to avoid through medical measures, early discovery or treatment. The indicator is internationally established and used in comparisons within the EU. All in all, mortality within 256 diagnoses and seven chapters are included based on the ICD10 classification. Examples of included diagnoses are appendicitis, asthma, gallstone inflammation and cervical cancer. This may be seen as an indicator of the health care effectiveness, and a high number of deaths within this indicator could be caused by low quality (NBHW 2005). The indicator is based on standardized age rates per 100 000 inhabitants within the council where the country population of 2000 is used as the standard population. Moreover, it encompasses diagnoses treated in both primary and specialized somatic care.

The second group consists of five year survival rates in breast, large intestine and rectum cancer. It measures the relative survival rate in relation to the expected survival rates for persons without cancer diagnoses, adjusted for the average expected lifetime within the councils. From an efficiency perspective, this indicator is only able to reflect aspects concerning extended survival, where the treatment is one factor, due to lack of timely overlap between detection and the cost measure. The third group consists of four indicators within delivery care consisting of perinatal mortality measuring the death of a fetus between 28 weeks and after delivery, neonatal mortality within 28 days after delivery, vitality of newborn children immediately after childbirth (Apgar score), and

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[9] These are also in general more reliable due to using ascertained administrative data sets (Romano & Mutter 2004).

[10] Nine process indicators are excluded. They consist of vaccination frequency for children and elderly, share of patients treated at specialized stroke center, share of patients with prostate cancer given curative treatment, proportion of diabetes patients checked for vision changes, proportion of patients with surgical re-operation of inguinal hernia, share of AMI (STEMI) patients treated with primary PCI, share of patients receiving preventive clopidogrel treatment and share of non AMI (NSTEMI) patients receiving coronary X-ray. Two indicators concerning the share of late abortions and health policy related avoidable mortality (such as traffic accidents) are excluded due to factors outside the control of the health care sector. Seven indicators within orthopedic care are excluded due to data based on the provider council. Finally, one indicator concerning accessibility is excluded together with four indicators that do not timely overlap the activity model.

perineal ruptures during vaginal childbirth. All indicators are based on standardized age rates where the total population of delivered women during 2002-2004 is used as the standard population. The next group belongs to diabetes care through the indicator of proportion of patients fulfilling the goal for blood sugar value measured as Hba1c<6%. Moreover, this patient category mainly reflects care delivery within primary care.

The fifth group concerns stroke care by the indicators of fatality rate within 28-days, age standardized with all diagnoses of stroke in 2000 used as the standard population, and level of functional ability after a stroke (share of patients dependent on others for the activities of daily living, ADLs). This is measured through a follow-up patient survey three months after a stroke. It serves as an indicator of the activities in respect of an acute state and rehabilitation. The final group regards cardiac care measured by AMI fatality rate within 28 days, age standardized with all diagnoses of AMI - with an age of above 20 - used as the standard population in 2000.

Shortcomings in indicator validity
Marshall and Muramatsu (2003) define quality of care as that portion of a patient's outcome over which health care providers have control. But the ability to achieve a good health outcome is not only a function of county council performance but also of patient-mix, social and environmental aspects (Salinas-Jiménez and Smith 1996). It is obvious that the personal characteristics are very important and that they have very different cost implications for securing certain outcomes by the county councils. The severity of illness may vary across providers and among the county councils and a severely ill patient is more likely to do poorly than a less severely ill patient, regardless of the quality of care (Marshal & Muramatsu 2003). Most of the indicators used are adjusted for age differentials but no adjustment is made for factors such as hereditary, severity, earlier diseases or comorbidity. Moreover, the underlying health status of the population within the councils will have an impact, which is influenced by factors such as income and social environment, outside the control of the council (Grossman 2000). Thus, the interpretation of the results of the outcome model must be cautious because these chosen indicators are not unequivocal measures of relative effectiveness of the delivery of health care.[11]

Adjustment for patient mix and rural location
We use the equalization system as one way to adjust for differences in patient-mix within the councils. In this regard, the part of the model that covers differences in patient characteristics, aiming at describing the expected health care need within the councils, is utilized. The equalization factors consist of age, sex, population, income, living conditions, marital and occupational status together with the number of especially severe patients within 96 diagnoses in both somatic and psychiatric care. Besides this, we also make adjustments for rural location.

The adjustment in the equalization system is based on the expected standard cost per inhabitant when differences in expected care need and exogenous structural factors are accounted for. The standard cost should be regarded as the cost level that each council

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[11] The patient selection problem is, though, less severe in a consumer perspective than in a producer perspective.

should have in order to secure equal conditions and if services were provided at the same level of ambition and efficiency. The adjustments are here made for the combined effects of equalization of expected care need and rural location where the amount of net allowance received or contribution made per inhabitant is subtracted from/added to the cost measure.[12]

General aspects
Besides the shortcomings concerning lack of risk adjustment, other factors need to be mentioned. The outcome model is limited to a small subset of the services provided by the councils and many important aspects are not included. Thus, the chosen indicators should be seen as a way to capture quality effects and may only be regarded as proxies used in order to describe health outcomes in the councils. Moreover, an important shortcoming is that after adjustments are made there could still be an amount of variation that reflects measurement error, where differences concerning the point of registration of diagnosis among the councils is one potential source. This is also negatively affected by the fact of defective timely overlap within and between the two models.

6.5. Factor analysis
Due to the desirableness of keeping the input and output vectors small, we also use PCA/Factor analysis to weight the indicators in different subfields consisting of more than one variable, in order to make a composite within this group. Moreover, to avoid the intrinsic weighting difficulties, we use statistical tools to extract as much information as possible from indicators belonging to the same subfield. The aim is to account for the highest possible variation in the different indicators by extracting a few shared common factors. The factors are extracted by Principal Component Analysis (PCA) where each factor consists of the correlation (loading) between the indicator and the latent factor. This is achieved by transforming correlated original variables into a new set of transformed uncorrelated variables using the correlation matrix. The new variables, (factors) are linear combinations of the original ones and sorted according to the amount of variance they account for in the original data (Nardo *et al.* 2004, Kline 1992).

In factor analysis only a subset of the components are retained, the ones with the largest amount of variance. A number of different decision rules are used to decide how many components to retain. We use the most common approach and retain factors that after rotation have associated eigenvalues larger than one, individually contribute to the explanation of the overall variance by more than 10 percent, and cumulatively contribute more than 60 percent (Nardo *et al.* 2004, Kline 1992).

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[12] The adjustments follow the same reasoning as in the activity model (see footnote 8) but is in one way computationally different. Firstly, the average standard cost of primary and specialized somatic care is calculated. The equalization index is then multiplied with the standard cost in order to calculate each council's allowance or contribution to the system. This number is finally subtracted from/added to the final costs. The equalizations index, though, is aimed at equalizing the conditions on a comprehensive level and not only in primary and specialized somatic care. Consequently, there is a risk that the equalization of especially severe groups within psychiatric care will affect the results if the incidence of this group is unrelated to other factors in the index. This would, however, only have a minor effect.

We also use rotation of factors in order to minimize the number of basic indicators that have high loadings on the same factor. This is done in order to approximate a simple structure and to enhance the interpretability of the factors.

The method is illustrated in the subfield of delivery care:

Table 2.PCA/Factor analysis, extraction method, rotated principal component analysis.

Factors	Eigenvalues	Variance explained (%)	Cumulative variance explained (%)
1	1.77	45.26	44.25
2	1.084	26.10	71.36
3	0.626	15.65	87.01
4	0.52	13.00	100.00

In the next step, the single indicators within the two common extracted factors (1 and 2) are weighted according to the proportion of the variance (loading) explained by the indicator (i.e. the normalised squared loadings), while each factor in turn is weighted according to its contribution to the portion of the explained variance in the dataset (i.e. the normalised sum of squared loadings). The resulting weight in the composite is then accomplished by weighting each indicator according to its relative contribution to the explanation of the overall variance of the two factors (Boylaud *et al.* 2000)

Table 3. Factor analysis, weight construction.

	Factor 1		Factor 2		
Indicator	Factor loadings	Weights of indicator in factor	Factor loadings	Weights of indicator in factor	Weights of indicator in composite
Perinatal mortality	0.77	0.34	0.04	0.00	0.210
Neonatal mortality	0.70	0.28	-0.39	0.14	0.226
Apgar score	0.82	0.38	0.07	0.00	0.240
Perineal ruptures	0.01	0.00	0.96	0.86	0.325
Selection criteria:					
Weights of factors in composite	0.62		0.38		
Eiegenvalues	1.77		1.084		
Total variance explained by factors	71.36				

A desirable feature of factor analysis is that it is based on the structure in the data and the weighting only corrects for the overlapping information of two or more correlated indicators (Nardo *et al.* 2004).

In order to transform the sub-indicators, within each group consisting of more than one variable, that are measured in different units, all indicators are expressed as percentage deviations from the mean value. This is an invariant transformation and this normalisation is done for all subfields in order to express all group indicators in the same unit (Nardo *et al.* 2004). Finally, in the DEA-analysis, inversion is used to transform "bad outputs" such as mortality rates, where a smaller number is more desirable (Schell 2001).

Table 4. Output weights

Outputs	Weight	Mean	Standard deviation
Avoidable mortality, health care related		1	0.14
Number of deaths among 100 000 inhabitants			
Five year survival rate with cancer disease		1	0.03
Large intestine cancer	0.29		
Rectum cancer	0.29		
Breast cancer	0.41		
Diabetes care		1	0.06
Share of patients fulfilling goal for Hba1c			
Stroke care		1	0.09
Mortality within 28-days	0.50		
Share of ADL-dependent patients	0.50		
Delivery care		1	0.14
Perinatal mortality	0.21		
Neonatal mortality	0.23		
Perineal ruptures	0.33		
Apgar score	0.24		
Cardiac care		1	0.08
AMI mortality within 28-days			

7. Results

The activity model estimates the efficiency of resources used and the production of intermediate health care that is offered on a population basis. A score of one implies that the county council is on the production frontier and that there are no other councils that outperform it. Three councils constitute the production frontier in the activity model, and hence serve as a reference in relative efficiency measures. Moreover, the average DEA-score in the activity model is 0.941 and may be interpreted as a potential to reduce costs within this sector by 5.9 percent (1-0.941) without reducing the number of performed intermediate activities.[13]

Four councils (almost eight) constitute, on the other hand, the production frontier in the outcome model and the average score is 0.953. One potential explanation to the higher average DEA-score in the outcome model is that this model is less discriminating due to the fact that more output variables are used (Jacobs *et al.* 2006). In Fig. 2. Salter diagrams of the efficiency scores in both models are depicted where the width of the bars indicates the size of the council.

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[13] This amounts to a possible yearly average reduction of costs by 684 SEK per inhabitant.
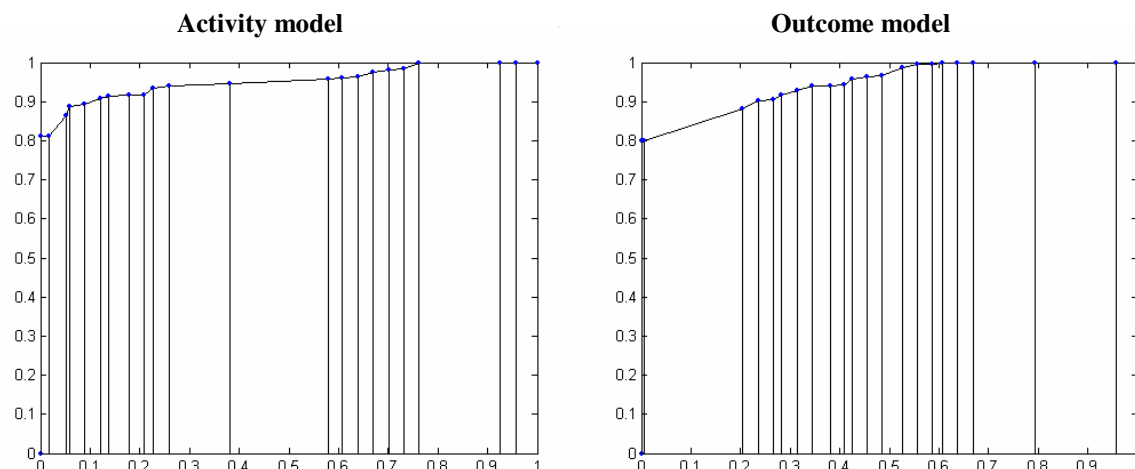
Fig. 2. Cost efficiency scores in activity model (DEA-ACT) and outcome model (DEA-OUT). The breadth of the bars is measured as the average number of admissions within specialised somatic care for 2002-2004 in relation to total admissions.

The main objective is, however, not to focus on the separate efficiency measures but the relationship between the models. By using the relevant adjusted input measures in both models we are able to compare the impact of either using activities or outcomes as outputs. Thus, we use a Pearson correlation test together with a Spearman rang correlation test in order to investigate the relationship between the scores in the both models. Both tests show a weak positive correlation between the models, and we are able to reject the null hypotheses of no correlation at a 10 percent level.

Table 5. Correlations between DEA-ACT and DEA-OUT.

	Pearson correlation DEA-ACT	Spearman rang correlation DEA-ACT
DEA-ACT	1	1
DEA-OUT	0.37*	0.39*

One potential explanation is naturally the use of costs as an input measure in both models, even though they are adjusted for different parts of the equalization system. The remaining correlation between the costs measures is 0.88, which is why this effect is essential. However, costs can not be considered to be the only explanation of the correlation, due to a general positive correlation between the health-related output groups and the activity model. This finding tends to support the interpretation that cost efficiency regarding activities and outcomes foremost may be seen as complements in the production process.

Table 6. Correlations between the activity model and health-related outcomes.

	DEA-ACT
DEA-ACT	1
Avoidable mortality	0.176
Cancer care	0.245
Diabetes care	0.551***
Stroke care	-0.356
Delivery care	0.063
Cardic care	0.099

*** Statistically significant at 1% level.

8. Analysis of efficiency scores

In order to investigate potential causes of the efficiency differences among the councils, within and between both models, we employ multiple regressions to determine those factors that are correlated to performance. Thus, the efficiency scores are regressed against factors that are likely to influence county council cost efficiency regarding performed intermediate activities and health-related outcomes. The independent variables, in terms of Donobedians' classification, may be seen as structural factors, and we consequently investigate if they are significantly associated with efficiency. Due to the fact that efficiency scores are bounded at both ends of 0-1 distribution, application of OLS is expected to yield asymptotically biased estimates (Greene 1981). A censored Tobit regression model is instead considered appropriate for this data (Jacobs *et al.* 2006, Ferrer &Valdmanis 1996).

Relation between bought and sold health care (BUY/SOLD)
The councils produce on average 92 percent of the health care consumed by their population within specialized somatic care, where the remaining part is bought from other councils, mainly within regional care. However, there are relatively large differences among the councils concerning this factor and most obvious is that councils with university hospitals are net providers and that all other councils are net consumers. This factor also captures the effect of university hospitals. One possible hypothesis is that the net providers are disadvantaged from an activity perspective due to a higher proportion of more severe cases (outliers within the DRGs) that are not fully reflected in the intermediate production data, and that the effect will be the opposite in the outcome model due to the fact that these councils have the most highly specialized care. This factor is measured as the average relation between the proportion of bought and sold number of admissions in closed somatic care in relation to the totally consumed and produced in 2003-2004. Consequently, the hypothesis refers to a positive relation in the activity model and a negative one in the outcome model.

Proportion of primary care in relation to specialized somatic care (PRIM/SPEC)
Primary care constitutes the base in the health care system and may be seen as a guardian that steers the priorities against somatic care. Increased concentration on primary care has

also been seen as a way to move consumption from open somatic care to the less expensive primary care (Baker & McClellan 2001). The variable used is constructed by the average proportion of resources spent on primary care in relation to specialized care between 2002 and 2004. Our hypothesis is that this factor will have a positive impact in both models.

Proportion of private provision (PRIV)
Even though county councils own and operate most health care facilities there is, to varying degrees, a segment of alternative providers within the councils. The element of private providers is mainly found in primary care, in the form of private practitioners or health centers, and there are only a few private hospitals (Anell 2005). Besides capturing the impact of variations in ownership structure, the extent of alternative producers may also be seen as reflecting the level of competition within the councils, as they, to some extent, play the role of competitors to public providers. The empirical findings concerning whether these effects are beneficial in terms of efficiency, including both productivity and quality aspects, are, however, ambiguous (Kessler & McClellan 2002, Celleni *et al.* 2000, Dalmau-Matarrodona & Puing-Junoy 1998, Burgress *et al.* 2003). Gerdtham *et al.* (1999)[14] found, from a producer perspective, no significant effect of this factor on the productivity of the councils[15]. The variable is measured here by the average proportion of care bought from private providers in relation to the overall net cost in primary and specialized care between 2002 and 2004.

Reimbursement method (REIMB)
Since several councils introduced a purchaser/provider split combined with output-related reimbursement there has been an overall tendency to use reimbursement in global budgets. The differences in reimbursement systems used are consequently of minor degree and the incentives are generally weak. Output-related elements are foremost used to stimulate production within predetermined cost ceilings. However, a small number of councils utilized a higher degree of output-related reimbursement during the studied period. We use a dummy variable to investigate the effect of those councils that described their reimbursement method as mainly output related in 2001 and 2004 (Olsson & Torling 2005). One possible hypothesis is that this effect is positive in the activity model due to stronger incentives concerning produced activities, but negative in the outcome model because of theoretical considerations of dysfunctional quality incentives.

Scale
Due to the use of ratio measures the DEA-model is applied under the assumption of constant returns to scale. We use the total number of admissions within specialized somatic care in order to investigate if scale effects could explain differences in efficiency. Gerdtham *et al.* (1999) rejected increasing returns to scale from a producer perspective within the councils. However, this variable causes problems of multicollinearity in the regression, which is why this factor is excluded and instead investigated in a separate test.

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[14] Due to lack of data, the value for one council (Gotland) is measured as the proportion of private physician visits in relation to total visits.
[15] The variable used is measured as the share of private physician visits in out-patient specialized care.

Equalization system (EQU)
The different adjustments made in both the models are aimed at controlling for whether expected care need and rural location will or will not affect the performance of the councils. By utilizing the combined effect of expected health care need and rural location as an independent variable, we investigate if the overall equalisation system has an additional effect upon differences in efficiency. We use the average equalization index, including expected health care and rural location, between 2002 and 2004. The hypothesis is that this system will not have an effect upon performance in either of the models, since the system is constructed in order to accomplish equal conditions for an average service level.

From the above discussion we perform a Tobit analysis of the following model:

$$DEA_i = \alpha + \beta_1 \times BUY / SOLD + \beta_2 \times PRIM / SPEC + \beta_3 \times PRIV + \beta_4 \times REIMB + \beta_5 \times EQU + \varepsilon \quad (4)$$

where DEA_i is the scores from the models.

9. Results multiple regression

The overall explanative power, measured by the pseudo R^2, of the included regressors is low, and much of the variation in efficiency scores remains unexplained in both models. This could possibly be influenced by the small sample size. Romano and Mutter (2004) points out that structural measures typically explain little of the observed variations in outcomes. The results from the outcome model must also be interpreted with special caution due to the explorative nature of this model.

Table 7. Results multiple regression

Dependent variable	DEA-ACT	DEA-OUT
INTERCEPT	1.639***	2.012***
	(4.406)	(5.029)
BUY/SOLD	0.000	-0.001
	(0.010)	(-0.619)
PRIM/SPEC	0.367	0.521**
	(1.554)	(2.042)
REIMB	0.034	-0.032
	(0.864)	(-0.814)
PRIV	-0.001	0,000
	(-0.593)	(-0.413)
EQU	-0.792*	-1.091**
	(-1.890)	(-2.398)
Jarque-Bera	0.942	0.287
Pseudo R^2	0.202	0.270
Log likelihood	25.986	23.698

Asymptotic t-values are given in parentheses. *** Statistically significant at 1% level. ** Statistically significant at 5 % level. * Statistically significant at 10 % level. We also controlled for multicollinearity not being present in the regressors by calculating the inverse of the correlation matrix. The highest variance inflation factor (VIF) for the regressors was 1.883 and where VIF>10 indicate harmful multicollinearity

(Kennedy 2001). Normality of residuals is also ascertained by insignificant Jarque-Bera test statistics in both the models (p-values presented in the table).

There is hardly any effect of the relation between bought and sold health care on the councils in both models, even though the signs are in line with the hypotheses. One interpretation is that neither net consumers nor net providers hereby obtain any relative efficiency advantages but the costs of bought care could be seen to correspond well to delivered activities and health-related outcomes. The existence of university hospitals may also be seen as not affecting the efficiency scores in both models due to their connection to the above factor. A larger proportion of resources spent on primary care has a significant positive impact on the efficiency score in the outcome model though, and the sign of the activity model is also corresponding. This effect must foremost be seen as originating on the input side. In order to interpret this result one must also consider how this effect is related to other factors concerning the achievement of an effective integration of different parts of the health care system.

The insignificant effect of private provision is in line with earlier studies conducted from a producer perspective (Gerdtham *et al.* 1999). A possible explanation is that contracting with private providers has conflicting effects where the potential positive efficiency effect from increased competition could be counteracted by increased informational asymmetries in external contracting compared to in-house contracting. There is also an increased tendency for the councils to focus on co-operation among providers rather than competition. Rules governing behaviour have instead been shown to have a greater impact on performance than differences in ownership status (Celleni *et al.* 2000). Our results concerning the effect of different reimbursement systems, even though insignificant, are in this direction. This result could, in relation to earlier studies that found a positive impact upon performance through this factor, be due to the utilization of relatively weak output-related incentives and consequently in general small differences in reimbursement methods among the councils. Another possible effect is that this factor is less influential from a consumer than a producer perspective. However, the signs of the coefficients are consistent with the hypothesis, at least indicating potential tradeoffs in incentives structures concerning quantity and quality.

An interesting aspect is the negative impact of the general equalization system in both the models. This indicates that councils with high expected care needs and worse structural conditions have a lower technical efficiency concerning performed intermediate activities and health-related outcomes even after controlling for these factors in both models. One explanation is that the measures used in the form of DRGs and weighted patient contacts in primary care are not able to fully describe differences in patient mix within the councils. Cost differentials exist even within DRG-groups and weighted patients contacts do not adjust for differences in diagnoses or severity. Councils with a more severe patient mix are thus potentially disadvantaged from a relative efficiency perspective. Another potential explanation is, particularly in an activity model perspective, that the equalization system may be seen as generating a soft budget constraint, where the received proceeds are not reflected in the actual care utilization in the councils. Finally, we found no significant effect, though it has a positive sign in both

models, of our scale factor, which corresponds to earlier studies (Gerdtham *et al.* 1999) and the visualisation in the Salter diagrams (see Fig. 2.) of both the models.[16]

10. Conclusion

In the order to get an enlarged picture of the production of health care it is also essential to include, besides traditional measures of productivity, measures related to the final objectives of health care, such as health, improved health or health-related quality of life. Thus, the main aim of this study is to widen the performance study and scrutinize the potential links of an enlarged set of performance indicators of health care such as resource use, activities performed and health-related outcomes. By utilizing Data Envelopment Analysis we, in this regard, investigate the relative cost efficiency of the 21 Swedish county councils through two efficiency models; an activity model, focusing on traditional efficiency measures in terms of the production of intermediate outputs, and an outcome model, including aspects related to the final goods of the health care sector. The efficiency of intermediate activities is measured as DRG-points in open and closed specialised somatic care and weighted patient contacts in primary care. In order to grasp the qualitative outcome within the councils, clinical measures of health related outcomes, mostly consisting of survival/fatality rates, of six different health areas are used as outputs. The positive correlation between the models and a general positive correlation between the activity model and the included health areas seem to suggest the absence of a potential trade-off between high productivity of intermediate outputs and quality in terms of health related-outcomes. Both dimensions should in this regard rather be seen as complements in the production process. This result also strengthens the relevance of studies based on intermediate output measures in assessing efficiency within the health care sector. However, health care entities are complex organizations, producing numerous activities in multiple areas and the included indicators cover only limited dimensions of relevant quality aspects. In order to achieve a more conclusive picture of the relationship between the quantity and quality dimensions the inclusion of other essential quality components - such as measures of process, patient satisfaction and accessibility within the health care sector - is required.

A second aim, of this paper, is to explore the underlying reasons for the different efficiency scores of the county councils. In this regard, the explanatory power of the included structural factors is low, suggesting the importance of searching for other factors concerning, for example, organisation and management of essential agency relationships, integration of different parts of the health care system and co-operation between municipalities and councils. An interesting finding, though, is the negative impact of the equalization grant system even after cost adjustments,. One interpretation is that the equalization causes an element of moral hazard for the net receivers, which has a negative influence on cost incentives. However, in order to reach a conclusive picture,

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[16] The coefficient in a single Tobit regression in the activity model is 0.000 with an asymptotic t-value of 0.989 and corresponding p-value of 0.32. The coefficient in the outcome model is 0.000 with an asymptotic t-value of 0.714 and a corresponding p-value of 0.48.

this factor mostly suggests the need for better measures concerning how to adjust for differences in patient mix within the councils.

While the data envelopment analysis is shown to be a potentially important tool in efficiency analysis within the health care sector, the robustness and validity of the empirical findings hinge, of course, on the quality of the available data. The utilized data is not ideal in this regard. The joint availability of risk-adjusted output measures capturing differences in patient case mix, together with longer time series, will in essential ways improve performance evaluations within the health care sector.

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