Impact of State hospital rate setting on capital formation

by Jerry Cromwell

For this article, a new national data base of Medicare cost reports on more than 2,000 hospitals is used to measure the impact of State prospective rate setting on capital formation. Several investment measures are analyzed, both in nominal and real terms, using a combination of descriptive and multivariate techniques. Results indicate that, over the last decade, State hospital rate-setting programs have had little demonstrable effect on capital formation and they have not caused any significant aging of plant assets. Programs in both New York and Massachusetts were found to be associated with a slowing in the rate of bed growth, however, resulting in significant long-term cost savings.

Ever since the introduction of Medicare and Medicaid in 1966, health costs have been rising at an annual rate of more than 12 percent. Expenditures for the hospital sector alone have been climbing at approximately the same rate (Freeland and Schendler, 1981). More recent trends are very encouraging; the American Hospital Association (AHA) reports cost-per-case growth fell from 10.1 percent to 4.6 percent in 1985. However, several other trends and projections are ominous. First, hospital depreciation costs continued to rise faster than in 1983, exceeding 17 percent; and interest cost growth exceeded 20 percent (American Hospital Association, 1985). Then there is the tremendous backlog in Certificate of Need applications in several States (amounting to several billions of dollars). Finally, in the face of national bed occupancy rates under 70 percent and "excess" beds running at perhaps 10-20 percent of total beds, projections of desired hospital investment as high as $145 billion (Lightle and Plomann, 1981; ICF, Inc., 1983; and Cohodes, 1983) for the 1980's, are quite disturbing (McClure, 1976). The occupancy rate for short-term general hospitals peaked in 1970 at 78 percent, then fell consistently to 73.8 percent in 1979. By 1984, it was 68.9 percent (American Hospital Association, 1985).

If hospitals are successful in borrowing *all* the capital needed to achieve their renovation or expansion goals, high interest and depreciation charges will place an enormous burden on the industry's already overloaded cost structure. If they are completely unsuccessful, their long-run asset base could be seriously eroded. Neither possibility is desirable.

Two broad solutions to the capital problem are more (or different) regulation and more competition. Regulatory efforts impinge on capital growth in three ways. First, there are programs like Certificate of Need and the Federal Section 1122 that apply direct financial sanctions to unauthorized bed or large equipment investment. These programs appear to have been relatively ineffective and inequitable in most States, primarily because of local vested interests in hospital growth (Havighurst, 1977; Salkever and Bice, 1976; Policy Analysis, Inc., 1981).

Second, utilization review and professional standards review organizations (PSRO's) have an indirect effect on hospital capital needs by affecting hospital utilization, admission rates, and average stays. Although some evidence exists that PSRO's have reduced utilization, no empirical link with capital formation per se has been documented (Health Care Financing Administration, 1980).

Finally, many States have established prospective reimbursement (PR) programs that set hospital payment rates for one or more classes of patients, e.g., Medicaid, Blue Cross. Preliminary results suggest that some of these programs have been effective in controlling hospital costs (Coelen and Sullivan, 1981; Biles, Schramm, and Atkinson, 1980; Anderson and Lave, 1984; Morrisey, Sloan, and Mitchell, 1982) and proliferation of expensive services (Cromwell and Kanak, 1982). This form of regulation is usually preferred over other methods because it is less intrusive, less subject to co-optation by the industry or consumer groups, less costly to administer, and it gives administrators more latitude in adjusting inputs to stay within the rates. Very little evidence exists, however, that unequivocally links rate setting to a slower rate of capital formation (Sloan and Steinwald, 1980; Cromwell et al., 1976). This article is devoted to an investigation of such a linkage. More specifically, we will test the hypothesis that a fixed rate per day or admission, set prospectively, will retard the rate of new investment in beds and fixed and movable equipment. We will also test the auxiliary hypothesis that important differences in the way prospective rates are set in the various States produce unequal incentives to invest in beds and equipment that are measurable using comparative statistical techniques. Such evidence is particularly germane at this time given the introduction of Medicare's prospective payment system in 1984. What we have learned about prospective payment and hospital investment in various States should shed light on the potential impact of PPS in this crucial area.

This article is in seven parts. The first outlines a general theory of hospital capital formation under rate regulation. The theory is then modified in the next section to reflect important differences in prospective payment across the programs. Next, an overview of data sources, sampling, and analytic

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methods is provided. This is followed by descriptive statistics on the level and growth in hospital capital formation and econometric estimates of rate setting impacts. A discussion of the policy implications concludes the article.

Theory

The rate of capital formation (in percentage terms) in any State can be written as the sum of three components: the percentage growth in capital intensity (or deepening) per bed; the growth in the average number of beds per hospital (or capital widening); and the growth in the absolute number of hospitals in the local area. For the first two, a structural demand equation for capital at the hospital level can be derived as a function of capital and labor input prices, r and w, respectively, hospital output price (p), and a vector of hospital preferences, Z:

$$\Delta K = I = f(r, w, p, Z), \qquad (1)$$

where $\Delta K = I =$ rate of hospital investment.[1]

Embedded in r, the cost of capital, would be the extent of philanthropy and retained earnings enjoyed by institutions; the more philanthropy and/or earnings, the lower the hospital's capital cost and the higher the investment rate, ceteris paribus. Greater demand, reflected in output price, also raises the rate of investment as each unit of capital generates more net revenue.

Hospitals' preferences reflect a fundamental trade-off between capital intensity and bed size for a given demand. That is, hospitals can be large, investing relatively more in beds to accommodate more patients but treating them less intensively (a large city hospital may be one example), or they can be smaller but treating patients more intensively with sophisticated equipment (teaching hospitals may be an example of this type). Tremendous variation in size and intensity across hospitals clearly obtains as a product of these differences in preferences as well as factor prices, insurance coverage, and other demand-side factors. Of course, to the extent that greater intensity translates into higher perceived quality, a hospital's demand is shifted outwards—resulting in larger, more intensive institutions (Feldstein, 1977).[2]

No hospital instantaneously adjusts its inputs and bed stocks to changing market conditions. Assuming a partial stock adjustment model that makes the change in stocks a positive function of the size of the gap between desired and actual levels (Sloan and Steinwald, 1980), investment will be greater where exogenous changes are more frequent and severe—such as in a rapidly growing city. Where demand is shrinking, hospitals are more apt to let their stocks depreciate (a form of disinvestment), eventually leading to reduced bed complements and/or facilities and services).

[1]For a formal derivation of equation (1), see Feldstein (1977).
[2]Feldstein modifies his earlier model to incorporate quality-shifted demand.

Rate regulation affects investment in two ways. First, it establishes price ceilings that reduce the overall profitability of any service. This is the direct price, P, or demand-side, effect. Second, by redefining the way capital costs are included in the hospital's total cost base, it alters the price of capital, r.[3] This is the indirect capital-cost, or supply-side, effect. For example, if a program sets stringent rates but allows price-level depreciation in its rate base, the direct effect of rate setting on investment is negative, and the indirect effect is positive, leaving the net effect on the rate of investment ambiguous.

Per diem programs should discourage capital-deepening investment in particular (e.g., computerized axial tomography (CAT) scanners) with fewer effects on capital-widening projects (e.g., bed additions). This is because a limited payment per day of stay will not fully compensate hospitals for more technology-intensive care per day of stay. Of course, any increase in hospital capacity must achieve occupancy minimums to avoid inflating per diem costs. Per discharge and total hospital budget programs are less asymmetric with respect to investment type because they are more inclusive.[4]

As to how the cost of capital, demand-side influences, hospital preferences, and rate regulation effects were measured and analyzed, the reader is referred to the subsequent section on multivariate results.

Theory versus practice

How this rather simple dichotomization of rate setting (per diem versus per discharge and total budget) works in practice is far more complicated, and clear predictions of investment are impossible. This is because of the variety of methods chosen to implement either system. Shown in Table 1 is a summarization of the main features of 15 State programs, when they were implemented, which payers are included, and under what conditions the hospitals participate. Also shown are the major changes in the programs over time. Maryland, for example, implemented its inflation adjustment system (IAS) in 1978 and its guaranteed inpatient revenue (GIR) program in 1979. The range and diversity of programs afford no easy characterization of prospective systems. Indeed, it would be misleading to lump the mandatory, all inclusive New York per diem system that was operational for 10 years with, say, the small, voluntary Blue Cross program in western Pennsylvania. Regarding capital costs in particular, seven additional factors further confound simple predictions of State-specific efforts.

[3]For an application of neoclassical investment theory to the hospital's cost of capital that includes adjustments for taxes, cost-based reimbursement, and inflation, see Cromwell et al. (1984).
[4]A more detailed discussion of the relationship between unit of payment and capital formation can be found in Sloan and Steinwald (1980) and Cromwell and Burstein (1984).

Table 1
Features of prospective reimbursement programs prior to 1980

Program	Fiscal year review began/ major changes	Locus of authority	Scope of payer coverage	Hospital participation	Compliance	Provision for negotiation	Type of prospective limit
Arizona	1973	DOH[1]/HSA's	Blue Cross Commercial Self-pay	Mandatory	Voluntary (public disclosure)	Yes	Budget review only
Colorado	1972	DOH	Medicaid	Mandatory	Mandatory	Yes	Per diem
Connecticut	1975	Independent Commission	Commercial[2] Self-pay	Mandatory	Mandatory	Yes	Total revenue less allowances
Indiana	1960	Indiana Blue Cross	Blue Cross Commercial Self-pay	Mandatory (for Blue Cross)	Mandatory (for Blue Cross)	Yes	Budget review
Kentucky	1971	Blue Cross	Blue Cross	Voluntary	Mandatory	Yes	Budget review only
Maryland	1975	Independent Commission	Blue Cross Charge payers	Mandatory	Mandatory	Yes	Budget/rate review
	1978 IAS		All payers	Mandatory	Mandatory	Yes	Budget/rate review
	1977-1979 GIR		All payers after 1978	Mandatory	Mandatory	Yes	Per case-rate to rate
Massachusetts	1975	Independent Commission	Medicaid	Mandatory	Mandatory	No	Per diem
	1976		All payers except Medicare	Mandatory	Mandatory	No for Medicaid	Per diem—Medicaid Charges—other
Minnesota	1975	Hospital association from DOH	Blue Cross Commercial Self-pay	Mandatory	Voluntary	Yes	Budget review only
Nebraska	1973, ended 1978	Hospital association	Blue Cross Commercial Self-pay	Voluntary	Voluntary	Yes	Budget review only
New Jersey	1975	DOH	Blue Cross Medicaid	Mandatory	Mandatory	Yes	Per diem
	1977			Mandatory	Mandatory	Yes	Per diem (more detailed review)
New York	1971	DOH/Blue Cross	Blue Cross and Medicaid	Mandatory	Mandatory	No	Per diem
	1976			Mandatory	Mandatory		Per diem (add tighter screens)
	1978		Add charge payers	Mandatory	Mandatory	No	Per diem—Medicaid/ BC; charges—others (add external LOS penalty)
Rhode Island	1975	Blue Cross/ State budget office	Blue Cross/ Medicaid/ Medicare	Mandatory	Mandatory	Yes	Budget/rate review and statewide cap
Washington	1976	Washington State Hospital Commission	All except Medicare/ Medicaid	Mandatory	Mandatory	Yes	Budget/unit charges review
	1978		All payers	Mandatory	Mandatory	Yes	Budget with volume incentive
	1978		All payers	Mandatory	Mandatory	Yes	Budget with no volume incentive
	1978		All payers	Mandatory	Mandatory	Yes	Budget/unit charges review
Wisconsin	1971	Committee of State/BC/ industry	Blue Cross	Mandatory	Mandatory	Yes	Budget review and approval
	1977		Add all except Medicare	Mandatory	Mandatory	Yes	
Western Pennsylvania	1971	Blue Cross	Blue Cross	Voluntary	Mandatory	Yes	Per diem
	1974		Add Medicare	Voluntary	Mandatory		
	1979		Add Medicaid	Voluntary	Mandatory		

[1]Department of Health.
[2]Blue Cross patients are covered under a separate Blue cross-sponsored experiment.

NOTES: BC is Blue Cross. HSA's is Health Services Agencies. LOS is length of stay. GIR is guaranteed inpatient revenue.

Defining capital costs

Few PR systems pay for debt principal explicitly, allowing the hospital instead to set up an annual depreciation schedule to cover it. Interest remains an allowable expense by itself (with minor conditions). With inflation, historically based depreciation is inadequate for replacement, necessitating more equity or borrowing in the future.[5] Some programs recognize this by paying either price-level or accelerated depreciation for movable equipment (e.g., Maryland, New Jersey, and New York). Maryland and New Jersey also reimburse cash requirements for principal plus interest on buildings unlike New York which pays historical depreciation.

Underestimating replacement costs would be a much more serious problem for the industry if the net cost of debt were higher. Rapid inflation in charges, tax-exempt bonding, and cost-based payment all work to dramatically lower debt costs (Cromwell et al., 1984; Cromwell, 1984) encouraging investment even in "historical cost" States. According to reasonable assumptions, the typical hospital's effective or true cost of debt could range between 1 and 3 percent. Moreover, capital investment can be a way of improving the hospital's short-run financial position, even if the long run is riskier. This arises from the excess of allowable depreciation over repayment of debt principal in the loan's earlier years, improving cashflow. Thus, we cannot predict lower building investment under historical depreciation methods—even in New York—if hospitals are "gaming" the system in this way.

Certificate of need

Most rate-setting programs require Certificate of Need (CN) approval before including depreciation in the hospital's rate base. CN programs alone should decrease the rate of bed and building investment but not discourage equipment and service investment if it falls below review thresholds, an hypothesis borne out in previous CN evaluations (Havighurst, 1977; Salkever and Bice, 1976; Policy Analysis, Inc., 1981). Hence, per diem rate-setting systems with stringent CN programs (e.g., New York) may minimize the effects of perverse length-of-stay incentives in each system alone, with CN constraining expansion and rate-setting dampening intensity.

Cost and utilization screens

Nearly all programs have formal or informal screens for such things as hospital utilization, occupancy rates, average costs per day, admissions, or lab tests. Where effective, they can discourage capital formation by disallowing higher operating costs associated with the investment. New York is an excellent example. Hospitals must meet minimum occupancy rates or incur a occupancy penalty that effectively lowers their per diem payment for covered patients.[6] The threat of occupancy penalties also raises the risk of losses that in turn can raise the true cost of capital. New York also imposes routine and ancillary per diem and per discharge cost screens, with disallowances for any excesses over the mean. Any investment that raised operating costs without a commensurate increase in patient days or admissions would also lead to disallowances and higher real capital costs.

Payer coverage

Next, States vary in the number and type of payers covered by the program. Partial coverage renders the true cost of capital an amalgam of different insurer cost-finding methods, and hospitals may find it in their best interests to undertake the investment, incur capital "losses" on a small number of PR patients, and recoup most if not all of the loss on noncovered patients (often those with Medicare).

Static and dynamic compliance

A distinction also needs to be made regarding the type of rate compliance that a program requires. Under static compliance, hospitals receive a per diem rate based on current period allowable costs. If current costs exceed allowed revenues, short-run losses are incurred. A more subtle requirement involves dynamic compliance whereby programs " . . . incorporate penalties into their system to eliminate the incentive for hospitals to overspend in one year in order to raise the cost base on which future years' allowable revenues are derived." (Hamilton, Walter, and Cromwell, 1980). Without dynamic compliance, hospitals could incur short-run losses on a new capital project until the additional costs are "worked into" the cost base on which future per diems or charge schedules are set. Once in the base, they are guaranteed higher payment, unless they continue to exceed peer group variable cost screens. States differ both in method and rigor in this key area of compliance.

Negotiations

Most prospective payment programs have involved some form of rate negotiation—New York being a notable exception. Decisions emanating from face-to-face meetings may override established screens or policies regarding allowable capital costs, making it hazardous to predict effects a priori. Such negotiations have considerably weakened the certificate-of-need process, which, in turn, could weaken PR constraints on capital formation given the CN "pass through."

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[5]For a thorough critique of insurer depreciation methods and the increasing indebtedness of hospitals, see Cleverley (1979).

[6]For a critique of New York's rate-setting methodology as it applies to capital reimbursement, along with a critique of the programs for Massachusetts, New Jersey, and Maryland, see Cromwell, Wedig, and Calore (1983).

Stringent rates

Finally, and most telling, is the feedback of price controls on financial status and future capital formation. States with very stringent payment rates should not be candidates for large capital expansion, renovation, or replacement, regardless of their generosity in reimbursing capital. Hospitals are likely to be in weaker financial shape, and the risk of additional losses on new projects is greater, thereby raising both the cost of debt and equity.

When combined with the other six factors, uneven stringency makes any system's effects on capital—let alone any other variable of interest—basically unpredictable. Moreover, with only 15 rate-setting programs varying across 6-7 key characteristics, it is statistically impossible to separate their independent effects from the overall program effect. Thus, we are left to discover the net effects of all seven factors from empirical interstate comparisons.

Sample frame, data sources, and measures

Sample frame

The sampling frame for this study was the list of all community hospitals that responded to the AHA annual survey in any year between 1969 and 1977. A one-quarter random sample of all U.S. short-term community hospitals was drawn first, then supplemented by the addition of any other community hospitals in each of 14 PR States: Arizona, Colorado, Connecticut, Kentucky, Massachusetts, Maryland, Minnesota, Nebraska, New Jersey, New York, Rhode Island, Washington, Wisconsin, and Western Pennsylvania. (Because Indiana's program began long before 1970, no pre-program data were available, and it was therefore dropped from the analysis of capital formation.) The result was a full sample of more than 2,700 hospitals. All available years for the 1970-79 period were included in the data file, giving 10 years of data for most institutions.

Data bases and definitions

A hospital-year analytic file was then constructed from three sources: AHA Hospital Annual Survey Statistics, HCFA Medicare Cost Reports, and other secondary data. AHA survey tapes provided information on bed size, ownership, teaching status, and facilities and services. These data are well known, and require no additional elaboration.

Data on hospital investment do not exist for a large number of hospitals over an extensive period, necessitating construction of a new data base. As part of their annual reporting to the Health Care Financing Administration, hospitals are required to submit a Medicare cost report that includes a balance sheet with current and fixed assets. Assets can then be used in change form to calculate investment rates (described below).

Once 21,000 balance sheets were computerized, extensive editing, cleaning, and replacement algorithms were undertaken to insure that items added and did not jump up and down in meaningless patterns.[7] To avoid throwing out large positive and negative investments a priori, visual inspection and hand correction of more than 600 outlier hospitals was done by the author. Most outliers were easily fixed by comparing reported asset changes to changes in costs, beds, and volume statistics. Changes inconsistent with growth in hospital size or activity were reset to original values. The end product was an asset data file with over 21,000 hospital years (1970-79) with positive net total fixed assets, with 16,000-17,000 hospital years with gross buildings and movable equipment separately, and with 12,000-13,000 hospital years with net buildings and equipment. Recent cost report data for the early 1980's were unavailable, limiting analysis to earlier versions of the programs. The most significant omission is the New Jersey diagnosis-related group system.

Gross versus net investment

The prime dependent variable for the capital formation analysis is the change in the stock of real net capital available for production in any period. Real stocks net of accumulated depreciation is a better measure of basic capacity than gross stocks as gross output capacity falls with asset age; repair and maintenance costs increase, lowering net revenues; and older equipment should be less productive in general because of capital-embodied technical change (Kendrick, 1961).

Our data base for developing real stock estimates differs from most in that we have access to hospital balance sheets that give asset values by year in nominal terms; no investment data are reported per se, but they are derivable in theory as changes in asset stocks. It is not usually possible from this series alone to determine whether the hospital has replaced, expanded, or discarded assets. Nevertheless, intertemporal comparisons of (or changes in) gross or net assets can be a useful indicator of the relative growth in productive capacity. For evaluation of rate-setting effects on capacity, this seems a relevant capital measure, if not the very best in all cases. Because many hospitals did not allocate depreciation by buildings versus movable equipment, only gross investment analyses are done by asset component—i.e., gross building and gross movable equipment. Finally, the investment series for any one hospital or even large numbers of hospitals is still quite volatile in spite of the extensive cleaning and editing procedures already described. (An appendix that has a more detailed explanation of the cleaning and editing procedures is available from the author.)

[7]The appendix that provides detailed information on our editing procedures is available from the author.

Construction and equipment price inflation

Inflation in construction and equipment costs greatly complicate the issue. We prefer a measure of capital input in constant dollars for several reasons. First, more expensive replacement without any technical improvement would not show up as positive investment just because it cost more. Second, by deflating the asset series, we are effectively measuring capital stocks assuming base period efficiency levels (Kendrick, 1961). Care must be taken, however, not to deflate too much. Only gross investment flows (or the change in asset values) and not asset stocks should be deflated.

Construction cost indexes reflecting the composite cost for residential, nonresidential, and institutional buildings were obtained from McGraw-Hill (1981). Annual city index values for the 1970's were aggregated to the nine census divisions level and reindexed to 1969 for all cities to provide a base year for comparison. The construction index was then used to deflate the gross and net building investment series. Over the 1969-79 period, the index rose 144 percent, a 9-percent compound growth rate in building prices.

Unpublished national professional and scientific equipment cost deflators were furnished by the Bureau of Economic Analysis, U.S. Department of Commerce, for 1969-79. According to these data, medical equipment costs rose 73 percent over the 11-year period, or about one-half the rate of building cost inflation.

A combined construction-and-equipment deflator was then developed to deflate changes in net total fixed assets, using a weighted average of the two deflators. Weights of .75 and .25 reflected the relative fraction of buildings and movable equipment, respectively, in total fixed assets. For 1979, the composite index was 2.26 for the United States, implying a 126-percent increase in average capital prices over 1969, or about 8 percent per annum. (The appendix in which the investment price deflator is discussed in more detail is available from the author.)

Age-of-capital effects

The impact of asset vintage on the probability and size of observed investment is obvious from the foregoing discussion. Hospitals with an older plant and older equipment should exhibit greater absolute changes in gross and net assets, ceteris paribus. If vintage is systematically related to the adoption of prospective reimbursement (say, PR is adopted in Northeastern States with older facilities), then care must be taken not to ascribe vintage effects on investment to the programs.

As a check on age inequalities across PR and control hospitals, a base-period proxy of asset vintage, or depreciation rate, was included in the descriptive analysis. $Nb = 1 - (NA_t/GA_t)$ provides a rough measure of average vintage in percent terms, where N = number of years an asset has been depreciated, b = annual depreciation rate (= 1/expected asset lifetime, using straightline depreciation), and (NA_t/GA_t) = the ratio of net (NA) to gross (GA) assets. For N = 10 and b = .05, Nb = .5, implying that 50 percent of the 20-year lifetime of the building has been depreciated (i.e., 10 years). In the empirical work, Nb will be defined in terms of the cumulative building depreciation rate. Aggregate rates across hospitals are then weighted by admissions to more closely link the age of assets in a State to the patients being treated.

Unfortunately, our data did not allow us to calculate a weighted depreciation rate averaged across asset vintages. Asset price inflation produces a downward bias to capital aging when assets are not replaced one for one. This is because the minor depreciation rate of newer assets is overstated in a cumulative total. Our measure, therefore, is only a rough approximation.

Market entry and exit

A final issue concerns the measurement of investment for new hospitals and closures in their first and last years, respectively. Obviously, no pre-data or post-data exist for these cases on which to calculate investment rates. If we ignore this problem, initial investments and final divestments are set to missing, and we derive PR effects for surviving institutions alone. It is conceivable, however unlikely, that PR programs have been retarding industry capital formation, not among survivors, but only by discouraging the building of new hospitals and shutting down existing facilities. (Such appeared to be the case for New York but not for other PR States.) To allow for both possibilities, we first identified hospitals that opened and closed from AHA data, then set beginning- or end-period (dis)investment equal to total assets (deflated) or beds in the first and last reporting periods—plus for openings in the first year, minus for closures in the last. The results automatically account for unequal closure and merger rates using these adjustments (Cromwell and Burstein, 1984).

Descriptive findings

Year-to-year rates of net investment in real (deflated) total fixed assets per hospital (DDNFAS) are shown in Table 2 for 14 PR States and a control group of hospitals in other States. The year the program was implemented is given in parentheses below the States' name, and the average number of reporting hospitals is in the right column. Control hospitals showed a fairly stable pattern of positive growth. Real net investment per hospital averaged between $200,000 and $400,000 from 1972 through 1979, with a slight upward trend. Expansion paths in PR States varied considerably, however, partly reflecting the volatility of any investment series in small samples. Arizona after 1976, Wisconsin after

Table 2

Annual change in (deflated) net total assets, gross buildings and fixed equipment, and major movable equipment assets per hospital, by State: 1971-79

State	Type of asset	1971	1972	1973	1974	1975	1976	1977	1978	1979	Sample size
		Amount in thousands									
Arizona (1973)	DDNFAS	$196	$415	$415	$315	$337	$169	$637	$739	$1,129	46
	DBFE	408	601	323	651	220	596	249	850	409	30
	DMEQ	85	390	259	159	197	106	183	52	1,061	25
Colorado (1972)	DDNFAS	-132	62	214	216	515	806	142	102	238	70
	DBFE	208	53	283	73	450	661	279	252	420	45
	DMEQ	54	124	133	322	138	184	85	78	104	45
Connecticut (1975)	DDNFAS	898	1,484	469	154	300	469	1,003	342	517	33
	DBFE	691	2,090	2,731	346	360	662	1,058	528	291	25
	DMEQ	116	454	412	219	214	354	504	246	214	25
Kentucky (1971)	DDNFAS	284	653	874	696	41	88	359	142	182	102
	DBFE	321	557	946	168	142	-19	407	114	160	80
	DMEQ	83	122	241	106	85	68	181	250	141	70
Massachusetts (1975)	DDNFAS	381	484	375	559	278	964	186	196	-47	106
	DBFE	535	213	472	318	331	773	136	405	173	70
	DMEQ	37	155	182	176	194	266	147	170	154	65
Maryland (1975)	DDNFAS	833	26	257	692	1,588	-252	514	186	819	45
	DBFE	899	339	279	1,210	1,526	-140	590	107	810	36
	DMEQ	203	97	38	451	184	143	221	260	364	38
Minnesota (1975)	DDNFAS	111	188	394	166	125	967	181	149	-277	138
	DBFE	142	158	534	324	163	155	238	-197	-91	70
	DMEQ	-48	157	271	175	164	239	158	117	116	70
Nebraska (1978)	DDNFAS	8	6	42	1,420	469	660	436	236	58	89
	DBFE	26	171	92	1,015	363	322	226	253	95	60
	DMEQ	27	65	65	498	148	111	137	79	66	50
New Jersey (1975)	DDNFAS	-259	583	397	483	304	325	403	199	657	95
	DBFE	886	700	70	352	-4	36	-28	302	246	20
	DMEQ	215	575	35	127	21	100	122	138	324	20
New York (1971)	DDNFAS	99	523	384	500	329	436	579	124	432	262
	DBFE	537	892	483	527	421	450	578	273	484	220
	DMEQ	-58	-16	107	230	181	223	228	171	162	220
Rhode Island (1975)	DDNFAS	-6,457	348	-67	-87	-28	194	19	19	170	12
	DBFE	798	4,985	2,980	244	294	229	318	-977	1,682	5
	DMEQ	65	30	44	60	98	104	94	176	26	5
Washington (1976)	DDNFAS	147	3	172	196	267	228	326	83	116	92
	DBFE	183	70	92	296	279	80	437	87	50	45
	DMEQ	212	37	33	47	139	216	197	208	176	45
Wisconsin (1971)	DDNFAS	63	344	47	285	365	331	312	228	634	127
	DBFE	63	332	236	520	703	56	307	313	856	80
	DMEQ	39	87	77	243	247	431	221	68	338	70
Western Pennsylvania (1971)	DDNFAS	384	395	197	297	521	439	432	769	519	82
	DBFE	583	478	286	124	443	352	375	537	428	70
	DMEQ	264	156	55	42	268	113	264	312	224	60
Other States	DDNFAS	127	289	281	227	289	375	277	281	370	1,043
	DBFE	326	306	290	268	275	274	167	270	254	750
	DMEQ	63	90	133	108	105	150	146	163	164	700

NOTES: Sample size refers to the typical number of hospitals reporting a given asset in a particular State for a given year.
DDNFAS: Annual change in deflated net total fixed assets.
DBFE: Annual change in deflated building and fixed equipment assets.
DMEQ: Annual change in deflated major movable equipment assets.
SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from Medicare Cost Reports, 1970-79.

1973, and western Pennsylvania after 1974 experienced what amounts to a boom in hospital investment, and Kentucky and New Jersey had early rapid growth followed by secular declines. Massachusetts and New York (the largest rate-setting State with over 260 reporting short-term hospitals) both show a trend very similar to that for New Jersey, only not as pronounced. No clear, uniform break in any series is evident for any State after the implementation of rate setting (although multivariate results reported later do show effects for Kentucky, Massachusetts, and Minnesota). The very large decline in net assets for Rhode Island in 1971 is the result of a major hospital closure and merger.

Trends in real building versus movable equipment investment have clearly moved in opposite directions over the 1971-79 period. (See DBFE and DMEQ lines in Table 2.) Gross (undepreciated) building and fixed equipment investment averaged $326,000 per hospital in the other control States in 1971, falling to $254,000 (in 1969 dollars) by the end of the decade. Gross movable equipment investment, on the other hand, nearly tripled from $63,000 per hospital to $164,000. Considered another way, in the early 1970's, hospitals added roughly $3 to their building assets for every $1 in movable equipment. That ratio narrowed considerably to 1.6:1 by 1979, reflecting a major bias towards equipment deepening.

Again, the numbers are much less precise when displayed on a State bias. Fortunately, Connecticut, Maryland, and New York all had response rates above 70 percent for buildings and equipment separately, and they may be more dependable for this reason. None of the three showed as clear a pattern as observed in the control group, but a rough, inverse trend does seem to be present. If we aggregate across the eight mandatory programs, we find the rate of building investment unchanged from 1971 to 1979, and equipment investment roughly doubled.

After deflation, the control group exhibited a 65-percent growth in real capital deepening (measured by the increase in net assets per bed) over the decade. By contrast, 9 out of 14 PR States had even higher rates, led by Kentucky, Colorado, and Rhode Island. Maryland, by contrast, had the lowest rate of capital deepening (44 percent). New York is particularly interesting because of its size, maturity, and stringency. Yet, real capital deepening took place in New York at a slightly higher rate than in U.S. hospitals generally (71 percent versus 65 percent). If the hospital industry in New York was seriously constrained in its capital expansion under a decade of "stringent" rate setting, simple numbers such as these do not show it.

Aging of capital

Let us turn our attention once again to net total investment by State and see how it affected the age of capital stocks. Although positive overall investment rates did not indicate any asset deterioration on average, some rate-setting programs may have produced a growing divergence between "winners" and "losers" that has had negative effects on age. Table 3 provides a rough measure of building asset vintage, measured by the percent of assets depreciated, at the beginning and end of the decade. The third and first quartile thresholds are given in parentheses next to the mean for the top and bottom quarter of the distribution.

Over the decade of the 1970's, Medicare Cost Report data revealed no material change in asset vintage among control hospitals, but the measured change may be biased towards zero (see data bases). Average building depreciation rates were 31 percent (in other States) to begin the decade, rising only one point to 32 percent 8 years later. Roughly 1 in every 4 hospitals reported their buildings at least 40-percent depreciated, and another quarter had less than a 20-percent depreciation rate.

Of the PR States at the beginning of the 1970's, Connecticut had the oldest, most depreciated buildings on the average (40 percent), Arizona had the newest (21 percent); although in both cases, the sample sizes were quite small (i.e., less than 25 percent of all hospitals reported building depreciation separately in either State). New York had very good reporting of net assets, however, and its 36 percent depreciation rate should be fairly reliable. Compared with control hospitals, the industry in New York started the 1970's with capital about 16 percent older, with one-quarter of its members maintaining

Table 3

Age distribution of hospital buildings and change in per capita beds, by State: 1971-72 and 1978-79

State	Building cumulative depreciation rate 1971-72 Mean	Building cumulative depreciation rate 1978-79 Mean	Cumulative percent change short-term beds per capita 1971-79
Arizona	0.21 (.29, .12)	0.26 (.40, .21)	−9.5
Colorado	0.30 (.33, .19)	0.31 (.39, .22)	−8.9
Connecticut	0.40 (.48, .23)	0.33 (.36, .24)	2.7
Kentucky	0.30 (.39, .16)	0.38 (.47, .27)	5.9
Massachusetts	0.35 (.45, .24)	0.35 (.45, .29)	1.9
Maryland	0.27 (.38, .18)	0.35 (.44, .30)	4.4
Minnesota	0.34 (.45, .26)	0.33 (.46, .23)	0.9
Nebraska	0.29 (.40, .18)	0.35 (.48, .25)	8.9
New Jersey	0.31 (.38, .18)	0.31 (.43, .23)	10.3
New York	0.36 (.46, .22)	0.35 (.47, .26)	−3.1
Rhode Island	0.27 (.32, .18)	0.46 (.60, .35)	1.1
Washington	0.27 (.38, .22)	0.34 (.49, .24)	−11.4
Wisconsin	0.33 (.44, .22)	0.30 (.42, .24)	−2.0
Western Pennsylvania	0.35 (.45, .25)	0.31 (.42, .24)	5.0
Other States	0.31 (.41, .20)	0.32 (.44, .23)	2.5

NOTES: Numbers in parentheses beside means are top and bottom quartile threshold percentages, respectively. Means are hospital rates weighted by total admissions.
SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from Medicare Cost Reports,. 1970-79.

structures at least 46 percent depreciated. Yet, the situation shows no deterioriation under a decade of rate setting, either on the average or among the older hospitals. In fact, by the end of the decade New York hospitals were younger than at the beginning, with no real change in the age threshold of the oldest structures.

Beds per capita

The bottom line of any analysis of capacity must consider beds per capita, given wide disparities in this statistic and the apparent fact that more beds usually mean greater hospital expenditures. With the exception of New Jersey, bed availability in all mandatory PR States grew fairly slowly relative to hospitals in other States (Table 3). New Jersey exhibited the largest increase in beds per capita (over 10 percent), as a result of rapidly growing bed sizes of existing hospitals. Even still, its 1979 rate of 3.87 beds per 1,000 was far below the national average (possibly because of the proximity of New York City and Philadelphia hospitals). New York was unique in having an 11-percent growth in bed size along with a slight decline in beds per capita, even though its population fell 500,000. This implies a rather significant decline in the number of independent institutions. Twenty-one hospitals did close in New York from 1971 through 1979 according to the AHA, one-half of them had less than 100 beds. Mergers counted for several more hospitals, giving the State by far the highest dissolution and consolidation rate in the country (about −3.0 percent per year from 1976 through 1979). New York also started the decade with the highest average occupancy rate of any State, 84 percent. Nevertheless, closures and consolidations drove the rate up to 87 percent by 1979.

Multivariate analysis

We begin this section by specifying the model to test for rate-setting effects on several capital formation variates. Equation (1) provides a guide, with the endogenous price-of-output variable replaced by exogenous demand and supply variables.

Dependent variables

The following six variables were selected for multivariate regression analysis:

At the hospital level
- Annual deflated change in net total fixed assets (DDNFAS).
- Annual deflated change in gross building and fixed equipment, excluding land (DDBFE).
- Annual deflated change in gross major movable equipment (DDMEQ).
- Annual change in bed stocks per hospital (DBDTOT).
- Annual deflated change in net total fixed assets per bed (DDNFASB).

At the county level
- Short-term beds per 1,000 population (BDPOP).

The first five investment measures are all flows based on the hospital as the unit of analysis. The last, BDPOP, is a stock variable based on the county. If prospective reimbursement has slowed the growth in beds per capita, either across all hospitals or by discouraging new entrants and closing existing institutions, this measure should reflect it. Another, even better bottom-line impact measure would have been net total hospital investment per capita, but our sample frame and data sources precluded acquiring such data on all hospitals in control counties that did not fall into the one-quarter random sample.

Measuring prospective reimbursement

A dummy variable regression approach is particularly suited to preprogram versus postprogram comparisons of stock variables that are temporally very stable, e.g., hospital costs per day. However, for an extremely volatile figure like investment, this approach could lead to misinterpretation because of its sensitivity to values recorded in just 1 or 2 years prior to or after implementation. Dummy variables that discriminate among changes in programs over time (Coelen and Sullivan, 1981) are particularly sensitive to large random investments in 1 or 2 years. Alternatively, we have specified the PR effect as the number of years each program has been in effect, realizing that random spikes may still tilt the trend line somewhat. A third approach of simply dropping extreme outliers is totally inappropriate here without strong reasons to believe the data are true reporting errors. Hand-checking did show many hospitals with huge increases followed immediately by similar decreases in assets; these cases were considered erroneous and were smoothed. Many other cases, however, showed enormous increases in assets in one year which appeared legitimate. Ignoring them could seriously bias all conclusions regarding PR impacts. PR coefficients can be interpreted as the average annual change in the dependent variable over the entire course of the program and their associated t-statistics, as the statistical significance of the trend. This specification has the advantage of simultaneously testing the hypotheses that the rate of change in capital formation is negative under prospective payment and is more significant in older, more mature programs. A priori predictions of State-specific program effects on investment are impossible, however, given the set of practical considerations discussed above. States rank high (or tough) on some, but never all, criteria. The one exception could be New York, the oldest, most stringent PR system in the country, where we could expect a retardation in investment.

Independent variables

Contained in Table 4 are the names, brief definitions, and means of all included independent variables that control for other systematic differences in hospital demand and supply across States and years. The PR dummies are set equal to one if the hospital was providing services in a State's program during the program's first year. They would be set to equal two during the program's second year, and so forth. Because the rest of the covariates are included primarily to avoid spurious conclusions of rate-setting effects, only a brief discussion of their role is provided.

Because hospital input prices, r and w, as well as output price, p, cannot be considered exogenous to a State's PR program, they are not explicitly controlled for in the independent variable list. Region-specific differences in all three, however, are captured with the regional dummies (NE-PAC). Furthermore, to the extent wages are exogenously determined by, say, unemployment rates, this is accounted for in the exogenous variable list.

The first five economic demand variables measure the population's ability to pay in terms of income, insurance coverage, and employment status. Wealthier States with growing insurance coverage should exhibit higher hospital investment through a simple-accelerator (or utilization) effect. Three demographic characteristics—years of schooling, birth rates, and percent white—also reflect medical need separate from ability to pay. Standard metropolitan statistical area location, size, and density are also included to capture known differences in medical needs and proclivities to use inpatient services in rural and urban areas. They are included to pick up area-wide need not captured in hospital-specific characteristics such as teaching status. Any other cross-section or time series changes in needs are picked up in the region and time dummies. Public versus proprietary ownership and teaching status are included as special preference variables for breadth (beds) versus depth (equipment) of investment. Bed-size class is included to control for any size preferences as well as the hospital's competitive and financial position. A class (e.g., less than 100 beds, 100-200 beds) variable is used to avoid any endogeneity with the rate-setting program. Two competitive variables, health maintenance organization (HMO) penetration rate and the hospital's share of county beds, are included to reflect supply-side investment needs. HMO share should lower hospital demand for capital while market share is indeterminate. Physician availability and degree of specialization are included to reflect possibilities of ambulatory substitution and specialist-induced equipment demand, respectively. The professional

Table 4

Variable definitions and means: Total sample, 1970-79

Variable	Definition	Mean
Dependent variables		
DDNFAS	Annual deflated change in net total fixed assets	—
DDBFE	Annual deflated change in gross buildings and fixed equipment, excluding land	—
DDMEQ	Annual deflated change in gross movable equipment	—
DBDTOT	Annual change in bed stocks per hospital	—
DDNFASB	Annual deflated change in net total fixed assets per bed	—
BDPOP	Short-term beds per 1,000 population at county level	—
Independent variables		
CAPINC	County per capita income	$4,757
COMMINS	Percent of State population covered by private insurance	87.400
POPT18	Percent of county population covered by Part A of Medicare	11.400
AFDC	Percent of county population enrolled in AFDC	4.19
UNEMRT	Unemployment rate, SMSA level in urban areas and average of all State SMSA's in rural areas	6.310
EDUC	Median years of schooling completed by county population as of 1970	11.600
BIRTH	Birth rate per 100,000 population (county)	1,512
WHITE	Percent of county population that is white	91.200
DSMSA	County located in an SMSA	.538
P	County population	517,000
POPDENS	Population per square mile (county)	1,912
GOV	Hospital owned by State or local government unit	.249
PROF	Hospital under proprietary ownership	.086
COTH	Hospital is member of Council of Teaching Hospitals	.065
BS	Bed capacity of hospital grouped by bed-size class	173
HMOPOP	Percent of population enrolled in an HMO in county (rural areas) or SMSA (urban areas)	1.740
MSHARE	Proportion of beds in market area (county or SMSA) occupied by hospital	.718
PHYSPOP	Patient-care physicians per 100,000 population (county)	120
SPMD	Percent of patient-care doctors who are specialists	64.800
DPSRO	Hospital covered by binding PSRO review in year	.200
CN	Certificate of need program initiated in State in current or previous year	.654
NE-PAC	Nine regional dummies; ENC in intercept	—
D71-D79	Annual year dummies, equal to 1 in all years beyond appropiate year	—

NOTES: AFDC is Aid to Families With Dependent Children. SMSA is standard metropolitan statistical area. HMO is health maintenance organization. PSRO is professional standards review organization. ENC is East North Central. PR is prospective reimbursement.

standards review organization's and CN dummies control for the investment-related effects of two other complementary, but distinct, regulatory programs. Nine regional and nine year dummies are included as further controls for any left-out variables correlated with the adoption of or changes in the PR programs.

Estimation methods

All hospital-level regressions were run using unweighted ordinary least squares on a reduced-form specification. Sample sizes ranged from 12,000 to 17,000 hospital years, depending on data availability. Weighting seemed unnecessary given the self-weighting nature of the dependent variable. Heteroskedasticity could still be a problem, but no improvement in estimation was gained by using investment per bed to scale for size effects. By contrast, BDPOP regressions used weighted least squares with county population as weights. We could also have weighted the PR hospitals by the percent of patients covered by the program, as in Sloan and Steinwald (1980), but did not do so for two reasons. First, insurer mix at the hospital level is endogenous, and hospitals severely constrained by PR would likely try to shift their mix towards non-PR patients, thereby producing an underestimate of rate-setting effects for a constant coverage. Second, as programs mature, their scope of coverage increases to protect against cost shifting; and the years-in-operation measure of PR naturally picks up this effect at the statewide level. Over 10,000 county-years were available for analysis.

Rate-setting effects

Presented in Table 5 are regression coefficients for only the rate-setting dummies for all investment variants. The overall R^2s of the models are quite low—except for the county beds per capita regression—but still statistically significant. This implies that most of the year-to-year variation in hospital investment is quite stochastic, attributable to chance and unobserved variables specific to institutions.

The results show very little in terms of PR impact on net total investment rates (col. 1, Table 5) although 8 of 14 coefficients are negative. The following three programs, however, show statistical evidence of a declining rate of investment over the program's life:

- Kentucky's program, which began in 1971, is associated with an $81,897 decline per year in the rate of real net investment per hospital.
- Massachusetts' program, beginning in 1975, is associated with an $86,549 decline per year.
- Minnesota's program, which also began in 1975, is associated with a $70,305 decline per year.

All three results must be interpreted cautiously. For Kentucky, no preprogram experience exists, and very high investment rates in the early 1970's are followed by rapid declines. The limited nature of the program in terms of scope (just Blue Cross) and its voluntary participation reinforces our doubts about the declining investment rate being program related.

Massachusetts' and Minnesota's situations are different from that of Kentucky in that a significant preprogram history exists showing stable or slightly declining investment rates (Table 2). Both showed extraordinary positive spikes in investment in 1976, however, the year after program implementation. If these spikes are one-time, adverse responses to the implementation of prospective payment, the downward bias imparted to any estimated trend lines warrants a cautious interpretation as well.

One other State's results are worth mentioning, New York's. Although its statistical significance is low (t = 1.2), the sign of the coefficient is negative (–$34,200) as predicted. Nevertheless, if the program has been as stringent on hospitals as claimed, it is surprising that a stronger, negative effect on investment is not observed. Hospital closures have been included in the data base as disinvestments, so that insolvent hospitals per se cannot explain why investment rates have not fallen more rapidly. As noted in the descriptive section, New York hospitals as a whole somehow managed to maintain relatively high investment levels in spite of clear revenue constraints. They may have done so at the risk of incurring substantial and expensive long-term debt that may greatly restrict new investment in the 1980's.

Evidence of a decline in the rate of hospital construction (DDBFE) is found only for three States: Connecticut, Rhode Island, and Kentucky. Because of extremely small sample sizes, any results for Rhode Island are highly sensitive to nonreporting as well as outliers. Absolutely no evidence is found for a decline in the rate of hospital construction in other PR States, including New York.

None of the three programs associated with declining construction investment show declining rates of bed expansion (DBDTOT) either. (Connecticut's rate is negative, but insignificantly.) Only New Jersey, beginning in 1975, shows an annual, statistically significant decline of 1.2 beds per hospital in the rate of bed expansion. Yet, the New Jersey program is not associated with a decline in beds per capita (col. 6, Table 5), implying that the slow bed-size growth after 1975 was consistent with slow population growth as well. Total short-term beds in New Jersey peaked in 1977 at 29,053, falling 1,235 to 29,818 in 1979. Population was unchanged, resulting in a decline in beds per 1,000 population from 3.96 to 3.79.

Rate-setting effects on capital deepening apparently were even less than for construction and beds (cols. 4 and 5, Table 5). Only two State programs show any evidence of a declining rate, both on investment per bed—Kentucky (–$471 per bed per year) and Massachusetts (–$421 per bed per year). Even though the result for Massachusetts is not quite statistically significant at the 10-percent level, we include it as a possible finding because of its consistency with the net total investment results. Together, they suggest that the rate of capital formation slowed in Massachusetts under rate setting, both in toto and on a per bed basis.

Capital deepening results based on movable equipment investment show no PR effects whatsoever. If anything, some evidence exists that New York hospitals increased their rate of equipment purchases by about $16,000 each year, ceteris paribus. This may be somewhat misleading in that the average rate of equipment investment in New York in 1978 and 1979 was about $80,000 less than in the early 1970's (with a t-statistic of 1.5). If the program has retarded equipment investment—investment often embodying new, life-saving technologies—we find no strong evidence of it, unless the last 2 years of the decade were a true harbinger of the future and not just a temporary retrenchment. Elsewhere (Cromwell and Kanak, 1982), we did find a slowing in the rate of service adoption in New York hospitals, but apparently it has not been associated with slower capital deepening.

Presented in the last column of Table 5 are PR regression results for the ratio of short-term hospital beds to 1,000 county population, based on over 10,000 county-years, 1971-79. Very few PR coefficients achieved statistical significance even at the 10-percent level, although 11 of 13 were negative. Only the programs for Arizona, Massachusetts, and New York had a definite association with beds per 1,000 population, all in the negative direction. Arizona's beds-per-capita ratio fell 10 percent in the 1970's in spite of an increase nationwide of 2.5 percent. This fall was likely because of the slow adaptive response of bed capacity to a rapidly growing, possibly healthier, population (37-percent growth from 1971 through 1979), and it should not be ascribed in toto or necessarily even in part to prospective reimbursement.

Massachusetts and New York are very different, having experienced stable or slightly declining populations over the 1970's. Our figures for 14 counties in Massachusetts show an absolute drop in both short-term beds and population beginning in 1975, the year Medicaid prospective payment was put in place. By 1979, beds had fallen by 669, from 25,045 to 24,376. Population fell more slowly after 1975, giving an actual decline in beds per 1,000. Considering that New York's initial beds-per-capita rate was below average to begin the decade, together with the fact that occupancy rates were very high and rose dramatically, and the population fell 500,000, the negative PR coefficient on bed availability probably indicates a true program effect.

Accepting the New York result as a real program effect, a coefficient of −.037 implies 650 fewer beds per annum on an average population of 17,500,000 in 1979. When evaluated in 1979 dollars, the annual savings on capital formation in New York could be as high as $30 million ($46,190 in net assets per bed times 650 beds), or 1 percent of the New York industry's net assets in 1979. From 1971 through 1979, program savings would be 6-7 times as much, or roughly $200 million, assuming a concomitant reduction in the book value of assets. Of course, this cost is not saved in any one year or even over a decade, but rather over the lifetime of the beds in the form of foregone interest and depreciation payments.

Table 5

Investment regression results: Prospective reimbursement variables

	Dependent variables					
Program variable	DDNFAS (1)	DDBFE (2)	DBDTOT (3)	DDMEQ (4)	DDNFASB (5)	BDPOP (6)
Arizona	56,046 (1.1)	8,112 (0.2)	0.040 (0.1)	−18,375 (0.9)	16 (0.1)	**−0.111 (2.6)
Colorado	24,590 (0.6)	45,217 (1.2)	0.266 (0.8)	779 (0.1)	**415 (2.0)	−0.038 (1.0)
Connecticut	−67,831 (0.8)	***−202,068 (2.9)	−0.873 (1.1)	−18,218 (0.7)	−143 (0.3)	−0.060 (1.3)
Kentucky	**−81,897 (2.5)	*−50,475 (1.8)	−0.110 (0.4)	−9,151 (0.8)	***−471 (2.8)	NI
Massachusetts	*−86,549 (1.7)	12,409 (0.3)	−0.635 (1.3)	−22,663 (1.2)	−421 (1.6)	**−0.074 (2.0)
Maryland	−10,135 (0.1)	−24,928 (0.4)	−0.142 (0.2)	−4,709 (0.2)	−17 (0.1)	−0.056 (1.2)
Minnesota	*−70,305 (1.7)	−42,268 (0.9)	−0.167 (0.4)	−4,709 (0.2)	−207 (1.0)	−0.029 (0.7)
Nebraska	18,315 (0.5)	17,910 (0.5)	**0.784 (2.1)	−10,050 (0.7)	223 (1.1)	0.080 (1.5)
New Jersey	−27,182 (0.5)	−48,514 (0.5)	**−1.244 (2.3)	−23,260 (0.6)	31 (0.1)	−0.005 (0.1)
New York	−34,200 (1.2)	−15,345 (0.6)	−0.325 (1.2)	16,050 (1.6)	−100 (0.7)	*−0.037 (1.8)
Rhode Island	191,050 (1.5)	***−410,906 (2.9)	−0.977 (0.8)	6,769 (0.1)	***2,479 (3.7)	−0.087 (1.0)
Washington	−24,340 (0.4)	−30,623 (0.5)	0.421 (0.9)	18,182 (0.9)	162 (0.5)	−0.056 (1.0)
Wisconsin	16,987 (0.4)	36,644 (1.2)	−0.021 (0.1)	16,175 (1.3)	3 (0.0)	−0.058 (0.8)
Western Pennsylvania	26,404 (0.8)	17,577 (0.5)	−0.427 (1.1)	−3,838 (0.3)	43 (0.2)	0.001 (0.0)
F	9.3	11.72	4.20	9.49	3.23	181.28
R^2	0.039	0.058	0.017	0.051	0.013	0.534
Degrees of freedom	17,133	13,214	17,133	12,170	17,134	10,293

***Denotes significance at .01 level.
**Denotes significance at .05 level.
*Denotes significance at .10 level.

NOTES: Program variables refer to the cumulative number of years each program was in effect. For example, prospective reimbursement dummies are set to equal 1 beginning in 1973, 2 in 1974, and up to 7 in 1979. All State subprograms like Maryland's guaranteed inpatient revenue have been supressed. All F-ratios significant at the 1-percent level. t-statistics are in parentheses.

The $200 million figure was derived by multiplying 650 beds times 9 years times $33,494 per bed, which was the average undeflated book value of net fixed assets per bed over the period.

Covariate effects

Although the rate-setting effects are the focus of this article, several of the other covariates are of interest in their own right. Here we provide a brief summary of the key findings. The interested reader is referred to Cromwell and Burstein (1984) for details.

Except for Aid to Families With Dependent Children (AFDC) coverage (positive), none of the demand-side variables were related to the rate of hospital-specific investment. Relevant supply-side covariates included teaching status ($1.1 million more per year holding bed size and other variables constant); ownership (for-profits invested $120,000 per year less); bed size (positive); nursing home beds per capita (negative); and the specialist mix (positive). Neither PSRO's or CN was significant.

Many demand-side variables were significant in the beds-per-capita regressions, however, including AFDC and Medicare coverage (both positive); private insurance coverage (positive); and population density (negative). Percent of teaching hospitals and specialist mix also added to beds per capita as expected. Finally, CN was found to be negatively related to bed availability (t = 2.0). Its coefficient of .09 implies a 2.2 percent reduction around the sample mean of 4.5 beds per 1,000, about .1 beds.

Discussion

The rate-setting programs under investigation in our study regulate quite different industries in terms of structure and capacity utilization. Programs in Connecticut and New Jersey were setting rates for hospitals that averaged over 300 beds versus only 114 in the State of Washington. Occupancy rates also varied nearly 20 points from 67 to 70 percent in Nebraska and Washington to from 84 to 87 percent in Rhode Island and New York. Finally, beds per 1,000 showed large variations as well, with Arizona and Washington at the low end (around 3.3) and Nebraska and Minnesota at the top (5.5-6.5 beds per 1,000). Clearly, different programs, in their design and implementation, must address different problems, with some concentrating on excess beds and low occupancy rates and others focusing on large, expensive institutions with redundant services and equipment.

Net real assets per hospital were growing everywhere in the United States in the 1970's at about 7.7 percent annually, with about 85 percent of the increase attributable to greater real assets per bed and the rest to more beds. Rate-setting States deviated far above (e.g., Arizona) and far below (e.g., Washington, Maryland) this norm, with New York remarkably similar to the Nation as a whole. Econometric results that held constant other investment-related factors showed few programs with any clear retarding effects. On the other hand, no evidence was found of a rapidly deteriorating capital stock in New York or elsewhere—with the possible exception of Rhode Island.

Of the few significant findings, those for Massachusetts and New York stand out in retarding overall bed growth per capita. This is emphasized given low capacity utilization elsewhere in the United States and the high depreciation, interest, and staffing costs associated with idle beds, not to mention possible inappropriate admissions or longer stays encouraged by underutilization.

As for PSRO's and CN, no effects on capital formation were found for the former program, which is not surprising given its focus on appropriateness of care. Because certificate-of-need programs are directly targeted to capital expansion, some findings were expected; and significant program results did come in the form of slower growth in beds per capita. Moreover, because of the difficulty in separating CN from rate-setting effects in a quasi-experimental design, any retarding impacts of rate-setting programs may well have been the result of a tough PR program combined with rigorous CN review—particularly in New York.

The implications of these findings for the current hospital environment are not entirely clear because no State under investigation employed a DRG-based payment scheme, nor was competition from other payers and HMO's as vigorous. To the extent capital is still considered a "pass-through," one might think it unlikely that significant reductions in capital spending have occurred. Stringent programs with strong inflation controls (e.g., New York) appear to introduce a genuine competitive effect on beds and closures and mergers that should produce long-run cost savings. This is likely to be the most immediate response to Medicare's prospective payment system and the proliferation of HMO's and preferred provider organizations. The principal effect of prospective reimbursement controls is to add risk to all investments, which inevitably leads to wider divergences in financial performance and more concentrated capital formation in the future. The length-of-stay incentives under PPS should also discourage building investment through the accelerator effect of lower demand. Unfortunately, no State program employed such strong incentives, leaving some doubt about post-PPS investment rates. Thus, it is not a foregone conclusion that the treatment of capital as a pass-through during the PPS transition period led to higher investment rates. Accelerator effects of declining volumes and greater financial risk may well have completely offset any perverse incentives. Future research may shed light on the relative strengths of capital cost pass-throughs versus declining utilization.

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