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Editor: Hasan Fleyeh

Nr: 2014:15

Working papers in transport, tourism, information technology and microdata analysis
ISSN: 1650-5581

On administrative borders and accessibility to public services: The case of hospitals in Sweden.

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This version: 2014-09-24

Abstract: An administrative border might hinder the optimal allocation of a given set of resources by restricting the flow of goods, services, and people. In this paper we address the question: Do administrative borders lead to poor accessibility to public service such as hospitals? In answering the question, we have examined the case of Sweden and its regional borders. We have used detailed data on the Swedish road network, its hospitals, and its geo-coded population. We have assessed the population's spatial accessibility to Swedish hospitals by computing the inhabitants' distance to the nearest hospital. We have also elaborated several scenarios ranging from strongly confining regional borders to no confinements of borders and recomputed the accessibility. Our findings imply that administrative borders are only marginally worsening the accessibility.

Key words: hospitals, optimal location, network distance, travel time, location model

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1. Introduction

A national, regional or any other administrative border might be considered a barrier to the free flow of goods, services, and people, and thereby hindering the optimal allocation of a given set of resources. As a consequence, in particular in borderlands, the highest achievable economic and social utility may not be attained. Van Houtum (2000) gives an extensive review of the study of borders with an emphasis on the EU and its internal borders. In spite, or maybe because, of the globalization process, the recent upsurge of research on borders is discussed by Andersson et al (2002). While not all borderland studies view a border as a barrier, it is widely held that borders reduce trade and are a demarcation of the labor market. In fact, a core part of the EU policy has been to promote cross-border transaction of goods, services, and labor towards a common European market. There are also a growing number of cross-border cooperation of public authorities in Europe. However, it is still too early to regard such cooperation as defining new territorial entities and joint regional policies (e.g. Perkmann, 2007; Popescu, 2008; Harguindéguy and Bray, 2009). Public services in the EU are still normally confined by national or regional borders. As an illustration, López et al (2009) discuss the funding of Spanish rail investments in light of them having substantial spill-overs in French and Portuguese regions bordering Spain.

Similar to transport infrastructure, health care is often under public control in the EU. In this paper, we examine how regional borders affect the spatial accessibility to hospitals within Sweden. Since Swedish regions are comparable in geographical size to many European countries such as Belgium, Denmark, Estonia, Slovenia, Switzerland, and the Netherlands as well as provinces in Italy and Spain and states in Germany with a self-governing of the health care, we believe the results will be informative of the internal borders' of Europe effect on the accessibility of health care.

To be specific, we address three issues. The first is the effect of borders on inhabitants' spatial accessibility to hospitals. The second is the quality of the location of hospitals and the resulting accessibility. The third is accessibility in relation to population dynamics.

Sweden, for several reasons, is a suitable case for a borderland study of accessibility to hospitals. Firstly, we have access to good data of the national road network and a precise geo-coding of the inhabitants, the hospitals, and the regional borders. Secondly, hospital funding, management, and operation are confined by the regional borders. Thirdly, after 200 years of a stable regional division of the country a substantial re-organization of the regions is due.

The paper is organized as follows: In Section 2, the institutional settings of the Swedish health care and the regional re-organization are discussed jointly with a short review on location models and their application in analyzing populations' spatial access to health care. Section 3 presents data, defines the distance measures, and provides some descriptive statistics of key variables. Furthermore, a sketch of how health care is organized in Sweden is given jointly with maps of Sweden that put the location model into the empirical context. In Section 4 the experimental design leading to a 'what-if' analysis and the optimization method are described. Results are presented in Section 5, and the paper ends with a concluding discussion in Section 6.

2. Swedish health care, accessibility, and location models

Health care in Sweden is organized and tax funded at a regional level because it is the regions' primary responsibility. The health care is politically controlled and the population can respond to its management by democratic channels such as elections and (less often) referendums. The regional division of Sweden has remained stable for more than 200 years, but it is currently subject to a major revision. The primary reason for the revision is that many regions as a consequence of population dynamics and historical decisions are locked up in suboptimal solutions within the region. Therefore it is difficult to operate health care efficiently which leads to long queues and high production costs (see e.g. McKee and Healy, 2002).

Health care service depends to a large extent on face-to-face activities and hence the spatial accessibility for the population is a key concern. Central to the supply of health care is the hospitals. Drawing on efficiency arguments, the trend in Sweden and elsewhere (Hope 2011) has been a concentration of hospitals in fewer locations with a possible consequent decrease in spatial accessibility for the population. The concentration seems to go hand in hand with urbanization, but it is counteracted by suburbanization, counter urbanization and urban sprawl from the 1960s. The net outcome on the accessibility for the population is unclear due to these counteracting forces. Nonetheless, the concentration of health care has led to a growing number of people questioning its management. For instance in the Swedish region Västerbotten, a recent referendum regarding a political proposal of further concentration of health care was enforced in September 8th, 2013. In the referendum, about 90% of the voters rejected the proposal.

The direction of the regional revision of Sweden is clear; the number of regions shall decrease from the present 21 regions to about 6 to 8 regions. The reason behind the revision is that larger regions imply greater populations, which allows greater potential to organize health care efficiently. As for spatial accessibility, such revision would reduce the presumed and negative border effect, but not necessarily lessen the sub optimality of solutions within the regions. Because of this, some political parties, and most notably the health minister, have argued for hospitals to be organized and managed on a national level. A key fact in the debate on administrative level of health care in Sweden ought to be spatial accessibility for the population under the alternatives, a fact that up to now is missing. Furthermore, there is no international study on the potential impact of a national administrative revision on the population's spatial accessibility to the hospitals to the best of our knowledge.

There are, however, many studies that measure and describe a population's spatial accessibility to health care usually in a confined area (e.g. Higgs, 2004; Perry and Gesler, 2000; Shi et al, 2012; Tanser et al, 2006). These studies did not provide, as a benchmark, the best possible spatial accessibility. To do so, an analytic procedure that, for instance, minimizes the average distance to the health care is necessary. To address such a general location problem the *p*-median model is commonly used (see e.g. Hakimi, 1964; Reese, 2006). The *p*-median model intends to find an optimal solution for the location of supply points that minimizes the average distance to the population's nearest supply point. This model has been applied to solve location problems of hospitals (see e.g. Daskin and Dean, 2004; Wang, 2012). Unfortunately, the *p*-median problem is NP-hard forcing most applications to address rather small problems of limited spatial reach. The largest *p*-median problem solved that we are aware of is synthetically generated data consisting of 89,600 nodes (Avella et al, 2012). Avella's et al (2012) problem is modest relative to a problem of optimizing spatial accessibility on a national level assuming geo-coded data with high geographical resolution.

It is, therefore, an open question whether it is possible to derive the benchmark of the best possible spatial accessibility for the population on a national level. We shall attempt to do so using about 5,400,000 inhabitants and their residence geocoded in about 190,000 squares each of which is 500 by 500 meters. The inhabitant will be assumed to patronize the nearest of Sweden's 73 hospitals by travelling along the shortest route on Sweden's very extensive road network of about 680,000 kilometers.

The *p*-median model is not the only location model relevant for optimizing spatial accessibility of hospitals. In a literature review by Daskin and Dean (2004) and more recently by Wang (2012), several location-allocation models for finding optimal location of health care facilities were described and summarized. The location models optimize facility locations according to different objectives. One common location model is the location set covering problem (LSCP) which minimizes the number of facilities covering the whole demand (Toregas and ReVelle, 1972). Relative to the *p*-median model, the LSCP model would lead to a change in the number of hospitals compared with the present situation and thereby indicating merging of current hospitals or adding of new hospitals. Another commonly used model was developed by Church and ReVelle (1974) who go in another direction by maximizing the demand covered within a desired distance or time threshold (maximum covering location problem, MCLP). Relative to the *p*-median model, the MCLP model put little weight on inhabitants in remote areas implying a drastic deterioration in accessibility for them. Yet another model is the center model described by Wang (2012) with the objective of minimizing the maximum distance to the nearest facility. The center model is perhaps best suited for emergency service planning as it, compared with the *p*-median model, gives heavy weight to the remote inhabitants and downplays the huge demand of densely populated areas.

To locate health care facilities of different hierarchical levels such as hospitals with specialized care and local health centers, the hierarchical type models have been proposed (Michael et al, 2002; Narula, 1986). Hierarchical location models locate *p* hospitals for health care with services on different levels simultaneously. Hierarchical location models are computationally very heavy which makes them most suitable for solving problems where the number of facilities and nodes for possible location is small.

Although the alternative location models are interesting, we will focus on the best possible spatial accessibility in the sense of minimizing the average distance to the nearest hospital for the population. In other words, the *p*-median model will be used. Furthermore, we will only consider homogenous hospitals meaning that hierarchical location models are unwarranted.

3. Data and descriptive statistics

Sweden is about 450,000 km^2. Figure 1 depicts the country’s 21 regions. The size of the regions ranges from 3,000 km^2 (the island Gotland) to the northernmost region Norrbotten of 97,000 km^2

with an average regional size of 21,000 km^2. To put the geographical size of the regions of Sweden in the European perspective, it may be noted that the smallest regions are of the size of Luxembourg, the middle sized are comparable with Belgium and German states, and the largest are comparable with Hungary and Portugal.

We have access to high quality, geo-coded data of the Swedish inhabitants as of 2008. They are geo-coded in squares of 500 by 500 meters. All inhabitants within a certain square are geo-coded to the center (point) of the corresponding square where the center is taken to be the demand point in the ensuing location analysis. The inhabitants are distributed in 188,325 squares making up approximately 10 percent of the country's area. The population used in the analysis is all the inhabitants in the age of 20 to 64 years and it amounts to 5,411,573.[1]

Figure 1a shows the distribution of the population. The population is asymmetrically distributed in the country due to natural conditions such as climate, variation in altitude, quality of the soil, access to water and so forth. The great part of the population lives in the southern part of the country and along the coast of the northern part. While the population density of Sweden (20 inh./km^2) is very low compared with other European countries, the variation in population density between the regions is substantial. The western part of northern Sweden is very sparsely populated with a population density below one inhabitant per square kilometer, whereas many regions in the southern parts have a population density of about 50 inh./km^2 with an extreme of 350 inh./km^2.

A hospital is a complex producer of health care and consequently its definition is nontrivial as discussed by Mckee and Healy (2002). For this study we have accepted a conventional classification of health care in Sweden used for hospital ranking in Sweden 2010 (Sveriges bästa sjukhus, 2010). This classification identifies 73 hospitals in Sweden.[2] The hospitals are located in 69 of the 1,938 settlements[3] (depicted in Figure 1b). Two settlements being the two largest cities in the country – Stockholm and Gothenburg – contain three hospitals each. In the search for optimal location of hospitals each of the 1,938 settlements are considered as a candidate for locating a hospital.

[1] The restriction to the working population is a consequence of the data having been gathered for labor market related studies.

[2] It goes without saying that a petite part of the health care is highly specialized and not offered everywhere. The national government funds and exercises the power to decide the location of such health care, but we shall abstract from it due to its rarity.

[3] Only settlements with more than 200 inhabitants according to the census of 1995 are considered in the location analysis.

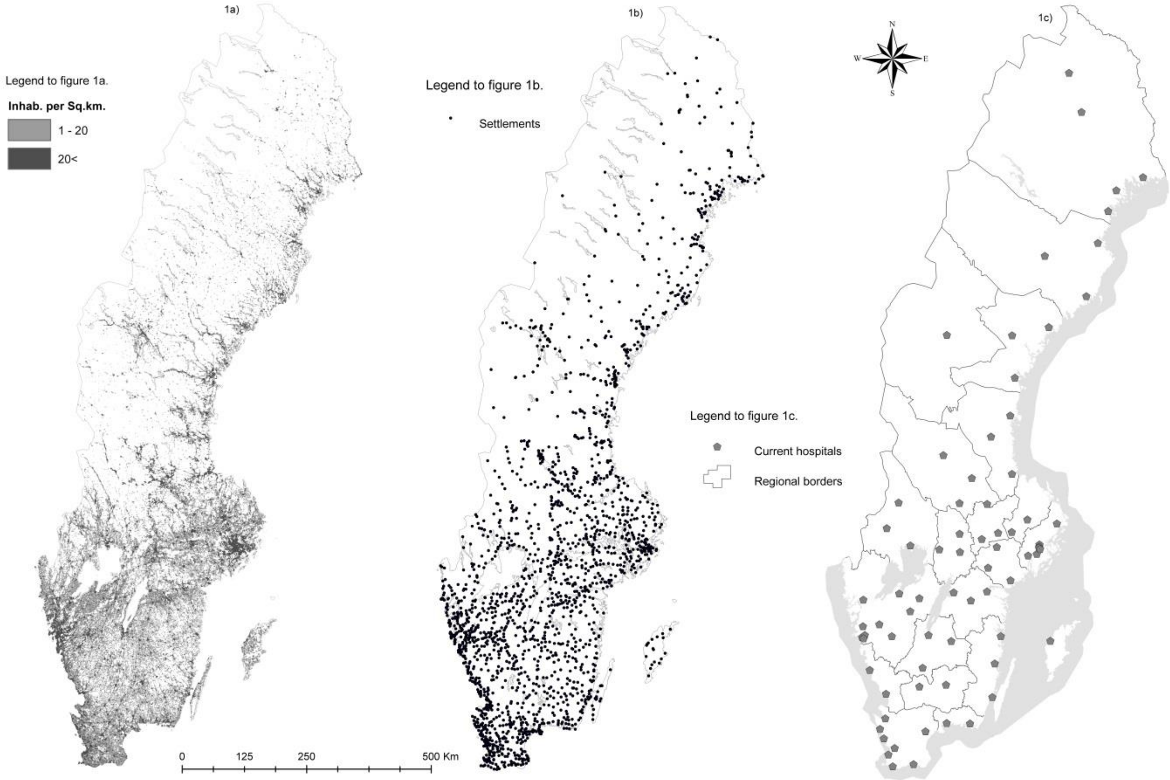

Figure 1a-c: Distribution of the population (a), settlements (b), and regions, current hospitals, and major national roads (c).

Figure 1c illustrates the locations of the 73 hospitals in Sweden. The number of hospitals in Sweden is low compared with other European countries. There is about 0.75 hospitals per 100,000 inhabitants in Sweden. The overall average for Europe is 2.6 hospitals per 100,000 inhabitants with a range from 1 (the Netherlands) to 6 (Finland) (Hope 2011). In spite of Sweden's dissimilarity to other European countries in this respect, the expenditure on health care in Sweden is similar to other European countries of about 10 per cent of the GDP.

The population size of the regions is about 300,000 inhabitants and consequently it is expected to be three hospitals per region. In fact, this is the case with three exceptions being the markedly more populated regions surrounding the cities Stockholm, Gothenburg, and Malmo. These regions have 6-9 hospitals and a population exceeding 1,300,000 inhabitants.

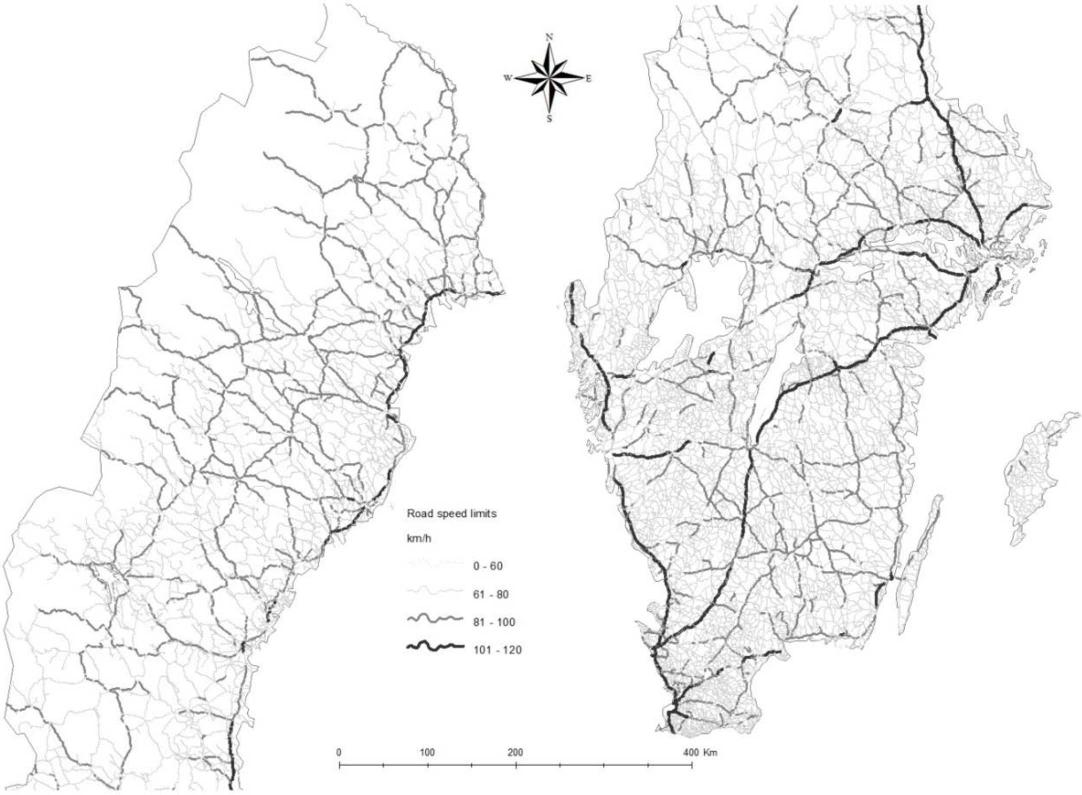

Figure 2: National roads and their speed limit.

As mentioned before, the inhabitants may travel between the residence and the hospital along some 680,000 kilometers of roads. National roads maintained by the state are the most important roads in the road network and they make up 15 per cent of Sweden's road network. We have retrieved the road network information from the national road data base (NVDB). In Figure 2 the national roads are visualized. There are 31,000,000 road segments stored in NVDB. Each segment is stored along with other attributes such as speed limit. The speed limit varies between 5 and 120 km/h with 80 percent of the road segments having a speed limit of 70 km/h. From Figure 2 it may be noticed that national roads with a speed limit below 80 km/h dominate in the rural areas while national roads with higher speed limits connect the larger towns by a sparse network. Within urban areas the speed limit is usually 50km/h or lower. We have processed the data into a country wide road network to enable both the computing of travel distance and travel time between the 188,325 demand points and the 1,938 candidate nodes for hospital location (Meng and Rebreyend, 2014).

While there is some latitude for the inhabitants to select the hospital to patronize within the region, it is safe to assume that the chosen hospital is that nearest to the residence and that the shortest route to the hospital is taken. This means that the shortest route between the hospitals and the demand points needs to be identified. To do so, we have used the algorithm originally proposed by Dijkstra (1959). At the onset, the algorithm identifies and set all nodes (i.e. settlements and demand points) as unvisited and assigns them infinity as distance. The algorithm begins with a starting node. This node is marked as visited and receives the distance 0. The distance of all its neighbors is then updated. The algorithm is thereafter iterating on all unvisited nodes. At each step the unvisited node with the lowest current distance from the starting node is picked. The node is marked as visited (and then its distance is the lowest distance to the starting node) and the distance of each of its neighbors to the starting node is updated if needed. The algorithm can stop at this stage if the node is the destination node. In our case, we continue the algorithm until all nodes are marked as visited since we need distances from one point to all the others. The resulting Origin-Destination (OD) matrix was created on a Dell Optiplex 9010 with an Intel Core I7-3770 (3.4 GHz) 32 Gb of RAM and a Linux operation system. It took 12.5 hours to generate the matrix. The final OD matrix is of the dimension 1,938 by 188,227 representing the candidate nodes of locating hospitals and the demand points in Sweden. 98 demand points were lost in the generation of the OD matrix due to residences without access to the road network.

4. Experimental design

As stated in the introduction, we intend to address three issues. The first one is the effect of borders on inhabitants' spatial accessibility to hospitals. The second is the accessibility to hospitals without restrictions of borders and where hospitals are optimally located. The third is accessibility in relation to population dynamics.

In addressing the first issue, we first compute the population's distance to the nearest hospital along the shortest route. In this computation, the inhabitants may only patronize a hospital in their residential region. In the alternative scenario, the inhabitants may patronize hospitals in any region in which case boundaries implied by the borders are removed. Thus, we also compute the distance when the inhabitant may patronize the nearest hospital of any region.

The second issue to be addressed is location of the current 73 hospitals. Are they located in a way that yields the best possible accessibility subject to the restriction of the 73 hospitals in the country? To answer the question we identify the optimum of the 73 hospitals where, by optimality, it is meant a location of the hospitals such that the population's distance to the nearest hospital (irrespective of regional borders) is minimized.

To find the optimal location of hospitals we use the *p*-median model. It can be stated as:

$$Minimize\ \frac{1}{R}\sum_{i=1}^{N}\sum_{j=1}^{M} h_i d_{ij}\, x_{ij}$$

$$\text{s.t.}\ \ \sum_{j=1}^{M} x_{ij} = 1,\ \ i = 1,2,\dots,N$$

$$x_{ij} \le y_j$$

$$\sum_{j=1}^{M} y_j = p$$

where R is the number of inhabitants, I is the set of demand nodes indexed by i, J is the set of M candidate locations (i.e. settlements) indexed by j, h_i is the number of inhabitants in demand point i, d_{ij} is the distance of the shortest route between demand point *i* and candidate location *j*, and *p* is the number of hospitals to be located. Furthermore, x_{ij} equals one if the demand point *i* is assigned to a hospital at location *j* and zero otherwise, whereas y_j equals one if a hospital is located at point *j* and zero otherwise.

The distance is measured both as travel distance in meters and travel time in seconds in the road network. Often Euclidian distance is used as a distance measure, but it has been found to be unreliable (Bach, 1981; Carling et al, 2012; 2014).

The *p*-median model assigns the inhabitants to the nearest hospital without considering the maximum capacity of a hospital. In this case, this might lead to absurdly large hospitals in Stockholm and Gothenburg since their large and concentrated populations are represented by one single settlement each. To overcome the problem in the implementation of the *p*-median model, we comply with the current situation by assigning three hospitals in the same candidate location in Stockholm and Gothenburg.

To solve the *p*-median problem is a nontrivial task as the problem is NP-complete (see Kariv & Hakimi, 1979) implying that enumeration of all possible solutions is infeasible. Much research has been devoted to develop efficient (heuristic) algorithms to solve the *p*-median model (see Daskin, 1995; Handler and Mirchandani, 1979). We solve the problem by using a common heuristic solution method known as simulated annealing (SA) (see Lenanova and Loresh, 2004). Alternative solution methods for the *p*-median model are extensively discussed by Reese (2006).

The virtue of simulated annealing as other heuristic methods is that the algorithm will iterate towards a good solution being not necessarily the optimum as a stopping point must be given. As a consequence it is unknown whether the solution is close to the optimal solution or not. However, it has been shown that statistical confidence intervals derived by Weibull estimator may be used for estimating the uncertainty of the solution with regard to the optimum (Carling and Meng, 2014). We run SA until the confidence intervals are very tight – in matters of travel time it amounts to some seconds.

As far as the third issue is concerned, identifying an optimal location of hospitals is done at a specific point of time. Is it likely that this optimum be robust to population dynamics? To address this question the population is divided by age and the optimal location of hospitals is identified for both the younger part of the population (20-39) and the older part (50-64). The dissimilarity of the two solutions is thereafter examined.

In sum, the experiments related to the aim of the paper examine the current situation to a number of counterfactual scenarios with regional borders removed, national (and optimal) allocation of hospitals, and redistribution of the population.

5. Results

5.1 The effect of removing regional borders

Table 1 shows the average and the median distance to the nearest of the current 73 hospitals. The inhabitants have on average 17.9 kilometers to their nearest hospital within the region while the median distance is 11.3 kilometers. The time it takes to travel the distance in the road network, assuming attained velocity to be the speed limit, is on average 15 minutes and 18 seconds while the median value is 11:06 minutes.

If the population was free to patronize hospitals irrespective of regional borders, the distance would decrease somewhat. For instance, the inhabitants would on average have the distance to a hospital shortened by 0.6 kilometers or by 25 seconds. The resulting improvement in accessibility would be about 3 percent.

The majority of the inhabitants would be unaffected by the removal of regional borders, a fact that follows from the median distance being (almost) identical in the current and the counterfactual situation.

Table 1: The inhabitants distance to the nearest hospital within the region as well as within Sweden.

	Within the region	Within Sweden

Measure	Mean	Median	Mean	Median
Distance (km)	17.9	11.3	17.3	11.3
Time (min)	15:18	11:06	14:53	11:08

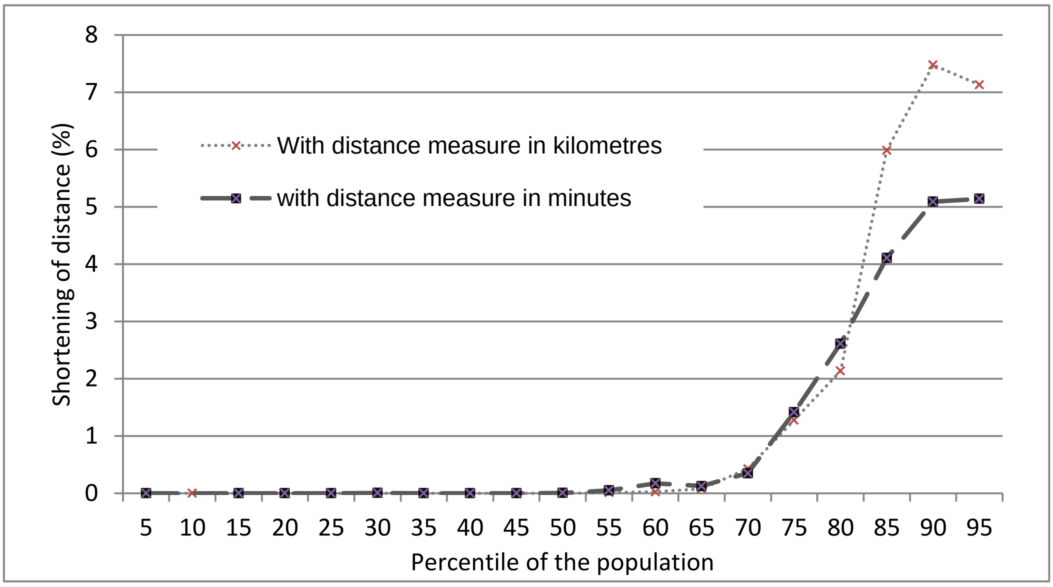

Figure 3: Rate of shortening in distance (in percent) to the nearest hospital due to removal of regional borders for percentiles of the population.

Unsurprisingly a fraction of the population living close to the regional borders would benefit from them being removed. To examine the size of this fraction of the population, we have computed each inhabitant's shortening of the distance to a hospital as a consequence of the removal of regional borders. Figure 3 gives the shortening in distance (in percent) to the nearest hospital. The figure shows that a majority of the inhabitants (55 per cent) would be unaffected as their nearest hospital already is located in their region of their residence. However, 45 percent of the inhabitants would be better off by having the opportunity of patronizing a hospital in a neighboring region. This opportunity would be of marginal importance though, as the shortening in distance is at the most of some 10 per cent.

As a result, the removal of regional borders has little effect on improving the accessibility to hospitals in Sweden. Most inhabitants would be unaffected, but those affected would be subject to a modest improvement in accessibility.

5.2 The effect of optimal location of hospitals

The present spatial accessibility to hospitals is rather poor as the average distance between inhabitants and hospitals is 17.9 kilometers. Is this a result of the current 73 hospitals being poorly located with regard to the population?

Table 2: The inhabitants distance to nearest current and optimally located hospital.

	Current location		Optimal location[a]		Shortening (%)	
Measure	Mean	Median	Mean	Median	Mean	Median
Distance (km)	17.3	11.3	16.2	10.4	6.4	8.0
Time (min)	14:53	11:08	13:54	10:00	6.6	10.3

Note: a) The 99% confidence intervals for the mean values are (16.16-16.20 km) and (13:51-13:54 min).

Table 2 gives the average and the median distance to all current 73 hospitals for the population being unrestricted by regional borders (cf Table 1). It also shows the inhabitants' distance to the nearest of 73 optimally located hospitals. The location of the 73 optimally located hospitals is depicted in Figure 4a. Finally, the table gives the resulting shortening of the distance as a consequence of hospitals being optimally located. The shortening in distance is of a modest 5-10 percent with the median indicating greater relative improvement for the inhabitants already closest to the hospitals.

Table 3: Relocation towards optimality. Number of hospitals, inhabitants affected and their distance to a hospital.

	Hospitals	Inhabitants	Mean distance nearest hospital		Shortening
Measure	relocated	Affected	current	optimal	(%)
Distance (km)	17	1,323,599	25.9	21.6	16.7
Time (min)	22	1,747,908	19:47	16:44	15.4

The scenario that the health care would be under national control with a resulting relocation of the 73 hospitals towards an optimal location is not far-fetched. Who would be affected if the scenario were to be realized? Table 3 gives some answers to this question. First of all, most of the current hospitals are optimally located. Only 17 (22 if optimized with respect to time) of the current hospitals would require relocation for attaining a maximum accessibility for the population under 73 hospitals (see Table 3). Secondly, a substantial proportion of the population, 24 per cent (31 per cent if optimized with respect to time), would be affected by the relocation towards optimal accessibility. Thirdly, the inhabitants affected by the relocation would have improvement in accessibility to hospitals with about 16 per cent.

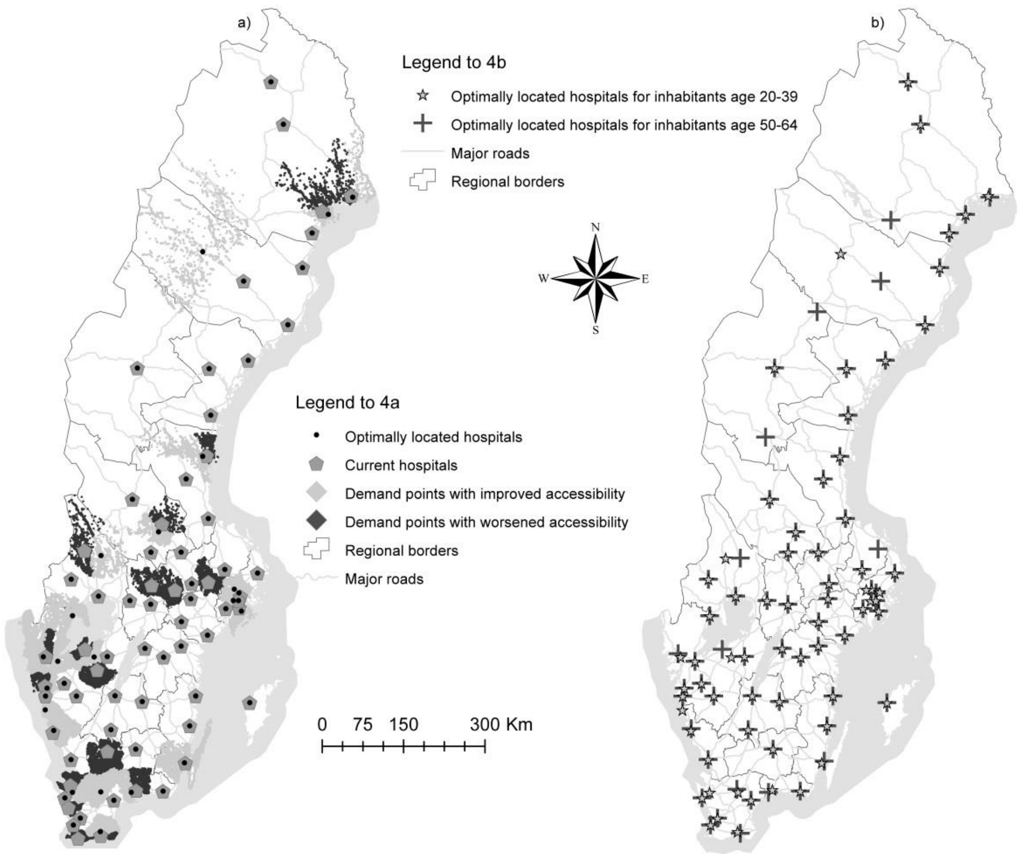

Figure 4a-b: Current and optimal 73 hospitals as well as inhabitants with improved and worsened accessibility as a consequence of optimal hospital configuration (a) and optimally located hospitals for inhabitants of 20-39 years and 50-64 years, respectively (b).

Relocation towards optimality would result in some inhabitants be closer to a hospital than presently and some inhabitants would be further away. To illustrate the underlying gross affect, inhabitants with improved and inhabitants with worsened accessibility are separated (Table 4). The magnitude of the improvement and the worsening is similar, but the number of inhabitants positively affected is about twice the ones negatively affected. Figure 4a visualizes the locations of the positively and negatively affected inhabitants (if optimized with respect to travel distance). In general, the relocation towards optimality implies a slight relocation from one town to the neighboring one.

To draw conclusions regarding the location towards optimality issue, the current location of the 73 hospitals are not far from an optimal solution with regard to the population's accessibility to hospitals. An optimal configuration of hospitals seems to be an exercise of carefully fine-tuning the location within the regions.

Table 4: Number of Inhabitants with affected accessibility by relocation of hospitals towards optimality, their

distance to the nearest hospital, and change in distance.

	Improved accessibility				Worsened accessibility			
		Mean distance to a hospital				Mean distance to a hospital		
Measure	Inhabitants	Current	Optimal	Difference	Inhabitants	Current	Optimal	Difference
Distance (km)	846,519	32.1	18.7	-13.4	477,083	15.0	26.7	11.7
Time (min)	1,163,453	23:16	14:34	-8:42	547,450	12:15	21:02	8:47

5.3 Robustness of optimal location to population dynamics

What effect do population dynamics have on the optimal locations? How much will a change in the spatial distribution of the population affect the accessibility to the optimal hospitals where the optimum is identified for a particular population at hand? We identify the optimum for groups of inhabitants. The first group is inhabitants aged between 50-64 years and the other group are those between 20-39 years. For these two sets of optimally located hospitals, we compute the accessibility for the inhabitants of 20-39 years.

Figure 4b shows the location of the 73 hospitals optimized with respect to travel time and the two groups. The configurations for the two groups are similar and there are 58 hospitals coincide with each other. The figure indicates that the younger population would require more hospitals around Stockholm and Gothenburg at the cost of fewer hospitals in the northwestern part of the country. The requirement is however not very critical. The younger population has today 13:31 minutes on average to the nearest hospital. An optimal location of hospitals for them would only reduce the time to 12:25 minutes. How much worse off would the younger population be if they had to accept a configuration of hospitals optimized for the older? The answer is less than 1 per cent or 5 seconds since their travel time would increase to 12.30 minutes. Thus, an optimal location of hospitals seems to be robust to a long-term spatial redistribution of a population.

5.4 Miscellaneous results

Returning to the issue of a reformation of the regional division in Sweden, what affect may it have on the spatial accessibility to health care? It is clear that the removal of borders is inconsequential. However, there is scope for some improvement by optimizing the location of hospitals. Is such improvement likely to follow from merging neighboring regions? Figure 5 shows two parts of Sweden. To the left panel the region surrounding Gothenburg known as Västra Götaland (the dark gray area) is shown, but hereafter simply referred to as the Gothenburg region. To the right the Stockholm region as well as neighboring regions (the light gray area) is shown. The Gothenburg region is a forerunner in the regional reformation. In 1998 three regions near to Gothenburg were merged into the Gothenburg region and as a consequence the hospitals of the three independent regions came under the power of one region. Stockholm and the neighboring regions depicted in Figure 5 are candidates for being merged into a single region (hereafter the Stockholm region).

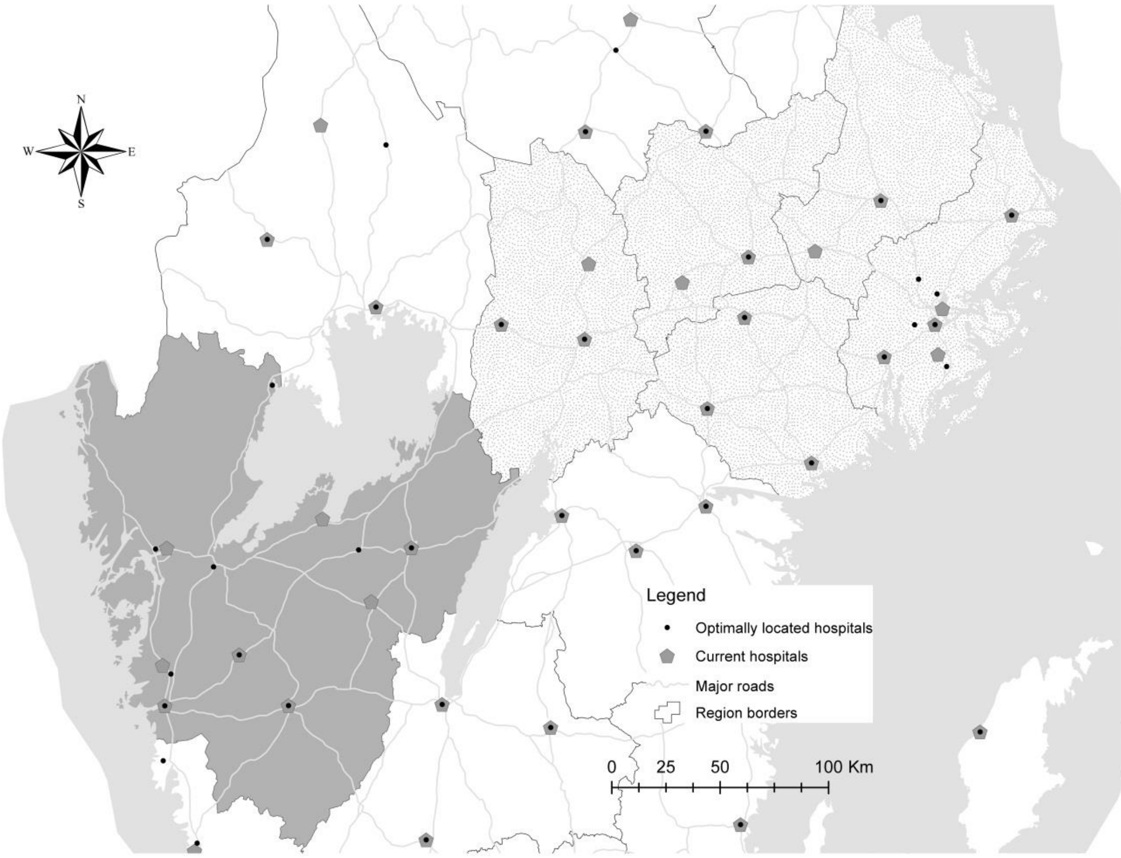

Figure 5: The factual Gothenburg region (dark gray area) and the hypothetical Stockholm region (light gray area).

If the reformation of the regional borders would have any effect on the interregional and suboptimal location of hospitals, then the hospital location in the Gothenburg region ought to be better than the Stockholm region which is not formed yet. This is checked by letting all regions be looked up with the current location of hospitals except the Gothenburg and the Stockholm region where hospitals may be relocated to the optimum within the region. The population is free to patronize hospitals in any region. Recall from Table 1 that the average travel time was 14:53 minutes for the population to the current hospitals. If the hospitals in the Stockholm region were optimally located, the average travel time would decrease to 14:39 minutes. Yet, if the hospitals in the Gothenburg region were optimally located, the average travel time would similarly decrease to 14:38 minutes. Hence, there is no reason to expect that the formation of an extended Stockholm region would generate a better location of the hospitals in such a not yet formed region than today.

The various experiments, so far, have indicated that any regional reformation will have little impact on the spatial accessibility to hospitals. One may wonder: how is the ongoing trend of concentration to fewer hospitals in Sweden as elsewhere affecting spatial accessibility? To address this question we have considered two scenarios. Out of the 73 hospitals in Sweden 48 of them are labelled emergency hospitals with a slight higher level of specialized care. The first scenario is that the 25 non-emergency hospitals would close and the country be left with current 49 emergency hospitals to serve the population. The average travel time would as a result increase by 26 per cent. The second scenario is that Sweden had twice as many hospitals as today, thereby being more similar to other European countries in terms of health care. In this scenario, the average travel time would decrease by almost a half (39 per cent). As a conclusion, the key to a spatially accessible health care is the number of hospitals.

6. Conclusion

A national, regional or any other administrative border might be considered as barriers to the free flow of goods, services, and people. These barriers hinder the optimal allocation of a given set of resources. As a consequence, in particular in borderlands, the highest achievable economic and social utility may not be attained. For this reason, it seems sensible that the EU policy has been to promote cross-border transaction of goods, services, and labor towards a common European market. Public services have, however, been exempted from the free flow of services and largely confined by national and regional borders. The present EU policy is, however, addressing the confinement of public services. So it is interesting to ask: Do the Europeans suffer from a poor accessibility to public services due to internal borders?

In this paper we have attempted to address this question by studying the effect of administrative borders within Sweden on the population's spatial accessibility by considering one prominent public service which is hospital service. We have elaborated several scenarios ranging from strongly confining regional borders to no confinements of borders as well as long-term population redistribution. Our findings imply that the borders are only marginally worsening the accessibility. Instead, the key to good spatial accessibility to hospital service is the number of hospitals. However, it is more likely that this number is under further decrease due to the ongoing concentration of hospitals.

While we believe that the case of Sweden can be extrapolated to a European setting, it would be interesting to replicate the study on a European level.

Acknowledgements

We are grateful to Hasan Fleyeh for comments on an earlier version of this paper.

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