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EFFECTS OF REGULATION ON HOSPITAL COSTS AND INPUT USE

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I. INTRODUCTION

IN the first half of this century, most regulations affecting hospitals were designed to promote quality assurance through accreditation and licensure of facilities and personnel. Then health planning, initially on a voluntary basis and subsequently made compulsory, arose from a dual concern for improving access to health services and for correcting alleged malfunctions in the health care marketplace. During the past decade, the growth of hospital expenditures has led to more targeted efforts to regulate specific sources of cost increases. At present, hospitals in the United States must cope with a wide variety, and still growing number, of controls developed by federal, state, and local governmental agencies and by some private organizations, including Blue Cross.

The case for hospital regulation is buttressed by a general consensus that the hospital market is far from the competitive ideal.¹ The majority of hospitals are nonprofit and therefore may not be as subject to pressures for efficient production as are profit-maximizing firms in competitive industries. Overinsurance also undermines incentives to implement cost-reducing innovations and has probably led to overuse of hospital services.² Many hospitals are local monopolists and perhaps monopsonists as well. Other structural characteristics of the industry, including medical-staffing privileges, severely limit patient and physician choice of hospital. Finally, given the "merit want" aspect of health and hospital care, society may not be satisfied with a market solution, even if the above impediments were not important.

Regulation offers the appeal of directly attacking the problems that cause

¹ General discussions of these issues include Stuart H. Altman & Sanford L. Weiner, *Regulation as Second Best*, in *Competition in the Health Care Sector: Past, Present, and Future* 421-47 (Warren Greenberg ed. 1978); Alain C. Enthoven, *Consumer-Choice Health Plan* (pts. 1 & 2), 298 *New England J. Medicine* 650, 709 (1978); Clark C. Havighurst, *Controlling Health Care Costs: Strengthening the Private Sector's Hand*, 1 *J. Health Politics, Policy, & Law* 471 (1977); and David S. Salkever, *Competition among Hospitals*, in *Competition in the Health Care Sector*, *supra*, at 149-62.

² See, for example, Martin S. Feldstein, *The Welfare Loss from Excess Health Insurance*, 81 *J. Pol. Econ.* 251 (1973).

inflation in hospital expenditures, while preserving the "quality imperative" and distributional-equity concerns that have historically characterized monitoring efforts in this industry. Yet, despite the widely held views of its benefits, there is a growing belief that regulation may have been oversold. The spate of controls on hospitals has, to put it mildly, not been met with universal approval, and critics have not been limited to parties with obvious and direct self-interest. Regulation is costly and may generate unintended side effects. Rapid responses to regulation are sometimes hindered by the litigation process, which occupies the energies of all parties. And because providers and investors have political and financial resources, regulatory agencies are subject to "capture."³

Policy discussions of the merits of both regulatory and market strategies to hospital cost containment often take place without reference to empirical evidence. And with a few important exceptions, strategies have been implemented without securing appropriate evidence, either prior to or as a byproduct of implementation.⁴ Some of the results of this study are testimony to the dangers of this approach.

This study's objective is to gauge the impact of three major forms of recent hospital regulation: controls on expansion of facilities and services; controls on allowable revenue and/or cost increases; and controls on utilization of hospital services. Specific regulatory programs examined are described in Section II. Our data base consists of a time series of cross-sectional data on 1,228 nonfederal, short-term general hospitals over six years, 1970 through 1975.⁵ Certain regulatory impacts, including hospital entry and exit, cannot be captured by this data base. Nor do we make any pretense of assessing the effects of regulation on access to hospital services or hospital quality.⁶ Our analysis focuses on hospital costs and demand for labor and nonlabor inputs. Estimated cost functions provide an overview of regulatory impact; estimated input equations can be more difficult to interpret, but they give an indication of the locus of regulatory impact. Therefore, we report both cost and input findings with the expectation that the combined results will be more illuminating than either type alone.

³ See, for example, William J. Curran, A National Survey and Analysis of State Certificate-of-Need Laws for Health Facilities, in *Regulating Health Facilities Construction* 85-111 (Clark C. Havighurst ed. 1974); J. Joel May, The Planning and Licensing Agencies, in *id.* at 47-68; and Richard A. Posner, Certificate of Need for Health Care Facilities: A Dissenting View, in *id.* at 113-21.

⁴ For exceptions, see reviews by Clifton R. Gaus & Fred J. Hellinger, Results of Prospective Reimbursement, 3 *Topics in Health Care Financing* 83 (1976) and Fred J. Hellinger, Prospective Reimbursement through Budget Review: New Jersey, Rhode Island, and Western Pennsylvania, 13 *Inquiry* 309 (1976).

⁵ Lagged dependent variables correspond to 1969 through 1974.

⁶ Except to the extent that input intensity relates to quality.

Section II presents a description of regulatory institutions including the specific programs examined in this study. Section III describes data, variable construction, and model specification. Empirical findings, with references to comparable findings from past research, are contained in Section IV. Conclusions and policy implications are presented in Section V.

II. CURRENT REGULATORY INSTITUTIONS

Regulation of Facilities and Services Growth

Regulation of facilities and services growth emphasizes control of hospital bed expansion and other forms of hospital capital formation. Prominent examples of this type of regulation are: (1) state certificate-of-need (CON) laws, which require state-designated agencies to regulate the expansion or modernization of the hospital plant as well as, in some cases, the provision of new hospital services; (2) the P.L. 92-603, Section 1122 review program, in which the states, as voluntary participants, use the reimbursement mechanisms of Medicare and Medicaid to regulate facilities and services growth; and (3) requirements of some Blue Cross plans linking reimbursement for certain hospital capital expenditures to approval by health planning agencies.

This form of regulation finds its rationale in (1) "Roemer's Law," which states that hospital beds generate their own demand;⁷ (2) a concern that overinvestment in beds and other facilities leads to excess capacity,⁸ the costs of which must be supported by the public through health-insurance purchases; and (3) a distributional concern of planners that capital expenditures are not made by the market where they are most needed. In principle, not only does control of facility and service expansion reduce capital expenditures, it also reduces the employment of labor and nonlabor inputs and associated expenditures.

Certificate-of-need was given congressional support in 1974 by passage of the National Health Planning and Resources Development Act, P.L. 93-641, which requires all states to adopt a CON program.⁹ As of the mid-1970s, most states had enacted CON laws and had begun participating in the

⁷ See Milton I. Roemer & Max Shain, *Hospital Utilization under Insurance* (1959); and Milton I. Roemer, *Bed Supply and Hospital Utilization: A Natural Experiment*, 35 *Hospitals*, Nov. 1, 1961, at 36.

⁸ This view is less than fully consistent with a "strict constructionist" interpretation of Roemer's Law.

⁹ For details of P.L. 93-641, especially as it applies to CON, see James F. Blumstein & Frank A. Sloan, *Health Planning and Regulation through Certificate of Need: An Overview*, 1978 *Utah L. Rev.* 3; and Randall Bovbjerg, *Problems and Prospects for Health Planning: The Importance of Incentives, Standards, and Procedures*, 1978 *Utah L. Rev.* 83.

Section 1122 program.¹⁰ The latter program has uniform basic provisions. Approval by state-designated planning agencies of hospital capital expenditures exceeding \$100,000, of changes in bed size, and of changes in services offered is required as a precondition for full reimbursement for services financed under Social Security Act programs. In contrast, there is substantial interstate variation in CON in terms of comprehensiveness, dollar "thresholds" above which expenditures must be approved, and review and appeals procedures.¹¹ Coverage generally extends to hospitals and nursing homes but not to doctors' offices, although this has been proposed. Many state laws provide for surveillance of health-service expansion, even when substantial capital expenditures are not involved. CON is a reactive form of regulation—the regulated institution, rather than the agency, takes the initiative in proposing a particular capital expenditure. Moreover, decertification of existing facilities and services is only in the discussion stage.¹²

In contrast to CON, which gives the state the power to absolutely forbid unapproved capital expenditures, the 1122 and Blue Cross programs use the third-party reimbursement mechanism as a regulatory tool. In principle, hospital expenditures attributable to unapproved capital projects are not reimbursed, and the hospital has to secure funds to cover these expenses from other sources, including other third-party payors. Unlike CON, the importance of these programs is proportional to the fraction of hospital revenues from Medicare and Medicaid (1122 programs) and Blue Cross (Blue Cross compliance programs). If these are unimportant revenue sources, the hospital may find it desirable to go ahead with a capital expenditure project without planning agency approval. Because all regulation of facilities and services involves planning agency deliberations, there is likely to be considerable overlap among the three programs in the process of granting approvals.

Most past research on facilities and services regulation focuses on certificate-of-need.¹³ Lewin and Associates assessed the experience of several states with various forms of regulation, including CON and 1122.¹⁴ Among

¹⁰ U.S. Department of Health, Education, and Welfare (DHEW), Bureau of Health Planning and Resources Development, Division of Regulatory Activities, *Status of Certificate of Need and 1122 Programs in the States* (1978).

¹¹ A three-tier application and review process is common (though not always in the sequence mentioned): review by an area-wide or regional planning agency with frequent provision for public hearings; approval by the state comprehensive planning board; and issuance of the certificate-of-need by the authority of the appropriate state department. CON statutes also permit appeals of adverse decisions.

¹² See William G. Kopit, Edward J. Krill, & Karen F. Bonnie, *Hospital Decertification: Legitimate Regulation or a Taking of Private Property?* 1978 Utah L. Rev. 1979.

¹³ Blumstein & Sloan, *supra* note 9, present a more detailed review of these studies.

¹⁴ Lewin and Associates, Inc., *An Analysis of State and Regional Health Regulation* (Report

the findings of this study were indications (from interviews of hospital administrators) that CON had increased planning and coordination among hospitals within communities, but that CON program reviewers favored existing providers to the detriment of new entrants. Both of these findings raise questions of an antitrust nature.¹⁵ This study also found indications of anticipatory responses of hospitals to CON legislation in the form of accelerated timetables for facility construction and introduction of new services. If this behavior is prevalent, it may take years for CON regulations, once implemented, to offset anticipatory actions, especially when coupled with "grandfathering."¹⁶

The best-known multivariate studies of CON are by Salkever and Bice, and Hellinger.¹⁷ Using state data for the 1968-1972 period, Salkever and Bice found that CON reduced bed expansion, but increased plant assets per bed, leading to the conclusion of no net impact on total investment (change in plant assets). The Hellinger study, based on data for 1972 and 1973, concluded that CON and 1122 have not significantly reduced hospital investment, but some suggestive evidence of a potentially negative impact was obtained. Both of these studies evaluated effects of legislation at a very early stage in implementation when such effects may not have been detectable. At issue, of course, is not only whether such legislation is able to slow growth in hospital facilities and services, but also whether it produces responses in less-regulated areas of hospital activity. None of the research conducted to date has addressed the latter question.

Revenue-Cost Regulation

Regulation of hospital revenues and costs attempts to directly impede inflation in this sector by placing limits on increases in charges and input expenditures. The most important manifestations of this approach are: (1) the wage and price controls of the Nixon administration's Economic Stabilization Program (ESP); and (2) prospective reimbursement (PR) programs

to the Health Resources Administration, DHEW, under contract no. HEW-OS-73-212, February 1975).

¹⁵ See James F. Blumstein & Terry Calvani, *State Action as a Shield and a Sword in a Medical Services Antitrust Context: Parker v. Brown in Constitutional Perspective*, 1978 Duke L. J. 389.

¹⁶ A dramatic example of the consequences of grandfathering occurred in Florida, where it has been estimated that 2,150 "grandfather" certificates were issued before the effective date of the statute. This is especially striking when one considers that in the year after CON took effect in that state, only 123 certificates-of-need were issued. See Lewin and Associates, Inc., *supra* note 14.

¹⁷ See David S. Salkever & Thomas W. Bice, *Impact of State Certificate of Need Laws on Health Care Costs and Utilization* (Final Report to the National Center for Health Services Research, DHEW, under contract no. HRA-106-74-57, January 1976); and Fred J. Hellinger, *The Effect of Certificate-of-Need Legislation on Hospital Investment*, 13 Inquiry 187 (1976).

instituted by some state agencies and Blue Cross plans which establish ceilings on amounts that will be reimbursed to hospitals by participating third-party payors.

Beginning in August 1971, both wages and prices were controlled by ESP, although, inadvertently, not reimbursement of costs by third-party payors.¹⁸ In December 1972, regulations specific to institutional providers of health care were issued which limited growth in annual revenue due to (justifiable) price increases to 6 per cent. As ESP progressed, unanticipated administrative problems and political considerations led to exceptions, including exemption of low-wage employees from a 5.5 per cent limit on wage increases. The hospital variant of ESP was patterned after the general ESP program, emphasizing limits on price rather than expenditure increases as many health care experts would have preferred.

The most comprehensive empirical evaluation of ESP's impact on hospitals is by Ginsburg.¹⁹ Using regression analysis of aggregate data for the nine U.S. Census Divisions for 44 quarters (1966-1973), he found that ESP had no significant effect on hospitals except for a slight negative impact on average wages. Ginsburg attributed the failure of ESP to have a major impact on costs to: disincentives to control costs (for example, the 6 per cent limit became a floor as well as a ceiling), ambiguous regulations, and expectations in the hospital community that ESP would be short-lived and hence not worth large-scale adjustments.

A generic definition of prospective reimbursement, as stated by Dowling is "... a method of paying hospitals in which (1) amounts or rates of payment are established in advance for the coming year, and (2) hospitals are paid these amounts or rates regardless of the costs they actually incur."²⁰ In contradistinction to cost-based reimbursement in which (at least in principle) costs generate revenue, PR (again in principle) gives hospitals reasons to be concerned with the cost implications of changes in quantity, quality, style of care, scope of services, and efficiency because third-party payors under PR do not cover "overruns."

¹⁸ Paul B. Ginsburg, *The Impact of the Economic Stabilization Program on Hospitals and Hospital Care* (Final Report to DHEW under contract HSM 110-73-467, October 15, 1976), has argued that it is likely that few hospitals took advantage of this loophole because, at the time, hospitals believed the controls would be short-lived and were uncertain whether cost increases realized during this period would be included in subsequent rate bases.

¹⁹ See *id.*; and Paul B. Ginsburg, *Impact of the Economic Stabilization Program on Hospitals: An Analysis with Aggregate Data*, in Hospital Cost Containment 293-323 (Michael Zubkoff, Ira E. Raskin, & Ruth S. Hanft eds. 1978). There are several other studies on ESP effects. For example, there is descriptive evidence that hospital profits fell during ESP. See Richard W. Furst & John S. Dunkelberg, *Study Shows ESP Reduced Hospitals' Profitability*, 59 *Hospital Progress*, Aug. 1978, at 59, for evidence on North and South Carolina hospitals and a review of evidence on profits nationally during ESP.

²⁰ William L. Dowling, *Prospective Reimbursement of Hospitals*, 11 *Inquiry* 163 (1974).

Uniformity among PR programs statewide virtually ends with this definition. Important variations include (1) compulsory or voluntary hospital participation; (2) payors covered (for example, Medicaid, Blue Cross, commercial insurers); and (3) use of a formula or budget-review method for prospective rate setting. *A priori*, one can safely conclude that voluntary systems are unlikely to be effective as a general strategy for hospital cost containment, and we have excluded such programs from our empirical analysis.

Until recently, the only formula PR system was New York's and the New York experience, because of the number of years and hospitals covered, must dominate any current evaluation of formula PR, including ours. Under formula PR systems, the prospective rate is established by solving an equation of variables pertaining to individual hospital characteristics (for example, size, ownership, and teaching status), hospital performance (for example, occupancy rate, prior cost experience), and factors external to the hospital (for example, the general inflation rate). The formula is recomputed periodically, usually yearly, to arrive at a new prospective rate. This method involves relatively little direct interaction between hospitals and the rate-setting authority; therefore, it is less costly to administer and, although possibly more arbitrary, less likely to be redirected to the hospital's advantage.

Under budget-review PR systems, the hospital develops a budget for the prospective year which is reviewed by the PR authority. Items in the budget deemed unnecessary or excessive are eliminated or reduced. Hospitals are generally given the opportunity to negotiate or appeal budget-reducing decisions. Once the final budget has been approved, a payment rate is established that covers the hospital's budgeted costs. Because this method permits maximum recognition of individual hospital characteristics, it tends to be preferred by hospitals over the formula method. In fact, when given the choice between being regulated by budget review or a formula, all New Jersey hospitals chose the former.²¹ This is indirect evidence that the formula method tends to be tougher on hospitals than the budget method.

The extent to which patients in a hospital's market area have insurance covered by revenue-cost controls should bear a direct relationship to their influence on hospital behavior. This factor is incorporated in our analysis by defining our PR variables as proportions of patients in the market area with third-party coverage (for example, Medicaid, Blue Cross) governed by particular types of PR, either formula or budget-review.

A number of recent studies of the efficacy of state PR programs have yielded inconclusive results. A multivariate analysis of downstate New

²¹ Paul N. Worthington, *Prospective Reimbursement of Hospitals to Promote Efficiency: New Jersey*, 13 *Inquiry* 302 (1976).

York's (that is, New York City and vicinity) formula program showed reductions in both costs per day and per case, but evaluations of the upstate New York, New Jersey, and Rhode Island programs produced many insignificant and sometimes perverse results. In a tabular analysis of the New York experience, both downstate and upstate, Berry reported that PR (1) reduced net hospital revenue, (2) slowed down the growth in average costs, and (3) lowered the ratio of capital to labor costs.²² Although suggestive, one has to be somewhat cautious about accepting evidence from comparisons of trends that disappear in multivariate analysis.²³

Utilization Review

In principle, utilization review (UR) serves the dual objective of cost and quality control. In practice, these two objectives conflict.²⁴ *Some* measures of quality are cast in terms of utilization (and its associated costs), that is, more quantity is better quality.²⁵ Hence, there is no reason to expect that utilization review systematically reduces hospital costs, especially when the program stresses quality in general and utilization-oriented indicators of quality in particular. However, it would clearly be unwise, *a priori*, to rule out the notion that these programs lower costs *on average* without reference to empirical evidence.

The major current federal thrust in this area is the Professional Standards Review Organization (PSRO) program, which was just implemented on a widespread basis during the mid-1970s and is too recent to influence the

²² See Ralph E. Berry, Prospective Rate Reimbursement and Cost Containment: Formula Reimbursement in New York, 13 Inquiry 288 (1976).

²³ Unfortunately, insufficient information is currently available on administrative aspects of PR programs. For example, is an independent rate-setting commission more effective than a state agency? How do both the numbers and characteristics of the regulatory staff affect outcomes? Such questions are beyond the scope of the present study.

²⁴ For a detailed discussion of the cost-quality tradeoff, see Clark C. Havighurst & James F. Blumstein, Coping with Quality/Cost Trade-offs in Medical Care: The Role of PSROs, 70 Nw. U. L. Rev. 6 (1975).

²⁵ Quality assessment is an inexact science. As stated by The Institute of Medicine, Assessing Quality in Health Care: An Evaluation (1976):

"Determining the effectiveness of quality review programs is particularly difficult—in part because of methodological problems, but also because of the absence of valid and reliable information. The effect of review on quality of care usually is described anecdotally because of limitations in current measures of health status or outcome. Although improvements in quality attributed by program officials to review may be impressive, there is no current method for relating the individual anecdotes to the total review effort in a manner which would facilitate the determination of cost effectiveness. Because of the close link between quality and utilization of services, the relative ease of measuring utilization, and its associated relationship to cost control, effectiveness is frequently measured in terms of utilization, as expressed in costs. However, the measures customarily used are frequently inadequate and difficult to interpret."

Id. at 2-3.

behavior of hospitals in our sample. Our evaluation of UR is confined to reviews undertaken by Blue Cross and state Medicaid agencies. In general, these reviews, at least during the early 1970s, occurred after the care had been rendered. As Lewin and Associates noted, *ex post* review causes two problems.²⁶ First, if treatment has already taken place, the major remaining question is who will pay for it. Second, physicians tend to be more reluctant about judging their peers after it is too late to affect the treatment process than to confer with them while medical decisions remain open to change.

Nevertheless, it is conceivable that the threat of embarrassment or non-payment has a dampening effect on utilization and indirectly on costs and input use. Empirical evidence on the effectiveness of UR as a cost-containment tool is not encouraging on the whole,²⁷ but there are a few exceptions.²⁸

III. DATA, EMPIRICAL SPECIFICATION, AND ESTIMATION

Data

The observational unit for our empirical analysis is the individual hospital. All hospitals selected are: nonfederal, short-term general; located within the National Opinion Research Center's Primary Sampling Units; and respondents to the American Hospital Association's (AHA) annual survey of hospitals, our core data source, in *each* of seven years, 1969-1975. This selection process yielded a sample of 1,228 hospitals, 21.3 per cent of all nonfederal, short-term general hospitals (as of 1975). Our hospitals come from 34 states (including Washington, D.C.) and 250 counties throughout the United States. The Primary Sampling Unit framework of the National Opinion Research Center yields a self-weighting sample of the 1970 U.S.

²⁶ See Lewin and Associates, Inc., *supra* note 14.

²⁷ See, for example, Richard F. Averill & Lawrence F. McMahon, A Cost Benefit Analysis of Continued Stay Certification, 15 Medical Care 158 (1977); Earl Brian, Foundation for Medical Care Control of Hospital Utilization: CHAP—A PSRO Prototype, 288 New England J. Medicine 878 (1973); and *id.*, Government Control of Hospital Utilization, 286 New England J. Medicine 1340 (1972); Karin Dumbaugh & Duncan Neuhauser, The Effect of Pre-Admission Testing on Length of Stay, in *Organizational Research in Hospitals* 13-28 (Stephen M. Shortell & Montague Brown eds. 1976); Bruce A. Flashner *et al.*, Professional Standards Review Organizations—Analysis of Their Development and Implementation Based on a Preliminary Review of the Hospital Admission and Surveillance Program in Illinois, 223 J. Am. Medical Ass'n 1473 (1973); George A. Goldberg & Don C. Holloway, Emphasizing "Level of Care" over "Length of Stay" in Hospital Utilization Review, 13 Medical Care 474 (1975); and Jonathan Kolb & Victor W. Sidel, Influence of Utilization Review on the Hospital Length of Stay, 203 J. Am. Medical Ass'n 95 (1968).

²⁸ Bruce C. Stuart, Medicaid Cost Containment Policy: Utilization Controls (The Urban Institute, Working Paper No. 986-08, 1976), concluded that state Medicaid programs combining stringent claims review, prior authorization, and retroactive payment denials may constrain costs.

population; our 1,228 hospitals are representative of the population served by nonfederal, short-term general U.S. hospitals rather than the universe of these hospitals. Compared to the universe, sample hospitals are: larger on average (268 versus 163 beds); more likely to have medical and nursing school affiliations; and less likely to be controlled by local government. Mean occupancy rate and average length of stay are, on average, about 5 to 7 per cent higher in sample hospitals. Our analysis focuses on the six-year period, 1970-1975. 1969 data are used only for lagged dependent variables.

Empirical Specification

The bulk of our empirical work consists of eight regressions with cost and input dependent variables. The two cost dependent variables have total costs in the numerator and adjusted patient days and admissions as denominators. Both are reported because exogenous regulation and other variables may have differential effects on different cost components. For example, a program that affects primarily patient length-of-stay may have a substantial effect on cost per admission and a negligible or opposite effect on cost per adjusted patient day. Adjusted patient days are the sum of inpatient days and weighted outpatient visits. The weight is the ratio of average revenue per outpatient visit to average revenue per inpatient day, computed for each observational hospital.

Input regression dependent variables are: RNs, LPNs, "other" employees, an index reflecting plant assets associated with specific facilities and services, current nonlabor-input expenditures and beds "set up and staffed." Our specification of labor-input variables reflects staffing data availability on the AHA general survey files. Data are given on full and part-time RNs, LPNs, interns and residents, employed physicians, and total employees, from which full-time equivalents (FTEs) have been calculated.²⁹ The "other employee" category is total FTE employees minus the sum of the specified employee types. Interns and residents and employed MDs were not included in the analysis because they cannot be regarded simply as inputs to the production of hospital services. Employment of interns and residents and, often, salaried MDs involves production of educational services. Moreover, the compensation methods of many "hospital-based" physicians, particularly those in radiology and pathology, are the result of bilateral negotiations between physicians and hospitals rather than input-choice decisions on the part of hospitals alone. Thus, analysis of physician employment is best left to studies specifically tailored to account for these factors.

The asset index was obtained by regressing 1975 net plant assets per bed, adjusted for geographic variation in price levels, on a comprehensive list of

²⁹ Two part-time employees equal one FTE.

binary variables representing hospital facilities and services (for example, cobalt therapy program, premature nursery, family planning service, home care department) and a few other standardizing variables which remain constant or nearly so from year to year (for example, region of the United States, city size). The estimated parameters from this "hedonic" asset regression indicate the amount of fixed capital associated with specific facilities and services. Since facilities and services vary over time and, of course, among hospitals, so does the index. When used as an explanatory variable in our average cost regressions, predicted assets per bed (ASSETB) represents the sophistication of the asset base, patient case-mix, and associated interest costs.³⁰

Our current (that is, noncapitalized) nonlabor-input variable measures yearly hospital expenditures per bed on supplies, food, minor equipment, insurance, contract purchases, and similar expenditures, but excludes depreciation and interest expense. Like all monetarily-expressed variables, it is measured in constant dollars as there is no good way to measure current nonlabor inputs in physical units.³¹

Typically, one thinks of changes in bed supply, our final input, in terms of long-run additions to hospital plant or, less frequently, retirement of existing capacity. However, hospitals also have the option of some short-run change in bed supply by decreasing the number of "set-up and staffed" beds or by adding beds to fill existing underutilized space. Because of high fixed costs and inflexibility of space, such options tend to be limited. Nevertheless, we observe some small changes in bed complements of individual hospitals; major changes tend to represent the fruits of building programs or, in isolated instances, retirement of large sections of the hospital plant.

Exogenous variables in all cost and input regressions include eleven regulation variables describing controls on hospital facility and service expansion, on revenues and costs, and on utilization of services.

Five binary variables represent certificate-of-need. The variable PRECON is one for hospitals located in a state in the year immediately preceding the introduction of CON. Thus PRECON can be one for, at most, one of the six years. This variable is designed to account for anticipatory behavior. An operating CON program is classified as either comprehensive or noncomprehensive. As defined, comprehensive programs include service-expansion

³⁰ We recognize that facilities and services variables have not been validated as case-mix variables. Further, binary variables do not account for variations in scale. Ralph E. Berry, *Product Heterogeneity and Hospital Cost Analysis*, 12 *Inquiry* 67 (1970), used these variables in a manner similar to ours.

³¹ Hospitals face numerous trade-offs between current labor and nonlabor expenses, particularly with regard to choices of whether to provide laundry, housekeeping, dietary, and other labor-intensive services internally or to purchase such services externally on a contract basis or via sharing arrangements with other hospitals.

review *and* have a threshold for review of equipment purchases of less than \$100,000. These programs presumably leave less room for the kind of compensatory effects reported by Salkever and Bice, such as growth in assets per bed or labor inputs.³² We make a further distinction between “new”—the first or second year of operation—and “mature” programs—more than two years of operation. Several states changed from “new” to “mature” during 1970-1975. Thus, in a limited way, we are able to gauge changes in CON impact as the program matures. (It is possible that CON becomes more effective through a form of “learning-by-doing.”) Prefixes “C” and “N” in front of CON designate comprehensive and noncomprehensive programs, respectively; suffixes 1 and 2 identify new and mature programs, respectively.

Most of our remaining regulatory variables operate in conjunction with third-party reimbursement. Hence, to construct the variables, a binary variable indicating that the regulatory program exists is multiplied by the proportion of the population in the hospital’s area with the kind of insurance for which the regulation in question applies. The variable S1122 is the product of a binary variable indicating whether the program exists in the hospital’s state and the sum of Medicare (MCARE) and Medicaid (MCAID) population proportions, since Section 1122 applies to these programs. The variable BCPAA is the product of a binary variable which equals one if the Blue Cross plan in the hospital’s area requires local planning agency approval for major capital expenditures and Blue Cross’s market share in the (Blue Cross plan catchment) area. As noted above, neither 1122 nor the Blue Cross program forbids the hospital from undertaking capital expansion or modernization; however, current expenditures associated with these capital purchases can be disallowed.

The ESP program, termed ESP in the analysis and defined as the fraction of the year that ESP was in effect, is the first revenue-cost regulation variable. Formula (FPR) and budget (BPR) prospective reimbursement programs are defined as the products of binary variables identifying that the program was in effect and the proportions of the relevant populations covered. Since PR may apply to virtually any type of insurer and there is substantial interstate variation on this score, we have devoted considerable effort to computing the relevant population proportions.

The variable UR represents hospital utilization review programs developed by Blue Cross or Medicaid. It too is weighted by the relevant (Blue Cross and/or Medicaid) population proportions.

In our theoretical work, we have found that comparative statics analysis yields very few unambiguous predictions about the effects of regulation on

³² See Salkever & Bice, *supra* note 17; *id.*, The Impact of Certificate of Need Controls on Hospital Investment, 54 *Milbank Memorial Fund Q.* 185 (1976).

hospital costs and input employment.³³ But even though relationships cannot often be signed, directions of *intended* impacts are clear from the vantage point of the policy maker. In this sense, it is not necessary to use economic theory to generate hypotheses about the effects of regulation. The null hypothesis can simply be that specific regulatory arrangements designed to contain costs and input expansion do not in fact achieve this objective.

Remaining independent variables in both cost and input regressions capture potential effects of variations in product-demand determinants, factor prices, and hospital characteristics that may influence the nature of the hospital product and types of patients treated. Apart from some computational innovations, these variables are, for the most part, very similar to those used in past studies of hospital costs. To conserve space, the nonregulation variables are not discussed; however, they are defined in Table 1 and parameter estimates are shown in Table 2's cost regressions in the next section. The fact that many nonregulation variables have plausible effects on the dependent variables lends further support to our conclusions about regulatory impacts.³⁴

Functional Form and Estimation

All regressions are estimated using a technique for pooling time series of cross sections developed by Nerlove.³⁵ Details on the estimation procedure are given in the Appendix.

With the exception of the binary hospital characteristics and the regulation variables, which enter linearly, all cost function variables are in log form. This is also true of independent variables in the input regressions. With the exception of the bed regression, dependent variables in the inputs regressions are expressed as the ratio of the log of the input variable to the log of beds. By substituting the coefficients from the bed regression, all input regressions can be converted from ratios into levels. Estimating input regressions in ratio form greatly reduces multicollinearity and the necessary restriction on the input-beds elasticity is reasonably costless.³⁶ One should expect the adjustment speed to be far more rapid with some inputs than with

³³ See Frank A. Sloan & Bruce Steinwald, *Insurance, Regulation, and Hospital Costs* (forthcoming 1980).

³⁴ See *id.* for a full discussion of these variables and related empirical findings.

³⁵ See Marc L. Nerlove, *Further Evidence on the Estimation of Dynamic Economic Relations from a Time Series of Cross Sections*, 39 *Econometrica* 359 (1971).

³⁶ One must assume that the input-beds elasticity is one. Previous analysis of demand for RNs showed this to be approximately true. See Frank A. Sloan & Richard Elnicki, *Professional Nurse Staffing in Hospitals, in Equalizing Access to Nursing Services: The Geographic Dimension* 27-56 (Frank A. Sloan ed. 1978) (DHEW Publication No. HRA-78-51).

others. In fact, parameter estimates on explanatory variables representing input lag structure show this.³⁷

Both cost and input equations contain lagged dependent variables. In the cost equations, we specify a Koyck lag structure by including lagged cost dependent variables. Speed of adjustment is given by one minus the parameter estimate on the lagged dependent variable (percentage of the difference in logarithms between the current and the equilibrium value made up in one year, two years, and so on). Our specification for inputs explicitly considers interdependencies among inputs in their lag structures. This flexible dynamic approach, developed by Nadiri and Rosen, allows, for example, demand for a specific type of labor to rise above its equilibrium value in the short run to accommodate output expansion due to the fixity of certain nonlabor inputs.³⁸

IV. EMPIRICAL RESULTS

Descriptive Evidence

Variable definitions, means for 1975, and growth rates (in percentages) between 1970 and 1975 are shown in Table 1. All monetary variables have been deflated by an area price index computed from Bureau of Labor Statistics data (mean for metropolitan areas in 1972 = 1.00); thus, growth rates are in real terms. Costs per adjusted patient day and per admission rose 31 and 27 per cent, respectively. Labor costs (not shown) grew less rapidly than total costs, implying a shift from labor to nonlabor expenses during the six-year period. This is dramatically illustrated by the input variable growth rates. All were positive, but the growth in real current nonlabor expense per bed, 42 per cent, was by far the greatest.³⁹ Because of the 7 per cent average growth in beds in sample hospitals during the period, growth in inputs *per hospital* was somewhat more than the per-bed figures shown in the table.

The manner in which certificate-of-need variables were constructed makes growth percentages meaningless, so the latter were not reported in Table 1. In 1970 there were four states with active CON programs; in 1975

³⁷ Reported in Sloan & Steinwald, *supra* note 33.

³⁸ See M. Ishaq Nadiri & Sherwin Rosen, A Disequilibrium Model of Demand for Factors of Production (1974).

³⁹ Although the Consumer Price and the Wholesale Price Indexes tracked the American Hospital Association's Nonlabor Input Price Index (NLIP) fairly well from 1967 through 1973, the NLIP rose relative to the two federal indexes during 1974 and 1975. If we had used the NLIP, the rate of increase in real current nonlabor expenses per bed would have been about 35 rather than 42 per cent. On the NLIP, see J. Alexander McMahon & David F. Drake, The American Hospital Association Perspective, in Hospital Cost Containment 76-102, *supra* note 19. In our input regressions, we (roughly) account for discrepancies between our index and the "true" index by including time as an explanatory variable.

TABLE 1
VARIABLE DEFINITIONS, MEANS, AND GROWTH RATES

	Mean 1975	% Change 1970-75
<i>Dependent Variables</i>		
Total Cost per Adjusted Patient Day*	\$112.20	31.1
Total Cost per Admission*	\$1,007.30	26.9
RNs per Bed	0.50	12.6
LPNs per Bed	0.21	2.5
Other Employees per Bed	1.77	8.1
Predicted Net Plant Assets per Bed (ASSETB)*	\$32,433	5.6
Current Nonlabor Expense per Bed*	\$9,658	41.6
Total Beds	268	7.2
<i>Regulation Variables</i>		
Proportion of Hospitals in States with:		
Year Prior to CON Program Taking Effect (PRECON)**	0.071	***
Noncomprehensive, Young CON Programs (NCON1)**	0.080	***
Noncomprehensive, Mature CON Programs (NCON2)**	0.517	***
Comprehensive, Young CON Programs (CCON1)**	0.015	***
Comprehensive, Mature CON Programs (CCON2)**	0.096	***
Proportion of Population in Areas Where Hospitals Are Subject to:		
Section 1122 Regulation of Capital Expansion (S1122)	0.105	***
Blue Cross Planning Agency Approval Requirements (BCPAA)	0.226	51.7
Formula Prospective Reimbursement Programs (FPR)	0.109	23.9
Budget Prospective Reimbursement Programs (BPR)	0.087	200.0
Utilization Review (UR)	0.384	9.4
Proportion of Months Economic Stabilization Program in Effect	0.0	***
<i>Demand Variables</i>		
County Population per Square Mile (DENS)	4,491	-5.2
County Population per Nonfederal, Office-Based MD (POPMD)	960	-7.2
County General Practitioner Proportion (GPPROP)	0.210	-20.2
County Population per "Other" Hospital Bed (POPBD)	2,609	22.3
County Population Proportion Age 65 and Over (MCARE)	0.102	5.2
State Population Proportion under 65 and Eligible for Medicaid (MCAID)	0.096	29.7
County "Depth of Coverage" under Private Health Insurance (INS)*	\$256	24.3
Proportion of Hospital Charges Subject to Cost-Based Reimbursement (COSTB)	0.529	10.4
<i>Factor Supply Variables</i>		
Hourly Wage for "Other" Hospital Employees (OTHWG)*	\$3.21	1.3
Hospital Has Received Collective Bargaining Request (COLREQ)	0.405	202.2
Hospital Has Signed Collective Bargaining Agreement (UNION)	0.292	43.1
Hospital Has Had a Strike or Other Work Stoppage (STRIKE)	0.059	63.9
<i>Hospital Characteristics Variables</i>		
Hospital Is Government-Owned (GOVT)**	0.141	***
Hospital Is Privately-Owned, For-Profit (PROP)**	0.082	***
Hospital Has Medical School Affiliation (MEDSCH)**	0.263	***
Hospital Has a School of Professional Nursing (NURSCH)**	0.180	***
Hospital Has Less Than 100 Beds (SIZE1)**	0.192	***
Hospital Has 100-249 Beds (SIZE2)**	0.360	***
Hospital Has 250-399 Beds (SIZE3)**	0.248	***

* Monetary variables are deflated by an area price index (mean metropolitan cost of living in 1972 = 1.00).

** Binary variables (= 1 if hospital has designated attribute; = 0 otherwise).

*** Percent-change statistics are not computable or not meaningful.

there were twenty-six. Most of the programs were what we have termed "noncomprehensive" in that they did not review changes in services or their "threshold" for review of equipment purchases was relatively high. Growth in other regulatory programs combines the advent of new programs with growth in market shares of third parties to which existing programs apply. Thus, budget prospective reimbursement shows the most growth in Table 1 primarily because several programs were instituted during the 1970-1975 period. However, formula PR had a higher absolute proportion in 1975 because of relatively heavy representation of New York hospitals in our sample. On the whole, there was a considerable amount of regulatory activity during the 1970-1975 period, which is beneficial to our regression estimation procedure based on a time series of cross sections.

Cost Regressions

Empirical results pertaining to total hospital costs per adjusted patient day and per admission are presented in Table 2. Although our interest centers on the parameter estimates from the regulation variables, other exogenous variables are shown so that readers may evaluate the entire set of regressions. The majority of coefficients are statistically significant at conventional levels, using two-tail tests of significance. The coefficients' signs are mostly plausible in the sense that they agree with past research results⁴⁰ or are readily interpreted.⁴¹ Moreover, the R^2 s, on the order of 0.5, are relatively high for cross-sectional analysis with several thousand degrees of freedom. Coefficients of the lagged dependent variables (LDEP), 0.39 in the cost per patient day regression and 0.42 in the cost per admission regression, imply that about 60 per cent of the difference in the logarithms between actual and equilibrium average costs is made up within a year. In other words, the effect of a change in any of the exogenous variables is realized fairly quickly.

⁴⁰ See, for example, David S. Salkever, *A Microeconomic Study of Hospital Cost Inflation*, 80 J. Pol. Econ. 1144 (1972). See also Karen Davis, *The Role of Technology, Demand and Labor Markets in the Determination of Hospital Costs*, in the *Economics of Health and Medical Care* 283-301 (Mark Perlman ed. 1974); and *id.*, *Theories of Hospital Inflation: Some Empirical Evidence*, 8 J. Human Resources 181 (1973). Real per capita income in the hospital's county was initially included in our cost regressions but was dropped because of collinearity with the wage variable.

⁴¹ The dependent variables, lagged dependent variables, demand variables (except for COSTB), OTHWG, and ASSETB are in log form. Thus, the associated parameter estimates are elasticities. Remaining explanatory variables, which are either binary or proportions, enter linearly. Associated coefficients denote rates of growth in the dependent variable when the explanatory variable is binary. When the explanatory variable is a proportion, one should take explicit account of the variable mean in interpreting the parameter estimate. For example, if the coefficient is 0.035 and the mean proportion 0.1, a rise from 0.1 to 0.2 would raise the dependent variable by 0.35%.

TABLE 2
AVERAGE COST REGRESSIONS

Variable	Total Cost per Adjusted Patient Day	Total Cost per Admission	Variable	Total Cost per Adjusted Patient Day	Total Cost per Admission
PRECON	0.0099** (0.0050)	0.0043 (0.0047)	INS	0.20* (0.021)	0.17* (0.020)
NCON1	0.024* (0.0054)	0.0087*** (0.0051)	ASSETB	0.0051 (0.0034)	-0.0011 (0.0032)
NCON2	0.047* (0.0069)	0.035* (0.0064)	OTHWG	0.064* (0.016)	0.056* (0.015)
CCON1	-0.00054 (0.0085)	0.015*** (0.0080)	COLREQ	0.025* (0.0057)	0.030* (0.0054)
CCON2	-0.0082 (0.0098)	0.0060 (0.0092)	UNION	0.033* (0.0090)	0.021* (0.0085)
S1122	0.0018 (0.020)	-0.014 (0.019)	STRIKE	0.039** (0.018)	0.027 (0.017)
BCPAA	-0.0066 (0.0073)	-0.014** (0.0069)	GOVT	0.036 (0.033)	0.039 (0.032)
FPR	0.017 (0.031)	0.076* (0.029)	PROP	0.053 (0.043)	-0.041 (0.040)
BPR	-0.030* (0.011)	-0.0083 (0.010)	MEDSCH	0.13* (0.028)	0.14* (0.027)
ESP	-0.0055*** (0.0032)	-0.0067** (0.0030)	NURSCH	-0.022 (0.031)	0.016 (0.030)
UR	0.017 (0.052)	-0.063 (0.049)	SIZE1	0.047* (0.015)	-0.046* (0.014)
COSTB	-0.13* (0.050)	-0.0037 (0.048)	SIZE2	0.013 (0.012)	-0.034* (0.011)
DENS	0.0072*** (0.0042)	0.010* (0.0040)	SIZE3	0.014 (0.0088)	-0.013 (0.0083)
POPMD	0.0048 (0.0087)	0.0070 (0.0082)	LDEP	0.39* (0.011)	0.42* (0.011)
GPPROP	-0.097* (0.015)	-0.097* (0.014)	CONST	0.62	1.19
POPBD	0.0076** (0.0032)	0.0022 (0.0030)		$R^2 = 0.50$	$R^2 = 0.51$
MCARE	0.053** (0.025)	0.087* (0.023)		$F(32,6110)$ $= 188.4^*$	$F(32,6110)$ $= 200.2^*$
MCAID	0.035* (0.0060)	0.014* (0.0056)			

* Significant at the 1% level (two-tail test).

** Significant at the 5% level (two-tail test).

*** Significant at the 10% level (two-tail test).

As suggested above, the intended effects of various regulatory controls on hospital costs, from the standpoint of the policy maker, is unambiguously negative. In this regard, Table 2's regression results are not very encouraging in that over half of the parameter estimates for the regulatory program variables are positive. One might argue that positive parameter estimates may reflect a tendency for states with the most rapid inflation in hospital costs to be most likely to adopt regulatory controls; that is, the regulation variables may pick up omitted state effects. However, the combination of including lagged dependent variables and the estimation methodology of pooled time series of cross sections should have eliminated this problem.⁴² The regressions were run with the regulation variables stepped in last to permit testing the null hypothesis that the entire vector of regulatory variables makes no significant contribution to reducing unexplained variance in costs per adjusted patient day and per admission. The *F*-statistics for this test were far above the level to reject the null hypothesis at the one per cent level in both regressions. However, because both positive and negative regulation parameter estimates were obtained, one cannot infer from this test that regulation *per se* has had a consistent impact on hospital costs, holding other factors constant.

Five variables pertain to certificate-of-need. The PRECON coefficients in Table 2's regressions imply a (statistically significant) positive anticipatory response of costs to CON. Remaining CON parameter estimates suggest that comprehensive programs (CCON1 and CCON2) have essentially no impact on hospital costs while noncomprehensive programs (NCON1 and NCON2), especially the more mature ones (NCON2), tend to have positive impacts. The short-run effect of a mature, noncomprehensive program is to raise total expense per adjusted patient day by nearly 5 per cent; the long-run effect is over twice this. To the extent that compensatory actions are taken in response to CON, it is not at all surprising that such responses are more pronounced in states with noncomprehensive programs.⁴³

Results pertaining to the two remaining capital expansion control programs are mixed. Parameter estimates of S1122, the variable which measures proportions of populations covered by Medicare and Medicaid in years

⁴² ASSETB and bed-size dummy variables, which have been entered separately in the cost regressions, may themselves be affected by facilities and services regulation. However, because ASSETB demonstrates a negligible impact on costs and the bed-size categories are quite large, we are not concerned about potential indirect effects of the regulatory programs on costs. Given our parameter estimates pertaining to ASSETB and total beds as dependent variables (see Table 3 *supra*), such indirect effects appear to be very slight.

⁴³ Although the nature of their sample is different and they do not distinguish between comprehensive versus noncomprehensive and new versus mature programs, our results are consistent with those of Salkever and Bice. See Salkever & Bice, *supra* note 32. If anything, Salkever and Bice's estimates of certificate-of-need impact on hospital costs are *slightly* more favorable toward CON than ours.

when the federal control program was in effect, have variable signs in the two cost regressions with relatively high standard errors. These results, taken together, imply that 1122 regulation of capital expansion has had no impact on hospital costs. The BCPAA coefficient in the cost per admission regression is negative and statistically significant, but with small implied long-run effects. Of all facilities and services regulation programs, Blue Cross's requirements for planning agency approval appear in the most favorable light. By themselves, however, they are by no means a panacea.

Several evaluations of state efforts to control hospital costs via prospective reimbursement (PR) were conducted during the mid-1970s.⁴⁴ These evaluations were hampered by (1) small sample sizes, (2) concurrent effects of the Economic Stabilization Program, and (3) limited and different methodologies used in each of these studies. Probably the best inference that can be drawn from past research is that PR may have had a small moderating influence on hospital costs, but the estimates of PR impact were often statistically insignificant and the methodologies frequently raised more questions than were answered.

At least on paper, the stronger form of prospective reimbursement is formula-based which, compared to budget-based systems, gives much less discretionary power to program administrators. Unfortunately, New York dominates the formula-PR picture. Hence, our evaluation of formula PR is largely a tale of regulation in one state. It is possible that our time series cross-section pooling methodology, which is designed to eliminate time-invariant, unspecified hospital effects, may in instances such as this "throw out the baby with the bath water," namely, discard information on the effect of New York formula PR as well as other unspecified hospital or state effects. In any case, the FPR coefficients are positive in Table 2's cost regressions and statistically significant in the average cost per admission regression. This finding should be contrasted with those of Berry, who concluded that formula PR had had a negative impact on hospital costs in New York state.⁴⁵ Berry's results are based on aggregated data. Moreover, he found that the negative impact of PR was far greater on revenues than costs.

The budget-based prospective reimbursement (BPR) estimates pertain to hospitals located in several states. The coefficient in the total expense per adjusted patient day regression is negative and statistically significant at the 1 per cent level, implying that if *all* of a hospital's patients were to obtain

⁴⁴ See Abt Associates, Inc. *et al.*, Evaluation of Nine Prospective Rate Setting Programs (1978); Abt Associates, Inc. & Policy Analysis, Inc., Analysis of Prospective Payment Systems for Upstate New York (Final Report to Social Security Administration under contract no. HEW-OS-74-261, April 6, 1976); Berry, *supra* note 22; Hellinger, *supra* note 4; and Worthington, *supra* note 21.

⁴⁵ See Berry, *supra* note 22.

coverage under budget-based PR programs, the short-run (first-year) impact would be to reduce costs per patient day by 3 per cent. The implied long-run impact corresponding to this parameter estimate is 4.8 per cent. Of course, few hospitals currently have all patients with insurance covered by budget PR. Coefficients of both PR variables tend to be more positive in the cost per admission regression than the cost per adjusted patient day regression. One plausible explanation for this is that, regardless of the overall effect on costs, PR tends to exert a positive influence on average length of stay.

Table 2's regressions indicate that the Economic Stabilization Program (ESP) caused a slight reduction in hospital cost inflation during the years it was in effect. Having ESP in effect for an entire year reduced cost per adjusted patient day by slightly over 0.5 per cent in the first year, and if the program had continued, about 0.9 per cent in the long run. Of course, the fact that the program was short-lived may account for its not having a greater impact, as Ginsburg has suggested.⁴⁶ Our results are slightly more favorable to an assessment of ESP than those of Ginsburg, who found very little evidence of overall impact on hospital costs. The present analysis has the advantage that the time series extends beyond ESP's terminal year.

As previously noted, we are only able to crudely measure the effects of Blue Cross and Medicaid efforts at utilization review (UR) and have no evidence on the PSRO program established under the 1972 Amendments to the Social Security Act. Also, since utilization measures are the denominators of our cost dependent variables, some possible effects of utilization review may be missed. Nevertheless, it is possible that utilization review has a negative impact on the provision of certain expensive and sometimes "unnecessary" services. Our UR measure should capture at least part of this influence. The regression estimates imply that UR has no impact on average cost per adjusted patient day, but the corresponding coefficient in the average cost per admission regression is negative and larger than its standard error. These results are plausible because if UR reduces length-of-stay, it should have a greater impact when an average cost measure with an admissions denominator is used. Data on utilization review are only available for 1974, and, therefore, the only reason for interyear variation in UR stems from changes in the proportions of patients with types of insurance covered by utilization review programs. Since these proportions change slowly over time, most of the variation in this variable is cross-sectional. The pooling methodology may be unduly "hard" on the UR parameter estimates, forcing them into insignificance. The UR parameter estimates in OLS variants of the average cost regressions (not shown) were both negative and statistically significant at the 1 per cent level. If these estimates had been influenced by

⁴⁶ See Ginsburg, *supra* notes 18 and 19.

omitted state effects, the coefficients probably would have been positive, not negative.

Input Regressions

Table 3 presents structural parameter estimates of regulation variables (PRECON through UR) from the input regression set and associated short-run (one-year) impact multipliers. The input dependent variables are RNs per bed, LPNs per bed, other employees per bed, predicted net plant assets per bed, current nonlabor expenses per bed, and total beds. Impact multipliers, pertaining to the first five dependent variables give the combined indirect effect (via regulation's impacts on beds) and direct effect (on $\ln(\text{input}) - \ln(\text{beds})$) of the regulatory programs. Thus, they show effects of the explanatory variables on input levels rather than ratios (to beds). Parameter estimates pertaining to nonregulation independent variables are not reported in Table 3.

Several findings unfavorable to certificate-of-need emerge from Table 3. With regard to beds, we find a positive anticipatory response to CON. Judging from the PRECON parameter estimate in regression (6), there is a 1.4 per cent increase in bed growth during the year preceding the introduction of CON. The noncomprehensive programs, which presumably emphasize controls on bed supply, have no impact on beds whatsoever. By contrast, the comprehensive programs show a positive impact, especially during the first two years (CCON1). Possibly, the CCON1 coefficient, and even CCON2's, reflect some of the anticipatory effects captured by PRECON. In any event, there is no way to conclude from Table 3 that CON has reduced the growth in beds in our cohort of 1,228 hospitals. In fact, these programs, through anticipatory effects and other forces, seem to have actually stimulated bed growth in some states.

Although the coefficients of the CON variables on assets per bed in regression (4) are insignificant at conventional levels, they are indeed uniformly negative as are the impact multipliers, with two exceptions (for which the positive coefficients are very small). In terms of both assets per bed and assets *per se*, noncomprehensive programs show a slightly more negative effect than their comprehensive counterparts. We are unable to explain why. For both comprehensive and noncomprehensive programs, the "mature" programs (designated by the suffix "2") have somewhat more strongly negative effects on assets than their younger counterparts. These results differ from those of Salkever and Bice, who found CON raised assets per bed.⁴⁷

Current nonlabor and labor expenses are not directly controlled by any CON program. Although there are some negative signs on CON variables in

⁴⁷ See Salkever & Bice, *supra* note 32.

TABLE 3
INPUT REGRESSIONS—REGULATION VARIABLE COEFFICIENTS AND SHORT-RUN (ONE-YEAR)
IMPACT MULTIPLIERS

Variable	(1) RNs per Bed	(2) LPNs per Bed	(3) Other Employees per Bed	(4) Assets per Bed	(5) Current Non- labor Expenses per Bed	(6) Total Beds
PRECON	-0.0088 (0.011) 0.005	-0.0090 (0.020) 0.005	-0.0037 (0.0082) 0.010	-0.013 (0.020) 0.001	-0.012 (0.012) 0.002	0.014** (0.0062) —
NCON1	0.0071 (0.011) 0.007	0.014 (0.021) 0.014	0.022* (0.0087) 0.022	-0.023 (0.021) -0.023	0.013 (0.012) 0.013	-0.000076 (0.0069) —
NCON2	0.011 (0.015) 0.011	0.014 (0.029) 0.014	0.023*** (0.012) 0.023	-0.033 (0.028) -0.033	0.0088 (0.017) 0.009	0.00037 (0.0090) —
CCON1	-0.0030 (0.018) 0.020	0.032 (0.035) 0.055	-0.016 (0.014) 0.007	-0.019 (0.034) 0.004	-0.023 (0.020) 0.000	0.023** (0.011) —
CCON2	0.0018 (0.021) 0.014	0.083** (0.039) 0.095	-0.011 (0.016) 0.001	-0.024 (0.039) -0.012	-0.023 (0.023) -0.011	0.012 (0.013) —
S1122	0.079*** (0.047) 0.039	0.17*** (0.091) 0.13	0.045 (0.037) 0.005	-0.033 (0.087) -0.073	-0.0012 (0.052) -0.041	-0.040 (0.028) —
BCPAA	-0.0030 (0.015) -0.023	-0.014 (0.029) -0.034	0.032* (0.012) 0.012	0.079* (0.028) 0.059	-0.013 (0.017) -0.033	-0.020** (0.0092) —
FPR	-0.056 (0.052) -0.014	0.19** (0.095) 0.25	-0.023 (0.040) 0.019	0.046 (0.11) 0.088	-0.037 (0.055) 0.005	0.042 (0.041) —
BPR	0.030 (0.023) 0.035	0.023 (0.044) 0.027	0.019 (0.018) 0.028	0.022 (0.043) 0.027	-0.025 (0.025) -0.020	0.0054 (0.014) —
ESP	-0.010 (0.013) -0.002	-0.039 (0.025) -0.031	-0.025** (0.010) -0.017	-0.069* (0.024) -0.061	-0.029** (0.012) -0.021	0.0080 (0.0076) —
UR	-0.089 (0.070) -0.16	0.075 (0.12) 0.028	-0.069 (0.052) -0.12	-0.11 (0.18) -0.16	-0.086 (0.073) -0.13	-0.047 (0.085) —

Note: Each regression coefficient is followed by its standard error in parentheses and the impact multiplier below. In regression (6), the coefficients and impact multipliers are identical. See text.

* Significant at the 1% level (two-tail test).

** Significant at the 5% level (two-tail test).

*** Significant at the 10% level (two-tail test).

the demand for labor regressions (1) through (3), all corresponding impact multipliers are positive, which suggests a definite compensatory response to CON. The largest positive effect is on the demand for LPNs in states with comprehensive programs. The CON coefficients in the current nonlabor expense regression (5) are often negative, but corresponding impact multipliers are virtually zero.

In sum, our results on CON are generally consistent with Salkever and Bice's, but we differ on particulars. Like Salkever and Bice, we find compensatory responses to CON; however, ours are on the labor rather than on the nonlabor side. Salkever and Bice did not assess CON impacts on labor use. Results on CON from our input analysis are broadly consistent with our results on costs; however, CON's compensatory effect on labor inputs is more evident from the input analysis.

Section 1122 programs had essentially zero impact in Table 2's total cost regressions, but they had a significantly positive impact on labor expense per adjusted patient day (not shown). These results are confirmed in Table 3 (even though not all S1122 parameter estimates are statistically significant). Section 1122's impacts on nonlabor inputs in regressions (4) and (5) tend to be negative, but these negative impacts are offset by positive S1122 coefficients in the labor demand regressions (1) through (3). Basically the same arguments apply to 1122 as to CON. If third-party payors do not want to pay for nonlabor inputs, hospitals will find other ways to spend money. This finding, coupled with the CON results, suggests that projections of savings resulting from reducing "excess bed capacity" may seriously miss the mark because pressing in one place (for example, nonlabor inputs) may create a bulge elsewhere (for example, labor inputs).⁴⁸

Table 3's results pertaining to the Blue Cross planning agency approval variable (BCPAA) are not consistently negative as in Table 2's average cost regressions. BCPAA has a significantly negative impact on bed expansion, but not on assets (or assets per bed). Also, these programs seem to have reduced hospital demand for RNs and LPNs but stimulated demand for other employees.

Of *all* regulation variables considered, ESP has the most definite negative impact on input use. Although ESP, not surprisingly, had no effect on beds due to its temporary nature, the ESP variable shows significantly negative impacts on assets per bed and current nonlabor expense per bed. Signs on the ESP coefficients in all three labor regressions are negative, albeit insignificant, in two of the three regressions. With the exception of beds, all impact multipliers relating ESP to levels of input use are negative. Multi-

⁴⁸ For a policy discussion of the excess hospital capacity issue, see Walter McClure, *Reducing Excess Hospital Capacity* (Prepared for Bureau of Health Planning and Resources Development, DHEW, under contract no. HRA-230-76-0086, October 15, 1976).

pliers are as high as -0.06 , the multiplier on assets. These findings are consistent with Table 2's average cost results.

Although states' experiences with prospective reimbursement have been studied at length,⁴⁹ there is little evidence on PR effects on input use *per se*. Overall, the input regression results confirm the cost regressions in that formula PR (FPR) does not have a negative impact on most inputs. An exception is nursing, where a substitution of LPNs for RNs is evident. Abt Associates and Policy Analysis found a similar tendency in a study of prospective reimbursement effects on New York hospitals.⁵⁰ We find no support whatsoever for the view that formula PR lowered the capital-labor ratio, a conclusion reached by Berry in his descriptive analysis of New York's formula PR system.⁵¹ Table 3 indicates that both assets per bed and beds rise, rather than fall, in response to FPR.

The budget PR (BPR) coefficients do not show stimulus to internal hospital growth implied by their FPR counterparts; nor is the implied reduced-form positive impact on assets as great in regression (4). However, BPR's positive impact on labor in equations (1) and (3) appears even larger than FPR's. On the whole, the input analysis is less favorable than the cost analysis to budget PR.

Most of the utilization review (UR) parameter estimates are negative in the input regressions, although never statistically significant. The implied savings on inputs attributable to UR are substantial, almost too high to be believed. We are reluctant to place too much weight on the UR results because (1) both conceptually and institutionally, this type of program would be expected to be a comparatively weak form of regulation, (2) our UR variable is not well measured, and (3) the variable is not strong in our cost regressions. However, these results do suggest a need to investigate utilization review programs in greater depth.

As with the cost regressions, *F*-tests were performed to test the null hypothesis that the vector of regulation variables does not contribute significantly to reducing unexplained variance in the input regressions, with other independent variables entered first. Results of these tests were substantially different from the cost regressions. The *F*-statistic was significant at the 1 per cent level only in the other employees per bed regression, significant at the 5 per cent level in the LPNs per bed regression, just below the 5 per cent level of significance in the assets per bed and beds regressions, and insignificant in the RNs per bed and current nonlabor expenses per bed

⁴⁹ See Gaus & Hellinger, *supra* note 4; and Hellinger, *supra* note 4, for summaries of these studies.

⁵⁰ See Abt Associates, Inc. & Policy Analysis, Inc., *supra* note 44.

⁵¹ See Berry, *supra* note 22.

regressions. The low levels of significance reflect the fact that fewer regulation parameter estimates were statistically significant in the input regressions than the cost regressions. Of course, a regulatory program might affect only one type of input and still have a substantial impact on average costs.

V. CONCLUSIONS AND IMPLICATIONS

Our evidence suggests that, as a group, regulatory programs did not meaningfully contain hospital costs during the first half of the 1970s. The results are consistent with three alternative views: (a) the regulations examined in this study do not have the capability of controlling hospital costs; (b) the regulations are effective, but our empirical approach was inappropriate to capture these effects; or (c) the regulations are potentially effective, but the time period studied was not long enough or was too soon after implementation in most cases for these effects to have become measurable. We feel that the first explanation is far more likely than the third and leave it to readers to judge the second.

There are a number of ways that one might accept these findings but still favor the regulatory approach to containing hospital costs. One plausible view is that the findings do not demonstrate regulatory failure *per se* but rather the inadequacy of a piecemeal approach to hospital cost containment. Regulation proponents might contend that many of the programs studied affect only a fraction of the hospital's patients or only limited dimensions of hospital behavior, and that such programs cannot be expected to achieve desired results unless they are sufficiently comprehensive to preclude compensatory responses of hospitals in unregulated areas of activity.

While this is not an unreasonable point of view, it would stretch credulity to attempt to make a case for more stringent and comprehensive regulation based on empirical evidence presented in this paper. Our findings are largely consistent with those from past multivariate research, and the methodology is sufficiently robust to detect manifestations of desired regulatory impacts if indeed they were present. With few exceptions, the bulk of this evidence has to be taken as generally unfavorable to regulatory solutions to hospital cost inflation. Moreover, there is some support in these findings (for example, positive parameter estimates of regulation variables in cost and input regressions) for believing that regulatory agencies are subject to capture and that hospitals can devise ways for circumventing most regulations. Health policy analysts who advocate organizational innovations and fostering competition in the hospital sector via, for example, promotion of health maintenance organizations, might see these findings as supportive of their position. If regulation is not the solution, increased competition, despite its limitations in this sector, is a logical alternative.

The descriptive evidence in Table 1 clearly shows the inflationary trend in real hospital costs and upward trend in input employment in recent years. Nonlabor costs have increased faster than labor costs. The hospital-industry literature of this period is full of accounts of how increases in expenses such as food, fuel, insurance, and so on have aggravated inflation and made it difficult for hospitals to adhere to regulatory guidelines regarding cost increases. One would expect nonlabor costs to have increased the most, and indeed current nonlabor expenses were by far the fastest growing of our input variables during this period. Still, the increase in labor inputs, measured on an FTE basis, was also substantial. Moreover, the growth of RNs relative to LPNs indicates some substitution toward higher quality and more expensive inputs. We suspect that there are many other examples of upgrading that American Hospital Association data do not permit us to measure. And it is difficult to embrace the view that inflation in factor prices is *the* culprit, in light of these increases in real inputs per bed.

One of the more salient specific findings pertaining to regulation is the indication of anticipatory effects of certificate-of-need programs in the beds regressions. We have virtually no information on the long-run "threat effects" of regulation of this sort, but major capital expansion programs clearly span several years from inception to completion. Therefore, some additions to hospital beds, generated by the prospect of future regulation, may not be manifested until long after implementation of a regulatory program. The solution to this problem is unclear; it is unlikely that "surprise" regulation is a politically viable concept and, in any case, development of CON programs in states which currently do not have them should not surprise anyone, especially since P.L. 93-641 requires states to do so.

Our empirical findings also indicate the presence of compensatory responses of hospitals to capital expansion regulation. Such effects were manifested in parameter estimates pertaining to CON and Section 1122 program variables in cost and labor input regressions. These results provide some support for the view that noncomprehensive regulatory programs tend to produce cost-increasing responses in unregulated areas. Additional indirect support for this view is provided by our results pertaining to ESP. The descriptive evidence and parameter estimates on ESP, the most comprehensive of the regulatory programs studied, do indicate a slowdown in total cost increases and input employment expansion during the ESP period.⁵² This type of global approach to hospital cost containment may not represent an effective long-term solution to inflation in this sector, but we feel compelled to point out that this is one of the few indications of cost-reducing influences of regulation that we were able to obtain.

⁵² Year-by-year statistics on growth in real hospital costs (not shown in Table 1 *supra*) indicate that growth rates were lowest during the ESP period.

Past research, on the whole, has failed to show that prospective reimbursement contains hospital costs. Our findings also suggest that PR has, at best, a very small negative effect on costs and input use. All we can say is PR has not proven itself to be an effective inflation strategy, and current reliance on PR to hinder future hospital cost increases is empirically unjustified. Formula PR, at least on paper, seems promising, but, based on this study, it does not appear to be superior to budget-review PR.

Data limitations have forced us to measure some regulatory programs crudely (for example, utilization review), to combine program variants which might have productively been defined as separate explanatory variables (for example, prospective reimbursement programs using different units of payment), and to ignore a few programs altogether. Among the latter are PSROs. It may be unfair to infer much about the PSRO program from this study. However, "advance warnings" regarding the lack of cost-limiting incentives inherent in PSRO have been stated more strongly than those that have accompanied the implementation of programs included in the present analysis.⁵³ If there is any correspondence between advance warnings and program outcomes, one should not be very hopeful regarding cost effects of the PSRO program.

Our study assesses the impact of regulation on individual hospitals as opposed to hospital markets. By definition, our sample consisted of relatively "healthy" hospitals in that only hospitals existing in all sample years were selected. Regulation may have been tougher on the "unfit" who may have been forced to close or merge. Anecdotal evidence suggests that such activities have been relatively frequent in heavily regulated states such as New York and Massachusetts. If mergers and closures connote improved efficiency in the hospital market, clearly this potential benefit of regulation is deserving of closer attention in future research.

We may as well make the commonplace suggestion for further empirical analysis with more and better data on regulatory programs. There have been additional developments on the regulatory front after our period of study. A major part of future research on hospital regulation should be devoted to empirical analysis of *area* influence on hospital performance. Such research should examine the total market area effects of regulation on hospital utilization and expenditures. This is particularly true of capital investment regulation. Do such regulations cause inefficient hospitals to seek mergers or exit from the market? How do they affect entry and propensity toward development of shared services and similar arrangements? The payoff to research of this type may be greater than that from more microeconomic analysis of regulatory effects on individual hospitals.

⁵³ See, for example, Havighurst & Blumstein, *supra* note 24.

Finally, this research has left us with some feelings of uncertainty regarding the hospital decision-making process on response to regulations. Our theoretical work, not reported here, has shown that comparative statics analysis assuming a single hospital decision maker is not very useful in developing predictions of regulatory impact. On the policy front, the debate over hospital regulation has emphasized that there are competing interests *within* the hospital, particularly between the medical staff and administration. Future research that explicitly recognizes variations in medical staff characteristics and organizations may be fruitful in discovering reasons underlying variations in hospital performance in response to regulation. Put another way, is "control" (however defined) of medical staff a necessary condition for containment of hospital costs? We would like to know the answer to this question and suspect that many policy makers would share our interest.

APPENDIX

ESTIMATION PROCEDURE

The econometric approach used in this study was developed by Nerlove for analysis of a time series of cross sections.⁵⁴ According to Nerlove's formulation, the equation's disturbance term may be decomposed into two independent elements, a time-invariant "state" effect (in our study, hospital effect) μ_i and a state- and time-independent effect ν_{it} . Then the structure of the equation's disturbance term may be expressed as

$$E(e_{it}e_{i't'}) = \begin{cases} \sigma^2 = \sigma_\mu^2 + \sigma_\nu^2, & i = i', t = t' \\ \sigma_\mu^2, & i = i', t \neq t' \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

$$E(e_{it}) = 0, \text{ for all } i \text{ and } t.$$

Let $\rho = \sigma_\mu^2/\sigma^2$. The parameter ρ is the proportion of variance of the disturbances accounted for by the time-invariant error component. Estimates of ρ are obtained by a three-step process. First, a regression is run on differences between actual values for a given hospital in year t and the hospital means evaluated over all years. Second, parameter estimates from the first step are used to derive an estimate of σ_μ^2 according to

$$\hat{\sigma}_\mu^2 = \frac{1}{N} \sum_{i=1}^N \{(y_{i\cdot} - y_{\cdot\cdot}) - \sum_k \hat{b}_k(x_{i\cdot}(k) - x_{\cdot\cdot}(k))\}^2, \quad (2)$$

where N stands for the number of observations in any year, in our case the number of hospitals, $y_{i\cdot}$ and $x_{i\cdot}$ are means for each hospital, $y_{\cdot\cdot}$ and $x_{\cdot\cdot}(k)$ are grand means (over

⁵⁴ See Nerlove, *supra* note 35.

all hospitals and years), and $\hat{b}_k$ are estimated parameters from the first stage regression. Given σ_u^2 , it is possible to form $\hat{\rho}$. Using $\hat{\rho}$, one calculates estimates of $\hat{\epsilon}$ and $\hat{\eta}$, which are characteristic roots of the variance-covariance matrix of the disturbances.

$$\epsilon = [(1 - \rho) + T\rho] \quad \eta = (1 - \rho). \quad (3)$$

Third, given estimates of ρ , ϵ , and η , a second regression is estimated.

$$\begin{aligned} \left[\frac{y_{it} - y_i}{\sqrt{\hat{\eta}}} + \frac{y_i}{\sqrt{\hat{\epsilon}}} \right] &= \alpha \left[\frac{y_{it-1} = y_i(-1)}{\sqrt{\hat{\eta}}} + \frac{y_i(-1)}{\sqrt{\hat{\epsilon}}} \right] \\ &+ \beta \left[\frac{x_{it} - x_i}{\sqrt{\hat{\eta}}} + \frac{x_i}{\sqrt{\hat{\epsilon}}} \right] + \frac{\gamma}{\sqrt{\hat{\epsilon}}} + \left[\frac{u_{it} - u_i}{\sqrt{\hat{\eta}}} + \frac{u_i}{\sqrt{\hat{\epsilon}}} \right], \quad (4) \end{aligned}$$

where, assuming a Koyck distributed lag, $y_i(-1)$ is the mean of the lagged dependent variable for observational unit (hospital) i .

Nerlove demonstrated that the above approach is equivalent to the use of generalized least squares on a model with the above error variance-covariance structure. Using Monte Carlo methods, he concluded that the approach described here shows least bias, lowest mean square error, and greatest overall robustness against specification error.

In this study, estimated values of ρ are quite plausible. For example, in our input analysis, $\hat{\rho}$ is highest for beds (0.98) and lowest for LPNs and current nonlabor inputs (0.78 and 0.79, respectively). The estimate of $\hat{\rho}$ is 0.95 in both cost regressions. As $\hat{\rho}$ approaches 1, dependent and explanatory variables become simple differences between current values and, in this application, the 1970-1975 mean for each hospital. With values of ρ near 1, this technique places considerable weight on changes over the observational period.

Using OLS, a simultaneous equation problem may well arise. That is, high cost and/or input employment states may be the first to implement cost and input controls. Yet, as seen with reference to equation (3), with a ρ near 1, all time-invariant effects are subtracted out. What largely remains is information of a time-varying nature.