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Program Evaluation and
Methodology Division

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January 31, 1991

The Honorable Pete Stark
Chairman, Subcommittee on Health
Committee on Ways and Means
House of Representatives

Dear Mr. Chairman:

In the traditional model of health services delivery, a community's health care providers study the prevalence of illnesses within the community and decide what services are needed to treat them. This model presumes, then, that when an expansion in capacity (the ability to provide those services) is needed, the providers' decisions will be based solely on the community's health status.

Another model of health services delivery, known as Roemer's law, assumes that increases in the ability to provide health services lead to increases in the rate at which health services are actually provided (volume).[1] This model expects health care providers to adjust the rate at which services are delivered to respond to available capacity as well as actual need. To this way of thinking, "a built bed is a filled bed."[2] That is, the model postulates that when bed capacity is in short supply physicians may decide to admit only seriously ill patients. But, as capacity increases, physicians may also admit patients who are not as seriously ill and likely would not have been admitted if capacity were scarce.[3]

If Roemer's law is correct and the provision of some services is discretionary (that is, based at least partially on available capacity), that suggests a number of policy options for controlling costs. Foremost among these is a strategy based on the assumption that limiting or restricting hospitals' capacity will decrease volume and thus achieve cost savings without affecting access to needed care. However, if decisions to provide services are based primarily on the occurrence and prevalence of illness, limiting capacity might well result in lower volume, but at the sacrifice of reducing necessary access to health care.

[1]Milton Roemer and Max Shain, Hospital Utilization Under Insurance (Chicago: American Hospital Association, 1959).

[2]E.K.A. Van Doorslaer and R.C.J.A. Van Vliet, "A Built Bed Is a Filled Bed?: An Empirical Re-examination," Social Science Medicine, 28 (1989), 155-164.

[3]Roemer and Shain assumed that the patients' ability to pay was not an issue because they had insurance.

Roemer's law is not very different from the idea in criminal justice that if prison capacity is expanded, prison population will swell to fill the space. In both cases, the argument is about whether increased capacity is used meaningfully or whether it merely augments the volume of services without showing measurable improvements.

Methodology

Objectives

You asked us to determine if completed studies of health services delivery support Roemer's model. Further, if these studies did not permit a judgment about Roemer's law, you wanted us to indicate what research gaps needed to be filled to reliably determine its accuracy. Specifically, our study focused on the following questions:

- What is the relationship between capacity and volume shown in these studies?
- What research gaps, if any, need to be filled to reliably assess the validity of Roemer's law?

Scope

Because this report focused on completed studies of Roemer's law, we did not examine the law independently of those studies. Also, we did not go beyond our objectives to assess the consequences for the health care system if Roemer's law were shown to be true and capacity were limited. We conducted this review between March 1989 and March 1990 in accordance with generally accepted government auditing standards.

Analysis

We identified more than 200 studies that examined either Roemer's law or, more generally, how capacity influences the volume of health services provided. Twenty-nine of these studies (listed in appendix III) met the three criteria we set for inclusion in our review: empiricism (they quantitatively measured the effect of changes in capacity on volume); timeliness (they were published after 1979); and relevance (they used U.S. data).[4]

In 21 of the studies, the researchers measured "capacity" as the number of available hospital beds and "volume" as the number of hospital

[4]The results of these 29 studies were reported in 30 separate publications.

admissions. Two of the studies used the availability of medical technologies and six used the availability of physicians as measures of capacity.[5] None of the studies reported data collected later than 1983.

We chose meta-analysis because it is the most appropriate method for synthesizing the results of quantitative studies. Appendix I discusses how we combined those results to determine the strength of the relationship across studies. In brief, we

- identified relevant studies through computerized bibliographic searches and expert consultation;
- described the strength and direction of the relationship between capacity and volume from each study with a quantitative measure;
- summarized the measures for all the studies to obtain an overall measure of the relationship between capacity and volume for the relevant studies that we identified;
- grouped the studies according to the complexity of their research design, the type of patient studied, the data analysis technique used, the sample type, the time period when the data were collected, and the size of the geographic unit analyzed;
- combined the quantitative measures within each subgroup of studies to obtain a summary measure of the relationship between capacity and volume for that subgroup of studies; and
- compared the subgroups' summary measures to determine if it was the manner of conducting the studies that led to differences in their results.

The chief limitation of meta-analysis is that it is necessarily dependent on the quality and quantity of the available studies. Moreover, our use of meta-analysis required that we have all the statistics associated with an analysis. When studies did not include this information, we contacted their authors to obtain it. These efforts were successful for 10 of the 29 studies. We concluded that those 10 studies did not differ meaningfully from the 19 studies that were not included. There was no credible reason for believing that the needed information was systematically unavailable except for the time that had elapsed since the studies were conducted (see table I.1).

[5]The quantitative relationship between volume and capacity for hospital admissions is of similar magnitude and direction to that for physicians and technologies, although the processes that underlie these relationships may be quite different.

Principal Findings

Relationship Between Capacity and Volume

We quantitatively summarized the data from the research studies to determine to what degree capacity was related to volume. Generally, the relationship was not strong—a correlation of 0.21 (see table II.1). We found some evidence that for the period covered by the data in these studies—from 1979 to 1983—health services capacity did contribute somewhat to the volume of services provided, but other factors were much more important. Nonetheless, even a weak relationship can be important from a budgetary point of view. For example, in 1983, a reduction of one bed per thousand population would have reduced admissions by over 4 percent (equivalent to about $5 billion in costs) or reduced length of stay by almost 3 percent (equivalent to over $3 billion in costs). Thus, in answer to your first question, we found only a weak relationship between capacity and volume; however, such a relationship could have substantial cost impact.

Research Gaps

With regard to your second question, it is clear that some gaps in the research need to be filled if the relationship between capacity and volume of health services is to be better understood. First, the changes in health services that accompanied the adoption of Medicare's Prospective Payment System in 1983 are not reflected in the earlier studies we analyzed. For example, Peer Review Organizations, created to monitor hospital performance under Prospective Payment, deny payment for unnecessary admissions and thus provide incentives for outpatient treatment. Post-1983 data must be reviewed to determine what the current relationship may be.

Second, the increase in outpatient surgery, especially ophthalmological surgery, due in part to technological changes, has reduced the number of hospital admissions. Most of our studies (21) measured hospital beds and admissions, and the reduction in hospital admissions might have reduced the relationship between capacity and volume. Therefore, new studies are needed to measure discretionary services for those specific situations where new policy is now being applied, such as with Medicare enrollees.

Third, the manner in which studies of capacity and volume are conducted can affect their findings. Research designs should eliminate

alternative explanations. For example, an increase in the volume of hospital admissions can be due to a deterioration in health status, and thus, deteriorating health status must be eliminated as an explanation before capacity can be used to explain the increased volume.

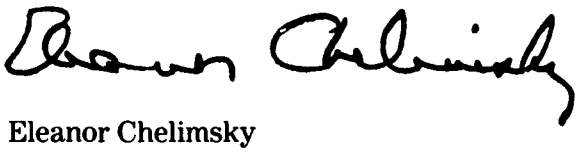
Appendix II describes how we determined what research gaps would need to be filled to establish Roemer's law. We examined the information that we had developed from the completed studies in conjunction with the findings from the meta-analysis. Appendix III identifies the 29 studies.

Agency Comments

We did not obtain agency comments because no agency was directly involved in this study. We will, however, send copies of this report to interested persons upon request.

If you have any questions or would like additional information, please call me at (202) 275-1854 or Kwai C. Chan, Director of Program Evaluation in Physical Systems Areas at (202) 275-3092. Other major contributors to this report are listed in appendix IV.

Sincerely yours,



Eleanor Chelimsky
Assistant Comptroller General

Contents

Meta-Analysis Results

We conducted a meta-analysis of research studies to determine whether a relationship exists between health services capacity and volume of services used and, if it exists, whether the evidence would support Roemer's law (that is, capacity affects volume). We identified relevant studies, quantitatively described the relationship between capacity and volume in each, and summarized the relationship for all the studies.

Identifying Relevant Studies

As the first step in the meta-analysis, we established criteria for inclusion and screened the abstracts of over 1,300 completed studies found in a computerized, topical, bibliographic search to determine which studies met our criteria. From this initial listing, we identified and retrieved over 200 studies that were (1) published after 1979 and (2) measured the extent to which capacity and volume were related.

Those studies whose abstracts did not provide enough information for us to apply our criteria were also obtained for review. We identified additional studies by conducting computerized citation searches for investigations and investigators referenced in studies that we had obtained previously and had found especially relevant. These computerized citation searches continued until we failed to find relevant studies that had not been identified earlier. Finally, experts in the health services field reviewed a list of the studies that met our criteria to ensure that there were no omissions.

This search procedure identified 29 studies that were appropriate for the meta-analysis. Table I.1 shows selected characteristics of these studies. Appendix III lists the 29 studies.

Besides studies that measured the number of hospital beds and admissions or discharges, three studies measured the availability of physicians, two focused on the usage of particular medical devices (such as electronic fetal monitors and intraocular implants), and one addressed competition between hospitals. None of the studies included data collected after 1983, although many studies were published after that date. This means that changes in the health services environment that followed the adoption of Prospective Payment in 1983 are not reflected in these studies.

To avoid combining studies in which volume may have been determined by factors not relevant to the United States, we excluded those that did not use U.S. data. We also excluded those that measured capacity and volume in ways other than the number of hospital beds, the presence of medical devices that could be linked to specific procedures, or the number of physicians available in a geographic area or population. Thus, we excluded studies whose focus was an individual's ability to pay (except as an adjustment), the financial status of hospitals, or the use of mental health services. Volume, defined as the rate at which health services are provided, was measured as length of stay, the number of discharges or admissions, or the number of surgical or medical procedures completed.[1] In addition, we excluded studies in which the measure of volume included the time individuals waited to see physicians and the price or cost of the service because those measures did not reflect the rate at which health services are provided.

[1]Other measures, such as number of bed days, may have been more appropriate, but they were not used in enough of the studies.

Table I.1: Selected Characteristics of the Studies Identified

Study characteristic	Matrix obtained[a]	Matrix not obtained[a]	Total
Median year of publication	1985	1985	1985
Median year of data collection	1980	1976	1978
Median sample size	130	349	205
Median capacity/volume correlation	0.16	0.10	0.11
Complex studies[b]	40%	68%	59%
Unit of analysis			
Market area[c]	70%	21%	38%
Hospital	20	32	28
Individual	0	26	17
MSA[d]	10	11	10
State	0	11	7
Population			
General	60%	68%	66%
Medicare enrollee	30	11	17
Michigan Blue Cross/Blue Shield	10	11	10
Medicaid recipient	0	5	3
AFDC recipient[e]	0	5	3
Scope			
National	40%	47%	45%
State	50	26	34
Regional	0	16	10
Counties	0	11	7
Thirty-one largest MSAs[d]	10	0	3
Analytic technique			
Ordinary least squares[f]	50%	37%	41%
Two-stage least squares[g]	10	47	34
Ordinary least squares changes[h]	20	11	14
Correlational[i]	20	5	10
Capacity measured as			
Hospital bed density[j]	70%	84%	79%
Physician density[k]	30	16	21
Volume measured as			
Admissions/discharges[l]	60%	42%	48%
Utilization rate or intensity[m]	20	21	21
Length of stay[l]	0	26	17
Procedures using new technology[n]	10	5	7
Occupancy rate[l]	0	5	3
Days of care[l]	10	0	3

[a]A statistically significant difference in the year of data collection was found between the 10 studies for which matrices were obtained and the 19 for which matrices were not obtained. However, because no

other significant differences were found between the selected characteristics of the two sets of studies, we concluded that any differences between them were trivial.

[b]We rated studies complex if their research designs were able to eliminate at least three plausible alternative explanations for their results. For example, studies that eliminated health status, border crossing, and differentials in the ability to pay as explanations for changes in volume were rated as complex.

[c]Market areas designate the geographic areas that are served by specific hospitals, physicians, or groups of physicians.

[d]MSAs (Metropolitan Statistical Areas) are defined by the U.S. Bureau of the Census as an area in which there is a total population of 100,000 and in which there is a city or urban area with a population of at least 50,000.

[e]Aid to Families With Dependent Children.

[f]Ordinary least squares, also known as multiple regression, is a statistical procedure used to examine the relationship between capacity and volume while adjusting for other factors.

[g]Two-stage least squares is a sophisticated statistical form of multiple regression that, among other uses, can be used to analyze longitudinal data.

[h]Ordinary least squares with changes is the same as ordinary least squares, except that capacity, volume, and the other factors are measured as the difference between one time period and another.

[i]Correlational analysis is a statistical procedure that yields a correlation coefficient that measures the degree of linear relationship between volume and capacity without adjusting for other factors.

[j]The number of hospital beds per capita, usually beds per thousand population.

[k]The number of physicians per capita, usually physicians per thousand population.

[l]Different measures of hospital utilization are related as follows: patient days of care is the product of length of stay and number of admissions; average daily patient days of care divided by the average number of beds is the occupancy rate.

[m]A measure of the per capita rate at which services are provided.

[n]The number of procedures or treatments using new technologies such as electronic fetal monitors or intraocular implants.

Describing the Relationship Between Capacity and Volume

To describe the strength and direction of the relationship between capacity and volume, we used the correlation coefficient because it can be used to combine results from different measures across the studies.[2] That is, by using a correlation coefficient, the studies using physician availability or new technology as measures of capacity could be combined with the majority of the studies that used hospital beds as a measure of capacity.[3]

[2]The correlation coefficient used here is computed as the semi-partial correlation between capacity and volume.

[3]A less desirable characteristic of the correlation coefficient is that it cannot be used to directly indicate how much volume is associated with an increase in capacity. However, we provide an estimate of how admissions and length of stay would be affected by a change in the bed supply based on the average bed supply and average variation in the bed supply, average number of admissions, and average length of stay for the U.S. community hospitals in 1983 (see table II.1).

A correlation coefficient can range in size from -1 to 1, with 0 indicating no relationship, -1 indicating the strongest possible inverse relationship (the more capacity, the less volume), and 1 indicating the strongest possible positive relationship (the more capacity, the more volume).[4] If capacity is related to volume, then changes in the amount of available capacity will be associated with changes in volume. Thus, if the correlation coefficient, hypothetically, were found to be -0.10, then there would be a small tendency for any increase in capacity to be associated with a decrease in volume. Alternatively, if the correlation coefficient were found, hypothetically, to be 0.3, then there would be a moderate tendency for an increase in capacity to be associated with an increase in volume.

Summarizing the Relationship

In using the correlation coefficient to summarize the relationship between capacity and volume, we had to overcome a technical problem. With few exceptions, studies of capacity and volume used statistical techniques related to multiple regression. This approach yields quantitative descriptions of the strength of the relationship between capacity and volume that may not be comparable across all studies.

The problem is that multiple regression techniques estimate the relationship between volume and capacity while "removing" or adjusting for the contribution of other factors to volume (such as the number of medical doctors available or the price of admissions or procedures). The correlations between capacity and volume will typically vary depending upon which of these other factors are included in the analysis. Because the studies we examined included a variety of factors, the indicators of the strength of the relationship are not comparable across studies.

Overcoming the lack of comparability among the studies involved two steps.[5] In the first, we constructed a "synthetic" correlation matrix that captured the relationships between volume and capacity plus all the other factors that were analyzed in two or more studies.[6] We then used

[4]The range of a correlation from -1 to 1 is the upper bound for a perfectly linear relationship and is probably smaller for the relationship between capacity and volume.

[5]A brief discussion of meta-analyzing regressions is found in John E. Hunter, Frank L. Schmidt, and Gregg B. Jackson, Meta-Analysis: Cumulating Research Findings Across Studies (Beverly Hills, Calif.: Sage Publications, 1982), pp. 157-8.

[6]To perform this step, we had to obtain the full zero-order correlation matrix from each study. This was possible for 10 of the 29 studies summarized in table I.1. The method for combining correlations can be found in Larry V. Hedges and Ingram Olkin, Statistical Methods for Meta-Analysis (New York: Academic Press, 1985).

the synthetic matrix to run a regression analysis, which produced a semi-partial correlation between capacity and volume—adjusted for age, race, sex, education, physician density, health status (disease rate, infant mortality), alternative treatment availability (nursing home beds, long-term care beds), and available hospital population (population density, percent enrolled in a Health Maintenance Organization).

The semi-partial correlation produced by this procedure was 0.21, which indicates a positive, but weak, relationship between capacity and volume after controlling for the effects of the other variables. That is, we found only a small tendency for high volume to be associated with high capacity and low volume to be associated with low capacity after we attempted to remove the influence of other factors.[7]

Evidence for a Weak Causal Connection

Even though we found a small positive relationship between capacity and volume, that alone does not show that increased capacity causes increased volume. Because such a relationship would exist whether capacity is influencing volume or whether the relationship is due to some other factor influencing both capacity and volume, one must also determine whether capacity is influencing volume.

The temporal order of capacity and volume (changes in capacity precede those in volume) is sometimes accounted for as part of the research study design. Of the 16 studies that found an association of at least 0.10 between capacity and volume, seven established that changes in capacity preceded volume changes while nine studies could not determine temporal order. The seven that established temporal order used data that measured changes between two points in time and the statistical technique known as "two-stage least squares regression" to infer that changes in capacity do precede those in volume.

There is, thus, evidence from some of the studies we analyzed that capacity contributes to volume but in a very small way. However, using 1983 averages for admissions and length of stay, a reduction of one bed

[7]Because the available data were not produced by experimentally controlling other factors that might influence volume, the estimate of a 0.21 correlation between capacity and volume may be somewhat in error. That is, one source of error is caused by omitted variables. For example, some portion of this correlation may really reflect variations in health status, which have not been removed by our analysis. For a discussion of such issues, see M. Blumberg, "Inter-Area Variations in Age-Adjusted Health Status," Medical Care, 25 (1987), 340-53. A second source of error is due to sampling errors found within each of the studies. The third source of error may be due to differences in the correlation structures of the different studies. Although we are uncertain about the exact magnitude of the relationship between capacity and volume, we believe the evidence clearly indicates that it is a weak one.

per thousand population would have reduced admissions by over 4 percent, equivalent to about $5 billion. Reducing length of stay by almost 3 percent would equate to about $3 billion. Thus, a weak relationship can nonetheless have a major impact on costs. But it is also the case that a number of other factors that are not specified in our analysis, taken together, had greater influence on the volume of health care services prior to 1983 than did capacity.

Gaps in the Current Research

We examined the information that we had developed from the completed studies to determine what research gaps need to be filled to reliably assess the validity of Roemer's law. Using meta-analysis, we diagnosed inconsistencies in the studies that pertained to the strength of the relationship found between capacity and volume. We also assessed the studies' adequacy as a means of proving or disproving the law by reviewing their research designs, data, and methods.

Information From Completed Studies

By examining information developed from the completed studies, we identified some of their omissions. These omissions, in light of recent changes in health services, indicate some research gaps that need to be filled.

Diagnosing Research Gaps

Diagnosing the research gaps that are suggested by inconsistencies in the completed studies involved the following steps. First, we

- classified the studies according to how they had been conducted (that is, their research design characteristics);
- selected design characteristics that our own review of the studies had indicated could affect the strength of the relationship between capacity and volume (that is, present in at least half of the studies); and
- used a measure of the strength of the relationship between capacity and volume to summarize each subgroup of studies in which a design characteristic was present or absent.

After obtaining these correlations, we compared them to determine if the presence of a design characteristic affected the strength of the relationship between capacity and volume. Correlations that differed greatly when the research design characteristic was present, compared to when it was not, indicate that a research gap may exist.[1] We concluded that a gap exists if it is not known why the presence of a design characteristic influences the results.

[1]Significance testing cannot be used to determine if the difference between correlations is meaningful because the studies cannot be considered a probability sample. We determined how meaningful a difference was by considering if the correlations differed by at least a factor of 2. See Lee Sechrest and William H. Yeaton, "Magnitudes of Experimental Effects in Social Science Research," Evaluation Review, 6 (1982), 579-601, for a discussion of why significance tests are not appropriate for determining how meaningful research differences are and what other techniques can be used to determine the meaningfulness of research differences.

Research Design Characteristics

We used six research design characteristics to group the studies.

- Complexity (simple, complex): A design was rated as complex if it was able to eliminate at least three plausible alternative explanations of the study's results.
- Patient type (general, special): Populations that were not limited to specific patient types such as Medicare enrollees or aid recipients were considered general.
- Data analysis technique (simple, other): Ordinary least squares was considered simple, as opposed to all other techniques.
- Sample type (national, other): A sample was national if it represented the United States as a whole as opposed to regions or states.
- Time period (before 1980, after 1980): This referred to when the data were collected.
- Small geographic area (small area, other): This was a unit of analysis consisting of a market area (hospital or physician) or a Metropolitan Statistical Area, as opposed to other units of analysis.[2]

Summary Correlations for Design Characteristics

Table II.1 shows the summary correlations between capacity and volume for the presence and absence of the research design characteristics by which we classified the studies. To demonstrate what correlations of this size might imply for hospital settings, we estimated the changes in length of stay and number of admissions when capacity changes by one unit. For example, studies that did not use a national sample had a correlation between capacity and volume more than nine times larger than studies that used a national sample. For a hospital in 1983, a correlation of 0.21 might be associated with a length of stay of 0.22 days and 6.60 admissions per bed. That is, when the number of beds per thousand population decreases by one, length of stay and number of admissions decrease by 0.22 days and 6.60 admissions per bed.

[2]More explicit definitions of these research design characteristics are in table I.1. Instead of evaluating the studies using a global measure of "quality," we rated those aspects of research design that have been identified as comprising quality.

Table II.1: Effect of the Presence and Absence of Selected Research Design Characteristics on the Strength of the Relationship Between Capacity and Volume

Research design characteristic	Characteristic present			Characteristic absent		
		Capacity change of one bed yields volume change of			Capacity change of one bed yields volume change of	
	Semi-partial correlation[a]	Number of admissions	Length of stay (days)	Semi-partial correlation[a]	Number of admissions	Length of stay (days)
General population[b]	0.23 (0.31)	8.19	0.27	0.12 (0.14)	3.70	0.12
National sample[c]	0.07 (0.08)	2.11	0.07	0.68 (1.33)	35.12	1.16
Pre-1980 data[d]	0.16 (0.19)	5.02	0.17	0.56 (0.77)	20.33	0.67
Complex design[e]	0.27 (0.32)	8.45	0.28	0.16 (0.21)	5.55	0.18
Simple data analysis[f]	0.12 (−0.18)	−4.75	−0.16	0.46 (0.72)	19.01	0.63
Small area[g]	0.10 (0.12)	3.17	0.10	0.47 (0.66)	17.43	0.58
All studies	**0.21 (0.25)**	**6.60**	**0.22**	[h]	[h]	[h]

[a]The associated standardized regression coefficient, in parentheses, was used to estimate the impact of changes in capacity on volume; a change in capacity of a standard deviation in the bed supply leads to a change in volume of one standard deviation in admissions or length of stay. The averages and standard deviations for the bed supply, number of admissions, and length of stay were based on the U.S. community hospitals in 1983.

[b]Population of patients representative of all types of patients, as opposed to patient types such as Medicare enrollees and recipients of Aid to Families With Dependent Children.

[c]Sample of patients that is representative of patients nationally, as opposed to a sample of patients representative of a state or region.

[d]Data collected before 1980, as opposed to data collected after 1980.

[e]Designs that we rated as eliminating three or more plausible alternative explanations, as opposed to designs that we rated as eliminating fewer than three alternative explanations.

[f]Analytic technique of ordinary least squares was used, as opposed to any other analytic technique. The negative sign of the semi-partial correlation indicates that a decrease in the bed supply would cause an increase in admissions and length of stay.

[g]The unit analyzed was a Metropolitan Statistical Area or a market area, as opposed to some other unit of analysis.

[h]Does not apply.

Comparisons Among Summary Correlations

Comparisons among the summary correlations indicated that, with the exception of "time period," design characteristics affected the strength of the relationship between capacity and volume. Research gaps exist in some completed studies because the reasons why these design characteristics are associated with inconsistencies in the strength of the relationship are not evident. For example, studies that we rated as having complex designs may have found stronger relationships between capacity and volume because they eliminated the influence of factors that deflated the relationship.

In studies whose designs are not complex, the most important characteristics, based on the summary correlations and the usual need for methodological rigor, are simple data analysis and small geographic area. Studies that use simple data analytic techniques, such as ordinary least squares, may not adequately establish that capacity changes precede volume changes. The size of the geographic unit analyzed may affect the relationship between capacity and volume because its size may affect the amount of capacity that is available.

Research Gaps to Be Filled

Some research gaps, reflecting omissions in the available research that we identified from reviewing our studies' research designs, data, and methods, need to be filled if the validity of Roemer's law is to be further examined. Other research gaps, indicated by research design characteristics that affected the strength of the relationship between capacity and volume in our studies, need not all be filled to ascertain whether the law is correct.

Measures Should Reflect Full Scope of Services

Most of the completed studies of volume and capacity measured hospital beds and admissions rather than the full scope of currently used health services. Increases in the delivery of health services that rely on the use of outpatient treatment and procedures based on new technologies indicate that studies to determine the validity of Roemer's law should use measures of volume and capacity that reflect these increasingly used health services.

Data Should Include Post-1983 Changes

Data more recent than those used in our studies are needed to reflect the important changes that occurred in the health services environment after the adoption of Prospective Payment in 1983. For example, one change that accompanied the adoption of Prospective Payment is lower community hospital admissions. A consequence of lowered admissions could be the elimination of the relationship between capacity and volume when measured by hospital beds and admissions.

Research Designs Should Eliminate Other Explanations

Research designs should eliminate alternative explanations for their findings. The 10 studies used in our meta-analysis included only seven that did. In addition, because the manner of conducting a study can affect its findings, studies should include techniques for determining what effect the unit of analysis has so that valid conclusions about capacity and volume can be reached.

Affected Populations Should Be Studied

Although nationally representative samples are necessary for examining the truth of Roemer's law, populations that would be affected by policies based on the law should also be used in testing it. Such potentially affected populations should be studied because the strength of the relationship between capacity and volume depends upon the characteristics of the population.

List of Studies

John L. Ashby, Jr. "The Impact of Hospital Regulatory Programs on Per Capita Costs, Utilization, and Capital Investment." Inquiry, 1984, 21:1, 45-59.

*W. Ross Brewer and Mary Anne Freedman. "Causes and Implications of Variation in Hospital Utilization." Journal of Public Health Policy, 1982, 3, 445-54.

Luk J. Cannoodt and James R. Knickman. "The Effect of Hospital Characteristics and Organizational Factors on Pre and Postoperative Lengths of Hospital Stay." Health Services Research, 1984, 19:5, 561-85.

Frederick A. Connell, Robert W. Day, and James P. LoGerfo. "Hospitalization of Medicaid Children: Analysis of Small Area Variations in Admission Rates." American Journal of Public Health, 1981, 71:6, 606-13.

Jerry Cromwell and Janet B. Mitchell. "Physician-Induced Demand for Surgery." Journal of Health Economics, 1986, 5:4, 293-313.

Sherman Folland and Miron Stano. "Sources of Small Area Variations In The Use of Medical Care." Journal of Health Economics, 1989, 8, 85-107.

Deborah Freund, Richard H. Shachtman, Marshall Ruffin, Dana Quade. "Analysis of Length-of-Stay Differences Between Investor-Owned and Voluntary Hospitals." Inquiry, 1985, 22, 33-44.

*Lois Friss, Bernard Friedman and John DeMakis. "Geographic Differences In The Use of Veterans Administration Hospitals." Social Science and Medicine, 1989, 28:4,347-54.

Frank D. Gianfrancesco. " Hospital Specialization and Bed Occupancy Rates." Inquiry, 1980, 17, 260-67.

*Paul B. Ginsburg and Daniel M. Koretz. "Bed Availability and Hospital Utilization: Estimates of the 'Roemer Effect'." Health Care Financing Review, 1983, 5:1, 87-92.

Marsha G. Goldfarb, Mark C. Hornbrook, and Craig S. Higgins, "Determinants of Hospital Use: A Cross-Diagnostic Analysis." Medical Care, 1983, 21:1, 48-66.

*Marian Gornick, "Trends and Regional Variations in Hospital Use Under Medicare." Health Care Financing Review, 1982, 3:3, 41-73.

Joel Hay and Gerard Anderson. "The Hospital Services Market: A Disequilibrium Analysis." Southern Economic Journal, 1988, 54:3, 656-65.

Mark C. Hornbrook and Marsha G. Goldfarb. "A Partial Test of A Hospital Behavioral Model." Social Science and Medicine, 1983, 17:10, 667-80.

James R. Knickman and Anne-Marie Foltz. "A Statistical Analysis of Reasons for East-West Differences in Hospital Use." Inquiry, 1985, 22, 45-58.

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* Zero-order correlation matrices were obtained from these studies.
†The data from this study were reported in an earlier publication.

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