Measuring inpatient and outpatient costs: A cost-function approach

by Kathleen Carey and Theodore Stefos

In this article, the authors estimate a multiple-output cost function for a sample of 2,235 hospitals during the period 1984-88 to disaggregate total costs into inpatient and outpatient components. The results suggest that outpatient cost growth is roughly proportional to that of inpatient cost, despite much higher relative growth in revenues and utilization on the outpatient side. The stability in the outpatient/inpatient cost ratio implies that the increase in the outpatient-to-inpatient utilization ratio was offset by a decline in their relative unit costs.

Introduction

A major feature of the movement toward hospital cost containment in the last decade has been the replacement of expensive inpatient care with less costly outpatient care. Most discussions about the increasing reliance on outpatient care focus on utilization and revenue measures. A more important issue for hospital payment policy, however, is how actual costs have been affected by this shift from inpatient to outpatient services. Trends in relative cost changes are not easily identified because hospital accounting systems do not easily disaggregate total cost into inpatient and outpatient components. Cost-finding methodologies are complex, allowing hospitals considerable discretion in cost-allocation patterns. Furthermore, an incentive was created by the prospective payment system (PPS) to allocate costs to centers incurring outpatient charges because Medicare pays a fixed amount per inpatient discharge but continues to pay for outpatients on the basis of reasonable cost. Changes in relative costs have important implications in the current environment of changing methods of payment for hospital outpatient services. Concern over increases in Medicare outpatient expenditures led to congressional legislation in 1986 that mandated the implementation of a PPS for outpatient care. An understanding of true cost increases is critical to the adoption of a plan that accurately reflects outpatient costs.

In this article, we provide a methodology for disaggregating total cost into inpatient and outpatient components to examine relative changes. This is accomplished through estimation of a multiple-output total-cost function for a sample of acute care hospitals for the years 1984-88.

Background

The adoption of PPS by Medicare in 1983 changed the payment basis for hospital inpatient care from hospital-specific costs to diagnosis-related groups (DRGs). Under PPS, hospital payments are made according to "prices" that are determined by averaging historic costs for specific groups of diagnoses across hospitals. The force behind this change was the Federal Government, the largest third-party payer for inpatient care. An intended consequence of PPS was the substitution of less expensive outpatient care for inpatient care, without compromise of quality.

The change in the Medicare system was not the only impetus behind the increased emphasis on outpatient care. Hospitals have also been influenced by other third-party payers, who have also been trying to contain costs. Managed care options have been expanded, as has the use of copayments and deductibles. Many plans (including the majority of Blue Cross and Blue Shield plans) have adopted fee schedules similar to those of PPS. Technological advances have also expanded the range of possibilities for outpatient service. New techniques in cataract extraction and cardiac catheterization, for example, have made it possible for people to undergo these procedures without an overnight stay.

The magnitude of the increase in outpatient utilization over the period of this study is dramatic. The annual number of outpatient visits reported by community hospitals rose from approximately 210 million to 270 million from 1984 to 1988. (Data in this paragraph and the next are from American Hospital Association [1991].) The surge occurred in the number of hospitals offering services as well as the types of services being performed. In 1984, 49 percent of community hospitals reported having an organized outpatient department. That figure increased to 78 percent by 1988. The proportion of hospitals reporting the performance of ambulatory surgery increased from 91 to 95 percent during the same period.

The substantial shift from inpatient to outpatient activity is also reflected in changes in inpatient and outpatient revenue components. Whereas total revenues in community hospitals increased by 44 percent from 1984 to 1988 (from $156 billion to $224 billion), outpatient revenues more than doubled during the same period (from $22 to $46 billion). Medicare payments accounted for approximately 40 percent of hospital revenues. Program payments for hospital outpatient services increased by $2.2 billion from 1984 through 1987, or at an average annual growth rate of 18 percent.

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Reprint requests: Kathleen Carey, Management Science Group, U.S. Department of Veterans Affairs, 200 Springs Road, Bedford, Massachusetts 01730.

Mounting Medicare payments for outpatient care led to a call for the development of a prospective payment method for such care. In 1986, Congress passed the Omnibus Budget Reconciliation Act, which directed the Secretary of Health and Human Services to develop a prospective payment plan for all types of hospital outpatient care. Implementation of this law requires a system for outpatient classification, and one grouping method currently under consideration and discussed later is ambulatory patient groups (APGs) (Lion et al., 1990). This scheme is similar to that of DRGs, which rely on charge data for calibration of payment weights. If there is a discrepancy between the true cost of outpatient visits and the charges made for those visits, distortion could occur in the establishment of their payment rates.

Empirical methodology

In this section, we describe a procedure for disaggregating total costs into inpatient and outpatient components, which includes an estimable multiple-output cost function. To identify outpatient costs, we employ the concept of incremental costs as described in Baumol, Panzar, and Willig (1988). Outpatient costs are the incremental costs incurred as a result of outpatient activity:

$$OC = TC(DIS,OPV,X) - TC(DIS,0,X) \qquad (1)$$

where OC represents outpatient costs, TC represents total costs, DIS and OPV represent the number of discharges and outpatient visits, respectively, and X is a vector of exogenous variables. All other costs are ascribed to inpatient activity. Therefore, assuming total costs are the sum of outpatient costs and inpatient costs, inpatient costs are

$$IC = TC(DIS,0,X). \qquad (2)$$

Specifically, the cost function is evaluated at the actual level of outpatient visits and at zero outpatient visits. The difference is the incremental cost of outpatient service. Given this breakdown of total costs, hospital-specific cost components can be obtained. The discussion then turns to a multiple-output cost function that can be used to determine the disaggregated costs described in equations (1) and (2).

The hospital cost-function literature contains an extensive variety of empirical models. The majority of these fall into one of two categories. One type estimates average cost per patient or per patient day as a function of various regressors that are considered to affect costs. This widely used set of "behavioral" cost functions is often accused of being ad hoc and of lacking foundation in the assumptions of the usual production theory. Another group of models, following the work of McFadden (1978), employs "flexible" functional forms that regress total cost on output levels and input prices and, hence, are more consistent with the characteristics of the standard economic theory of production. The most popular of these forms is the translog cost function. The advantage of these models is that they are better suited for the calculation of the scale and scope economy measures that have been developed for multiple-output production. However, these models have been criticized for the large numbers of parameters that must be estimated and for excluding many factors that are known to be significant in explaining variation in costs of complex, modern hospitals. Some recent work estimates "hybrid" cost functions that incorporate a number of desirable features from both existing types of models (Grannemann, Brown, and Pauly, 1986; Vita, 1990). Hadley and Zuckerman (1990) expand the literature with a dynamic model designed to capture the process of adjustment to PPS. However, a consensus has not been reached on the appropriate form of the hospital cost function.

Because our major objective is to disaggregate total costs into inpatient and outpatient components, the function to be estimated is a total-cost function. As the focus is not scale or scope economies nor substitution of inputs, we chose a form that, although not derived from any particular production technology, incorporates many factors likely to be important in explaining hospital cost variation. Our approach draws from the work of Grannemann, Brown, and Pauly (1986).

Having no evidence that hospitals are in longrun equilibrium, our expression is that of shortrun total costs:

$$TC = Pe^{f+u} \rightarrow \ln TC - \ln P = f + u \qquad (3)$$

where

$$\begin{aligned} f = A &+ \alpha_1 DIS + \alpha_2 DIS^2 + \alpha_3 DIS^3 \\ &+ \beta_1 OPV + \beta_2 OPV^2 + \beta_3 OPV^3 \\ &+ \gamma_1 LOS + \gamma_2 LOS^2 + \gamma_3 LOS^3 \\ &+ \Sigma \delta_k X_k \end{aligned}$$

and

TC = total variable costs (non-capital-related),
P = input price index,
DIS = number of discharges,
OPV = number of outpatient visits,
LOS = average length of stay,
X = a vector of other exogenous factors that affect total costs, and
u = random disturbance term.

Geographic input price variation is a major determinant of cost variation. The only input price measure available was the index of local area wage rates that has been produced by the Health Care Financing Administration (HCFA) for use in determining prospective payments to hospitals. To impose the assumption of linear homogeneity in input prices, the dependent variable used in the equation is the logarithm of total cost minus the logarithm of the wage index. Variation in the cost to the hospital of energy and food may be partially reflected in wage rates, which must compensate workers for higher costs of living.

The second- and third-order terms for the variables for the number of inpatient discharges and outpatient visits are consistent with a cost function that exhibits U-shaped average and marginal cost curves. There are two aspects of inpatient care: the number of patients and the patient length of stay. These may be entered separately, as discharge and average-length-of-stay variables, or combined into one total-days-of-care variable. We chose the former approach, although the latter would likely yield a similar result. Use of our functional form allows for outpatient levels to take the value of zero, which is the case for outpatient visits for some hospitals. Calculation of the incremental cost of outpatient activity also requires that the cost function be evaluated at a level of zero outpatient visits for each hospital. The vector of remaining variables, which are described in a later section, was chosen based on the results of previous studies. We make the assumption that output is exogenous as has commonly been done in other studies (Conrad and Strauss, 1983; Grannemann, Brown, and Pauly, 1986; Friedman and Shortell, 1988; Hadley and Swartz, 1989; Hadley and Zuckerman, 1990).

Data description

The majority of data used in this analysis comes from two independent sources: the American Hospital Association (1984-88) (AHA) *Annual Survey of Hospitals* and the HCFA Hospital Cost Reporting Information System (HCRIS) data files. Data were obtained for the years 1984-88.[1] The HCRIS files are cycles one through five (1984-88) of PPS supplemented by the Tax Equity and Fiscal Responsibility Act (TEFRA) data set, which was used to complete the PPS data for 1984. The sample represents all hospitals for which both AHA and PPS data were available, after eliminating specialty hospitals, all-inclusive-rate payers, and hospitals with fewer than 100 beds. The data bases of those 68 hospitals subject to all-payer systems of payment were not comparable with those of the larger group; the group of small hospitals exhibits cost structures that are distinctly different from those of hospitals having 100 or more beds. This latter point was verified using the Chow test for structural difference between the sample that included and the sample that excluded small hospitals (n = 3,961 and n = 2,235, respectively).[2] This unique data set consists of 2,235 hospitals, both non-profit and proprietary. Summary statistics describing the sample of hospitals are listed in Table 1.

Total fixed assets, drawn from the HCRIS data, are used as a measure of fixed capital in estimating the shortrun cost function. In doing so, it is assumed that capital stock is exogenous. To test this assumption, i.e., to supply evidence of whether or not hospitals are in longrun equilibrium, we performed the Hausman (1978) specification test for exogeneity of the capital variable for the year 1988. If capital is exogenous, it will be uncorrelated with the error term in the cost function. The null hypothesis of no misspecification (no correlation with the error term) is tested by comparing two sets of parameter estimates of the cost function: one using total fixed assets and one using an instrumental variable that is correlated with fixed assets but uncorrelated with the error term.[3] The specification test is based on the statistic

$$m = (\hat{\beta}_1 - \hat{\beta}_2)' \, (M_1 - M_2)^{-1} (\hat{\beta}_1 - \hat{\beta}_2)$$

where $\hat{\beta}_1$ and M_1 are the parameter estimates and the covariance matrix from the estimation using the instrumental variable, and $\hat{\beta}_2$ and M_2 are similar estimates from the model using total fixed assets. The m-statistic has a $\chi^2(K)$ distribution, where K is the number of unknown parameters. Because the value of m is 2.29, and the critical value at the 1-percent level is 40.29, we fail to reject the null hypothesis and therefore incorporate the actual value of total fixed assets into the cost function.

The cost and discharge variables just described were obtained from the HCRIS data set; outpatient visits were obtained from the AHA data. The dependent variable contains all costs exclusive of capital-related expenditures. In addition to the cost, output, and capital variables, additional explanatory variables appear in the cost function. Case mix (measured using the Medicare DRG case-mix index) is included to control for output variation among inpatients that is not captured by the discharge and length-of-stay variables. This estimate of the costliness of a particular hospital's Medicare patient load was unavailable prior to the adoption of PPS by Medicare. Although still imperfect, it improves on many earlier cost studies that relied on cruder case-mix measures. As done by most previous researchers, we treat this variable as exogenous.

The implications of market concentration for hospital costs have been addressed in a number of recent works. Many of these studies have found evidence of various forms of non-price competition (for example, by quality or range of service offerings), with the general conclusion that greater market competition is associated with higher costs (Joskow, 1980; Robinson and Luft, 1985; White, 1987; Hadley and Swartz, 1989). Zwanziger and Melnick (1988) demonstrate that this effect is changing in California hospitals. We include a Herfindahl index as a measure of market structure. This was constructed using the county as the market and the number of discharges as a measure of output from which to determine market shares. Garnick et al. (1987) found that the county is an acceptable alternative to a uniform geographic area in defining markets.

We control for other factors considered important in explaining hospital costs using dummy variables. Scope or range of services has not been measured precisely in most cost functions; often the interaction terms for various outputs are examined in an attempt to establish the presence of economies or diseconomies of scope.

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[1]Because reporting years were not coincident across the sample, data for some hospitals were aligned such that time periods were congruent. The start date for 1984 was October 1, 1983. For a further description of the data recycling process, see Management Science Group (1991).

[2]The hypothesis of no structural difference between the two samples was rejected for all 5 years (F = 4.2, 4.7, 5.0, 5.6, and 5.6 for 1984-88, respectively).

[3]The instrumental variable is the fitted value for total fixed assets obtained from estimating the following reduced-form equation: Total fixed assets = $a + b$ * beds + c * total fixed assets lagged.

Table 1
Means and standard deviations for selected regression variables: 1984-88

Variable	1984	1985	1986	1987	1988
Facility operating expenditures in thousands of dollars	$32,493	$34,274	$37,006	$40,126	$44,193
	(30,648)	(32,951)	(36,333)	(39,759)	(43,880)
Number of discharges in thousands	10.02	9.81	9.58	9.51	9.54
	(6.86)	(6.89)	(6.90)	(7.23)	(7.27)
Number of outpatient visits in thousands	57.88	59.29	62.92	67.67	74.36
	(72.24)	(74.18)	(79.75)	(82.06)	(84.40)
Average length of stay in days	7.01	7.27	8.11	8.34	8.27
	(3.46)	(5.15)	(6.86)	(7.17)	(7.22)
Fixed assets in millions of dollars	20.25	23.56	25.79	27.44	29.27
	(23.31)	(26.10)	(29.42)	(31.71)	(34.75)
Case-mix index	1.11	1.15	1.19	1.21	1.25
	(0.10)	(0.12)	(0.13)	(0.14)	(0.15)
Herfindahl index	0.38	0.37	0.38	0.38	0.38
	(0.32)	(0.32)	(0.32)	(0.32)	(0.32)
Wage index	1.02	1.02	1.02	1.02	0.96
	(0.15)	(0.15)	(0.14)	(0.16)	(0.15)
Community-service dummy	0.39	0.26	0.17	0.18	0.27
	(0.49)	(0.44)	(0.38)	(0.38)	(0.44)
Full-range-service dummy	0.42	0.51	0.44	0.41	0.52
	(0.49)	(0.50)	(0.50)	(0.49)	(0.50)
Major teaching dummy	0.09	0.10	0.10	0.10	0.10
	(0.29)	(0.30)	(0.30)	(0.30)	(0.29)
Minor teaching dummy	0.16	0.16	0.16	0.17	0.17
	(0.37)	(0.37)	(0.37)	(0.37)	(0.37)
Large urban dummy	0.34	0.34	0.34	0.33	0.33
	(0.47)	(0.47)	(0.47)	(0.47)	(0.47)
Small urban dummy	0.39	0.40	0.40	0.40	0.40
	(0.49)	(0.49)	(0.49)	(0.49)	(0.49)
Non-profit dummy	0.73	0.73	0.73	0.73	0.73
	(0.44)	(0.45)	(0.44)	(0.44)	(0.44)
For-profit dummy	0.12	0.12	0.12	0.12	0.12
	(0.32)	(0.32)	(0.32)	(0.33)	(0.33)
N	2,047	2,170	2,198	2,186	2,127

NOTES: Because reporting years were not coincident across the sample, data for some hospitals were aligned such that time periods were congruent. The start date for 1984 was October 1, 1983. For a further description of the data recycling process, see Management Science Group (1991). Standard deviations shown in parentheses.

SOURCES: Health Care Financing Administration: Data from the Hospital Cost Reporting Information System, file 1984-88; American Hospital Association (1984-88).

We incorporate a scope-of-services index that is calculated by cluster analysis and verified using Guttman scale statistics and that follows the methodology developed by Klastorin and Watts (1982) (also Henderson, DeFiore, and Stefos, 1990). We have grouped the hospitals (which are ranked on a scale of 0 to 18, where hospitals having a higher index offer more services) into three categories of service availability ranging from lowest to highest: basic, community, and those offering the full range of services. Our service-index approach to economies of scope differs from that of Grannemann, Brown, and Pauly (1986), who include interaction terms between output pairs.

Finally, dummy variables are included for teaching status, population size, and ownership. The level of teaching activity is classified into three groups: major teaching (affiliation with a medical school and membership in the Council of Teaching Hospitals), minor teaching (medical school affiliation only), and non-teaching (neither affiliation nor Council of Teaching Hospitals membership). Population of a hospital's surrounding community was coded by collapsing the metropolitan statistical area (MSA) size into one of three groups: large urban (more than 1 million), small urban (100,000 to 1 million), and rural. Ownership is categorized as non-profit, profit, and government (city, county, or State facility). The teaching and population variables were obtained from the AHA data set; the ownership dummy was defined from HCRIS data.

Results

The cost function was estimated separately for each year. This allows for comparison of relative costs over time. As in most of the literature on cost functions, our regression technique is ordinary least squares (OLS). A potential hazard for estimation of total costs on cross-sectional data is the presence of heteroscedasticity associated with output levels. A useful procedure for detecting this violation of OLS assumptions in the case of a multiple-output cost function is the Park-Glejser test (see Vitaliano, 1987, for another application of this test to a hospital cost function.) Glejser (1969) generalizes the test to allow for the case of heteroscedasticity, in which the error term is proportional to more than one of the explanatory variables. In addition to testing for the failure of the assumption of a constant error term variance, the test supplies an estimate of the covariance matrix of the disturbance term, u: $\sigma^2\Omega$. The inverse of the diagonal

Table 2

Regression coefficients and *t*-statistics for hospital cost functions

Variable	1984	1985	1986	1987	1988
Intercept	14.04	14.09	14.37	14.92	15.03
	(198.61)	(219.45)	(235.14)	(226.88)	(244.52)
Number of discharges in thousands	0.21	0.22	0.22	0.17	0.17
	(48.54)	(45.33)	(49.68)	(44.41)	(48.32)
Number of discharges squared	−7.53 E-3	−7.80 E-3	−7.90 E-3	−4.25 E-3	−4.06 E-3
	(−30.88)	(−29.26)	(−32.91)	(−29.51)	(−34.04)
Number of discharges cubed	9.03 E-5	9.23 E-5	9.39 E-5	2.94 E-5	2.86 E-5
	(22.82)	(21.28)	(24.62)	(22.17)	(25.51)
Number of outpatient visits in thousands	2.82 E-3	2.65 E-3	1.92 E-3	1.77 E-3	2.02 E-3
	(9.50)	(10.26)	(8.80)	(8.49)	(8.16)
Number of outpatient visits squared	−8.13 E-6	−6.47 E-6	−4.24 E-6	−2.42 E-6	−3.70 E-6
	(−6.78)	(−6.77)	(−6.11)	(−4.55)	(−4.79)
Number of outpatient visits cubed	4.69 E-9	3.40 E-9	1.92 E-9	9.22 E-10	1.68 E-9
	(5.92)	(5.82)	(5.42)	(3.86)	(4.28)
Average length of stay in days	7.11 E-2	7.63 E-2	4.04 E-2	3.05 E-2	2.90 E-2
	(9.97)	(16.20)	(11.86)	(8.31)	(8.02)
Average length of stay in days squared	−1.90 E-3	−2.94 E-3	−1.28 E-3	−1.28 E-3	−1.22 E-3
	(−4.85)	(−15.22)	(−12.52)	(−11.07)	(−10.50)
Average length of stay in days cubed	1.53 E-5	2.67 E-5	8.27 E-6	9.33 E-6	8.88 E-6
	(2.94)	(13.74)	(10.66)	(9.87)	(9.79)
Fixed assets	3.63 E-3	4.82 E-3	4.62 E-3	4.54 E-3	4.25 E-4
	(9.14)	(9.54)	(10.71)	(9.86)	(9.35)
Fixed assets squared	−6.06 E-6	−8.59 E-6	−9.07 E-6	−5.98 E-6	−9.50 E-6
	(−3.91)	(−3.28)	(−5.01)	(−3.90)	(−5.68)
Case-mix index	0.93	0.94	0.87	0.69	0.64
	(17.34)	(20.34)	(19.81)	(13.92)	(14.69)
Herfindahl index	−0.21	−0.20	−0.20	−0.18	−0.15
	(−10.25)	(−10.22)	(−10.16)	(−8.21)	(−6.61)
Community-service dummy	6.18 E-2	3.56 E-2	3.43 E-2	5.25 E-2	6.79 E-2
	(4.57)	(2.63)	(2.57)	(3.57)	(4.45)
Full-range-service dummy	9.01 E-2	3.10 E-3	−9.51 E-3	4.21 E-2	8.48 E-2
	(5.83)	(0.22)	(−0.76)	(2.75)	(5.20)
Major teaching dummy	0.20	0.23	0.18	0.10 E-2	0.13
	(9.15)	(10.63)	(9.07)	(4.23)	(5.51)
Minor teaching dummy	4.24 E-2	5.44 E-2	4.22 E-2	2.76 E-2	2.76 E-2
	(2.97)	(3.86)	(3.13)	(1.74)	(1.81)
Large urban dummy	−3.25 E-2	−2.70 E-2	−2.83 E-2	−1.66 E-2	−1.68 E-2
	(−1.93)	(−1.61)	(−1.72)	(−0.88)	(−0.91)
Small urban dummy	−4.15 E-2	−3.38 E-2	−3.02 E-3	−9.06 E-3	−1.15 E-2
	(−2.88)	(−2.35)	(−2.15)	(−0.57)	(−0.72)
Non-profit dummy	1.17 E-2	8.80 E-3	1.01 E-2	−2.18 E-3	−5.78 E-3
	(0.87)	(0.67)	(0.78)	(−1.49)	(−0.40)
For-profit dummy	6.94 E-2	2.42 E-2	2.30 E-2	−1.48 E-2	−0.52 E-3
	(3.78)	(1.34)	(1.29)	(−0.74)	(−0.26)
R^2	.9289	.9284	.9374	.9196	.9266

NOTES: Because reporting years were not coincident across the sample, data for some hospitals were aligned such that time periods were congruent. The start date for 1984 was October 1, 1983. For a further description of the data recycling process, see Management Science Group (1991). *t*-statistics shown in parentheses.

SOURCES: Health Care Financing Administration: Data from the Hospital Cost Reporting Information System file, 1984-88; American Hospital Association (1984-88).

matrix contains the weights to be used in a weighted least squares (WLS) regression. The Park-Glejser test indicated the presence of heteroscedasticity for the years 1984-86 and 1988. Consequently, WLS regressions were performed for those years and OLS was applied to 1987. The Belsley, Kuh, and Welsch (1980) diagnostics were applied; no problems due to multicollinearity were detected. The regression results are listed in Table 2.

The coefficients on the discharge, outpatient visit, and LOS variables exhibit a highly significant pattern of positive, negative, and positive for quantity, quantity squared, and quantity cubed, respectively. The case-mix index is highly significant and exhibits the expected positive sign. The sign on the Herfindahl index is negative, which is supportive of the theory of non-price competition. However, this interpretation should be made with caution. Small rural markets tend to have lower input prices, and because the only included input price is the wage index, it is possible that the Herfindahl measure could be incorporating the effect of omitted input price measures. Major teaching hospitals and those located in large urban areas are more expensive, as has been shown in previous empirical work. Previous authors (Grannemann, Brown, and Pauly, 1986; Vita, 1990) failed to find evidence of complementarities among their specific measured outputs. The signs of the coefficients on our scope-of-service dummy variables also fail to indicate the presence of economies of scope. However, these results are only suggestive, and the topic is one in need of further investigation.

Table 3

Mean hospital operating costs estimated using regression results and average annual growth rates: 1984-88

Hospital characteristic	Inpatient costs 1984	1985	1986	1987	1988	Average annual growth	Outpatient costs 1984	1985	1986	1987	1988	Average annual growth
	Millions of dollars					Percent	Millions of dollars					Percent
Overall	$27.8	$29.0	$32.5	$34.5	$37.3	6.6	$4.4	$5.0	$4.4	$5.5	$6.7	7.4
100-399 beds	20.2	21.1	23.2	24.7	26.5	6.2	2.6	2.8	2.3	2.7	3.4	6.8
400 or more beds	66.2	67.3	77.5	82.0	89.3	8.2	13.7	15.5	14.1	19.0	22.4	10.7
Major teaching	78.3	80.0	91.6	93.0	101.5	7.9	17.8	20.8	19.0	25.5	29.3	10.5
Minor teaching	39.5	41.1	45.6	49.9	53.5	7.1	7.0	7.5	6.2	7.8	9.6	7.4
Non-teaching	19.0	19.7	21.7	23.3	25.2	6.3	2.3	2.3	2.0	2.3	3.1	7.0
Large urban	37.7	39.7	45.0	47.8	50.9	6.7	6.8	7.6	6.8	8.6	10.3	6.6
Small urban	30.2	31.3	35.1	37.8	41.3	7.0	4.7	5.3	4.6	5.9	7.3	8.3
Rural	11.6	11.7	12.8	13.2	14.6	5.8	1.1	1.1	1.0	1.1	1.4	7.0
Non-profit	30.6	31.7	35.4	37.7	41.0	6.7	5.1	5.6	4.9	6.1	7.6	7.1
For-profit	16.7	16.6	18.4	19.5	21.2	5.5	1.2	1.2	1.1	1.3	1.7	7.7
Government	23.2	25.9	29.1	30.8	32.3	6.9	3.9	4.9	4.4	5.8	6.3	8.2

NOTES: Because reporting years were not coincident across the sample, data for some hospitals were aligned such that time periods were congruent. The start date for 1984 was October 1, 1983. For a further description of the data recycling process, tsee Management Science Group (1991).

SOURCES: Carey, K., and Stefos, T., U.S. Department of Veterans Affairs, 1992; and Health Care Financing Administration: Data from the Hospital Cost Reporting Information System file, 1984-88.

The results of the estimated cost functions were used to disaggregate total costs into inpatient and outpatient components. Equations 1 and 2 were evaluated for each hospital using the estimated cost function to determine hospital-specific values. In particular, for hospital i,

$$\ln TC_i = \ln P_i + A + {}_1DIS_i + {}_2DIS_i^2 + {}_3DIS_i^3 + \beta_1 OPV_i + \beta_2 OPV_i^2 + \beta_3 OPV_i^3 + {}_1LOS_i + {}_2LOS_i^2 + {}_3LOS_i^3 = \Sigma\delta_k X_{ik} \quad (4)$$

$$\ln IC_i = \ln TC_i - (\beta_1 OPV_i + \beta_2 OPV_i^2 + \beta_3 OPV_i^3) \quad (5)$$

$$TC_i = e^{\ln TC_i} \quad (6)$$

$$IC_i = e^{\ln IC_i} \quad (7)$$

$$OC_i = TC_i - IC_i \quad (8)$$

The means of inpatient and outpatient costs are listed for each year by various hospital categories in Table 3. As seen in the final column, inpatient costs grew at an average annual rate of 6.6 percent and outpatient costs at a rate of 7.4 percent. This result contrasts starkly with the relative change in inpatient and outpatient revenues already discussed. Revenues for outpatient services rose much more rapidly than costs in the 5 years following the introduction of PPS.

Discussion

The results of the cost-function disaggregation procedure indicate that the growth rate of outpatient costs did not differ substantially from that of inpatient costs, despite considerable differences in the relative utilization patterns and revenue components. To further explore this finding, it is useful to consider the relationship between total cost, output levels, and unit costs. The ratio between the two components of cost may be represented as

$$\frac{OC}{IC} = \frac{OPV}{DIS} * \frac{\frac{OC}{OPV}}{\frac{IC}{DIS}}. \quad (9)$$

That is, the ratio of costs is equal to the product of the ratio of output and the ratio of unit costs. Because the ratio of outpatient to inpatient costs remained relatively steady, and the ratio of outpatient visits to discharges rose, it follows that the ratio of the average incremental cost of an outpatient visit to the average cost of a discharge fell. Table 4 lists the outpatient visit and discharge unit costs by the same hospital strata. In 1984, the overall average incremental cost of an outpatient visit was 2.3 percent of the average inpatient cost; by 1988, this percentage had fallen to 1.7. The decline in the outpatient/inpatient unit cost ratio offset the increase in the ratio of outpatient visits to inpatient discharges.

Because the trend in unit costs for outpatient services is a finding of this analysis that was unanticipated, an interpretation of that result is in order. (The mean of outpatient unit costs in 1988 is $57 in 1984 dollars, which is 11 percent lower than the 1984 unit cost.) An economic effect that could partially account for this is economies of scale. The output-volume change for outpatient activity from 1984 to 1988 is considerable: The average number of visits rose from 58,000 to 74,000 or 28 percent. Additional econometric evidence of economies of scale appears in a study of the determinants of 1987 Medicare hospital outpatient department costs by Miller (1992). He found that average hospital outpatient department costs decrease with volume.

Table 4

Inpatient cost per discharge and outpatient incremental cost per visit estimated using regression result

Hospital characteristic	Inpatient cost per discharge					Outpatient cost per visit				
	1984	1985	1986	1987	1988	1984	1985	1986	1987	1988
Overall	$2,729	$2,917	$3,297	$3,629	$3,914	$64	$66	$52	$57	$66
100-399 beds	2,636	2,829	3,195	3,535	3,816	51	51	40	42	49
400 or more beds	3,196	3,350	3,788	4,086	4,385	128	135	110	127	144
Major teaching	3,978	4,054	4,512	4,642	4,961	135	147	119	139	155
Minor teaching	2,845	3,065	3,453	3,730	4,002	92	94	76	83	95
Non-teaching	2,549	2,736	3,101	3,472	3,758	49	48	38	40	47
Large urban	3,292	3,473	3,914	4,246	4,559	84	87	70	77	88
Small urban	2,624	2,815	3,176	3,485	3,816	69	71	57	62	73
Rural	2,160	2,361	2,692	3,079	3,260	30	29	23	23	28
Non-profit	2,792	2,963	3,343	3,656	3,939	70	72	57	62	72
For-profit	2,620	2,882	3,187	3,622	3,975	45	42	34	34	41
Government	2,511	2,726	3,160	3,505	3,744	49	54	43	49	55

NOTES: Because reporting years were not coincident across the sample, data for some hospitals were aligned such that time periods were congruent. The start date for 1984 was October 1, 1983. For a further description of the data recycling process, see Management Science Group (1991).

SOURCES: Carey, K., and Stefos, T., U.S. Department of Veterans Affairs, 1992; and Health Care Financing Administration: Data from the Hospital Cost Reporting Information System file, 1984-88.

One change that accounts for an increase in the use of outpatient services is the rise in the number of ambulatory surgical procedures performed in hospitals. Because these operations are relatively costly, it might be expected that they would drive up the average cost of a hospital outpatient visit. Despite the focus on growth in ambulatory surgery, it should be noted that such surgery comprises a relatively small portion of total outpatient volume. In 1988, less than 4 percent of all outpatient visits reported by community hospitals were for surgical procedures (American Hospital Association, 1990-91). Not all ambulatory surgery patients are treated in hospitals. The percentage of hospitals reporting ambulatory surgery rose from 91 to 95 during the period of this study, and the number of freestanding ambulatory surgical centers (ASCs) rose 670 percent from 1983 through 1990 (Prospective Payment Assessment Commission, 1992). Medicare changed the incentives for utilization of these facilities beginning in 1988 by bringing hospital outpatient surgery payments more in line with the lower rates already established for ASCs.

Two caveats should be stated here. As previously noted, the increase in the number of outpatient visits in the sample of hospitals in this study is very large. The figures in Table 1 indicate that the average hospital reported 16,000 more outpatient visits in 1988 than in 1984. The question arises whether some of this increase is the result of unbundling on the part of hospitals. Some States have instituted their own non-Medicare cost-containment regulations that do not permit rate increases but do allow for volume adjustments. It has been suggested that hospitals have split services into multiple billable pieces in order to increase payments. This practice could be reflected in the AHA number-of-visits measure, because each appearance by an outpatient to one unit of the hospital is counted as a visit. Pre-admission testing on an outpatient basis has been another response by hospitals to fixed payments per discharge. This unbundling practice is a way of increasing the payment for the same workload. To the extent that the increase in number of visits from 1984 to 1988 is partially the result of overreporting or changes in the way visits are counted, unit costs for the outpatient component for the later years would be underestimated. (The variation in total costs resulting from outpatient activity is spread out over a larger number of visits.)

The second caveat involves a methodological concern. Although the estimated equation is a variable-cost function that excludes capital expenditures, it is questionable whether a remaining non-capital element of measured costs that is fixed with relation to number of discharges and number of outpatient visits could be significant. Similarly, the incremental-cost approach cannot properly allocate costs that vary jointly with inpatients and outpatients. If a considerable amount of joint costs is assigned to inpatients by this methodology, then our measure of outpatient costs is biased downward. However, the trends that are observed during the 4-year period of study would hold, assuming that the nature of fixed and joint costs is stable over time.

Another approach to disaggregation of cost components is that taken by AHA in its method for representing multiple hospital outputs in a single measure. AHA relies on revenue data as a proxy for costs in this procedure. Discharges are adjusted (multiplied by an adjustment factor) such that "adjusted discharges" refer to the number of discharges that the hospital could serve if it were offering no outpatient or other non-inpatient services. The desired adjustment factor is the ratio of total cost to inpatient cost, which converts non-inpatient services to discharge equivalents. (AHA adjusts inpatient days by the same adjustment factor.) Assuming that total costs are the sum of inpatient costs and outpatient costs, the desired adjustment factor may be expressed as

Table 5

Inpatient cost per discharge and outpatient incremental cost per visit assuming identical revenue-to-expense ratios for inpatient and outpatient activities

Hospital characteristic	Inpatient cost per discharge					Outpatient cost per visit				
	1984	1985	1986	1987	1988	1984	1985	1986	1987	1988
Overall	$2,675	$2,774	$2,979	$3,224	$3,443	$94	$115	$128	$136	$141
100-399 beds	2,500	2,604	2,800	3,040	3,245	91	112	126	135	139
400 or more beds	3,543	3,605	3,848	4,119	4,399	107	132	135	143	154
Major teaching	4,420	4,289	4,554	4,819	5,215	103	131	135	140	148
Minor teaching	2,956	3,110	3,283	3,475	3,715	95	114	137	149	146
Non-teaching	2,397	2,501	2,703	2,956	3,151	92	114	125	133	140
Large urban	3,313	3,432	3,669	3,952	4,168	106	130	144	155	162
Small urban	2,615	2,692	2,888	3,133	3,417	94	114	127	137	142
Rural	1,963	2,061	2,241	2,460	2,585	78	99	109	111	115
Non-profit	2,718	2,832	3,033	3,274	3,510	94	114	126	132	140
For-profit	2,518	2,658	2,812	3,088	3,281	114	136	159	182	170
Government	2,586	2,590	2,846	3,095	3,249	79	106	112	120	127

NOTES: Because reporting years were not coincident across the sample, data for some hospitals were aligned such that time periods were congruent. The start date for 1984 was October 1, 1983. For a further description of the data recycling process, see Management Science Group (1991).

SOURCES: Carey, K., and Stefos, T., U.S. Department of Veterans Affairs, 1992; and Health Care Financing Administration: Data from the Hospital Cost Reporting Information System file, 1984-88.

$$\text{Adjustment factor} = \frac{TC}{IC} = 1 + \frac{OC}{IC}. \quad (10)$$

Adjusted discharges are then calculated as

$$ADJDIS = DIS * \left(1 + \frac{OC}{IC}\right) \quad (11)$$

and unit cost as

$$\text{Cost per adjusted discharge} = \frac{TC}{ADJDIS}. \quad (12)$$

The latter is algebraically equivalent to dividing inpatient cost by unadjusted discharges (*IC/DIS*). However, AHA uses the ratio of total revenue to inpatient revenue as a proxy for the ratio of total cost to inpatient cost. Hence, the AHA adjustment process is a revenue-based approach to calculation of unit costs. Table 5 lists the AHA costs per adjusted discharge along with the implied outpatient unit costs (*OC/OPV*). This revenue-based approximation to changes in unit costs substantially overestimates outpatient costs and cost increases and underestimates those of inpatient costs as observed by comparing the results listed in Table 5 with those of Table 4. Finally, the adjustment factors calculated using the cost-function approach to disaggregation of inpatient and outpatient components are listed with the AHA adjustment factors in Table 6. The discrepancy between cost- and revenue-based unit costs and adjustment factors is most serious among hospitals that are smaller, less urban, and non-teaching, as seen by comparing the results listed in Tables 4 and 5 as well as the results in Table 6.

Implications

The growth rate of hospital outpatient costs has implications from the perspective of both policy and research. Regarding policy, there is a current effort by both government and private insurers to control hospital payments for outpatient services. The results of our research indicate that hospital outpatient costs are not rising nearly as rapidly as are outpatient revenues. Attempts at bringing payments more in line with actual cost increases will have a serious impact on hospitals with the largest discrepancies between costs and revenues. These tend to be the smaller, rural, and non-teaching facilities in the sample.

The classification scheme currently under consideration by HCFA for Medicare outpatient payment is APGs. This system is similar to that of DRGs, which relies on charge data for calibration of payment weights. The appropriateness of using charge rather than cost data for the annual recalibration of DRG weights has been the subject of some debate. Work by Cotterill, Bobula, and Connerton (1986) using 1981 data showed little difference between use of cost and charge data. The results of the study by Rogowski and Byrne (1990) showed that, by 1984, cost- and charge-data-based DRG weights were less congruent. However, the authors counsel the use of charge data. In addition to the timeliness of charge data, there are severe limitations of accounting cost data available at the discharge level. Even the best cost data are partially based on charge data, so that many of the same biases are at work in either case. Price (1989) updated the issue with a study using 1986 data, which showed much larger differences between cost- and charge-based weights than previously found.

This issue needs re-examination in the context of outpatient prospective payment. Results of the present work indicate that the discrepancy between outpatient costs and revenues was significant and grew during the period 1984-88. If historical charge data are used for weighting of outpatient payment groups, the system could be seriously distorted in favor of those procedures for which charges have been set well above costs. If outpatient rates in general are biased upward and inpatient rates downward, the smaller hospitals would be particularly vulnerable because of their relatively smaller outpatient departments.

Table 6

Comparison of outpatient-adjustment factors estimated using cost-function regression results with those estimated using reported revenues

Hospital characteristic	Estimated using cost-function regression results					Estimated using reported revenues				
	1984	1985	1986	1987	1988	1984	1985	1986	1987	1988
Overall	1.12	1.12	1.10	1.11	1.13	1.17	1.21	1.24	1.27	1.31
100-399 beds	1.10	1.10	1.08	1.09	1.10	1.17	1.22	1.25	1.29	1.32
400 or more beds	1.21	1.22	1.17	1.21	1.23	1.15	1.19	1.19	1.20	1.23
Major teaching	1.24	1.26	1.20	1.26	1.28	1.17	1.21	1.21	1.22	1.24
Minor teaching	1.17	1.17	1.13	1.14	1.16	1.16	1.20	1.23	1.24	1.27
Non-teaching	1.10	1.10	1.07	1.08	1.10	1.17	1.22	1.25	1.28	1.33
Large urban	1.14	1.15	1.11	1.13	1.15	1.16	1.20	1.22	1.25	1.28
Small urban	1.13	1.14	1.11	1.12	1.14	1.18	1.21	1.25	1.27	1.31
Rural	1.07	1.07	1.06	1.06	1.08	1.17	1.22	1.26	1.31	1.34
Non-profit	1.13	1.14	1.10	1.12	1.14	1.18	1.22	1.25	1.27	1.31
For-profit	1.06	1.06	1.05	1.05	1.06	1.13	1.17	1.20	1.25	1.29
Government	1.11	1.12	1.09	1.11	1.12	1.18	1.22	1.25	1.28	1.34

NOTES: The revenue-ratio-adjusted factors listed here were derived from application of the American Hospital Association (AHA) adjusted methodology to prospective payment system data. The differences between these factors and those using the AHA data are very small. The overall AHA data revenue-ratio adjusted factors for 1984-88 are 1.17, 1.21, 1.24, 1.26, and 1.29. The Wilcoxon signed-rank test was applied to test the hypothesis that the mean of the difference between the cost-function-adjusted factor and the revenue ratio is zero. For the overall results, the hypothesis was rejected for all 5 years with probability value $< .0001$. Because reporting years were not coincident across the sample, data for some hospitals were aligned such that time periods were congruent. The start date for 1984 was October 1, 1983. For a further description of the data recycling process, see Management Science Group (1991).

SOURCES: Carey, K., and Stefos, T., U.S. Department of Veterans Affairs, 1992; and Health Care Financing Administration: Data from the Hospital Cost Reporting Information System file, 1984-88.

Cost-allocation patterns also have research implications, particularly for the results of studies that rely on AHA revenue-ratio adjusted output measures. If relatively high outpatient revenues are not reflective of true costs, then adjusted output measures will overstate true output levels. Consequently, measures of cost per unit of output will be understated. Examination of changes in unit costs demonstrates the extent to which trends in the variables are misrepresented by the revenue-adjusted measures. From Table 4, it is seen that the cost-function measure of discharge unit cost rose 43 percent from 1984 through 1988, while the revenue-ratio measure of this variable (Table 5) declined by 29 percent. Measures of hospital labor productivity will also be understated if based on AHA adjusted output measures, although these trends are more difficult to gauge because tracking measures of labor inputs over time is confounded by a number of factors. (The latter issues are well described in Cromwell and Pope, 1989.)

Conclusion

It should be noted that the results of much empirical research are dependent on the reliability of AHA adjusted cost and output measures. Numerous studies have used the AHA cost per adjusted unit of output as the dependent variable in estimations of average cost functions. Researchers should be aware of changing patterns of cost allocation and of how use of revenue or charge data as a proxy for costs may affect their conclusions. Improvements in hospital accounting data would be beneficial for future research as well as in construction of DRG and APG weights and payment levels.

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