The impact of internal markets on health care efficiency: Evidence from health care reforms in Sweden

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Working Paper Series in Economics and Finance, No 170

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***** We would like to thank Magnus Johannesson for helpful comments on an earlier draft of this paper. The financial support from the National Corporation of Swedish Pharmacies is gratefully acknowledged.

Abstract

A purchaser/provider split together with output-based reimbursement were recently introduced by several Swedish county councils. These changes have been motivated by arguments of efficiency and consumer choice. This paper tests the null hypothesis that hospital services are provided as efficiently by county councils with internal markets as by county councils with budget reimbursement. We first estimate technical efficiency using data envelopment analysis and then we regress the efficiency scores as the dependent variable on new internal organisations in a multiple regression by use of pooled cross-section data for the 26 county councils for two years (1993 and 1994). The results reject our null hypothesis and we conclude that the organizational changes in the county councils improve health care efficiency. Our results further indicate that the potential savings in costs due to a hypothetical switch from budget based allocation to a performance based allocation is about 13%. We also found some evidence indicating that county councils with a non-socialist political majority are relatively more efficient than those with a socialist regime and that large county councils are more efficient than small county councils.

Keywords: internal markets, productivity, regression analysis, pooled data.

1. Introduction

The Swedish health care system is publicly managed. The financing and delivery of health care services are supplied by the 26 politically, economically and administratively ”independent” county councils (including some independent municipalities) in a monopolistic integrated system in which most facilities are owned as well as managed by the public county councils. However, the system has been exposed to several reforms in recent years. One major reform has been the introduction of internal markets, i.e. separating the responsibility for buying health care from the provision of services within the county councils. This change aimed at introducing competition among providers and thereby increasing incentives to use available resources more efficiently.

Frontier-based studies of the aggregate productivity in Swedish health care are infrequent. Färe et al. (1995) and Färe, Grosskopf and Roos (1994) estimated Malmquist productivity indices for two samples of Swedish hospitals. The papers reported a decline in productivity during the pre-reform period 1980-1991. Productivity studies of the reforms and organizational changes that have taken place in the Swedish health care system are also few. One study is Jonsson (1994), in which productivity measures for one county council with a purchaser/provider split were compared with measures for 14 county councils without new organizational systems. Jonsson (1994) used simple, non-frontier based, productivity estimates (ratio benchmark measures). Further, no hypothesis tests were made on the estimated productivity measures. However, the results indicated that productivity had improved more in the county council with output-based reimbursement than in the county councils in the control group.

The present paper performs a similar analysis, but with methods that allow representations of multiple outputs (and multiple inputs) and deviations from maximum productivity, e.g.

technical efficiency. Technical efficiency is defined as the relation between observed and optimal values of outputs conditioned on the level of inputs. Efficiency is thus measured relative to a production frontier. This type of method has been used to analyze the impact of different reimbursement systems on efficiency in US health care (Borden 1988, Bedard and Wen 1990). No such studies have however been performed on Swedish health care data to analyze the efficiency impact of internal markets. As is common in these types of study, data availability does not allow the output side to be measured in terms of health status. Efficiency is therefore evaluated relative to a number of intermediate health care outputs such as number of surgeries and admissions. This paper also statistically tests the null hypothesis that hospital service in county councils with internal markets is equally efficient as in county councils with budget reimbursement. To conduct the test we first estimate technical efficiency by data envelopment analysis (Charnes et al 1995) and then we regress the efficiency scores as the dependent variable on new internal organisations as a regressor among others in a multiple regression analysis, using pooled cross-section data for 26 Swedish county councils for two years (1993 and 1994).

The remainder of the paper is organized as follows: Section 2 briefly describes organizational changes in the Swedish health care system; Section 3 outlines an analytical framework. Section 4 describes the data and methods. Section 5 reports the results and Section 6 ends the paper with some concluding remarks.

2. Organizational changes in Swedish health care

The Swedish health care system is basically an integrated system where the local authorities (the county councils) control both the funding and the provision of health services. The internal allocation of resources has traditionally been based on budgets where providers receive an annual grant to cover all their services. This system of funding gave the providers a high degree of freedom to use resources for different purposes. The development in the health care system during the 1990s shows some radical changes in the principles for allocating resources in the system. The system has been exposed to several reforms introduced by the central government or by the county councils themselves. One of the major reforms is the purchaser/provider split within the county councils. A common principle in the reform has been to induce politicians to concentrate on the interest of citizens by separating the consumer/purchaser and provider roles within the county councils. The providers in these counties remain under public ownership, but politicians have decided not to be represented on the boards of hospitals and health centers. They therefore have less decision-making power at the operational level. In organisations based on a purchaser/provider split politicians are represented in collective purchasing units who are contracting with autonomous providers.

In contrast to earlier changes affecting the organizational and financial structure of the county councils, individual county councils now develop their own management control systems. Changes in such systems during the 1960s and 1970s were designed and developed centrally by the Federation of County Councils. The implementation of collective purchasing units has been structured differently. Some county councils have decentralized the purchasing function to local units corresponding to health districts, and others have established central agencies acting as collective purchasers of health care for all citizens. The models separating consumer and provider interests have been implemented successively. The collective purchasing units usually receive their resources on the basis of population characteristics (number of inhabitants, age, etc.), which are used for purchasing health services from providers within the county council, but purchases from external providers are also allowed.

Through 1995 twelve of the 26 county councils had implemented some type of model featuring a purchaser/provider split. These county councils represent more than 50 percent of the total population in Sweden. However, most county councils are still allocating resources by the traditional budget process. Five of the twelve county councils have implemented a comprehensive system of internal markets. The purchase of health services was first implemented in the surgery specialities. Specialities with a higher degree of uncertainty about costs and outcome and where the output of the service is difficult to observe (psychiatry, geriatrics) were included later.

The implementation of internal markets has also changed the way providers are reimbursed. The earlier budget process has been replaced by various output-related reimbursement mechanisms (fee-for-service or fee-per-diagnosis). Such arrangements have been adopted slowly and applied where most appropriate.

3. Analytical framework

There is no unified theory of hospital behavior, but there are different models which differ according to the role of external factors and internal factors. Several models stress the importance of internal factors, e.g., Harris (1977). Berki (1972) states that the internal structure of the hospital is of overriding importance as compared with external factors when it comes to explaining hospital behavior. A major explanation for the weak role of external factors is the existence of third-party payers. Third-party financing is common in most health care systems, leaving the resource allocation decisions to the patient-physician relationship. The experience from several countries shows that the third-party payers have played an passive role in this process (Hurst 1991).

The importance of internal factors draws attention to the principles for allocating resources and delegating responsiblities within the hospital. In health care organizations, as in any organization above a minimum size and complexity, there is a separation of ownership and management. The transfer (or change) of property rights between parties has strong effects on the organizational structure. In public health care there are different complex patterns of transfers of property rights. If we consider the politicians as the principals there are several agents supposed to act in their interest (managers, heads of clinics etc.). Of course the role of the physicians is of major importance; they act as ”double” agents on behalf of both politicians and patients (Blomquist 1991). In the present paper, we are interested in the relationship between politician and physician, and how this is handled by payment systems as a tool for controlling the behavior of the agent.

The importance of internal factors motivates focusing on different actors, where each actor is assumed to maximize his utility function inside the hospital's organizational framework. The output of the hospital is a function of these internal relationships. The most frequently studied actor is the physician. In a model developed by Pauly and Redisch (1973) the physicians dominate the principal-agent relationship through their professional position and informational advantages, and have access to any surplus of revenue over expenditures generated in the hospital. This model can also be used to analyze how physicians use their position to achieve objectives other than net incomes, e.g., status, promotion possibilities. In public health care systems the physicians have limited possibilities for maximizing income, but can instead use their clinical freedom to achieve these other objectives.

In this study we take the view that hospitals in the pre-reform system were reimbursed by global budgets (or block grants) not related to the output. In fact inputs were often used as proxies for outputs. This reimbursement system gives space for discretionary behavior, but we do not know how this managerial discretion was used. Still, we assume that the lack of incentives for efficiency resulted in productivity losses. With the introduction of internal markets and output-related payment the degree of discretionary behavior has been limited. The limitation of discretionary behavior can have had positive productivity effects, e.g. a reduction in the degree of X-inefficiency and/or a higher growth in productivity. At least, these were the intentions of the organizational reforms.

The fundamental hypothesis of this paper concerns the effect of implementing internal markets on efficiency. However, efficiency in hospital services is determined by variables other than internal markets alone, i.e. age structure, economies of scale, alternative (private) health services, financial status and political majority of the county councils.

Age of population: It is well known that the proportion of the elderly has some impact on health care costs. During the last decades there has been a relative shift of resources from younger and middle-aged inhabitants towards the elderly population (Gerdtham 1993). The intensity of treatment has increased for the elderly, indicating that productivity gains might be harder to achieve for a population with a high proportion of the elderly. Since the proportion of elderly persons varies across catchment areas for hospitals, we have included age as a variable to standardize for case-mix differences across county councils. Our hypothesis is that the proportion of elderly persons has a positive impact on the estimated inefficiency measures.

Economies of scale: A factor that has been used to explain efficiency differences in health care studies is economies of scale (Kooreman 1994, Ferrier and Valdmanis 1996). In the DEA-model we allow the production technology to exhibit constant and non-increasing returns to scale. Thus, economies of scale are to some extent allowed for in the estimation of the efficiency measures. However, it is possible that efficiency varies with the size of the county councils even when returns to scale are allowed for, and it is this effect that we want to capture by using scale as an explanatory variable. Our hypothesis is that large units are more efficient than small units.

Alternative health services: Even if the health care market and especially the hospital sector can be characterized as a monopoly market, there usually exists a small segment of alternative suppliers. These providers have to various extents been able to contract with public health care payers. In that sense they also play a role as competitors to public providers. Studies of productivity in other sectors show that public providers subjected to external competitors have a higher productivity than those with a monopoly (e.g. Millward and Parker 1983). Since the major supply of private providers is found in out-patient specialist care, we use the share of private physician visits in that subsector to catch this effect. Our hypothesis is that the supply of private health service has a positive effect on productivity.

Financial status: An argument for local governments to introduce economic incentives in order to increase productivity has been the fiscal situation. With growing demand for treatments and a decline in revenues during the recession, the only way out has been to improve productivity in order to meet the new needs. We assume that the pressure to improve productivity has been strongest for health care authorities with a poor financial status. Our hypothesis then is that county councils with a poor financial status, ceteris paribus, have a higher productivity in their health services.

Political majority: A factor that has been treated in political science is the role of political majorities; the hypothesis is that social democratic governments tend to increase public expenditure faster that non-socialist governments (Castles 1982). These analyses have focused on explaining the growth of overall public expenditure. Still, there are similar arguments from non-socialist parties when it comes to supporting the introduction of market mechanisms and competition within the public sector. Our hypothesis is that non-socialist political majorities on the county councils, ceteris paribus, have a higher productivity in hospital services compared with social democratic majorities.

The discussion above has served to identify potentially important factors to be included along with observable measures in the regression for technical efficiency. They are summarized in the following ”theoretical model”:

$$Y = f(INTMAR, AGE, SCALE, ALTER, FSTATUS, POLMAJ) \quad (1)$$

where notation and anticipated signs of partial derivates are:

Y=Technical inefficiency

INTMAR = Internal markets (-)

AGE = Age of population (+)

SCALE = Economies of scale (-)

ALTER = Alternative health services (-)

FSTATUS = Financial status (+)

POLMAJ = Political majority, i.e. non-socialist government (-)

4. Data and methods

Most of the county councils have not introduced an internal markets system (a purchaser/provider split) with or without output-related payments. There is no official classification of the county councils into those having implemented an internal market and those relying on the budget process. There are also differences within some county councils as regards how output-related payments have been used in different specialities. In this study we use the classification and grouping of the county councils according to the studies in Table 1.

TABLE 1 IN HERE

According to these studies, 12 county councils had partially implemented different systems of internal markets and 5 of them changed their system into a comprehensive one with a purchaser/provider split for short-term surgery and internal medicine.

All other data are taken from various official records. In the empirical application we concentrate on productivity for short term care. This is motivated by the fact that the internal markets have been focused on this type of health care delivery. Two variables are used as proxies for input use. The first variable is the total cost for short-term care (COST in Table 2). The cost figures are taken from annually published financial records (Landstingsförbundet 1994a) and are deflated by the county council price index. Cost is used since data on labor use are not easily accessible for short term care. It is, however, recorded on an aggregated level, i.e. when somatic, primary and psychiatric health care are aggregated. The cost measure we use does not include expenses for capital services. We therefore include the number of beds (BEDS) as a crude proxy for capital costs. Values for this input are taken from Landstingsförbundet (1994b).

As usual the conceptual output in health care delivery, change in health status, is difficult to measure; this implies that a number of intermediate outputs are used instead. Five types of output measures are used. The first is the number of operations in short-term care (OPERA). These data are taken from the National Board of Health and Welfare inpatient care register (Socialstyrelsen 1996). The next output is the number of admissions. This variable is divided into two variables: admissions in surgical (ADSUR) and short-term internal medicine (ADMED). The admission data are taken from the compilations made by the Federation of County Councils (Landstingsförbundet 1994b). Finally, the last output category is the number of physician visits in short-term surgical care (VISUR) and internal medicine (VIMED), respectively. The data source is the same as for the admission data. Descriptive statistics are reported in Table 2.

TABLE 2 IN HERE

The costs for short term care have been stable between 1993 and 1994, but on the other hand the number of beds have decreased steadily. For the output variables both (average) increases (OPERA, ADMED and VIMED) and decreases (ADSUR, VISUR) are found.

Our main hypothesis concerns the difference in efficiency between county councils that have introduced a comprehensive internal market organization and those that have kept the traditional integrated organization with budget based allocation. In this paper we use regression analysis, with efficiency scores as dependent variables. This approach has been used in several studies of hospital efficiency (see e.g. Kooreman 1994, Ferrier and Valdmanis 1996) Although influential factors such as quality and ownership can be allowed for, the two-stage approach has other problems and weaknesses. One problem is that correlation between independent variables and data used in the DEA-model can lead to biased and inconsistent estimates (Grosskopf 1996). Another problem is the bounded range of the technical efficiency measure. To remedy this problem the approach suggested by Lovell et al. (1995) is used. The first step is to apply the (”super”) efficiency estimator proposed by Andersen and Petersen (1993). This method is a variant of a standard data envelopment analysis (DEA) model. That is, when county council k is evaluated the unit k observations are removed from the input and output matrices that constitute the reference technology. The following LP problem is solved to estimate the modified DEA-scores (MDEA):

$$
\begin{aligned}
&\hat{D}\left(y_i, x_i\right) = \max\ \theta \\
&s.t. \\
&\theta y_{im} \le \sum_{\substack{k=1 \\ k \ne i}}^{K} z_k y_{km}, \quad m = 1, \ldots, M \\
&x_{in} \le \sum_{\substack{k=1 \\ k \ne i}}^{K} z_k x_{kn}, \quad n = 1, \ldots, N \\
&\quad \sum_{\substack{k=1 \\ k \ne i}}^{K} z_k \le 1
\end{aligned}
\tag{2}
$$

The MDEA-estimates are bounded below by zero instead of one in the standard DEA-model and efficiency is measured relative to all other units in the sample. For units with $\hat{D} \ge 1$ the estimate represents a measure of potential proportional increase in outputs conditioned on the level of inputs. This is the same interpretation as in the standard DEA model. For units with $\hat{D} < 1$, on the other hand, the efficiency estimate is interpreted as the amount by which the output vector can be proportionally decreased without being dominated by a combination of the other units in the sample.

Lovell et al. (1995) then suggest a semi-log transformation of the estimates in (1) as a dependent variable in a second-stage regression analysis. For the present analysis we proceed from ordinary least squares (OLS) and a linear functional form (untransformed dependent variable), but this assumption is carefully investigated within the framework of Box-Cox power transformation analysis (Box-Cox 1964, Zarembka 1974, Spitzer 1982). The working assumption for using OLS to estimate the model below is that the MDEA estimates are continuous and unlimited, and the errors are symmetric and have constant variance. The Tobit model is more realistic in that it restricts the observed value of the MDEA estimates to zero. When a substantial proportion of a population has zero or close to zero MDEA estimates, the Tobit model is likely to fit MDEA data better than the OLS model, and to imply a positive expected estimate of MDEA for all county councils. For purposes of comparison, we present both OLS estimates of untransformed MDEA estimates and the Tobit specification. Furthermore, since technical efficiency is estimated two times for each county council we use a repeated cross-section design with data values from two cross-sections (1993 and 1994). We use two cross-sections both in order to gain degrees of freedom if pooling is appropriate and to assess the stability of the estimated regressions.

From the discussion above we formulate the following regression model for the MDEA estimates:

$$\hat{D}_{it} = a + b_1 \times INTMAR_{it} + b_2 \times SOLID_{it} + b_3 \times POLMAJ_{it} + b_4 \times AGE_{it} + b_5 \times SCALE_{it} + e_{it} \quad (3)$$

where $\hat{D}_{it}$ is the MDEA estimates for the i:th county council 1,2,3,...26 at a specific time t (1993 or 1994), INTMAR is a 0-1 dummy for internal markets (INTMAR = 1 for internal markets, zero otherwise), FSTATUS is Solidity (FSTATUS = Equity/total assets), POLMAJ is a 0-1 dummy for political majority in county councils (POLMAJ=1 for conservative and/or liberal majority, zero otherwise=social democrat majority), AGE is the percentage of population older than 70 years, ALTER is the percentage of private visits to total visits to physicians, and SCALE is measured in terms of number of bed-days. b_1-b_5 are the parameters which are to be estimated from the data and a is the constant term. e_i is the stochastic disturbance term, which is assumed to have zero mean and constant variance. We test the following hypotheses: b_1, b_3, b_5, $b_6 < 0$ and b_2, $b_4 > 0$. Note that a negative sign implies a positive effect on efficiency and vice versa.

Descriptive statistics of the variables are summarized in Table 3 and the simple (bivariate) correlation coefficients are reported in Table 4. The first column of the correlation matrix shows the correlation coefficients between $\hat{D}_{it}$ and six regressor variables. The correlation coefficients are all of the predicted effects except for AGE. Five of the fifteen correlation coefficients between the explanatory variables are statistically significant at 0.1 or lower levels of significance. The correlations for the individual cross-sections are similar to the coefficients in Table 4.

TABLE 3 IN HERE

TABLE 4 IN HERE

5. Empirical analysis

Our OLS regression results are summarized in Table 5. The upper part of the table presents the partial regression coefficients from either cross-section, their differences and the estimates from the pure pooled cross-section. The lower part of the table presents various statistics for the evaluation of the estimated regressions and hence the statistical reliability of the regression coefficients. The corresponding maximum likelihood (ML) estimates of the conventional Tobit specification are presented in the Appendix. Below we focus on the OLS results, because little is gained by estimating the MDEA estimates by the Tobit model and the Tobit estimates collapse to those obtained by OLS.

TABLE 5 IN HERE

All three regression equations have high explanatory power (R^2). The regressors account for approximately 80% of the variance in efficiency across the county councils. The cross-sectional analyses of internal markets on efficiency are consistent with theoretical expectation irrespective of sample specification. The t-ratios are based on the conventional OLS covariance matrix estimator and the significance tests are one-tailed according to the predicted effects in equation 3. We found no large differences in the coefficients between the two cross-section samples, and all differences were statistically insignificant, individually as well as jointly. Furthermore since we could not reject the two null-hypotheses, that the variances of the two cross-section regressions were equal and that the regression parameters were jointly equal, it is justified to use the pooled estimates. We thus further concentrate our discussion on parameter estimates of the pooled regression.

The estimated effect of internal markets (INTMAR) is statistically significant at the 1% level with a negative sign, indicating that hospital services in county councils with internal markets are more efficient than those in county councils with budget reimbursement. Hence we conclusively reject our primary null hypothesis that county councils with internal markets are as efficient as county councils with budget reimbursement. The potential increase in outputs, or to put it another way, the potential savings in costs resulting from a hypothetical switch from budget based allocation to a performance based allocation, can be estimated from the predicted values at average values of all regressors except for INTMAR (0/1). Our results indicate that the potential cost savings are about 13% for the county councils with budget based allocation (13% = (predicted values for an average county council with budget based allocation/predicted values for an average county council with performance based allocation)-1)*100).

The estimated effect of pertaining the dummy for a conservative and/or liberal political majority on the county council (POLMAJ) is negatively significant at the 1% level, indicating that non-socialist majorities have a higher productivity in health services compared with socialist regimes. However, it should be noticed that in several of the county councils with internal markets which were ruled by non-socialist majorities in 1993-94, the social democrats had introduced the reforms in the earlier election period (1988-1991). The estimated effect of age (AGE) is negatively significant at the 5% level, which is not consistent with a priori expectation. Scale, or number of bed days, is negatively significant at the 1% level, indicating economies of scale in the sense that county councils with more bed days in hospital service, i.e. large units, are more efficient. It can be noted that we did not allow for increasing returns to scale due to the possibility of non-existent solutions in the LP problems. This could explain why small county councils are estimated as being more inefficient. However, an analysis of the traditional DEA efficiency estimates where all units are included in the reference technology showed a positive correlation between efficiency and scale for both years, even when variable returns to scale were allowed. Finally, the estimated effects of solidity and the ratio of private visits to total visits were clearly not significant.

To assess the magnitude of multicollinearity in the regressor data we calculated the condition number of the normalised product moment matrix (X'X). A condition number in excess of 30 indicates potential multicollinearity problems such as unstable estimates, inflated standard errors and difficulties in disentangling the impacts of the various regressor variables on the dependent variable (Belsley et al 1980). We found a condition number of 27.24 for the pooled regressor data. The internal R^2 of the product moment matrix was also calculated in order to attempt to identify which regressor variable(s) are accountable for multicollinearity. None is larger than the R^2 of the regression for $\hat{D}$. The largest internal R^2 is 0.50 for SCALE, i.e. the other five regressor variables acount for 50 percent of the variation in this regressor variable. The highest variance inflation factor (VIF) for the regressors included in the model was 2.021. The VIF for a regressor X_k is calculated as one over one minus the internal R^2. A rule of thumb is that a VIF>10 indicates strong multicollinearity (Kennedy 1985). Our conclusion is that the individual t-ratios should not be affected much by multicollinearity.

We found no evidence for non-normality or of heteroscedasticity in the residuals of the two cross-section regressions or in the pooled regression. We also evaluated the assumption of untransformed $\hat{D}$. In this case we specified a transformation parameter for $\hat{D}$ and used a one dimensional grid search in the LIMDEP software in order to determine the maximum likelihood estimates of the transformation parameters. Given these estimates it is easy to test a hypothesis about the optimal transformation of the dependent variable. As indicated in Table 5, we conclusively rejected the logarithmic transformation of $\hat{D}$ but we cannot reject the untransformed linear functional form. Ramsey's Reset F-test also supported the chosen specification.

6. Concluding remarks

In this study we estimate the effect of internal markets on efficiency in hospital care. Using Swedish data, we have compared county councils who had changed their internal resource allocation system into a comprehensive system of internal markets with those still relying on the traditional budget system. These changes aimed at introducing a new set of incentives for the publicly owned health care providers to use available resources more efficiently. In the paper we explicitly test the null hypothesis that hospital services in the county councils with internal markets are provided as efficiently as in county councils with budget reimbursement. The analysis was developed in two steps. In the first step we used DEA to estimate technical efficiency and then in the second step we regressed the efficiency score as the dependent variable on new internal organisations in a multiple regression using pooled two-year (1993, 1994) cross-section data analysis.

The results are in accordance with other work on the public sector using non-frontier analysis (Fölster 1993, Jonsson 1994,1996). In the regression analysis we could reject our null hypothesis and conclude that the county councils which changed their internal resource allocation system into an output-based system have significantly higher efficiency scores. It is also worth emphasizing that the efficiency cannot be attributed solely to the implementation of market mechanisms. The fact has to be considered that other initiatives and other reforms have been introduced during this period (e.g. the care of the elderly reform, the maximum waiting time guarantee). However, these reforms were implemented all over the country simultaneously and can hardly explain the differences between the county councils. Our results further indicate that the potential savings in costs of a hypothetical switch from budget based allocation to a performance based allocation is about 13%.

Furthermore, we also found that county councils with a conservative and/or a liberal majority seem to be more efficient than those with a social democratic majority. The results also showed that scale has a significant impact on efficiency, which implies that ”large” county councils tend to be more efficient than the ”small” ones. The estimated effect of solidity as a measure of financial distress and the percentage of private vists out of the total visits to physicians were in no case significant. The estimated effect of population older than 70 years on the efficiency scores was unexpectedly negatively significant, at least at the 5% level. One possible explanation for the negative sign of age of population may be that county councils with a higher share of elderly citizens have more pressure on them to be efficient, by comparison with county councils having a lower share of elderly citizens.

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TABLE 1: THE COUNTY COUNCILS AND SPECIALITIES WHERE A PURCHASER/PROVIDER SPLIT HAS BEEN IMPLEMENTED.

	Comprehensive system		**Partial system**
Year	*County Council*	*Speciality*	*County Council*
1991	Dalarna	Somatic care	
1992	Stockholm	Part of surgery	Uppsala
1993	Örebro	Somatic care	Malmöhus
	Sörmland	All health care	Östergötland
	Bohuslän	All health care	Kristianstad
			Gävleborg
			Västerbotten
			Göteborgs stad

Source: Anell & Svarvar 1993, Bergman & Dahlbäck 1995, Jonsson 1996

***TABLE* 2**: DESCRIPTIVE STATISTICS, INPUTS AND OUTPUTS.

			1993	**1994**
		Max	10 318	11 059
(x_1)	**COST**[$]	*Mean*	2 045	2 120
		Min	397	402
		Max	4 248	3 687
(x_2)	**BEDS**	*Mean*	1 050	975
		Min	199	186
		Max	145 536	146 785
(y_1)	**OPERA**	*Mean*	28 560	28 378
		Min	4 103	3 630
		Max	137 911	124 239
(y_2)	**ADSUR**	*Mean*	29 325	27 980
		Min	4 750	4 846
		Max	110 105	98 843
(y_3)	**ADMED**	*Mean*	26 036	25 333
		Min	5 055	5 021
		Max	1 011 900	964 100
(y_4)	**VISUR**	*Mean*	211 800	204 846
		Min	39 500	41 300
		Max	877 700	772 600
(y_5)	**VIMED**	*Mean*	142 023	138 600
		Min	26 200	24 300

[$] *COST in Million SEK, 1990 prices*

TABLE 3: DESCRIPTIVE STATISTICS FOR THE SEVEN VARIABLES USED IN ANALYSIS. 26 COUNTY COUNCILS, 1993 AND 1994.

	1993				1994			
Variable	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
$\hat{D}$	.99	.17	.3	1.2	1.01	.19	.3	1.3
INTMAR	.19	.40	0	1	.19	.40	0	1
FSTATUS	72.57	7.90	56.2	84.2	73.24	6.84	60.4	84.7
POLMAJ	.62	.50	.0	1.0	.62	.50	.0	1.0
AGE	13.29	1.29	10.6	15.5	13.33	1.24	10.6	15.2
SCALE	308.05	229.29	50	1305	289.73	196.37	49	1126
ALTER	12.67	7.92	3	35	11.42	7.83	4	35

TABLE 4: SAMPLE CORRELATIONS (BIVARIATE). 26 COUNTY COUNCILS, 1993 AND 1994.						
	$\hat{D}$	INTMAR	FSTATUS	POLMAJ	AGE	SCALE
$\hat{D}$	1.0000					
INTMAR	-.4595***	1.0000				
FSTATUS	.2416	-.5165***	1.0000			
POLMAJ	-.3563*	-.2160	.1165	1.0000		
AGE	.2792	-.1404	.0151	-.1681	1.0000	
SCALE	-.8247***	.3515*	-.2151	.2880	-.4194**	1.0000
ALTER	-.3276	-.0002	-.1053	.3819*	-.1557	.4941***

Significance:***p<.01, **p<.05, *p<.10. Two-tailed tests.

TABLE 5: LINEAR OLS ESTIMATION RESULTS: DEPENDENT VARIABLE : $\hat{D}$. (COVARIATES INCLUDED).[a]				
	1993	1994	Parameter differences	Pooled sample
VARIABLE	b_{93} (t-values)[b]	b_{94} (t-ratio)	b_{94}- b_{93} (t-ratio)	coefficient (t-values)
ONE	1.529*** (5.66)	1.510*** (3.86)	-0.020 (-0.04)	1.537*** (7.07)
INTMAR	-0.798E-01* (-1.46)	-0.126** (-1.89)	-0.046 (-0.53)	-0.105*** (-2.55)
FSTATUS	0.238E-03 (0.10)	-0.456E-03 (-0.13)	-0.000 (0.00)	-0.283E-03 (-0.14)
POLMAJ	-0.312E-01 (-0.77)	-0.984E-01** (-2.06)	-0.067 (-1.07)	-0.692E-01** (-2.33)
AGE	-0.232E-01* (-1.60)	-0.156E-01 (-0.85)	0.008 (0.12)	-0.199E-01** (-1.80)
SCALE	-0.628E-03*** (-5.86)	-0.737E-03*** (-5.07)	-0.000 (0.00)	-0.679E-03*** (-8.08)
ALTER	-0.118 (-0.41)	0.320 (1.00)	0.438 (1.01	0.125 (0.61)
N	26	26		52
Goodness of fit: R^2	0.83	0.77		0.78
Std.Dev.	0.08352	0.10287		0.08937
F(6)	14.96 (6,19)***	10.78(6,19) ***		26.85(6,45) ***
Normality[c] B-S $\chi^2(2)$	1.38	0.54		2.98
Homoscedasticity[d] B-P $\chi^2(6)$	3.21	3.24		4.33
Poolability tests[e]	-	-		
$\sigma^2_{93}=\sigma^2_{94}$, $F_{26-7,26-7}$	-	-		1.69
$\beta_{93}=\beta_{94}$, $F_{7,38}$				0.42
Multicollinearity[f1] Cond(X'X)	26.49	28.16		27.24
Functional form[g] $\lambda y=1(0)$ $\chi^2(1)$	0.01(8.32***)	0.11(4.30***)		0.21(10.53***)
Ramsey Reset F-test(3)	0.15	1.11		0.49

[a]Note that a negative sign implies positive effect on efficiency and vice versa. [b]*** p<.01,** p<.05,* p<.10. All t-tests are one-tailed. [c]Normal distribution of the residuals is tested by the Bowman-Shenton test statistic. [d]Homoscedasticity is tested by the Breusch-Pagan test statistic. [e]Poolability tests test equality of regression variances and of regression parameters in the subsamples of 1993 and 1994. [f]Cond(X'X) is the square root of the ratio of the largest and smallest eigen value of the normalised X'X matrix. Values larger than 20 may indicate potential multicollinearity problems. [g]Likelihood ratio test of logtransformation of the dependent variable (0) and a untransformed dependent variable (1).

[1] Internal R^2 for INTMAT, SOLID, POLMAJ, AGE, BDAYS and %PRIVBES are: 0.41, 0.24, 0.27, 0.19, 0.50 and 0.39.

APPENDIX

TOBIT SPECIFICATION: DEPENDENT VARIABLE : $\hat{D}$ (COVARIATES INCLUDED).[a]				
	1993	1994	Parameter differences	Pooled sample
VARIABLE	b_{93} (t-values)[b]	b_{94} (t-ratio)	b_{94}- b_{93} (t-ratio)	coefficient (t-values)
ONE	1.529*** (6.63)	1.510*** (4.52)	-0.020 (-0.05)	1.537*** (7.60)
INTMAR	-0.798E-01* (-1.71)	-0.126** (-2.21)	-0.046 (-0.62)	-0.105*** (-2.74)
FSTATUS	0.238E-03 (0.12)	-0.456E-03 (-0.15)	-0.001 (-0.19)	-0.283E-03 (-0.16)
POLMAJ	-0.312E-01 (0.37)	-0.984E-01** (-2.41)	-0.067 (-1.25)	-0.692E-01*** (-2.50)
AGE	-0.232E-01** (-1.87)	-0.156E-01 (-1.00)	0.008 (0.38)	-0.199E-01** (-1.94)
SCALE	-0.628E-03*** (-6.85)	-0.737E-03*** (-5.93)	-0.000 (-0.70)	-0.679E-03*** (-8.68)
ALTER	-0.118 (-0.48)	0.320 (1.17)	0.438 (1.18)	0.125 (0.65)
σ	0.714E-01*** (7.21)	0.879E-01*** (7.21)	0.017 (1.05)	0.831E-01*** (10.20)
N	26	26		52

[a]Note that a negative sign implies positive effect on efficiency and vice versa. [b]*** p<.01,** p<.05,* p<.10. All t-tests are one-tailed.