

**THE CBO
HOSPITAL COST CONTAINMENT MODEL:
A TECHNICAL ANALYSIS**

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**THE CBO HOSPITAL COST CONTAINMENT MODEL:
A TECHNICAL ANALYSIS**

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PREFACE

In September 1979, CBO published Controlling Rising Hospital Costs, a report analyzing the Carter Administration's hospital cost containment proposal and other options to contain hospital costs. The report had been prepared at the request of the Subcommittee on Health and the Environment, House Committee on Interstate and Foreign Commerce. An important tool used to analyze the Administration's proposal was a microsimulation model of the hospital industry. This paper describes the model for a technical audience.

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In keeping with the Congressional Budget Office's mandate to provide objective and impartial analyses, this study offers no recommendations.

Alice M. Rivlin
Director

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FIGURE

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FIGURE 1. EFFECT OF COST CONTAINMENT LEGISLATION ON
A HYPOTHETICAL HOSPITAL 21



SUMMARY

The Congressional Budget Office developed a microsimulation model of the hospital industry to analyze the Hospital Cost Containment Act of 1979 and other proposals aimed at reducing the growth in hospital expenditures. The analysis appeared in the paper Controlling Rising Hospital Costs, which was published in September 1979. This second paper describes the model, which was used to assess:

- o The likely savings to the federal government and other purchasers of hospital care; and
- o The distribution of these savings by type of hospital and by type of purchaser.

THE LEGISLATION

The Hospital Cost Containment Act of 1979 (H.R. 2626 and S. 570), proposed in March 1979 by the Carter Administration, would have set guidelines for increases in hospital expenditures and placed revenue controls on hospitals that failed to keep within them. The guidelines--based on the inflation rate for hospital purchases, population growth, and an intensity-of-resources factor--would have allowed hospital expenditures to increase by an estimated 14.5 percent in 1980. The controls would have limited increases in inpatient revenues per admission. Several kinds of hospitals--including small, nonmetropolitan hospitals and those in states with effective mandatory hospital cost containment programs--would have been exempt from the proposed program.

WHY MICROSIMULATION?

Microanalytic simulation involves forecasting the behavior of economic units--in this case individual hospitals--on the basis of a macroeconomic forecast and observed historical patterns of microeconomic behavior. With this process, data on past frequency distributions of levels and rates of change of hospital variables

are used to project future distributions. As a result, values for individual hospitals sum to projected aggregate values, while the historical distributional patterns are preserved.

Microsimulation was chosen to analyze the proposal because of the complex nature of the legislation, interest in the distributional effects of the legislation, and the need for speed and flexibility in performing analyses. Computation of the guidelines and revenue limits specified in the legislation required an analysis over several years of joint distributions of several variables such as hospital type and hospital location, and rates of change of expenditures, wage rates, and admissions, a task best handled with a microsimulation model. Microsimulation also permitted speedy estimates of the effects of amendments to the legislation. The model also allowed estimation of which types of hospitals would have been most affected by the legislation.

THE MICROSIMULATION MODEL

The task of estimating the size and distribution of the potential savings of the hospital cost containment proposal involved several steps. Specifically, we forecast aggregate hospital expenditures and other variables, developed forecasts for these variables for each individual hospital, determined which hospitals would meet or exceed their guidelines, and, for those hospitals exceeding their guidelines, determined the savings--that is, the amount by which revenues would be limited by controls.

Aggregate Current Policy Forecast

Hospital industry expenditures, revenues, admissions, wage rates, and the labor/nonlabor factor mix were forecast with econometric time series models using quarterly data. The forecasts assumed no changes in current policies for 1980 to 1985.

Simulation Base

A file of individual hospital data covering 1972-1977 was transformed ("aged") on the basis of the aggregate current policy forecast so that it represented the population of hospitals six years later. The annual level for each variable of interest for each hospital was inflated by the ratio of the projected aggregate level for that variable to the actual aggregate level from the

historical data. For example, since the increase in aggregate hospital expenditures between 1976 and 1982 was projected to be 140 percent, each hospital's 1976 expenditures were inflated by 140 percent to generate their values in 1982. As a result of this process, the ratio of a hospital's expenditures to the aggregate expenditure level for, say, the simulated 1982 survey was equal to the actual ratio in the 1976 survey.

Determining the Guidelines and Their Effects

Guidelines were determined for each hospital on the basis of formulas stipulated in the legislation. Once the guidelines were calculated, they were compared to the projected rate of increase in expenditures for each hospital. Hospitals with expenditure increases exceeding their guidelines were placed in a pool that would fall under controls the next year, while those that passed the guidelines were placed in the pool that would be reexamined the next year.

Measuring the Savings to Purchasers of Hospital Care

Limits on revenues per admission were calculated for those hospitals exceeding their guidelines the previous year. Savings were calculated by taking the difference between each hospital's projected revenues under current policies and those allowed by the legislation. For example, if a hospital's revenues were \$1.00 million in 1979, and if they would increase by 15 percent to \$1.15 million under current policies, a 12 percent revenue limit would result in \$0.03 million savings (\$1.15 million minus \$1.12 million) to purchasers of hospital care. Total savings were determined by summing the individual hospital savings.

Sensitivity Analyses

Three tests were made to determine the sensitivity of the savings estimates to the aggregate hospital forecasts, to the time period used to simulate future years, and to changes in assumptions about hospital behavior in response to the legislation. First, the tests found that the savings estimates were moderately sensitive to errors in the aggregate forecasts of hospital resource intensity. For example, a one percentage-point increase in intensity growth (the difference between expenditure growth per admission and input price growth) would increase five-year savings

by about 25 percent. Second, the estimates were not very sensitive to the specific years of survey data that were used. Third, the estimates were sensitive to assumptions about hospital behavior. While the main case assumed no change in hospital behavior in response to the guidelines, an alternative assumption that hospitals close to their guidelines would moderately alter their behavior would decrease five-year savings by about 20 percent.

CHAPTER I. INTRODUCTION

The Congressional Budget Office was asked by the Subcommittee on Health and the Environment, House Committee on Interstate and Foreign Commerce, to analyze the Hospital Cost Containment Act of 1979 and other options to contain hospital costs.¹ An important part of the analysis contained in Controlling Rising Hospital Costs, published in September 1979, was based on a microsimulation model of the hospital industry that was developed to analyze the impacts of this proposed legislation. The model was designed to assess:

- o The likely savings to the federal government and other purchasers of hospital care; and
- o The distribution of these savings by type of hospital and by type of purchaser.

This paper presents a technical description of the model. The remainder of this chapter describes the legislation and summarizes the microsimulation model. Chapter II discusses why the microsimulation technique was chosen. Chapter III describes in detail the microsimulation model and its use. Some of the results obtained from the model are presented in Chapter IV, which also discusses their sensitivity to assumptions and data.

THE HOSPITAL COST CONTAINMENT ACT OF 1979

The Hospital Cost Containment Act of 1979 (H.R. 2626 and S. 570), introduced in March 1979 by the Carter Administration, was designed to reduce the rate of increase in hospital expenditures. It would have been implemented in two stages. First, it would

1. A report on these analyses was released in September 1979. See Congressional Budget Office, Controlling Rising Hospital Costs (September 1979).

have screened hospitals on the basis of their characteristics or performance, exempting a substantial number. Second, revenue controls would have been placed on the remaining hospitals.²

Exemptions

The bill would have exempted a large number of hospitals from controls on the basis of their characteristics or their performance. With respect to characteristics, it would have exempted from revenue controls hospitals that:

- o Were located in nonmetropolitan areas and had admitted less than 4,000 patients per year over the previous three years;
- o Were operated by the federal government;
- o Provided mostly long-term or special care;
- o Derived at least 75 percent of their revenues from health maintenance organizations during the previous year;
- o Had been in operation less than three years; or
- o Were located in a state with a mandatory cost containment program approved by the Secretary of the Department of Health and Human Services (HHS).

The proposal also would have exempted other hospitals from controls on revenue as long as they stayed within the expenditure

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2. The Hospital Cost Containment Act of 1979 was favorably reported by the House Committee on Ways and Means, the House Committee on Interstate and Foreign Commerce, and the Senate Committee on Labor and Human Resources in 1979. Although the committees altered the original proposal in many ways, they retained the basic thrust of the Administration's bill. The House of Representatives eliminated the controls from the bill in October 1979. The Senate took no action on the bill.

Unless noted otherwise, this paper describes the version of the proposal ordered reported by the Senate Committee on Labor and Human Resources.

guidelines set by HHS. Should a hospital exceed its guidelines in any year, it would be subject to revenue controls for the duration of the program.

National Guidelines. The first performance test under the guidelines would have been a national one. If total national hospital expenditures increased by less than the national guideline, all hospitals would have been exempted from mandatory controls for the following year. Three elements would have comprised the national guideline: the percentage increase of a price index for hospital purchases, called a "market basket"; an allowance for population growth (currently 0.8 percentage point); and an allowance of one percentage point for increases in resource intensity.³ HHS would have calculated the price index using national weights and national price increases for each expenditure category in the hospital market basket. CBO estimated that this market-basket index would increase 12.7 percent in 1980 over 1979, resulting in a national guideline of 14.5 percent (the 12.7 percent for the market basket plus 0.8 percent for population growth plus 1.0 percent for resource intensity).⁴ This represented a rate lower than the 15.6 percent increase projected by CBO under existing policies.⁵

State Guidelines. If total national hospital expenditures exceeded the national guideline, then a performance test would have been applied to hospitals on a state-by-state basis. If total hospital expenditures within a state increased less than the state's guideline, the bill would have exempted all hospitals in

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3. Resource intensity refers to the level of resources provided on a per patient basis, after taking inflation into account.
 4. The higher of the actual increase or the increase estimated by HHS would be used to calculate the national guideline.
 5. Estimates presented here are the last ones provided to the Congress. They were based on January 1980 CBO economic assumptions, and assumed that hospitals would face guidelines first in 1980 and could first come under revenue controls in 1981.

that state.⁶ The guidelines would have varied among the states for two reasons. First, each state would have its own population growth factor. Second, hospitals would have their wage increases for nonsupervisory employees who were not physicians "passed through," so that each state's guideline would fully reflect differences in expenditure growth due to differences in wage increases for such workers.

Individual Guidelines. If the total expenditure increase in a state exceeded that state's guideline, the bill would then apply the performance test within the state on an individual hospital basis. The guideline for each hospital would differ from that for other hospitals in the state to the extent that its wage increases for nonsupervisory employees differed from those of other hospitals.

The Revenue Controls

The Hospital Cost Containment Act of 1979 would have placed controls on revenues of hospitals not exempt on the basis of either their characteristics or their performance. While the guidelines would apply to increases in total hospital expenditures, including those for outpatient services, the revenue controls would apply only to inpatient revenues. For hospitals under the revenue controls, the bill would have applied a cap on increases in inpatient revenue per admission from the year that the guideline was breached. If a hospital's revenue rose less than the cap in any year, the unused portion could be carried over into future years.

The starting point in the calculation of each hospital's cap would have been the percentage increase in the prices of the hospital's market basket for goods and services. Hospitals would have used the higher of the percentage increase forecast by HHS or the percentage increase actually experienced. The wage pass-through under revenue controls would have been the same as that

6. In practice, guidelines would be calculated for each hospital. If the sum of the differences between each hospital's actual expenditures and those allowed according to its guideline was zero or negative, then the entire state (or nation) would be exempt from revenue controls the next year.

used for the guidelines. No automatic resource intensity component would have been added in calculating the revenue cap, however.⁷

The proposals included three important adjustments to the basic revenue cap. The first of these was an "efficiency adjustment." HHS would increase the cap for hospitals with relatively low per diem routine costs, while that for hospitals with relatively high costs would be reduced. The second adjustment, which would have compensated for changes in a hospital's admission rate, was intended to reduce incentives to increase the number of admissions.⁸ The third adjustment, called the base-period adjustment, was intended to remove incentives for hospitals to increase their costs during the year before they expected to be subject to revenue controls. The cap would have been reduced by the amount by which a hospital exceeded its guideline in the previous year.

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7. For more details and other adjustments to the revenue cap, see CBO, Controlling Rising Hospital Costs.
 8. The admissions adjustment would have been left to the discretion of the Secretary of HHS. Under the formula assumed by the HHS staff, and used for this estimate, allowed hospital revenues would have equaled "deemed" admissions times allowed revenues per admission. "Deemed" admissions would have equaled actual admissions if the increase in admissions over the previous year had been less than 2 percent. If admissions had increased by more than 2 percent, "deemed" admissions would have equaled 102 percent of the previous year's admissions plus 75 percent of the admissions above 102 percent. If admissions had declined from the year before, deemed admissions would have equaled prior-year admissions minus 75 percent of the decline.

For example:

Base Period Admissions	Actual Admissions	"Deemed" Admissions
100	102	102
100	110	108 [102 + .75 (110-102)]
100	92	94 [100 - .75 (100-92)]

The Secretary of HHS would have been authorized to grant exceptions to hospitals under certain conditions. Although the legislation mentioned some general conditions for exceptions to be granted (for example, renovation costs or significant new services), no specific criteria were included.

THE MICROSIMULATION MODEL

Microanalytic simulation was chosen as the method for analyzing the hospital cost containment legislation. The technique involves forecasting the behavior of individual hospitals on the basis of an aggregate hospital forecast and past patterns of individual behavior relative to aggregate trends.

The task of estimating the size and distribution of the potential savings of the hospital cost containment legislation involved the following four basic phases, which are discussed in detail in Chapter III:

- (1) Forecasting aggregate hospital expenditures and other variables for 1980 through 1985 assuming no change in current federal policies (the "current policy" forecast);
- (2) Developing a current policy forecast for expenditures and other variables for each individual hospital (the simulation base). For example, if total hospital expenditures were projected to increase 14 percent in 1981, the numbers of hospitals that would increase their costs by 12, 13, 14, or 15 percent were projected;
- (3) Determining which states, and then which hospitals, would meet or exceed their guidelines; and
- (4) For those hospitals exceeding their guidelines, determining the difference between each hospital's current policy revenues and the revenues that would be allowed under the controls. Estimates of savings to the federal government and other purchasers of hospital care were derived by aggregating these differences.

CHAPTER II. WHY MICROSIMULATION?

Microsimulation involves forecasting the behavior of microeconomic units--in this case individual hospitals--on the basis of a macroeconomic forecast and observed historical patterns of microeconomic behavior. The starting point is an historical microdata file such as a survey. A set of behavioral equations are applied to each microeconomic unit to transform the historical file into a file simulating the original survey under different, in this case future, conditions. The simulated microeconomic behavior is constrained in the aggregate by macroeconomic parameters forecast outside of the model.¹ Using this process, distributional characteristics of the simulated population are determined by the behavioral equations and by the initial survey data, while the aggregate levels of the variables are determined by the macroeconomic forecast.

As mentioned in Chapter I, microsimulation was chosen to analyze the hospital cost containment proposal because of the complex nature of the legislation, the interest in distributional analyses, and the need for speed and flexibility in examining alternative proposals. The legislation specified a complex screening process, with guidelines for percentage expenditure increases applied first to state aggregates and then to individual hospitals in those states exceeding their guidelines. Revenue controls, in turn, would have been based, in part, on each hospital's past expenditure growth.

The microsimulation model was able to incorporate the necessary frequency distributions of rates of change of expenditures and other variables, which were particularly complex. To begin

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1. In some simulation models, but not this one, feedback mechanisms are built into the model so that distributional information forecast by the microsimulation modifies the parameters of the external macroeconomic model. This was unnecessary for the hospital cost containment model because no behavioral algorithms were simulated that would change the parameters of the macroeconomic model.

with, because the legislation specified guidelines and revenue caps based on a variety of variables, analysis of the legislation required the computation of joint distributions of such variables as hospital type and location, level of per diem routine costs (for the efficiency adjustment), and the rates of change in expenditures, inpatient revenues per admission, admissions, and wage rates. Assumptions of either independence or linear relationships among these distributions were unwarranted. Second, the shapes of the distributions, especially the percentage change in total expenditures, were skewed and non-normal (see Table 1).²

In addition, the savings estimates required the behavior of individual hospitals to be traced over time. It was necessary to determine which hospitals meeting their guidelines in the first year would meet them the next year as well. Those hospitals exceeding their guidelines in one year would be subject to revenue limits in the following year, with the limit determined partly by current activity and partly by the amount by which the guidelines were exceeded in the previous year. It was therefore necessary to preserve patterns of year-to-year variation in the rates of change of expenditures and revenues for individual hospitals in order to estimate savings for each hospital.

The microsimulation model allowed the determination of which type of hospitals would be most affected by the legislation. In other words, the model allowed CBO to answer questions such as, would large hospitals be penalized more than small ones, public hospitals more than proprietary ones, teaching hospitals more than nonteaching ones?

The development of a microsimulation model also allowed speed and flexibility in analyzing alternative proposals. It was anticipated that a large number of estimates would have to be made under strict time pressures when the bills reached the Committee mark-up stages. The ability to reestimate savings quickly in response to alternative assumptions about macroeconomic conditions or hospital behavior was crucial, as was the ability to incorporate proposed legislative amendments quickly into the estimation process.

2. For total expenditures, the null hypothesis of normality was rejected on the basis of the Kolmogorov-Smirnov D-test at the 0.01 percent level.

TABLE 1. DESCRIPTIVE STATISTICS ON SELECTED HOSPITAL VARIABLES:
1976-1977^a

	Percentage Change in Total Expenditures	Percentage Change in Adjusted Admissions ^b	Percentage Change in Expenditures per Adjusted Admission	Percentage Change in Wage Rates ^c
Median	13.7	0.2	13.9	8.3
Mean	14.8	0.7	14.6	8.6
Standard Deviation	11.5	9.9	11.9	12.4
Skewness	1.7	1.1	1.0	0.6
Kurtosis	10.3	8.2	5.6	2.9

SOURCE: American Hospital Association Annual Hospital Surveys, 1976, 1977.

- a. These statistics exclude hospitals with missing data, unusual data, and those exempted by legislation on the basis of characteristics or state cost containment programs. See Chapter III for details.
- b. Adjusted admissions is a measure combining the number of inpatient admissions and the volume of outpatient services in terms of equivalent inpatient admissions based on revenue levels. It is derived by multiplying the number of outpatient visits by the ratio of outpatient revenue per visit to inpatient revenue per admission and adding this to the number of inpatient admissions. For further details, see American Hospital Association, Hospital Statistics (1979).
- c. Payroll per full-time equivalent employee, used as a proxy for wage rate for nonsupervisory, nonphysician employees.

Two alternatives to microsimulation were considered. First, the aggregate forecast of hospital expenditures could have been compared to a forecast of the average limit on hospital revenues. But such a technique would have ignored the important screening process in the proposal and would have incorrectly summed individual hospital revenue increases that were lower than allowed increases with those greater than the limit.

Second, the distributions of relevant variables could have been summarized by fitting them with appropriate functional forms and then manipulating them manually. Such a method would have been less accurate and less flexible than microsimulation, however. Accuracy would have been lost in the process of approximating distributions. The loss of information would have been particularly severe when attempting to approximate the joint distribution between different years. Flexibility would have been lost as additional time would have been necessary to change the model's parameters in response to amendments to the bill or to new forecasts of hospital performance or economic conditions.

CHAPTER III. THE SIMULATION MODEL

As described in Chapter I, the modeling process involved four basic phases: (1) the aggregate current policy forecast; (2) the application of the aggregate current policy forecast to historical data for individual hospitals to create the current policy simulation; (3) the determination of which hospitals passed and failed their guidelines; and (4) the determination of the probable savings to purchasers of hospital care resulting from the cost containment legislation. This chapter describes in more detail the techniques employed.

AGGREGATE CURRENT POLICY FORECAST

Hospital industry expenditures, admissions, wage rates, and the labor/nonlabor factor mix were forecast separately. Time series regression models estimated with quarterly data from the National Hospital Panel Survey were used to forecast the aggregate variables. Revenue growth under current policies was assumed to equal expenditure growth; hence, growth in inpatient revenues per admission was proxied by growth in expenditures per adjusted admission. Wage increases were approximated by changes in each hospital's payroll per full-time equivalent employee, as specified in the legislation.

Prior to the simulation, the current policy forecast was adjusted to reflect the exemption of hospitals in states with their own cost containment programs (see below). On the basis of a separate analysis, we estimated that annual expenditure growth in the eight states with programs would be 3 percentage points below that in states without programs.¹ This raised the current policy forecast for annual expenditure growth for the remaining hospitals by 0.7 percentage point.

1. See CBO, Controlling Rising Hospital Costs, Chapter 4.

CREATING THE SIMULATION BASE

A file of data on individual hospitals covering six years of experience was transformed or "aged" on the basis of the aggregate current policy forecast to represent the same population six years later. This aging process resulted in a simulated data base of future hospital behavior.

Selection of the Data

The historical data were obtained from the American Hospital Association's (AHA) Annual Hospital Survey. Computer tapes for the years 1972 through 1977 were merged by hospital so that the behavior of individual hospitals could be analyzed over time.² While over 8,300 hospitals, including virtually every American hospital, are represented on this tape, only some were selected for use in the simulation (see Table 2).

Hospitals were deleted from the data base for four reasons. First, the legislation exempted hospitals in states with their own mandatory hospital cost containment programs, provided that the state's rate of expenditure increase was within 1 percentage point of its guideline. On the basis of our analysis of state program effectiveness and the discretion afforded the Secretary of HHS in the legislation, we assumed that eight states--Connecticut, Maryland, Massachusetts, New Jersey, New York, Rhode Island, Washington, and Wisconsin--would be exempt. Hospitals in these states (about 18 percent of all hospitals) were dropped from the analysis.³

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2. The data for earlier years were considered too incomplete and unreliable to use.
 3. HHS also assumed these states would be exempted. When the bill was introduced, Colorado had a cost control program. It was subsequently repealed in February 1980. The Rhode Island program is run by Blue Cross under guidelines from the state. Rhode Island hospitals were nevertheless dropped from the analysis because HHS officials expected the state's program to qualify for the exemption.

TABLE 2. HOSPITALS ELIMINATED BY COST CONTAINMENT MODEL SCREENS,
IN ORDER OF REJECTION

Reason for Elimination	Percent of Total Eliminated by the Legislation	Percent of Total Eliminated by CBO Screens	Percent of Total Failing Any Screen
State has mandatory cost containment program	18	--	18
Not a community hospital	13	--	13
Incomplete reporting or not in operation for full period (1973-1977) ^a	--	25	25
Failed one or more screens for outlier data	--	2	2
Small rural hospital	17	--	17

Total	48	27	75

a. Includes hospitals in existence for less than three years.

Second, the legislation specified the elimination of hospitals that were not "community hospitals." These included federal hospitals, long-term hospitals, and special service hospitals (such as psychiatric hospitals). About 13 percent of all hospitals were eliminated at this stage.

Third, hospitals were dropped if they had incomplete data for the period from 1973 to 1977, or if they failed to report to the AHA in any of these years.⁴ About 25 percent of all hospitals were eliminated on these grounds at this step.⁵