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Do Economies of Scale Exist in Swedish Health Care Provision?

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Abstract:
Rising health care expenditures is a large public concern in many countries. In the face of higher demands on health care systems, efficiency and the ability to economize with public resources are of increasing importance. One way to bring costs down is through large-scale solutions and the exploitation of economies of scale. During the preceding decade, Denmark and Norway have restructured their health care systems towards more centralism, changes that have been motivated by arguments of efficiency and equity. A similar reform has recently been proposed in Sweden, suggesting that the present 21 Swedish county councils should be replaced by significantly fewer regional authorities of equal size. The purpose of this paper is thus to study if county councils who has a large population base have lower per capita cost of health care than other county councils. The analysis is carried out with a panel data set covering 20 Swedish county councils from 2005 to 2012. I regress the respectively county council's cost deviation from an average of gross costs per capita on different size variables in a multiple regression. My empirical results lend some support to the idea that economies of scale exist in larger county councils. However, conflicting effects of the main explanatory variables on costs are found, and the results should therefore be interpreted with caution.

Keywords: economies of scale, health care, Swedish county councils, regression analysis

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Table of Contents

Introduction 3
Previous Literature 5
Theory 9
Preconditions and Determinants of Health Care Cost 10
    Age Structure 10
    Population Base 11
    Geographic Factors 12
    Social Factors 13
Data 14
    Control Variables 16
    Dependent Variable 17
    Assumptions 17
Method 19
Results 21
Discussion 24
References 26
Appendix A: Output Tables and Figures 30
Appendix B: Supplementary Data 33

Introduction

Health care expenditures have risen in nearly all developed countries over the past decades. As health care makes demands on resources at an increasing speed, which is faster than the expansion of the economies, a greater share of the total national income is being spent on health care. Across OECD countries, total health care expenditure of GDP is projected on average to increase by 7.7 percentage points between 2010 and 2060 (Maisonneuve & Martins 2013). There are several possible reasons for the surge in health care costs. As most people know, a demographic shift is taking place in many of the European countries. One of the consequences of an aging population is an increased financial burden of the health care system, accelerating the growth in public spending. Other common explanations that have been suggested are more advanced medical technologies, growing national income and institutional arrangements (Newhouse 1992). Less common, yet highly likely according to some economists, is what is called 'Baumol's cost disease', which might offer a theoretical explanation for the constant rise in health care expenditures as a share of GDP.

According to Baumol, health care is one of the sectors that symbolize 'Baumol's cost disease'. These are sectors that due to their labor-intensive nature are marked by slow productivity growth. Baumol points out the simple fact that, even though labor productivity is fairly stagnant in these sectors, wage rates tend to keep pace with the productivity growth of progressive industries, such as manufacturing, in order to keep attracting workers. Thus, given increasing wage rates but relatively constant productivity, unit costs of these sectors tend to rise over time, a process which is unavoidable according to Baumol, whose theory several studies have found evidence for (Hartwig 2007, Hartwig 2011, Colombier 2010, Bates & Santerre 2012).

In his original work Baumol illustrated this phenomenon with the live performing arts (Baumol & Bowen 1966). Here, the performer's labour is essentially the output; capital and technology do not play a major role in the production process, much less change over time. Since it is not an option to have the musicians play the symphony faster over time, one of the very few sources for productivity gains is, then, through economies of scale as a result of increased audience or longer seasons. The conditions might not be so different in the context of health care. It is true that technology gets more and more advanced in medical care and that the use of medical appliances is growing. But, as has been pointed out before, the difference in utilization of capital in health care compared to manufacturing can be substantial (Hartwig

2011). In the former sector, capital equips personnel with new equipment in order to improve treatments or diagnoses; in the latter sector, it is employed as a substitute for labor in order to increase productivity. Other sources to increase productivity in health care – such as economies of scale, if it can be justified – seem therefore to be needed; improved technology and increased use of capital can only mitigate so much of the productivity lag.

In light of the above, one would expect to see attempts to achieve and exploit economies of scale in health care. Looking at the Nordic countries, one can see that both Norway and Denmark have undertaken extensive reforms in the recent years, restructuring their health care systems towards more centralism and thus shifting away from the decentralized path that traditionally has characterized the countries. Expectations in both of these countries were to attain equality of care across the country, lower costs and increase efficiency, in part through economies of scale.

Possibly inspired by the recent developments in Norway and Denmark, the National Committee on Public Sector Responsibility in Sweden has proposed that, in the face of future demographic changes and scientific and technological development, the existing 21 Swedish county councils, which fund and manage most of the health care, should be replaced by significantly fewer regional authorities of fairly equal size.

Is there evidence of economies of scale from research that would support these potential changes in health care? Although the literature on economies of scale in health care is extensive, few empirical studies have been conducted on the topic in Sweden, and only one paper has specifically investigated the subject as regards to county council provision of health care (Bergman 2003). Furthermore, there is no established consensus among empirical studies of economies of scale to date. Different results emerge from the studies; overall, it appears that the literature on the subject can neither confirm nor reject the hypothesis of economies of scale, though few studies have shown that it actually pays off.

Because of mixed evidence and a limited amount of studies on Swedish health care, there is need for more empirical research on this topic. The purpose of this paper is thus to study whether the size of the county council affects per capita cost of health care. With this purpose in mind the following research question has been postulated:

- Is there evidence of economies of scale in Swedish health care provision?

The paper is laid out as follows. First, the existing literature on economies of scale in health care is reviewed ("Previous Research"). A theoretical background of the topic follows ("Theory"). After that, an overview of the general explaining factors is evaluated to provide a framework for the later empirical investigation ("Preconditions and Determinants of Health Care Cost"). The next two sections present the data and methods used to address the research question ("Data" and "Method"). The results of my study are then recorded, after which the discussion follows ("Results" and "Discussion").

Previous Literature

The literature on economies of scale is extensive, involving different methods and covering many different countries. There are hundreds of studies that in one way or other regard cost efficiency in health care. The great majority of them study the conditions of U.S. or U.K. health care and most of them have hospitals as the level of analysis. This paper is different in the sense that it studies county councils as opposed to hospitals or clinics.

It is common to try to estimate the cost function with regression analysis, but the most prevalent method in the literature is to use Data Envelopment Analysis (DEA). Through data techniques it is possible to directly compare inputs and production at different hospitals and establish what units are the most efficient. The method results in an index between zero and one, with one meaning maximal efficiency, which shows how effective the studied unit is (Söderström & Lundbäck 2002). Due to the complexity of DEA and the difficulty to get access to necessary and sufficient data for all the county councils, I have opted to use regression analysis instead.

Case-mix – that is, the type of patients a hospital is treating – is an important factor for comparison of health service units. Most of the earliest research on efficiency and scale effects in the hospital sector generally failed to control for case-mix. The common view of the literature today is that the more precise division of patients the better you can explain variations in cost and service of health care. One way of capturing case-mix differences is through DRG (Diagnosis Related Groups). It is a system whereby patients with similar diagnosis and resource consumption are grouped together. Using this as a measure, hospitals with a "heavy" case-mix and more severe disease patients can be identified. Since I found only a small variation in case-mix differences between the county councils, which I account for in the data section, I will not include a DRG-measure as variable.

One area within the field of economies of scale in health care analyzes specifically the effects of mergers. Goddard and Ferguson (1997) examine the impact of mergers in UK health care sector and conclude that the evidence on their effect is inconclusive. The expected benefits from mergers tend to not materialize and unexpected costs tend to arise after the mergers. This is in line with Posentt (1999), who observes that mergers of hospitals in the US do not lead to reduced costs through efficiency gains.

Burns & Pauly (2002) study the wave of integration efforts in US health care from the late 1980s to the 1990s. Their results show that integration fails to improve economic performance of hospitals. Moreover, the arguments that were used by proponents of integration and the goals underlying the efforts only partially corresponded to the benefits of mergers identified by academic literature.

Swedish health care has also gone through a period of restructuring. Between 1980 and the beginning of this century the number of acute somatic hospitals decreased from 118 to 71 within the country. The idea has been to rationalize hospital services, lower average costs and improve clinical outcomes. Ahgren (2008), which is one very few studies that investigates the effects of this trend toward concentration in Sweden, explores the responses to the merger of Blekinge hospital through sending out a questionnaire to circa 600 randomly selected employees. While the majority perceives economic incentives as the main drivers of change, only 10% believes that this target has been reached. Furthermore, neither economies of scale nor significant quality improvements are believed to have been generated by the merger.

A large number of hospitals were merged in the region of Västra Götaland in Sweden during the 1990s, the chief example being Sahlgrenska University Hospital, which was formed in 1997 after a fusion of three hospitals, now being the largest hospital of Nothern Europe. One study analyzes the productivity of hospitals in the region of Västra Götaland during the period 1998-2002. When controlling for different factors that affect costs, adjusting for ongoing processes of change, and correcting for increases in wage, inflation as well as differences in the account of medical care events, the authors find that the productivity has fallen by 10% during the period (Västra Götalandsregionen 2002).

Grönqvist et al. (1998) investigates the relationship between large-scale production and productivity of Swedish hospitals. When the hospitals with extreme values are excluded from the analysis, and when patient mix are controlled for, no connection can be seen between unit cost, measured as the cost per medical care event, and the size of the hospitals.

Gerdtham et al (1999) compares Swedish county councils that have implemented purchase/provider split and performance-based reimbursement with county councils that as of 1999 had not yet adopted this system. As output measures three variables are used: the number of physician visits, the number of surgical procedures and, to represent the inpatient activity, the number of discharges. Apart from the main finding of the study, which is that the productivity is 10% higher in county councils with purchaser/provider split than in those with traditional budget process, a noteworthy result emerging from their analysis is that returns-to-scale is constant in all of the county councils' provision of health care. This is interesting given the fact that large hospitals primarily are situated around metropolitan areas in the country.

Some international literature suggests the existence of economies of scale in the hospital sector. For example, Preyra & Pink (2006) investigate economies of scale and scope in the years prior to the restructuring of hospitals in Ontario, Canada. They find that that there were large unexploited gains to be made from consolidation. In a similar study, Pedersen et al (2012) analyze whether the Danish hospital sector was subject to economies of scale and scope in the three years preceding the 2007 restructuring reforms. Their results show that hospitals were characterized by unexploited gains from consolidations, suggesting that the rebuilding plans can possibly result in more efficient hospitals. The authors note, however, that, according to the literature on post-merger performance, horizontal integration has not proven to be a successful strategy.

Contrary to the findings above, some studies also indicate constant economies of scale or diseconomies of scale. Aletras (1999) estimates short-run and long-run translog cost functions for 91 Greek NHS hospitals and finds that neither economies nor diseconomies of scale are present in their hospital cost structure. Acknowledging the fact that hospitals produce different types of care, Vita (1990) estimates a multiproduct cost variable function using data on California hospitals. The results indicate that unit costs can rise, fall or stay constant at an increased production.

The above studies are concerned with economies of scale at the hospital level. This paper, in contrast, is more related to the work of Håkansson (1980), which is the first study to investigate differences with regard to health care costs per capita at the Swedish county council level, as opposed to the hospital level. Using control variables out of five main groups – demographic factors, geographic factors, resources in alternative forms of treatment, the

economic potential and the structure and organization of the medical care system – he does a regression analysis on cross-sectional data from 1973 on cost per capita in the institutional care. The results indicate that neither demographic nor geographic factors can explain the variation in costs between the county councils. Instead, the two factors accounting for most of the variation in the cost component are the economic potential of the county councils and the degree of centralization of the health care system. In other words, the greater the economic potential of the medical care authorities and the more centralized the medical care provided by a medical care authority is, the higher the medical care costs appear to be. Since economic potential is an important factor, I am taking in it into account in my model, measuring it as average taxable income in the county council.

My paper is first and foremost related to the work of Bergman (2003), who investigates how the size of Swedish entities providing health care influences per capita cost of health care. Whether economies of scale existed among the responsible authorities of health care in Sweden had hitherto not been studied; previous research had looked for scale effects only at the hospital level. The model Bergman employs will also be the basis for my data analysis. He uses multiple regression analysis where he, according to the standard cost method, constructs the dependent variable as the respectively responsible authority's deviation from an average of gross costs per capita. The results of the study indicate that economies of scale do not exist as a result of larger responsible entities. The factors that can explain most of the variation in the dependent variable are the average age of the population, the proportion of produced health care that is exported, the total area of the responsible authority and the taxable income per capita, suggesting that the factors influencing the costs of Swedish health care are structural. As Bergman notes, there are several structural factors affecting health care costs. Apart from a few differences, I will use the same basic set of control variables as he does.

As can be seen, the results of studies on economies of scale are somewhat conflicting. Moreover, the number of empirical studies on the relationship between the size of the responsible authority and health care costs in Sweden is limited. This paper should add more insight on this topic.

Theory

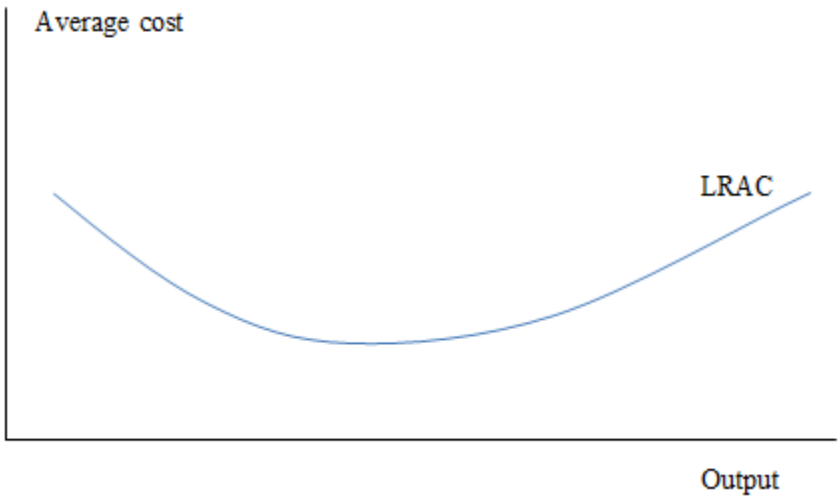
Economies of scale are said to exist in production when unit (average) cost decreases as the volume of output increases. There are several potential sources for economies of scale, but these three are considered to be the main factors (Rosen 1999):

- large amounts of fixed capital which allows for spreading of the fixed costs over a greater volume of output
- utilization of specialized resources such as equipment and staff
- bargaining power resulting in lower cost prices

On the other hand, there are also factors working in the opposite direction so that average cost increases as the output increases. For example, as the organization grows larger, control and coordination can become more difficult, which can lead to more than proportionally higher costs. Thus, there can be both advantages and disadvantages to obtain with increasing scale.

In economic theory the long-run average cost curve (LRAC) depicts how unit cost is affected by changes in productivity in the long run. It is usually assumed to be U-shaped. Long run average cost declines up to a certain production volume, after which it starts to increase. As can be seen in Figure 1, economies of scale exist in the range where average cost decreases with increasing output, while diseconomies of scale exist from the point where average cost increases as output increases.

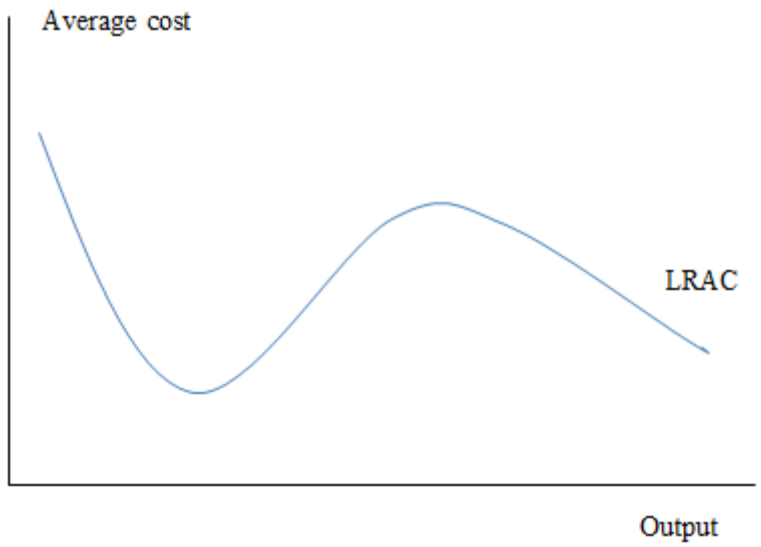
Figure 1 - The long-run average cost curve (LRAC)



Input prices are assumed to be fixed in Figure 1; they do not vary across different output volumes. The price variable is exogenously given to the model. In this case a lowering of the

prices will cause the LRAC curve to shift down. Had the price factor been endogenous to the model, the lowering could lead to an additional range of economies of scale, which is seen in Figure 2. This would be the case, for instance, if a firm or organization has large market shares and due to its dominating position enjoys lower input prices.

Figure 2 - LRAC when input prices vary with output



Preconditions and Determinants of Health Care Cost

In this section I review the general determining factors of health care cost on the macro level. This evaluation is intended to give an understanding of their potential effects on cost for the county council. Additionally, it will provide a framework for the empirical investigation and context for the forthcoming analysis.

Four main groups of factors will be used: age structure, population base, geographical differences and social factors. These are factors that I have found in the literature to be important for health care costs or a priori considered to be important.

Age Structure

Older people tend to consume more health care than younger people. Of all the medical care events that female patients consumed in 2006 in Sweden, 45% was consumed by patients 65 year or older. The corresponding share for male patients was 49%. Average care time is also increasing with age. While constituting 18% of the population, the group 65 years or older

accounted for 62% of the care-days. For the group 85 years or older, the share of care-days was seven times as big as the share of population (Sveriges Kommuner och Landsting 2007).

A study done in Stockholm county council in 2001 shows that health care during the last year of life accounts for 10% of the county council's total, yearly health care spending and 27% of the total number of in-patient bed days (Walander 2011). The patient's age is the most important factor for explaining differences in health care cost during the last year of life; costs tends to gradually decline with increasing age. Another factor with a strong relation to individual health care costs during the last year of life is income. The 20% of patients with highest incomes have on average higher health care costs than other groups. The main reason for this is not that they have had a larger amount of health care, but that their health care has been more costly.

While the share of young people is relatively evenly distributed over the regions, the proportion of elderly varies to a large degree over the country. It is highest in remotely located regions. For example, in places such as Dorotea, Åsele, Pajala and Överkalix over 30% of the population are 65 years or older, while the number is 15% for Stockholm, Gothenburg and Malmö (Glesbygdsverket 2013). Two of the main factors causing the differences in population structure are birth rates and domestic migration between regions. From a demographic perspective it is particularly problematic for a region when both of these components have a negative development. In all regions of the country the sparsely-populated areas have both negative net birth rate and negative domestic net migration. The immigration to these areas does not outweigh these two negative developments and thus their population is decreasing (Glesbygdsverket 2008). Moreover, these two factors are interconnected in the sense that young people are more prone to move, resulting in a shortage of population in reproductive age.

Population Base

Population base matters for the present study because differences in population are reflected in the size of the county councils' health care which is at the center of this study. The size of health care can be measured, for instance, by the number of available hospital beds or the number of medical care events. For the forthcoming empirical analysis I will be using the number of medical care events together with the amount of physician visits to capture the size of county councils' health care.

The population varies substantially between county councils. During the last couple of decades the population has concentrated more and more around the large cities. Roughly half of Sweden's population lives in the regions surrounding the three largest cities. With more than 2.1 million inhabitants, Stockholm has the largest population and is the most densely populated county council in Sweden. Västra Götaland has roughly 1.6 million inhabitants and Skåne 1.3 million inhabitants. Gotland is the smallest county council with a population of 57 000. The two next smallest are Jämtland and Bleking with a population of 126 000 and 152 000, respectively.

Turning to the size measures, the total number of average available hospital beds in 2007 amounted to 26 200, of which 80% was in somatic care and 20% in psychiatric care. Västra Götaland had on average 4585 available hospital beds, compared to Jämtland's 379. The total number of medical care events in 2007 amounted to 1.51 million, an increase of 1.5% since 2006. Somatic care accounted for 1.42 million or 94% of these. The inhabitants of Norrbotten and Västerbotten consumed the most somatic care, 168 medical care events per 1000 inhabitants, while the inhabitants of Blekinge consumed the least amount, 128 (Sveriges Kommuner och Landsting 2007).

The total number of medical care events a county council produces is partly dependent on its population base, but also on how many medical care events it is selling and buying from other county councils. Seven units in Sweden are university hospitals and provide so called "regionsjukvård", a more specialized health care which treats patients with more complicated diseases and injuries from all over the country. County councils with university hospitals bought the least amount of medical care events in somatic care in 2007, ranging from 1.5 to 6.7% of their consumption. Halland had the highest share with 13.7%. Uppsala treated the most patients from other counties; within the somatic care, 25% of the county council's produced medical care events were for other patients than its own inhabitants.

Geographic Factors

When it comes to the provision of services it is reasonable to organize operations so that for instance travelling to a school or a health center will not take too long. Time can be the decisive factor for people's health in emergency situations. One of the goals according to Swedish law is to provide adequate health care on equal terms and conditions to the whole population. Building structure and geographic conditions vary widely between the country's municipalities and county councils. Long distances and sparse population structure with

services based on small population base leads to higher unit costs, since fixed costs of each unit have be spread over a smaller number of inhabitants when the organization entails several but smaller units rather than one large. This means that, though the population base would not normally economically justify a medical center, county councils can be obliged to operate small local care centers in rural areas, which will entail additional costs (Tillväxtanalys 2011).

The additional costs mainly arise from long distances, i.e. the cost of travel, and, as mentioned above, from having small units, which exist due to the long distances. For county councils, long distances entail higher reimbursements to patients for travel-related expenses. Furthermore, due to long distance to nearest hospital, some medical centers may need to provide overnight stay (Molde 2000).

Sweden has a total area of 449 964 km^2. Norrland, which consists of the five most northern county councils, encompasses 60% of this area, while only 12% of the country's population lives there, yielding a population density of 4.4 people per km^2. The country as a whole has a population density of 21.5 people per km^2, with Stockholm being the most densely populated county council with 333 people per km^2.

Social Factors

A wide range of social factors influence population health, such as work, unemployment, early life, food, addiction, stress, transport, social exclusion, social support and the social gradient (World Health Organization 2003). I focus largely on unemployment in this section as this was the factor for which data was best available.

Unemployment varies depending on how the economy is developing. It also varies between county councils in the country. For example, in 2012 the unemployment rate was 6.83% in Stockholm and 6.95% in Jönköping, while it was 9.40% in Skåne and 10.25% in Gävleborg. During the preceding decade, Kronoberg had the lowest value of 4.10% in 2007, and Västernorrland the highest value of 11.03% in 2010 (database of Statistics Sweden).

Studies have linked unemployment to higher mortality and increased illness as well as abuse of drugs and alcohol (Arbetsmiljöverket 2011). In some of the cases, the relationship goes in both directions. For example, unemployment means a greater risk of substance abuse, but substance abuse also means an increased risk to become or remain unemployed.

Stuckler et al (2009) investigates the associations between economic cycles and changes in population health in 26 European Union (EU) countries between 1970 and 2007. The results

show that rises in unemployment are associated with increases in pre-mature deaths, from suicide and homicides, while traffic fatalities are reduced. Very large increases in unemployment are associated with increased alcohol abuse.

Using data on plant closures in Sweden in 1987 and 1988, Eliason & Storrie (2009) examine the impact of job loss on overall and cause-specific mortality. They find that overall mortality risk among men increases by 44%, which is seen during the first four years after job loss but not after that. For both men and women, there are especially strong increases in risk for suicide and deaths due to alcohol.

Henkel (2011) summarizes the results from a comprehensive review of the international research on unemployment and substance use between 1999 and 2010. The main findings show that risky alcohol consumption is more prevalent among unemployed, that substance abuse increases the likelihood of becoming unemployed and decreases the chance of finding and keeping a job, that unemployment is a significant risk factor for substance use, and that drinking and smoking patterns vary with economic cycles.

Another factor that needs to be accounted for here is taxable income. In both Bergman (2003) and Håkansson (1980) taxable income per capita, or the economic potential of the county council, is one of the variables that can explain most of the differences in the cost component. While Håkansson reasons that this effect stems from the tendency of county councils with better economic potential to provide surrounding services and increase staffing levels more than what is necessary to meet the demand, Bergman offers the possible explanation that consumers of health care with relatively higher taxable income, will demand relatively more from the health-care system compared with consumers with relatively smaller taxable income. Further evidence of the importance of this factor is found in a review on the determinants of healthcare expenditure. Among 20 studies four considered income to be the chief determinant of healthcare expenditure (Martin et al 2010).

Data

The data cover 20 out of Sweden's 21 county councils spanning from 2005 to 2012. Gotland had to be excluded from the analysis due to missing data. Since Statistics Sweden changed their method of measuring unemployment in 2005 this year was chosen as starting year.

In the previous section about the preconditions of health care cost I described how I had to take into account factors related to age structure, population base, geography and social differences. Here I describe the variables used to measure these factors, explain how each variable is constructed and where the data comes from. Table 1 defines all the variables used in the analysis.

Table 1: Definition of the variables used in the analysis

Variable	**Definition**
Cost deviation (*cost)*	Cost deviation from average cost per capita (in millions of SEK).
Private health care (*pcpriv*)	The proportion of private to total health care.
University Hospital (*univ*)	= 1 if university hospital, 0 otherwise.
Average age (*age*)	Average age.
Average length of life (*length*)	Average life expectancy at birth for each country.
Over 65 (*pcage*)	The proportion of population older than 65 years.
Physician visits (*visits*)	Total amount of produced visits to a physician (in thousands).
Medical care events (*events*)	Total amount of consumed medical care events.
Area (*area*)	Total area of each county council (in square kilometer).
Population density (*density*)	Population density, number of citizens per square kilometer.
Unemployment (*pcunemp*)	Share unemployed, as a percentage of labour force.
Taxable income (*tax*)	Taxable income per capita (in thousands of

	SEK).

Control Variables

To see whether the size of the county councils impacts the average cost of health care, two variables have been chosen: medical care events and physician visits. These are the main variables of interest in the present paper. If there are economies of scale in Swedish health care these variables will have a negative effect on per capita cost of health care; otherwise, if they have a positive impact, there are diseconomies of scale. The data comes from yearly publications of The Swedish Association of Local Authorities and Regions, SALAR.

The three variables average age, average length of life and people older than 65 are included to control for differences in age structure between county councils. This data comes from the databases of Statistics Sweden.

The two following variables, area and population density, have been included to control for differences in geographic factors. This data comes from Statistics Sweden.

Unemployment and taxable income represent features of the social structure of a county council. I have used unemployment data from Arbetskraftsundersökningarna, AKU (The Labour force investigation of Statistics Sweden). The data on taxable income comes from Statistics Sweden as well.

Private health care represents the proportion of private to total health care. It has been found that Swedish county councils who has a large proportion of health care performed by alternative producers are more economically efficient than other county councils (Rudholm et al 2007). It seems therefore wise to control for the proportion of private health care in county councils, especially since there has been an increase in the amount of health care provided by others than the county councils during the last decade. The data on private health care comes from SALAR's yearly publications.

Finally, a dummy variable for university hospitals is included. As has been mentioned, there are seven university hospitals in Sweden that provide specialized health care. Naturally, county councils that consume this health care pay for it. But since gross costs have been used to form the dependent variable in this study, it is needed to control for the effect this produced specialized health care has on costs.

Table 2 displays statistics for all the variables.

Table 2: Summary Statistics

VARIABLES	(1) mean	(2) sd	(3) min	(4) max
cost	-2.66e-08	1,764	-3,118	5,404
pcpriv	0.0910	0.0544	0.0296	0.291
pcunemp	0.0771	0.0145	0.0410	0.110
density	46.53	65.26	2.500	325.9
visits	1,329	1,720	296.6	8,027
length	80.77	0.682	79.28	82.43
age	41.88	1.251	38.90	44
tax	160.1	13.20	136.3	211.1
events	76,010	78,866	19,559	343,847
pcage	0.190	0.0277	0.102	0.235
area	20,210	22,369	2,931	97,257
univ (dummy)	0.350	0.478	0	1
Observations		160		

Dependent Variable

The dependent variable is constituted by the respectively county council's cost deviation from an average gross cost per capita. To compute it, gross costs of health care are divided with the number of inhabitants of the county council, yielding the cost per capita. After this has been computed for each county council, they are all summed up and divided by the number of county councils. This yields the national average cost. Then, to arrive at the cost deviation for a county council, its cost per capita is subtracted with the national average cost. The data on costs is gathered from SALAR's yearly publications.

Assumptions

In this paper it is assumed that input prices are fixed in the model. In the context of health care this means that wages and prices for capital and material do not vary systematically across different counties and hospitals. The two largest items of expenditure for health care providers are costs of labor and housing. Wages in Swedish health care are primarily determined through central negotiations which shouldn't leave much room for local wage differences. To the degree systems of internal rent differ between counties, however, capital prices can affect differences in hospital costs.

Another assumption in the model of this study is that health care between county councils does not differ in terms of quality, availability and service. This is a group of factors that probably is more suitable to study at a micro level with individual data. For the present study, however, the unit of analysis is the county council in Sweden. Although it is likely that there indeed are differences in service and treatment time between hospitals or clinics for a given diagnosis, I do not believe that these factors are relevant when one makes comparisons between county councils. Rather, it is likely that the observed differences on a clinical or hospital level largely will cancel out at the aggregated level of county councils. However, it could be the case that the more competent physicians are drawn, for various reasons, to bigger hospitals, most likely the university hospitals in the middle of the country. Also, these hospitals have better opportunities to test and employ new and better methods, which is more costly. Therefore, one could argue that there is a difference in quality of health care between different county councils. But if that is so, the quality differences will be related to the university hospitals, and in in the model of the present paper a dummy variable is included for university hospitals, whence this effect would be accounted for.

To support the assumption of similar quality between county councils it is relevant to mention some of the findings in a study done by the Swedish Association of Local Authorities and Regions, SALAR (Sveriges Kommuner och Landsting 2009). They investigate the relationships between the factors that are presented in the yearly report entitled Quality and Efficiency in Swedish Health Care from the same organization, which compares the counties and regions of Sweden based on a large number of indicators from the four perspectives medical outcomes, patient experience, availability and costs. One of findings in the study by SALAR is that there does not seem to be an opposition between quality and low costs in health care. If anything, there is a relationship between good medical outcomes and low costs. The variation in medical outcome results can instead largely be explained by differences in population characteristics. The analysis implies that it is crucial to adjust for external conditions, such as structure and case-mix when comparing units of health care, and that it can be difficult to discern the significance of the health-care system for health compared to other determinants.

In light of the above I note that case-mix, or patient-mix, is an important factor for comparison of health care units. However, when I made an analysis based on DRG-data of the differences in case-mix between the county councils, I found insignificant variation. The results are illustrated in a graph (see Appendix B). Patients were divided into four groups

based on the severity of their illness: very complicated, complicated, uncomplicated and uncharted. Normalization was done by dividing the number of patients of each county council for each group, with the total number of medical care events of the county council. As can be seen in graph, there is very little variation in case-mix between the units; hence, a variable based on DRG-classifications, controlling for case-mix, will not be included in the model.

Method

In order to examine my research problem I use Ordinary Least Squares (OLS) multiple regression analysis. Since this study wants to investigate whether economies of scale have any influence on the average cost per capita, the variables of particular interest are the ones capturing the size of the county council's health care, which, as seen in the previous section, are physician visits (*visits)* and medical care events (*events).*

When dealing with panel data one needs to assess whether random effects or fixed effects regression should be used. Since the random effects model assumes that the sample is randomly drawn from a larger population it cannot be used in this paper as I am investigating the county councils of Sweden. Thus I will use fixed effects. By using this model, I will remove any bias resulting from the omission of time invariant variables through the fixed effects transformation.

The basic outline of my model is as follows:

$$cost_{it} = \beta_0 + \beta_1 pcpriv_{it} + \beta_2 univ_{it} + \beta_3 age_{it} + \beta_4 length_{it} + \beta_5 pcage_{it} + \beta_6 visits_{it} + \beta_7 events_{it} + \beta_8 area_{it} + \beta_9 density_{it} + \beta_{10} pcunemp_{it} + \beta_{11} tax_{it} + a_i + u_{it}$$

The fixed effect term, a_i, contains unobserved factors that differ between cross-sections but are constant over time, and will thus not, after the fixed effects transformation, affect the variation in cost. There could be other geographical factors than area and population density which typically does not change over time. For instance, county councils with a modest climate might not need to spend as much on health care as county councils with severe weather conditions. This effect on health care spending will then be captured by a_i. One can think of other factors that could be roughly constant over time, e.g. related to socioeconomic status, such as education, which have an impact on health. People living in different county councils might have different attitudes towards their health or be differently inclined to seek

health care. Moreover, Stockholm could have higher wages in the health care sector due to persistently higher living costs. The unobserved effect could also contain the average ability of employees in health care provision.

Some of the variables show a relatively high correlation with each other which can be seen in Table 3. It can be noted that population density has a high positive correlation with both physician visits and medical care events and that all of these three variables have a negative correlation with the age related variables. The high correlation means that there will be a problem of multicollinearity in the model. This suggests that it can be difficult to include all the control variables in the model while estimating parameters with some precision. Thus I opt to use a limited specification together with the full specification above.

Table 3: **Correlation matrix**

Variables	*cost*	*area*	*univ*	*visits*	*tax*	*pcpriv*	*age*	*length*	*density*	*pcunemp*	*events*	*pcage*
cost	1.00											
area	0.51	1.00										
univ	0.18	-0.09	1.00									
visits	-0.35	-0.17	0.57	1.00								
tax	-0.10	-0.10	0.25	0.55	1.00							
pcpriv	-0.38	-0.36	0.38	0.73	0.68	1.00						
age	0.07	0.27	-0.75	-0.66	-0.36	-0.59	1.00					
length	-0.13	-0.36	0.24	0.19	0.58	0.37	-0.43	1.00				
density	-0.38	-0.33	0.44	0.91	0.61	0.81	-0.67	0.26	1.00			
pcunemp	0.10	0.14	0.02	-0.15	0.00	-0.06	0.33	-0.19	-0.19	1.00		
events	-0.35	-0.13	0.60	0.98	0.50	0.67	-0.64	0.17	0.83	-0.12	1.00	
pcage	0.10	0.20	-0.39	-0.42	-0.12	-0.26	0.76	-0.24	-0.43	0.45	-0.42	1.00

Consequently, I need a systematic approach to determine what control variables to include. To achieve this, I will employ two different selection procedures, stepwise regression and backwards elimination. The starting point of stepwise regression is an equation with the single best control variable. The equation is then built up by adding more variables if they pass a chosen significant level. The order of addition is determined by partial F-test values. This approach of selecting variables is recommended by Draper and Smith (1998) as it avoids working with more variables than are necessary while improving the equation at every stage.

Backwards elimination method starts off with an equation containing all variables instead. The partial F-test value is computed for every explaining variable. The lowest partial F-test value is then compared with a chosen significance level.

The results of these two selection procedures can be seen in Appendix A. The limited specification emerging from the estimations contains six explanatory variables.

$$cost_{it} = \beta_0 + \beta_1 pcpriv_{it} + \beta_2 univ_{it} + \beta_3 visits_{it} + \beta_4 events_{it} + \beta_5 area_{it} + \beta_6 tax_{it} + a_i + u_{it}$$

To test for heteroscedasticity I run a Breusch-Pagan test and a White test for the estimated model above (see appendix A). The results give strong indications of heteroscedasticity, which is why I opt to use robust standard errors in my regressions

The results from the estimations of the two regression specifications above are presented in the next section below.

Results

I first report the results from my two main specifications, one including the full set of variables, the other being limited. As robustness check, I then test for functional form misspecification and regress a model with quadratic terms of the variables added.

The results from the two different specifications are shown in Table 4.

Table 4: Results from the two specifications

VARIABLES	(1) Full	(2) Limited
pcpriv	14,897**	13,918**
	(5,816)	(5,590)
pcunemp	1,246	
	(3,723)	
density	-22.27	
	(44.26)	
visits	1.501*	0.944
	(0.868)	(0.678)
length	-172.0	
	(422.9)	
age	493.6	
	(578.9)	

tax	16.43	14.34
	(14.84)	(10.41)
events	-0.0293	-0.0337**
	(0.0170)	(0.0149)
pcage	-45,167**	-35,192**
	(20,328)	(12,491)
o.area	-	-
o.univ	-	-
Constant	-1,012	4,436***
	(35,049)	(1,312)
Observations	160	160
R-squared	0.248	0.234
Number of counties	20	20

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

One of the central variables, medical care events, has a negative and statistically significant relationship with cost deviation in the limited specification, whereas the size of the coefficient and significance level are reduced in the specification with the full set of variables. The other size variable, physician visits, on the other hand, has a positive influence on cost deviation, but is only statistically significant in the full specification regression, at the 10% level. These differences can be due to the high correlation seen earlier between the explanatory variables (see Table 3). A problem of high collinearity can cause the coefficients to change signs, a possibility I cannot rule out, but it does not necessarily do so. If the collinearity only produces high standard errors, then the model still is valid.

The proportion of private to total health care is statistically significant at the 5% level and its positive parameter indicates that there is a positive correlation between costs and the amount of private health care. Furthermore, the results show a negative and statistically significant relationship between costs and the proportion of people older than 65 years.

It is possible to think of a model with a different functional form. As was illustrated in the theory section, if the input prices are not assumed to be fixed, there could be an additional range of economies of scale in the curve. My estimates of the variables medical care events (*events)* and physician visits (*visits)* will then not capture the true relationship with costs. To check for functional form misspecification in the model I do a regression specification error

test (RESET), which produces a p-value of 0.0096. This is very significant and therefore evidence of a functional form misspecification.

To investigate whether the variables medical care events and physician visits can better account for the relationship with costs in a different functional form, I add quadratic terms of these variables to the limited specification.

$$cost_{it} = \beta_0 + \beta_1 pcpriv_{it} + \beta_2 univ_{it} + \beta_3 visits_{it} + \beta_4 events_{it} + \beta_5 area_{it} + \beta_6 tax_{it} + \beta_7 visits_{it}^2 + \beta_8 events_{it}^2 + a_i + u_{it}$$

Table 5 reports the results from the specification with quadratic terms added.

Table 5: Results from the two specifications with quadratic terms

	(1)	(2)
VARIABLES	Full with quadratic terms	Limited with quadratic terms
pcpriv	13,037**	12,858**
	(6,120)	(5,820)
pcunemp	676.6	
	(3,644)	
density	64.59	
	(75.39)	
visits	6.098**	4.639**
	(2.575)	(2.208)
length	-345.0	
	(401.3)	
age	928.4	
	(694.5)	
tax	13.67	15.07
	(14.26)	(10.05)
events	-0.0638**	-0.0471*
	(0.0300)	(0.0260)
pcage	-50,780**	-39,637**
	(21,507)	(14,041)
o.area	-	-
o.univ	-	-
visits2	-0.000507**	-0.000341**
	(0.000233)	(0.000145)
events2	9.70e-08*	6.85e-08
	(5.56e-08)	(5.69e-08)
Constant	-9,829	2,153
	(34,846)	(2,187)
Observations	160	160

R-squared	0.298	0.272
Number of county1	20	20

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As shown in Table 5, the main coefficient for physician visits (*visits)* in the limited specification is now more strongly significant than before, while the coefficient for its quadratic form is negatively significant at the 5% level. Thus, a positive estimate of β_3 coupled with a negative estimate of β_7 implies that costs fall for a higher number of physician visits.

The main coefficient for medical care events (*events)* is still negative but less significant than before and the coefficient for its quadratic term is, in contrast to *visits,* positive and insignificant.

To assess the significance of the quadratic variables I use a F-test. The two coefficients are jointly significant which could be taken as evidence in favor of including them in the model.

Discussion

The purpose of this paper has been to study if county councils with larger population bases have lower per capita cost of health care, that is, if there is evidence of economies of scale in Swedish health care provision. Following Bergman (2003), the respectively county council's cost deviation from an average cost per capita was used as the dependent variable in regression models trying to explain the variation in costs of different county councils. The main explanatory variables used to capture the size of health care were the amount of produced physician visits and the amount of consumed medical care events.

Although my regressions are statistically significant, they do not explain much of the variation in cost deviation, and it is doubtful that they will predict future observations accurately. However, since the purpose of this paper rather is to try establishing the direction of the relationship between certain key variables, the results can be used to discuss the research problem.

The results from the limited specification are somewhat conflicting. On the one hand, they show that the parameter estimate for medical care events (*events)* is negative and statistically significant at the 5% level, indicating that economies of scale exist in the county council provision of health care. This would mean that county councils are placed in the negative

interval of Figure 1 (see page 9). In contrast, the parameter estimate for the second size variable, physician visits (*visits),* is positive and statistically significant at the 10% level, thus having a weaker association with cost deviation than *events*. This implies diseconomies of scale in health care and would mean that the county councils are situated in the positive interval of Figure 1.

However, there is evidence of functional form misspecification in the model. Thus, when adding quadratic terms of the variables, I can observe some changes in the estimates. The coefficient for medical care events (*events*) is still negative but less statistically significant than before. More importantly, the coefficient for physician visits (*visits*) is positive and more strongly significant than before, while the coefficient for the quadratic term of *visits* is negatively significant at the 5% level. These results imply that the second interval in Figure 1 rather should have the form of the second and third interval of Figure 2 (see page 10). This relationship shows that costs fall for a higher number of physician visits.

Taken together, these findings lend some support to the idea that economies of scale exist in county councils with large population bases. The findings do therefore not coincide with the results presented by Bergman (2003), which could not point out the existence of economies scale in county council provision of health care. My results should, however, be interpreted with some caution. The sign of *events* differs from that of *visits* and the coefficient for the quadratic term of *events* lacks significance. The reason for this could be that the model is not specified in the right way. One problem may be that of high collinearity in the explanatory variables. If the multicollinearity inflates the standard errors then the model is still valid. But I cannot rule out the possibility that the collinearity causes the coefficients to change signs. Further econometric investigation would be needed to check the robustness of the results.

That the effect of people older than 65 years is negatively significant is contrary to what one would expect. A possible explanation for this could be that younger consumers of health care behave differently when it comes to seeking treatment and follow-up medical care, thus taking up more resources than older people. Another explanation might be that county councils with a higher proportion of elderly citizens are in greater need of being efficient than county councils with a lower proportion of elderly citizens.

Although the coefficient of taxable income is not statistically significant, its positive sign is in accordance with previous research, such as Håkansson (1980) and Bergman (2003) as well as

the literature on the determinants of health care costs, where it has been found to have a positive relationship with costs of health care.

Finally, an interesting expansion of this paper would be to include more detailed input information since health care costs are affected by prices on the resources used in the production, such as wages and prices for capital and material. To the extent applicable capital measures are not available, proxy variables could be included, using for instance the total number of hospital beds in a county council. In this study, I assume that quality of care does not differ between health care units. This is a crude assumption and ideally one would want to adjust for possible quality differences. Although the views on what constitutes adequate indicators for measuring quality differ, one possible way is to use a kind of mortality rate.

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Appendix A: Output Tables and Figures

Variable selection procedures

Estimated model through Stepwise regression (5% significance level)

Parameter	DF	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq
area	1	-0,0000168	4,51E-06	13,8587	0,0002
univ	1	-1,93066	0,38548	25,0843	<.0001

Summary stepwise regression:

Step	Variable entered	Score Chi-Square	Signif
1	*univ*	22,0821	<.0001
2	*area*	15,1878	<.0001

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Estimated model through Stepwise regression (10% significance level)

Parameter	DF	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq
area	1	-2,05E-05	5,13E-06	16,0305	<.0001
univ	1	-2,33502	0,45222	26,6615	<.0001
events	1	0,0000276	1,6E-05	2,9064	0,0882

Summary stepwise regression:

Step	Variable entered	Score Chi-Square	Signif
1	*univ*	22,0821	<.0001
2	*area*	15,1878	<.0001
3	*events*	2,9512	0,0858

Estimated model through backwards elimination

Regression Statistics	
Multiple R	0,7906912
R Square	0,6251925
Adjusted R Square	0,6104942
Standard Error	1101,1023
Regression F	42,53493
Sign Level of F	0
Observations	160

Variable	*Coeff*	*Std Error*	*t Stat*	*P-value*
Intercept	-3666,2054	1385,3136	-2,6465	1%
pcpriv	-8011,0097	3054,8287	-2,6224	1%
visits	0,8258	0,3372	2,4492	2%
tax	25,8852	9,3217	2,7769	1%
area	0,0347	0,0043	8,0313	0%
univ	2376,6346	229,8881	10,3382	0%
events	-0,0313	0,0069	-4,5522	0%

Heteroscedasticity tests

Stepwise regression model 10% significance entry/level

Test	chi2(n)	Prob > chi2
White's test	41,68	<.0001
Breusch-Pagan	34,93	<.0001

Stepwise regression model 5% sign entry/level

Test	chi2(n)	Prob > chi2
White's test	66,17	<.0001
Breusch-Pagan	45,7	<.0001

Backward elimination model

Test	chi2(n)	Prob > chi2
White's test	91,13	<.0001
Breusch-Pagan	45,55	<.0001

Appendix B: Supplementary Data

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Case-mix

DRG-data with normalization where patients are divided into four groups

2012	Very compl	Compl	Uncompl	Uncharted	Number of medical care events	Normal-ization	MMC Norm.	CC Norm.	Base Norm.	Uncharted Norm.
	MMC	*CC*	*Base*	*Uncharted*	*vtf*	*Norm.*	*MMC N*	*CC N*	*Base N*	*Uncharted N*
Blekinge	231	469	559	213	1472	1	0,16	0,32	0,38	0,14
Dalarna	433	947	1142	344	2866	1	0,15	0,33	0,40	0,12
Gotland	164	356	458	185	1163	1	0,14	0,31	0,39	0,16
Gävleborg	477	1102	1408	525	3512	1	0,14	0,31	0,40	0,15
Halland	507	1016	1050	411	2984	1	0,17	0,34	0,35	0,14
Jämtland	202	393	511	183	1289	1	0,16	0,30	0,40	0,14
Jönköping	523	1104	1271	454	3352	1	0,16	0,33	0,38	0,14
Kalmar	423	929	1061	444	2857	1	0,15	0,33	0,37	0,16
Kronoberg	344	658	770	276	2048	1	0,17	0,32	0,38	0,13
Norrbotten	507	1059	1180	463	3209	1	0,16	0,33	0,37	0,14
Skåne	1996	3964	4401	1578	11939	1	0,17	0,33	0,37	0,13
Stockholm	2236	4516	5014	1847	13613	1	0,16	0,33	0,37	0,14
Södermanland	433	934	1044	352	2763	1	0,16	0,34	0,38	0,13
Uppsala	702	1553	1578	614	4447	1	0,16	0,35	0,35	0,14
Värmland	513	1008	1024	378	2923	1	0,18	0,34	0,35	0,13
Västerbotten	587	1248	1442	532	3809	1	0,15	0,33	0,38	0,14
Västernorrland	450	976	1185	411	3022	1	0,15	0,32	0,39	0,14
Västmanland	329	695	792	313	2129	1	0,15	0,33	0,37	0,15
Västra Götaland	2185	4688	5301	1826	14000	1	0,16	0,33	0,38	0,13
Örebro	504	1109	1396	478	3487	1	0,14	0,32	0,40	0,14
Östergötland	734	1596	1996	681	5007	1	0,15	0,32	0,40	0,14

Graph of normalized values showing small variation in case-mix between county councils year 2012

