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# Medicare Inpatient Physician Charges: An Econometric Analysis

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*To control Medicare physician payments, Congress in 1989 established volume performance standards (VPS) that tie future physician fee increases to the growth in expenditures per beneficiary. The VPS risk pool is nationwide, and many observers believe it is too large to affect behavior. VPS could be modified by defining a separate risk pool for inpatient physician services and placing each hospital medical staff at risk for those services. Using a national random sample of 500,000 Medicare admissions, we explore the determinants of medical staff charges and comment on the policy implications. Multivariate analysis shows that charges increase with case mix and bed size but, surprisingly, decrease with the level of teaching activity. The teaching result is explained by the substitution of residents for physicians in these hospitals.*

## INTRODUCTION

To slow the rapid growth of Medicare physician expenditures, Congress enacted major Medicare physician payment reforms in the Omnibus Budget Reconciliation Act (OBRA) of 1989.<sup>1</sup> One component of the reform, VPS, is designed to give physicians incentives to control growth in service volume and intensity.

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VPS works by tying future physician-fee increases to growth in expenditures per beneficiary (after adjusting for the aging of beneficiaries, prices, and certain other factors). Under VPS, all physicians in the country are placed in a single risk pool, where the behavior of each physician affects all other physicians.<sup>2</sup>

There are two problems with VPS. First, many observers believe that the number of physicians who share responsibility is far too large to have a major impact on physician behavior (Rice and Bernstein, 1990). If this is true, VPS simply becomes a budget device to control spending through fee reductions. Second, a national VPS tied to growth rates is inequitable because historical physician practice styles are unchallenged. There is considerable evidence that physician practice styles vary substantially across the country, within small areas, and among individual physicians (Chassin et al., 1986, 1987; Holahan, Berenson, and Kachavos, 1990; Wennberg and Gittelsohn, 1982; Wennberg, McPherson, and Caper, 1984; Wennberg, Freeman, and Culp, 1987; Wennberg

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<sup>1</sup>In 1975, Medicare payments for physician services were approximately \$3.1 billion and accounted for 22 percent of total benefit payments. In 1990, Medicare physician payments were \$28.9 billion and accounted for 27 percent of total benefit payments. Between 1975 and 1990, Medicare physician spending increased at an average annual rate of 16.6 percent (U.S. House of Representatives, 1992).

<sup>2</sup>There are separate VPS for surgical and non-surgical services, but the appropriateness of separate fee updates and VPS for these services has been called into question. Over time, separate updates and standards could distort the relative values assigned to services under the Medicare fee schedule (Secretary of Health and Human Services, 1992).

et al., 1989; Welch et al., 1993; Feinglass, Martin, and Sen, 1991). This literature concludes that disease burdens, socioeconomic characteristics, and differences in insurance coverage do not fully explain these variations. Differences in practice style resulting from a lack of consensus among physicians regarding which services are necessary are thought to explain part of this variation.

These problems have prompted the consideration of alternative volume-control strategies, a number of which are centered around the hospital medical staff (Welch, 1989; Miller and Welch, 1992; Mitchell and Ellis, 1992). A medical-staff strategy would define a separate VPS for inpatient physician services and place each medical staff at risk for services provided during the admission.<sup>3</sup> These approaches overcome the national risk-pool problem by defining a small risk pool (the medical staff) with clear organizational mechanisms (e.g., utilization review, peer pressure) for controlling volume and intensity. Some of the medical-staff strategies address the inequities of the current VPS (which is tied to growth rates and applies the same penalty to all physicians regardless of their individual behavior) by defining performance standards in terms of physician service levels rather than growth rates. The medical-staff approaches differ from physician diagnosis-related groups (DRGs) because the medi-

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<sup>3</sup>The term "medical staff" refers to all physicians with privileges in a hospital. There are several reasons to focus on inpatient services. Inpatient physician services are easily identifiable given current claims data systems, and the basis for case-mix adjustment (i.e., DRGs) is readily available. Inpatient physician services represent a substantial proportion of total physician services (approximately 37 percent); and although they are growing less rapidly than non-inpatient physician services, they demonstrate a substantial growth in volume and intensity.

cal staff as a group, as opposed to the attending physician, is at risk for the admission. In addition, there would be minimal changes to the current reimbursement system under such a policy—physicians would continue to submit bills as they do now, and their fees would be adjusted depending on the performance of the medical staff as a whole.

To elaborate, a second-generation VPS would ideally be designed around some form of physician organization. Medical staffs of hospitals may be the most promising physician structure on which to base volume control. There are three broad medical-staff strategies that could be pursued. The most direct approach would use the admission as the basis for prospective payment. That is, a case-mix-adjusted payment per admission would be made to the medical staff. A second approach, consistent with the current VPS, would use admissions as a measure of growth. Growth in case-mix-adjusted charges per admission would serve as the volume standard by which medical-staff fees are adjusted. A third approach would limit payments to "high-cost" medical staffs by using case-mix-adjusted charges per admission to define a high-cost threshold (e.g., 115 percent of the national mean). Under any of the three strategies, there would be a single national performance standard for inpatient physician services against which the performance of a medical staff would be judged. Fees for the medical staff of each facility would be adjusted depending on their performance relative to the national standard.

All three medical-staff strategies address the risk-pool issue. Two of the strategies (payment per admission and high-cost medical staffs) are tied to the level of

physician services and thus address the equity issue. The strategy tied to growth rates does not address the equity issue.

Note that medical-staff approaches do not cover all physician services and thus would have to be part of a larger volume-control policy. Within the Medicare program, one could define national VPS for all physician services and use the medical staff as a mechanism to help physicians reach the national target. Alternatively, a medical staff strategy could be used in conjunction with non-inpatient VPS defined for each State, for example.

Our purpose here is to explore variations in inpatient physician volume and intensity per admission at the medical staff (i.e., hospital) level.<sup>4</sup> Inpatient physician volume and intensity are measured using deflated charges (henceforth, "charges"). We first construct a case-mix measure using physician charges per DRG as relative weights. A univariate analysis reports the distributive impacts of case-mix adjusting across hospital type (e.g., teaching or non-teaching) and the impact of including graduate medical education (GME) costs. A multivariate analysis examines the determinants of mean physician charges at the hospital level; assesses the performance of our case-mix index; and explores the need for adjustments by hospital type to avoid undesirable distributional consequences. These analyses are relevant to any of the medical staff policy strategies outlined above. For example, if a medical staff payment approach were undertaken, payment adjustments like those in the prospective payment system (PPS)—e.g., for

teaching activity or disproportionate share status—may be appropriate. Furthermore, this research explores determinants of inpatient physician charges that are not typically part of the reimbursement policy, most notably medical staff size and composition.

This article makes two other noteworthy contributions. Medicare physician services are a Part B service and are reimbursed out of the supplementary medical insurance (SMI) trust fund. However, the costs associated with interns and residents in teaching hospitals (i.e., GME costs) are considered a Part A service and are reimbursed out of the hospital insurance (HI) trust fund. Previous studies of Medicare physician hospital charges (e.g., Mitchell, 1985) have not included GME costs, although interns and residents provide physician services. Our analysis estimates GME costs and includes them with physician charges in teaching hospitals.

Medicare data sets are based on two types of beneficiary samples: a 5-percent national random sample and a 100-percent sample of selected States. Much of the previous research on Medicare physician charges in the hospital (e.g., Mitchell, 1985; Mitchell and Ellis, 1992) uses a 100-percent sample of selected States. Because the 100-percent sample includes all admissions for each hospital, its strength is that it yields unbiased estimates of variance within hospital type. Its weakness is that it is a non-random sample of hospitals.

Our analysis uses a random national 5-percent sample because our focus is mean physician charges nationwide. The strength of the 5-percent sample is that it is, in essence, a 100-percent sample of hospitals. The 5-percent sample has at

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<sup>4</sup>Generally, the terms "medical staff" and "hospital" will be used interchangeably, because a hospital cannot function without its medical staff (i.e., physicians) and vice versa.

least 25,000 admissions for each hospital type, which enables us to estimate with precision the mean charges per admission by hospital type. However, the number of admissions for a given hospital (sometimes below 25) may be too low to estimate, with precision, the mean for an individual hospital. Hence, the variance of charges within hospital type would be overestimated because it incorporates variance resulting from small sample sizes—5 percent instead of 100 percent of admissions for each hospital. Both types of samples are needed to fully understand inpatient physician services and to guide policymaking.

## DATA

For an inpatient admission, the facility bills (obtained from the Medicare provider analysis and review [MEDPAR] file) and physician bills (obtained from the Part B Medicare Annual Data [BMAD] file) for 1987 were linked on the basis of beneficiary identification and dates of service.<sup>5</sup> Physician charges were deflated for geographic price variations at the locality level using a prevailing charge index (Pope et al., 1988) and were summed for each admission. Physician charges deflated for price variations provide a reasonable measure of physician service volume and intensity. As mentioned, we will refer to “physician charges” (rather than “deflated physician charges”) throughout the article for expositional convenience.

Charges for each admission were aggregated two separate ways. First, a DRG-

level file was created (i.e., physician charges per admission by DRG). To create the DRG-level file, relative weights for each DRG were calculated by dividing the charge per admission for each DRG by the charge per admission across all DRGs. Second, a hospital-level file was created (i.e., physician charges per admission by hospital), and case-mix indexes for each hospital were computed using the national DRG weights. Various hospital characteristics (e.g., bed size; urban or rural location; teaching activity) were then merged from two Medicare hospital files (the Provider-Specific file and the Hospital Cost Report Information System file) and from the American Hospital Association’s annual hospital survey file.

As noted above, BMAD data include Part B physician charges. In teaching hospitals, interns and residents provide physician services in addition to physicians, but the salaries and fringe benefits of interns and residents are reimbursed through Part A. These costs account for approximately \$1.5 billion of Medicare expenditures. Therefore, we added GME costs on a per admission basis to our hospital-level analysis file.<sup>6</sup> The hospital-level analysis file contains 5,771 hospitals and represents about 484,000 admissions.

<sup>5</sup>A more detailed discussion of linking of inpatient facility claims and physician claims can be found in Miller and Welch (1993). Approximately 2 percent of admissions are transfers; consistent with the PPS treatment of transfers, we assigned physician services to the “receiving” hospital.

<sup>6</sup>First, a national mean cost per full-time equivalent (FTE) resident was estimated. The Health Care Financing Administration’s (HCFA’s) Bureau of Program Operations (BPO) has collected and audited data on GME costs and the number of FTE residents for 1985 for teaching hospitals. Using data for 1,089 hospitals, we calculated a national per resident amount of \$46,212. Because of extreme values in the data, we truncated per resident amounts greater than three standard deviations above the mean. Because our physician-charge data are for 1987, the per resident amount was inflated by 7.5 percent to \$49,678 in order to reflect Medicare Economic Index (MEI) increases from 1985 to 1987. Second, for each hospital, the per resident amount was case-mix adjusted and multiplied by the number of interns and residents per admission to obtain GME costs per admission.

## UNIVARIATE ANALYSIS

In this section, we first describe the construction of our case-mix measure. We then examine the distributional impacts of case-mix adjustment and of including GME costs by hospital type.

### Case-Mix Index Construction

As previously noted, physician charges per admission were calculated for each DRG. To obtain a set of national weights for physician services, the mean physician charge for each DRG was divided by the mean charge for all DRGs. In a hospital-level file, case mix was derived by multiplying the relative weight by the proportion of admissions in each DRG and summing across DRGs in the hospital. Thus, for each DRG, the physician charge per admission is the basis of the weight.

DRGs are a sound basis for the physician service case-mix measure. Mitchell et al. (1984) found that DRGs explain variations in physician charges per admission better than they do variations in hospital costs per admission. After the removal of outliers in an admission-level file, DRGs explain 70 percent of the variation in physician charges versus 32 percent for hospital costs. Furthermore, Mitchell et al. (1984) found that relative weights based on physician charges are highly correlated with PPS weights ( $r = 0.84$ ).

### Case-Mix Adjustment

The impact of case-mix adjusting is shown in Table 1, which displays adjusted and unadjusted physician charges by hospital type.<sup>7</sup> Case-mix adjustment has clear effects on the distribution by urban or rural location and bed size. Rural hospi-

tals are 34 percent below the mean for unadjusted charges but only 18 percent below the mean once case-mix adjustment has been made. Conversely, case-mix adjustment lowers the charges of urban hospitals (relative to the national mean) from 10 percent to 5 percent above the mean. Before case-mix adjustment, small hospitals (100 beds or fewer) have mean charges lower than the national mean, and larger hospitals (300 beds or more) have charges above the national mean. After case-mix adjustment, these variances remain, but case-mix adjustment moves them closer to the mean.

The effect of case-mix adjustment on the distribution of physician charges by teaching status is dramatic, but counterintuitive. Major teaching hospitals have unadjusted mean charges 17 percent above the national mean, but their case mix is 24 percent above the national mean.<sup>8</sup> As a result, their case-mix-adjusted charges are 6 percent below the mean. In fact, major teaching hospitals have lower mean charges than non-teaching hospitals when case mix is taken into account. Minor teaching hospitals have the highest case-mix-adjusted charges of all.

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<sup>7</sup>Because the clear policy precedent has been to protect hospitals from random high-cost cases, physician charges per admission were truncated for outlier costs. An outlier policy is intended to ensure against the adverse impacts of a few high-cost cases and to reduce the incentives for providers to deny access to potentially high-cost Medicare patients. Under Medicare PPS, when an admission has costs above some threshold, it is defined as a cost outlier, and the hospital receives an additional payment. Medicare PPS defines both day and cost outliers, although recent regulatory changes emphasize cost outliers. For purposes of this analysis, we simulated a cost outlier policy similar to Medicare PPS. Any admission with charges greater than 2.5 times the DRG mean is considered an outlier; this threshold results in an outlier pool of 3.9 percent. That is, 3.9 percent of charges would exceed the outlier threshold.

<sup>8</sup>Teaching hospitals are divided into two categories: major teaching (intern- and resident-to-bed (IRB) ratio > .25) and minor teaching.

**Table 1**  
**Mean Physician Charges per Admission, by Hospital Type**

Hospital Type	Inpatient Stays					
	Case-Mix Index	Mean Charges, as a Ratio of U.S. Mean Charges			Number of	
		Unadjusted	Case-Mix Adjusted	Case-Mix Adjusted With GME	Hospitals	Admissions in Sample (1,000s)
Total	1.00	1.00	1.00	1.00	5,771	484
<b>Control</b>						
Private Non-Profit	1.03	1.04	1.02	1.02	3,157	342
Government	0.91	0.82	0.89	0.89	1,252	64
For Profit	0.92	0.96	1.04	0.98	1,145	67
<b>Bed Size</b>						
Fewer Than 50	0.70	0.45	0.63	0.60	1,527	26
50-100	0.77	0.65	0.83	0.75	1,295	51
101-200	0.89	0.87	0.99	0.94	1,249	97
201-300	1.00	1.03	1.06	1.02	717	99
301-500	1.09	1.14	1.07	1.08	634	126
More Than 500	1.25	1.30	1.06	1.18	275	84
<b>Urban or Rural</b>						
Rural	0.80	0.66	0.82	0.77	2,668	109
Urban	1.06	1.10	1.05	1.07	3,034	374
<b>Teaching Status</b>						
Non-Teaching	0.91	0.89	0.98	0.91	4,749	299
IRB Ratio Less Than .25	1.14	1.18	1.06	1.10	801	144
IRB Ratio More Than .25	1.24	1.17	0.94	1.35	221	41
<b>Disproportionate Share</b>						
No	0.98	0.97	0.99	0.95	4,465	336
Yes	1.04	1.06	1.03	1.11	1,306	148
<b>Region</b>						
Northeast	0.99	0.97	1.00	1.05	897	110
North Central	1.01	1.02	0.99	0.96	1,628	90
South	0.98	0.98	1.00	0.99	2,009	196
West	1.05	1.05	1.00	1.00	1,228	88

NOTES: Charges and case mix are weighted by the admissions in a hospital. The number of hospitals by type may not sum to 5,771 because of missing hospital type values. GME refers to graduate medical education and is the case-mix-adjusted intern and resident costs per admission in teaching hospitals. IRB refers to intern- and resident-to-bed ratio and measures teaching activity. National mean charge per admission (unadjusted): \$1,046. National mean charge per admission (case-mix adjusted): \$1,025.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare 5-percent Beneficiary Sample Files, 1987.

This is in contrast to analyses of inpatient facility costs, where minor teaching hospitals have higher costs than non-teaching ones, and major teaching hospitals have higher costs than minor ones. (GME costs are an important component of teaching hospital physician costs, and their impact on teaching hospital charges will be discussed.)

We draw two conclusions regarding case-mix adjustment. First, case-mix adjustment is significant. Much of the devia-

tion from the national mean is accounted for by case mix. Second, the overall effect of adjustment is to move hospitals toward the national mean, although they usually maintain their respective positions. In particular, case-mix adjustment increases (relative to the national mean) charges for small, rural, non-teaching, and non-disproportionate share hospitals and decreases charges for large, urban, minor teaching, and disproportionate share hospitals (DSHs). A notable excep-

tion is the case of major teaching hospitals, where case-mix adjustment decreases charges relative to the national mean.

### Effect of Including GME Costs

Interns and residents provide physician services in teaching hospitals, and so conceptually these GME costs can be added to physician charges in teaching hospitals. When only Part B physician charges are considered, minor teaching hospitals have above average (case-mix-adjusted) physician charges (1.06), but major teaching hospitals have below average charges (0.94). This is contrary to expectations based on research involving inpatient facility costs, which increase with the size of the hospital's teaching activity (Sloan, Feldman, and Steinwald, 1983). Teaching hospitals are thought to engage in more diagnostic testing and intensive technologies as part of the teaching function (Martz and Ptakowski, 1978). Severity of illness, which is not captured by differences in case mix, is also thought to contribute to higher teaching hospital costs (Horn and Sharkey, 1983). Higher teaching hospital costs are recognized by Medicare PPS payments.

Given what is known of facility costs, we would expect physician charges in teaching hospitals also to be higher than the mean. In Table 1, when GME costs are added to mean physician charges, this is exactly what we find. Charges in major teaching hospitals increased from 6 percent below the national mean to 35 percent above the mean. As might be expected, adding GME also increases mean charges in very large (500 beds or more) hospitals and DSHs, relative to other hospitals.

## MULTIVARIATE ANALYSIS

We now explore the determinants of mean physician charges per admission. Because physician charges have been deflated, the dependent variable can be thought of as physician "service volume" per admission. Therefore, we are estimating an expenditure model. We wish to specify a model that will provide a comprehensive examination of the determinants of inpatient service volume and allow us to explore issues relevant to a medical-staff policy, such as the accuracy of our case-mix index, and the need to adjust for certain hospital characteristics, such as teaching activity. We assume that many of the same hospital-level factors affecting inpatient facility costs also affect inpatient physician service volume. Thus the model includes such traditional variables as bed size, case mix, and urban or rural location.<sup>9</sup> Because we are examining physician service volume, two new hospital characteristics are also included—size and specialty composition of the medical staff. Finally, market area characteristics (i.e., supply, demand, and price variation) are also expected to affect the amount of services provided by medical staffs, and variables such as physician supply and per capita income are included.

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<sup>9</sup>This assumes that inpatient facility services and inpatient physician services are compliments. Acting in the interest of the patient, the physician directs the course of hospital treatment. A complimentary relationship assumes that increases in physician services (e.g., more services or more complex services) will be associated with increases in facility services. It is possible that inpatient physician and facility services are substitutes for one another (e.g., nursing services may substitute for physician services at the margin). However, the literature suggests that these services are complimentary. Holahan, Dor, and Zuckerman (1991), and Menke (1990) examine the impact of PPS on Medicare physician expenditures and find that it reduced inpatient physician expenditures.

## Model Specification

Although we are not estimating a cost function, in specifying the model the inpatient PPS cost function literature serves as a precedent (Pettengill and Vertrees, 1982; Sheingold, 1990). Medicare inpatient costs are usually estimated as a function of case mix (measured using DRGs), input costs (measured using the area wage index), bed size, location (i.e., urban or rural), teaching activity (measured using the IRB ratio), and disproportionate share status (measured using the disproportionate share percentage defined by law). Region and type of hospital control (e.g., private non-profit) have also been included as explanatory variables.

Pettengill and Vertrees' (1982) analysis of inpatient costs using a DRG-based case-mix measure is of particular importance. Pettengill and Vertrees used single-equation ordinary least squares to estimate an inpatient hospital cost function, assuming a multiplicative relationship between costs and the exogenous variables (i.e., log-linear model). Their data included 5,071 hospitals, and their model explained 72 percent of variation in inpatient facility costs. One of the primary objectives of their analysis was to validate the case-mix index constructed using DRGs. They found a proportional relationship between case mix and costs; that is, a 1-percent increase in case mix yields approximately a 1-percent increase in costs. This was cited as *prima facie* evidence of the validity of their DRG-based case-mix index as a measure of relative costliness. In addition to incorporating their model specifications, we use their approach to evaluate the performance of our case-mix index.

The unit of observation for our analysis is the hospital, which is weighted by the number of discharges.<sup>10</sup> The dependent variable is the log of mean physician charges per admission, unadjusted for case mix.<sup>11</sup> (A second regression will use physician charges plus GME costs as the dependent variable.) There are three broad classes of independent variables. The first class is comprised of the typical variables used to explain hospital cost variation—case mix, bed size, and various hospital characteristics (e.g., teaching activity); the second class is comprised of medical staff characteristics (e.g., percent of specialists on staff); and the third class is comprised of market-area characteristics (e.g., supply of physicians). A log-linear functional form is used.

Case mix is constructed as described earlier, and it measures variations in the mix of patients across hospitals. Bed size is a proxy for scope of services and economies of scale. Location is measured using dichotomous variables for rural, other urban, and large urban areas (metropolitan statistical areas [MSAs] > 1 million); (the rural category is excluded). Location is a proxy for practice variations. Dichotomous variables measuring rural referral center (RRC) and sole community hospital (SCH) status are included for the same reasons. DSHs are hospitals that provide care to disproportionately large numbers

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<sup>10</sup>Twenty-nine HMO (mostly Kaiser) hospitals are eliminated because they do not submit physician claims. Additionally, 370 hospitals with extreme values on the dependent variable ( $\pm 3$  standard deviations) were eliminated as statistical outliers. Thus, the total number of hospitals potentially available for the regression analysis is 5,370. However, approximately 540 fewer hospitals are found in each regression because of missing values on the explanatory variables, particularly the medical staff characteristics.

<sup>11</sup>The dependent variable is unadjusted for case mix because we wish to examine the independent effect of case mix on physician services.



of poor persons. The level of disproportionate share in a hospital is measured by the Medicare PPS's disproportionate share percentage.<sup>12</sup> Proponents of the DSH adjustment argue that DSHs have higher costs because of greater severity of illness and the need to maintain more specialized staff and equipment. Teaching activity is measured using the IRB ratio.<sup>13</sup> Teaching hospitals are expected to have higher costs for the reasons discussed in detail earlier. Type of control is measured using dichotomous variables for non-profit, proprietary, Federal Government, and non-Federal Government (non-profit is the excluded category). Type of control is included as a measure of organizational efficiency and practice style.

We include two measures of the hospital medical staff.<sup>14</sup> The first, which measures the size of the staff, is the ratio of the number of physicians on the medical staff to the number of hospital beds. Mitchell et al. (1987) suggested that physician costs increase unnecessarily with the involvement of more physicians in the provision of care. The ratio of medical staff to beds is expected to have a positive sign. Charges per admission may be affected not only by the size of the medical staff (relative to the size of the hos-

pital) but also by the specialty composition of the staff. Hence, the second type of measure involves 4 categories of physician specialty: (1) generalist-general/family practitioners and internists; (2) surgeons; (3) medical specialists; and (4) radiologists/anesthesiologists/pathologists (RAPs).<sup>15</sup> The percent of staff in each of these categories was defined as a variable. To avoid perfect collinearity, generalists are the excluded group. We assume that charges per admission are higher in hospitals with more specialized medical staffs.

Region could be included in the model to control for additional unmeasured factors affecting physician charges per admission. However, these factors (supply, demand, and price) are better measured at the market level. For this analysis, market level is defined as the MSA where the hospital is located.<sup>16</sup>

We include three MSA-level variables in the equation. Physicians per 1,000 population is included to measure variations in physician supply. With greater physician supply, access is increased and, assuming an inducement response, physicians may respond to competition by influencing patients to demand more services. Physicians per 1,000 population has an expected positive sign. Per capita income for the elderly (65 years of age or over) is included as a measure of patient demand. Medicare beneficiaries are required to

<sup>12</sup>The disproportionate share percentage is defined by law. For the most part, it is the hospital's total days attributable to Medicare beneficiaries who also receive Supplemental Security Income payments divided by the total number of Medicare patient days, plus the number of Medicaid patient days divided by total patient days. There are special rules for urban hospitals with more than 100 beds and more than 30 percent of revenue from State and local indigent-care funds, rural hospitals with more than 500 beds, SCHs, and RRCs. Because most hospitals have disproportionate share percentages equal to zero, the disproportionate share percentage is measured as the log of (1 + DSH percent).

<sup>13</sup>Because most hospitals have IRB ratios equal to zero, teaching activity is measured as the log of (1 + IRB ratio). The IRB ratio was truncated at 1.0 to correct for extreme values.

<sup>14</sup>Medical-staff data (total and specialty breakouts) are obtained from the American Hospital Association (1987).

<sup>15</sup>Surgical specialty includes ophthalmology, orthopedic, thoracic, plastic, and other surgical specialties (e.g., neurological, colon/rectal, urology, etc.). Medical specialty includes medical specialties (e.g., pulmonary diseases, nephrology, allergy, etc.), pediatrics, obstetrics/gynecology, emergency medicine, dermatology, and psychology. RAPs include specialists in radiology, anesthesiology, pathology, and nuclear medicine. Although more distinctions could be incorporated into the specialty variable, regression analyses tend to lack the statistical power necessary to distinguish those categories. Fewer categories also limit multicollinearity.

<sup>16</sup>Rural areas in a State are treated as a single "market area."

pay a copayment for physician services; consequently, beneficiaries with higher income are expected to demand more services. The Medicare assignment rate is included as a measure of price. Physicians have the choice of accepting Medicare's allowed charge as payment in full (called "accepting assignment") or charging more than the Medicare allowed amount. Accepting assignment effectively lowers the price of services to the beneficiary. Thus, the assignment rate is expected to be positively related to charges per admission.<sup>17</sup>

### Regression Results

Table 2 reports the means and standard deviations of the regression variables in unlogged form and Table 3 reports the regression results. When reviewing traditional hospital characteristics (e.g., case mix, bed size), the inpatient facility cost literature and PPS literature served as our benchmark for an assessment of these results. That is, barring specific reasons to the contrary, independent variables are expected to have similar impacts on physician charges and on inpatient facility costs.

### *Factors Affecting Physician Charges*

Table 3 first presents Model 1 results (physician charges without GME costs), which account for 83 percent of the variation in physician charges during the inpa-

tient stay. As noted earlier, Pettengill and Vertrees (1982) accounted for 72 percent of variation in inpatient facility costs (although they used fewer independent variables and did not remove outlier costs). Most variables behave as expected. Mean physician charges increase with bed size and the disproportionate share percentage. Physician charges are higher in hospitals in urban areas than they are in rural areas, and charges in large urban areas appear to be higher than those in other urban areas. Both special categories of rural hospitals (SCHs and RRCs) have higher physician charges than other rural hospitals. Physician charges are lower in non-Federal Government hospitals.

The DSH result deserves separate comment. Analysis of growth from 1988 to 1989 using 100 percent claims data from selected States indicates that physician services per admission are growing more slowly in DSHs. This suggests that if these results are replicated using a later year of data, the DSH coefficient could be substantially lower.

Two regression results differ from previous analyses of Medicare inpatient facility costs. Mean physician charges decrease as teaching activity increases, which is consistent with the results of our univariate analysis, in which major teaching hospitals had lower physician charges than those of minor teaching hospitals. This issue is further explored when GME costs are included in the dependent variable as in Model 2. PPS analyses show that proprietary hospitals had 4 percent lower Medicare PPS operating costs per case in 1987 (Prospective Payment Assessment Commission, 1989). In contrast, our regression results show that

<sup>17</sup>Models of this kind often include additional market-level variables (Holahan, Dor, and Zuckerman, 1991). For example, the number of beds per capita presumably influences population-based inpatient expenditures largely through increased admission rates. Because our dependent variable is charges per admission, beds per capita was excluded. Although insurance coverage is also a measure of demand, medigap coverage is excluded because its measurement at the MSA level requires substantial amounts of imputation.

**Table 2**  
**Means and Standard Deviations of Regression Variables**

Variable	Mean	Standard Deviation
<b>Dependent Variables</b>		
Physician Charges per Admission <sup>1</sup>	\$1,047	372
(Physician Charges + GME) per Admission <sup>2</sup>	\$1,128	452
<b>Hospital Characteristics</b>		
Case Mix <sup>1</sup>	1.00	0.27
Bed Size <sup>3</sup>	316	227
IRB Ratio <sup>3</sup>	0.06	0.12
Disproportionate Share Percentage <sup>3</sup>	0.02	0.04
Hospital Type:		
Other Urban (percent) <sup>3,4</sup>	39.65	48.84
Large Urban (percent) <sup>3,4</sup>	37.65	48.45
Rural Referral Center (percent) <sup>3,4</sup>	5.56	22.92
Sole Community (percent) <sup>3,4</sup>	2.57	15.82
Proprietary (percent) <sup>3,4</sup>	13.47	34.13
Non-Federal Government (percent) <sup>3,4</sup>	13.29	33.95
Federal Government (percent) <sup>3,4</sup>	0.22	4.56
<b>MSA Characteristics</b>		
Physicians per 1,000 Population <sup>5</sup>	1.37	0.55
Income of Elderly <sup>6</sup>	\$11,661	1,704
Assignment Rate (percent) <sup>7</sup>	64.00	15.90
<b>Medical Staff Characteristics</b>		
Medical Staff per Bed <sup>8</sup>	0.66	0.46
Surgeons per Medical Staff (percent) <sup>9</sup>	26.28	8.21
Specialists per Medical Staff (percent) <sup>9</sup>	33.15	12.57
RAPs per Medical Staff (percent) <sup>9</sup>	11.31	5.93

<sup>1</sup>Data derived from 1987 MEDPAR and BMAD Files.

<sup>2</sup>Data derived from 1987 MEDPAR, BMAD, and GME Files.

<sup>3</sup>Data derived from 1987 HCRIS and Provider-Specific Files.

<sup>4</sup>Dichotomous variable, percent coded 1 is reported.

<sup>5</sup>Data derived from the Area Resource File.

<sup>6</sup>Data derived from the Area Resource File and CPS.

<sup>7</sup>Data derived from the 1987 BMAD Beneficiary File.

<sup>8</sup>Data derived from the AHA Annual Survey File and Provider-Specific Files.

<sup>9</sup>Data derived from the AHA Annual Survey File.

NOTES: All figures are discharge weighted. IRB ratio refers to intern- and resident-to-bed ratio and measures teaching activity. GME refers to graduate medical education and is the case-mix-adjusted intern and resident costs per admission in teaching hospitals. RAPs refers to radiologists/anesthesiologists/pathologists. MEDPAR is Medicare provider analysis and review file. BMAD is Part B Medicare Annual Data file. HCRIS is Hospital Cost Report Information System. CPS is Current Population Survey. AHA is American Hospital Association.

physician charges are higher in proprietary hospitals.<sup>18</sup>

The market-level variables perform largely as expected. As average income for the elderly increases, charges per admission increase. This is consistent with

previous research: Holahan, Dor, and Zuckerman (1991) found that income was positively related to inpatient physician expenditures per beneficiary at the MSA level. With higher assignment rates, beneficiaries effectively face a lower price for services and charges per admission increase. Holahan, Dor, and Zuckerman (1991) found no relationship between assignment rates and inpatient physician expenditures per beneficiary. In our model, only the supply variable, physicians per 1,000 population, is insignificant.

<sup>18</sup>One tentative explanation of the difference between the inpatient facility and inpatient physician results in proprietary hospitals is the difference in Medicare's payment methods. Under PPS, proprietary hospitals must contain facility costs at the same time that medical staffs of proprietary hospitals maximize reimbursement under fee-for-service rules. This explanation contradicts our underlying assumption regarding the complementary relationship between inpatient physician and facility services.

**Table 3**  
**Determinants of Physician Charges per Admission: Regression Results**

Independent Variable	Dependent Variable	
	Without GME (Model 1)	With GME (Model 2)
Intercept	*5.143 (21.83)	*5.057 (21.57)
Adjusted R <sup>2</sup>	0.83	0.86
Number of Hospitals	4,827	4,817
<b>Hospital Characteristics</b>		
Case Mix	*1.032 (76.29)	*0.957 (70.87)
Bed Size	*0.107 (21.12)	*0.117 (23.17)
IRB Ratio	* -0.632 ( -19.91)	*0.504 (15.85)
Disproportionate Share Percentage	*0.353 (4.74)	*0.555 (7.45)
Hospital Type:		
Large Urban	*0.147 (10.91)	*0.160 (11.90)
Other Urban	*0.114 (9.99)	*0.125 (10.94)
Rural Referral Center	*0.114 (8.92)	*0.122 (9.61)
Sole Community	*0.056 (3.48)	*0.061 (3.76)
Proprietary	*0.065 (8.87)	*0.066 (9.04)
Non-Federal Government	* -0.028 ( -3.63)	* -0.020 ( -2.59)
Federal Government	-0.117 ( -0.34)	-0.033 ( -0.65)
<b>MSA Characteristics</b>		
Physicians per 1,000 Population	-0.008 ( -0.65)	-0.006 ( -0.49)
Income of Elderly	*0.074 (3.00)	*0.078 (3.22)
Assignment Rate	*0.073 (7.66)	*0.063 (6.63)
<b>Medical Staff Characteristics</b>		
Medical Staff per Bed	*0.043 (8.13)	*0.040 (7.51)
Surgeons per Medical Staff	*0.274 (7.89)	*0.321 (9.28)
Specialists per Medical Staff	*0.105 (4.19)	*0.098 (3.89)
RAPs per Medical Staff	*0.224 (5.24)	*0.220 (5.14)

\*p < .01.

NOTES: t-values in parentheses. The dependent variable is the log of mean (deflated) physician charges per admission. Regressions are discharge weighted. GME refers to graduate medical education and is the case-mix-adjusted intern and resident costs per admission in teaching hospitals. IRB ratio refers to intern- and resident-to-bed ratio and measures teaching activity. MSA is metropolitan statistical area. RAPs are radiologists/anesthesiologists/pathologists.

SOURCES: Health Care Financing Administration, Bureau of Data Management and Strategy; Data from the Medicare 5-percent Beneficiary Sample Files; Miller, M.A., and Welch, W.P., The Urban Institute, 1993.

Of particular interest are the four medical staff characteristics—all are significant and perform as expected. As the ratio of medical staff to beds increases, charges per admission increase, suggesting that hospitals involving more physicians in the provision of care have higher physician charges. Note that the “supply” of physicians in the hospital affects charges, whereas the supply of physicians in the market area (i.e., MSA) does not. It appears that the hospital-specific measure is the better predictor.

The three medical staff percentages capture the degree of staff specialization; all are significant. Charges per admission increase with the staff’s proportions of surgeons, medical specialists, and RAPs relative to generalists. Whereas the statistical significance of the three staff variables was measured relative to the excluded group of generalists, we also examined the degree to which the three specialty groups were different from one another. The coefficient for medical specialists is statistically different from the surgeon coefficient ( $F$  value = 23.46) and from the RAP coefficient ( $F$  value = 6.83). The RAP coefficient is not statistically different from the surgeon coefficient ( $F$  value = 0.91). These results indicate that charges increase with the proportions of surgeons and RAPs on staff relative to medical specialists.

An example illustrates the size of the impact on charges of medical staff composition. The composition of the average medical staff in our sample is 26 percent surgeons, 33 percent specialists, and 11 percent RAPs. Assuming the means for all independent variables in the regression, mean physician charges per admission are about \$973. If the percent of surgeons were increased 10 percentage

points relative to generalists (and all other variables held constant), mean charges per admission would increase \$27 to \$1,000. Similarly, if specialists and RAPs were (separately) increased by 10 percentage points, average charges would increase by \$10 and \$25, respectively.

Finally, standardized coefficients (stb) measure the relative importance of the regressors in predicting the dependent variable given their variances as well as their coefficients.<sup>19</sup> Case mix (stb = 0.67) is overwhelmingly the most important determinant of charges per admission. Bed size (stb = 0.21), teaching activity (stb = 0.16), and urban location (large urban stb = 0.18; other urban stb = 0.14) are the next most important determinants. RRC status, proprietary ownership, assignment rate, medical-staff-to-beds ratio, and percent of surgeons on staff all have standardized coefficients between 0.05 and 0.07.

### *Case-Mix Performance*

Pettengill and Vertrees (1982) argued that a good measure of case mix should be proportional to costs at the hospital level, implying an elasticity close to 1.00 in a log-linear regression equation. Pettengill and Vertrees obtained a case-mix elasticity of 1.08 and found that their estimate was not statistically different from 1.00. Case mix in our regression has an elasticity of 1.03 but is significantly different from 1.00 at the 95-percent level of confidence. We conclude that our case-mix measure is approximately propor-

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<sup>19</sup>Standardized coefficients are the product of a variable’s coefficient and standard deviation divided by the standard deviation of the dependent variable. They are interpreted as follows (using case mix as the example): A 1-standard deviation change in case mix is associated with a 0.67-standard deviation change in charges per admission.

tional to physician charges and that the index could be used for policy formulations.

### *Including GME Costs*

As discussed earlier, salaries for interns and residents are reimbursed as GME costs under Part A. Because residents deliver physician services, these GME costs are conceptually physician costs. Using the same methods described in the univariate analysis, we calculate GME costs and add them to physician charges in order to examine them in a multivariate context.

Under Model 2 in Table 3, as expected, the regression results remain largely unchanged except that teaching activity now has a positive impact ( $b = 0.50$ ). Every 10-percent increase in the IRB ratio increases physician charges (plus GME costs) by about 6 percent. This coefficient is roughly equivalent to that found for inpatient facility costs (Pettengill and Verrees, 1982 [ $b = 0.57$ ]; Welch 1987, [ $b = 0.48$ ]). The coefficient for the disproportionate share percent continues to be positive ( $b = 0.56$ ), but it is higher than that found for physician charges alone ( $b = 0.35$ ). Analysis of standardized coefficients for this model are consistent with those in the model of physician charges: Case mix is the most important determinant followed by bed size, teaching activity, and urban location.

## **DISCUSSION AND POLICY IMPLICATIONS**

Inpatient physician services account for a significant proportion of all physician services (approximately 37 percent), and volume and intensity growth is more

rapid than might be expected.<sup>20</sup> This is striking given that existing PPS incentives to control facility costs might be expected to have a spill-over effect. This suggests that inpatient physician services represent a reasonable focus for a separate volume control policy. A medical-staff policy is a reasonable next step because such a policy would define a smaller risk pool and concentrate incentives in a physician organization with clear mechanisms for physicians to collaborate to control costs. Furthermore, medical-staff policies tied to the level of physician services (as opposed to the rate of growth) would improve equity.

Although a medical-staff policy would represent a reasonable incentive mechanism to change physician behavior, alone it would not cover all physician services. Clearly, a medical-staff policy would have to be implemented in conjunction with a VPS mechanism to control out-of-hospital services. One approach could be for the medical staff VPS to help physicians meet the current national VPS. Alternatively, there could be separate VPS for inpatient and non-inpatient physician services, with the former subject to a medical-staff model and the latter subject to a subnational model, such as one based on the State. If the medical-staff policy proved to be effective over time, it could be expanded to cover a greater proportion of physician services. One such expansion would be to place the medical staff at risk for an episode of care (e.g., a 4-week post-discharge window) as opposed to the inpatient stay only. (See Miller and Welch [1992] for discussion.)

<sup>20</sup>After controlling for fee increases (but not controlling for case-mix changes), Mitchell (1991) found that from 1985 to 1988, the typical patient received 30 percent more physician services during the inpatient stay.

Another such expansion would be to place the medical staff at risk for hospital outpatient department surgery. Finally, if global budget reforms are considered in the future, the medical-staff policy could be expanded to cover all inpatient physician services—Medicare, Medicaid, and private payers.

The analyses presented above suggest that any medical-staff policy (whether based on payment levels or growth rates) would have to use case-mix adjustment. In addition to the obvious PPS precedent, we find that case mix is the single most important determinant of physician-service variations. It is encouraging to find that using DRGs as the basis of the case-mix measure produces a coefficient close to 1.00, suggesting that it is a reasonable measure of case mix.

The standardized regression results indicate that, in addition to case mix, bed size, teaching activity, and urban or rural location are the most important determinants of physician services. Obviously, bed size would not serve as a direct adjustor but should probably be included as a control variable in any regression analysis undertaken to establish official payment-adjustor levels for other factors. Although an important determinant, one reason not to make an urban or rural adjustment is that PPS has moved away from the urban or rural distinction. Finally, the teaching coefficient is an important determinant, and there is a clear PPS precedent for making such an adjustment. The difficult policy issue here is the direction of the adjustment: Unless GME costs are counted as physician costs, the adjustment is negative for major teaching staffs.

The findings for the medical-staff variables are also noteworthy. Staffs that in-

volve more physicians in the admission or are more specialized have higher physician volume and intensity per admission. This suggests that the size and specialization of the staff present opportunities to obtain greater efficiency. We would also take the medical-staff variable results as an additional indication that using the medical staff as a risk pool is a reasonable approach.

We wish to close with a caveat and some considerations for future research. The caveat derives from Medicare's reform of physician payment. Whereas in the past Medicare payments to physicians were based on reasonable charges, Medicare now uses a fee schedule incorporating relative value units (RVUs). The fee schedule increases payment for evaluation and management services relative to procedural services, which would increase the relative weights for medical DRGs and decrease them for surgical DRGs. Plausibly, using deflated charges still reflects those historical distortions. Thus, the regressions estimated above should be re-estimated, using RVUs as the basis of the case-mix index and as the dependent variable. Such re-estimation could have important implications for our findings, particularly with respect to the hospital-type adjustors.

Whereas our analysis has pertained to mean service volume and intensity by hospital type, also of relevance is the amount of variance within a hospital type. For instance, the higher the variance, the greater the impact of a single payment rate for all hospitals within a category. As noted in the introduction, mean services are best analyzed with a national sample of beneficiaries—in effect, a 100-percent sample of hospitals. However, because the 5-percent sample overestimates the

variance, variance is best analyzed with a 100-percent sample of admissions in certain States (Mitchell and Ellis, 1992).

This issue of sample size raises one final direction for future research. Whether a medical-staff policy is based on growth rates or on levels, it is important to understand stability. That is, do case-mix-adjusted physician services per admission vary radically over time for a given hospital? The policy implication is obvious: Unless some degree of stability can be demonstrated, the reward-penalty structure of a medical-staff policy would appear capricious. An analysis of stability is best undertaken with both national 5-percent and State-specific 100-percent samples.

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