# Impact of conversion to Critical Access Hospital status on hospital efficiency

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## ABSTRACT

This study examines the impact of Critical Access Hospital (CAH) Program on hospital efficiency using a two-stage approach, where data envelopment analysis is used in the first stage to estimate cost, technical, and allocative efficiency scores of a sample of rural hospitals. Densities of efficiency scores of CAHs and prospectively paid rural hospitals are estimated and compared using a nonparametric kernel density estimator and a bootstrap-based test. In the second stage, efficiency scores are regressed on environmental variables using bootstrapped truncated regressions. Density analysis and results from bootstrapped truncated regressions show that CAHs are less cost and allocatively efficient compared to prospectively paid rural hospitals, without being less technically efficient. Relative to their pre-conversion selves, CAHs appear to be slightly less allocatively efficient, while they are slightly more technically efficient and no less cost efficient. Overall, our results suggest that the CAH Program may have decreased the allocative and cost efficiencies of those rural hospitals that converted to CAH status relative to prospectively paid rural hospitals, without significantly increasing their technical efficiency.

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## 1. Introduction

The Critical Access Hospital (CAH) Program, introduced by the Balanced Budget Act of 1997, has been created to protect small, financially vulnerable rural hospitals that might be important for access to health care services in isolated rural areas in the U.S. [1]. A hospital that converts to CAH status receives Medicare cost-based reimbursement provided it meets requirements such as restrictions on the maximum number of acute care beds and annual average length of inpatient stay. Under cost-based reimbursement, hospitals are reimbursed for the total costs of providing health care services. This reimbursement method was used by Medicare to pay for hospital services before 1983. Although access to health care services and hospital finances improved significantly, cost-based reimbursement led to a rapid increase in health care costs. Furthermore, historical evidence suggested that it was associated with inefficiency in hospital operations. Under cost-based reimbursement, payment levels equaled hospitals' costs. Thus, it provided incentives for hospitals to oversupply services, overuse resources, and increase costs in order to increase their revenues since Medicare paid for services on a cost basis [2,3].

In 1983, Medicare introduced a new payment method known as the Prospective Payment System (PPS). Medicare classified all illnesses into diagnosis-related groups (DRG) and estimated the average cost per case for each group. Under the PPS, hospitals are paid fixed prices based on the DRGs and are allowed to keep the difference between these fixed DRG prices and their costs. Thus, the PPS has provided incentives for hospitals to reduce costs and improve efficiency by motivating hospitals to keep their costs below the PPS rates in order to make profits [4]. Small rural hospitals, however, were particularly vulnerable to the financial pressures of the PPS and commonly failed to cover costs on Medicare patients [5].

The CAH Program has been created to maintain access to health care services in isolated rural communities by improving the financial conditions of small rural hospitals and preventing their closure. However, there have been concerns that Medicare cost-based reimbursement has provided a disincentive for CAHs to control costs and operate efficiently. In the 2005 Report to Congress, the Medicare Payment Advisory Commission (MedPAC) [6] states: "Although the CAH Program has helped preserve access to emergency and inpatient care in isolated areas, it may not have accomplished this goal in an efficient manner."

The objective of this paper is to determine the impact (if any) of CAH conversion on hospital efficiency. To achieve this objective, we use recent developments in the area of efficiency analysis implemented using a two-stage approach. In the first stage, we estimate hospital cost, technical, and allocative efficiency scores using data

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envelopment analysis (DEA) [7]. In simple terms, a firm is technically efficient if it uses the minimum quantities of inputs to produce a given level of outputs [8]. For the hospital sector, technical efficiency refers to the relationship between inputs used (i.e., capital and labor) and outputs produced (i.e., outpatient visits, inpatient days, surgeries, etc.). Allocative efficiency reflects the ability of a hospital to produce a given level of outputs using the optimal combination of inputs (i.e., cost-minimizing), given input prices. A hospital is (overall) cost efficient when it is both technically and allocatively efficient. Cost efficiency indicates the extent to which the hospital minimizes the cost of producing a specific level of outputs, given input prices.

Further, the densities of efficiency scores of CAHs and PPS (non-CAH) rural hospitals (which include hospitals prior to CAH conversion as well as non-converting, PPS rural hospitals) are estimated and compared using a nonparametric kernel density estimator and a bootstrap-based test proposed by Simar and Zelenyuk [9]. In the second stage, we use truncated regressions with bootstrap suggested by Simar and Wilson [10] to investigate how the conditional mean of efficiency scores is influenced by environmental variables such as CAH status, Medicare and Medicaid reimbursement, hospital ownership, etc.

Previous studies analyzed the impact of Medicare reimbursement changes on either cost efficiency [3,11] or technical efficiency of health care facilities [4] using standard methods such as DEA or stochastic frontier analysis. To the best of our knowledge, this is the first study that examines differences in all three Farrell [8] type efficiency measures jointly between hospitals operating under different Medicare reimbursement systems, using methodological advancements proposed by Simar and Zelenyuk [9] and Simar and Wilson [10]. We hypothesize that cost-based reimbursed CAHs are more cost inefficient than PPS rural hospitals because of the differences in Medicare reimbursement methods, and thus incentives, facing these two groups of rural hospitals. Additionally, we analyze not only whether CAHs are more cost inefficient than PPS rural hospitals but also whether this cost inefficiency increase comes more from technical inefficiency (i.e., hospitals do not use the minimum input quantities to produce their output levels) or allocative inefficiency (i.e., hospitals do not use the least-cost combination of inputs, given input prices, in producing their outputs).

Section 2 of this article presents background information on the CAH Program and Section 3 briefly reviews previous research on the performance of CAHs as well as on the impact of Medicare reimbursement changes on the efficiency of health care facilities. In Section 4, we summarize the methodological approach and the data used in the analysis is described in Section 5. Section 6 presents the results and discusses the principal findings, with conclusions presented in Section 7.

## 2. CAH Program

The CAH Program was introduced as part of the Balanced Budget Act of 1997 and it was subsequently expanded by the Balanced Budget Refinement Act of 1999 and the Medicare Prescription Drug, Improvement, and Modernization Act of 2003. A hospital that converts to CAH status has the advantage of receiving Medicare cost-based reimbursement, equivalent to 101 percent of actual cost, for inpatient and outpatient services delivered to Medicare beneficiaries. However, the hospital must meet several requirements before conversion: the hospital must be located at least 35 miles by primary road, or 15 miles by secondary road, from the nearest full service hospital or be declared by the state as a "necessary provider"; use no more than 25 acute care beds at any one time; annual average length of stay cannot be greater than four days, and the hospital must provide 24-h emergency care services. Before January 2006, states could waive the distance requirement using

the "necessary provider" provision. That is, a state could declare a hospital a "necessary provider" and qualify it for CAH conversion based on arbitrary criteria. Further, some CAHs were allowed to exist in Metropolitan Statistical Areas based on state regulations that declared them rural hospitals. MedPAC [6] estimated that only 17 percent of CAHs are more than 35 road miles from another provider, 67 percent are 15—35 miles, and 16 percent of CAHs are less than 15 miles from another hospital.

Rural hospitals that converted to CAH status have generally experienced significant improvements in their finances due to Medicare cost-based reimbursement. For example, hospitals that converted to CAH status have dramatically increased their Medicare payments and improved their all-payer profit margins from −1.2 percent in 1998 to 2.2 percent in 2003. For similar rural hospitals that did not convert to CAH status and remained on PPS all-payer profit margins declined from 2.2 percent in 1998 to −0.2 percent in 2003. Medicare payments to CAHs rose, on average, by 9.5 percent per year during the period 1998—2003, compared with a 3.3 percent rise for similar rural hospitals that did not convert to CAH status [6]. MedPAC [6] estimated that in 2003 payments per CAH were roughly $850,000 higher under cost-based reimbursement than they would have been under the PPS.

## 3. Literature review

The impact of Medicare reimbursement changes on the efficiency of health care facilities has been an important research topic. Morey and Dittman [12] examined the effect of cost-based reimbursement on the technical efficiency of North Carolina hospitals operating in 1978. Using DEA, they found that hospitals with a higher percentage of cost-based reimbursement tended to be less technically efficient. Sexton et al. [4] analyzed the effect of the PPS on the technical efficiency of 52 nursing homes in Maine using DEA with four years of data (two years before and two years after the introduction of the PPS). An unexpected result was that the average technical efficiency fell after the introduction of the PPS. In their paper, Chern and Wan [13] analyzed the impact of the PPS on the technical efficiency of hospitals in Virginia. They used a DEA model with two years of data (1984, before, and 1993, after the PPS was implemented) lumped together and found no statistically significant differences in technical efficiency over the study period.

Evaluating the performance of the CAH Program has spurred significant interest in the health services research area Stensland et al. [14] found that hospitals that converted to CAH status significantly increased their Medicare revenue, profitability, employee salaries, and capital expenditures. They estimated that, on average, inflation-adjusted revenue of hospitals that converted to CAH status increased by $518,571 per hospital, half of which was used to cover losses or retained as profits and the other half used to raise salaries and to cover other expenses. Using a panel data set on 89 rural hospitals in Iowa, Li, Schneider, and Ward [15] found that hospitals that converted to CAH status increased their operating revenues, expenses, and profit margins. Similarly, Schoenman and Sutton [16] also found that, after conversion to CAH status, hospitals dramatically increased their profitability due to Medicare cost-based reimbursement. Using a stochastic frontier cost function, Rosko and Mutter [11] compared the cost inefficiency of CAHs with that of prospectively paid rural hospitals and found that CAHs were, on average, more cost inefficient.

## 4. Methodology

To assess the impact of CAH status on hospital efficiency, we use a two-stage approach, where DEA is used in the first stage to estimate cost, technical, and allocative efficiency scores of each hospital in the sample. DEA uses linear programming (LP) to define