



The impact of hospital closures on geographical access: Evidence from four southeastern states of the United States



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ABSTRACT

This paper examines the effects of hospital closures on geographical access by potential patients, using data from four southeastern U.S. states. Using optimization models designed to minimize the adverse effects of hospital closures, extensive computations are performed and the results are discussed. The effects of the closures on the rural areas is also investigated. Finally, the paper determines which hospitals are most likely among those to be closed assuming that up to 10% of the existing hospitals in each of the four states were to be shut down. The overall conclusion of the empirical findings is that while differences exist among the states, efficiency, coverage, and equality measures for geographical access do not suffer significantly if only a few hospitals are closed in each state, provided these closures are done optimally to minimize impact. Further, for efficiency objectives, decision makers can follow a sequential strategy for closures and still be guaranteed optimality. The paper also discusses the effects of hospital closures on equity and it examines whether or not rural areas are disproportionately affected by closures.

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1. Introduction

Hospital closures or plans to close hospitals can be found almost daily in newspapers around the globe. References referring to this occurrence in the United States [1,2], United Kingdom [3], Germany [4], Canada [5] are but a few examples of this trend. It is important to note however that this is not a new trend. In fact, a report [6] from the United Kingdom regarding the years 1979–86 shows a large number of hospitals being closed in those years in the United Kingdom. While there are exceptions, a common observation about such closures is that the rural and underpopulated areas tend to be among those hit hardest.

It is helpful to try and understand some of the major forces behind many hospital closures. The first of these has to do with cutbacks in public spending since governments provide substantially for the expenditures for health care in most countries, including in the United States, where two government-run programs,

Medicare and Medicaid, cover a substantial portion of the US population. This expense is significant and growing in most countries, accounting for between 9%–13% of GDP in most developed countries (with the United States being at outlier at 17%), see [7]. As of the summer of 2015, seventeen countries have a public debt in excess of 100% of their respective gross domestic products, see [8]. It is apparent that in order to keep the burden of debt manageable, it is necessary to make adjustments or save money. Aside from a generally unpopular strategy to raise taxes in case of public health care or increasing fees in case of private care, the main way is to cut services of some sort: eliminating or decreasing state subsidies, cut services or require co-pays, shutting down programs, and similar courses of action. One of the possibilities includes the closure of hospitals. Whether or not hospitals are private or public, ownership (and hospital size) appear to make a difference when considering the closure of hospitals, as noted by Noh et al. [9] in the case of Korea. Furthermore, consolidation among private health care companies often leads to closure of hospitals [10]. The second important reason for the closures or relocations has to do with the inability to attract physicians to rural areas, see e.g., [11] and [12]. Nelson [13] provides some arguments that are designed to counter this trend. Our model is designed to have a “central planner,” who

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has the overall viability of the system in mind, rather than that of a subsystem such as an individual hospital or group of hospitals as is often the case in privately run systems.

Another reason for hospital closures is the reduction of demand. For instance in the early 1960s, an appendectomy required an average post-surgery hospital stay of 6.3 days [14], while advances in technology (laparoscopic appendectomy in this instance) have reduced this requirement to 1–2 days [15]. Finally, the fourth reason to cut funding or close hospitals is a result of the inefficiency of hospitals, see, e.g., [16] in the case of Germany.

While the closure of hospitals has been a well-known phenomenon for a while now, its impact on health care consumers has been less studied in the academic literature. Samuels et al. [17] note that among the hospitals closed in 1989 in the United States, two thirds were in rural areas. Updates on the closures of rural hospitals are reported in [18–21] and [22].

However, these papers above also point out that most closed hospitals were in close proximity of other, open, hospitals. This leads to the conclusion that most closures had no discernible effect on the quality of health care. Rosenbach and Dayhoff [23] examined hospital closures in eleven states that appear to represent a reasonable cross-section of the United States. The closures did not cause any changes in the mortality rates, and patients in affected areas were often rerouted to urban teaching hospitals. Liu et al. [24] report the effects of the closure of very small hospitals in rural Saskatchewan. They report that the extensive closures have had no negative effect on the quality of health care and the well-being of the population. Lindrooth et al. [25] investigate the effects of urban hospital closure on the operations and costs of the remaining hospitals. Buchmueller et al. [26] investigated hospital closures in Los Angeles County and used distances/travel time as their main criterion. It was determined that most hospitals that were actually closed were located in more affluent areas. As a matter of fact, the authors noted some improvements in the quality of health care after the closures of underperforming hospitals. In general, it was observed that closures shifted health care to more efficient hospitals and doctors' practices. Finally, Lindbom [27] uses a very different angle on hospital closures: how do voters punish the ruling parties, if they remove services voters believe they are entitled to? A common thread of assumption in all of these works cited above is that they assess the impact of hospital closures that have already occurred. To the best of our knowledge, there are no references regarding the impact of hospital closures on geographical access to customers, under the assumption that these closures are thoughtfully planned to minimize the overall adverse impact on customers. That is the point of departure of this paper.

In an effort to partially address the literature gap noted above, this paper focuses on the problem of hospital closures and determines the impact of these closures on geographical access using data from 4 states in the Southeastern US. Optimization modeling is used in deciding which hospitals to close, so that the overall adverse impact on customers is minimized. Our primary motivation for this work is that since they have been sited in the past based on needs at that point in time, hospital services at a particular location may no longer be in need, based on changing demographics, shifting settlement patterns, different types of treatment, and many others. In other words, the closure of hospitals can and should be rationalized by considering the effects of the closure on various constituents, provided the selection of hospitals to close is done using analytical modeling to minimize the impact of the closures.

In order to conduct our study, we will need to introduce and discuss a number of potential criteria to be discussed in this context, and, just as importantly, devise quantitative measures to operationalize their use.

As far as efficiency is concerned, we can distinguish between *individual efficiency*, which can be measured in terms of the average access time a potential patient has to a hospital, and *collective efficiency*, which measures the proportion of the population that is within a given distance or time from a hospital. Another issue that is somewhat more contentious and difficult to quantify is the concept of "equity." Following the literature, we will measure equality by the Gini index [28] which is the normalized area between the Lorenz curve [29] and the line of complete equality. While the Gini index has long been used as a criterion as an objective (for surveys, see, e.g., [30] and [31], while for a more recent formulation and optimization, see [32], problems have been reported (see [33] and [34]) regarding the measure's tendency to choose highly inefficient solutions. Finally, another important consideration in hospital closures concerns the rural – urban divide. More specifically, it investigates whether or not the hospital closures inordinately affect the rural population; see, e.g., [2]. In order to do so, we use a well-accepted measurement of the degree of rurality provided by the United States Department of Agriculture [35]. It will be elaborated upon below.

The main research questions in this contribution are then as follows:

- how do the recommended hospital closures obtained using optimization schemes compare to actual closures that have occurred in the past?
- As hospital closures are bound to occur over time, are the optimized closures stable? In other words, we want to enquire whether or not short-term optimal decisions will also result in long-term optima.
- how do the recommended closures affect equality of service? and
- do the recommended closures inordinately affect the rural or the urban population?

Before we proceed, it is important to discuss some of the fundamental assumptions of our study and the consequent caution that must be exercised in interpreting the results. The models we are using assume that there is a central planning authority, such as a Department of Health that decides how many and which hospitals to close. In the area under consideration in this paper, viz., four States in the Southeastern United States, there is a mix of publicly and privately owned hospitals, whose closures are decided in decentralized fashion. However, our assumption that closures were centrally organized and optimized provides a *lower bound* on the damage in terms of coverage and average access time or distance that is done to customers. This is the context in which our computational results should be interpreted. Furthermore, closures may not necessarily be viewed as recommendations, as closures may happen for reasons other than the ones we use. While the closures recommended by our model are based on patient-centered criteria, viz., coverage and average access time, actual (real) closures may be based on very different criteria. In case of private facilities, profitability is the main criterion. There is a connection to accessibility and coverage—if few people live within a reasonable distance from the hospital, it will not be profitable and it is likely to face closure. Similarly, public facilities may face closures for reasons such as

- Demographic changes that eliminate the need for a hospital at that site,
- Changing patient needs have resulted in a hospital having excess capacity, rendering it unprofitable,
- The state of the hospital, i.e., the structure may be dilapidated to a point, at which it is too expensive to renovate/retrofit given new regulations,
- The capacity of the present hospital may not be sufficient and the site may not allow for appropriate expansions

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