Expenditures for Hospital Care and Physicians' Services: Factors Affecting Annual Changes

by NANCY L. WORTHINGTON*

This article attempts to identify the major factors contributing to annual changes in per capital expenditures for the two largest components of national health spending—hospital care and physicians' services. Multiple regression analysis has been used to estimate the contributions of selected explanatory variables during 1950–73 for hospital expenditures and during 1957–73 for physician outlays. For both models, changes in the independent variables used to measure factor prices, real inputs, and utilization combine to explain a significant proportion of total variation. Although the explanatory variables each proved to be significant, the effect of real inputs—a reflection of technological change—was most pervasive for both types of expenditure.

AMERICANS ARE SPENDING significantly more for medical care now than they did in the past, in both absolute and relative terms. From 1950 to 1974, expenditures have risen more than 750 percent. In the short period since 1970, the rise has been greater than 50 percent. This growth in health expenditures has been faster than that of the economy in general: The share of gross national product represented by health was two-thirds higher in 1974 than it had been 20 years earlier.[1]

A number of factors contribute to produce these expanding outlays. Particular factors vary with category of expenditure, between services and supplies, and between institutional and professional services. In the broadest sense, however, the various factors can be classified into three categories—inflation, product change, and changes in quantity.

Inflation reflects the increase in price without an accompanying change in the quality of goods or services. Product change, which represents one of the most interesting and significant developments in the health industry, encompasses the far-reaching technological change in the delivery of health care and takes into account new equipment and drugs, increased labor inputs, and other nonlabor contributions with an impact on the quality of medical care delivered. Finally, changing quantities reflect the changing supply and demand generated by a growing population. To eliminate the effect of population growth on aggregate spending, per capita expenditures are utilized for the remainder of this article, and changing quantity reflects simply the change in per capita utilization of medical care services. Since per capita utilization is a function of both supply and demand factors, both are reflected in any measure of quantity change.

These factors in combination result directly in changing levels of spending for medical care. It should be noted, however, that while they are the direct determinants of spending levels, the factors themselves are to some extent responses by providers and consumers of medical services to developments in the external environment. Since 1950, for example, real disposable personal income per capita has risen 73 percent and has been accompanied by an increased consumer demand for goods and services. Third-party coverage of personal health expenditures during that same period rose from 32 percent to 65 percent, thereby lowering the net price of care to the consumer and facilitating his access to medical services. Technology introduced in the past two decades was never before available at any price. Moreover, certain patterns of medical practice—including the increasing use of technology—have developed because of the value placed on health by the American public and its rising expectations concerning the benefits of medical care.

Health expenditures in the United States are comprised of eight broad categories of personal services and three additional nonpersonal cate-

* Division of Health Insurance Studies, Office of Research and Statistics. The author wishes to thank Douglas Wilson, J. Michael Fitzmaurice, and Thomas Hodgson for their assistance.

[1] Nancy L. Worthington, "National Health Expenditures, 1929–74," *Social Security Bulletin*, February 1975.

gories. This article attempts to analyze the sources of year-to-year change in expenditures for the two largest of these components—hospital care and physicians' services. Together, these central providers of medical care account for 57 percent of all outlays and two-thirds of total personal health spending.

HOSPITAL CARE

The hospital has been the scene of many of the most dramatic developments in medical care. It has always had a central role in the health delivery system, but its importance has become increasingly significant in recent years. In 1974, there were 33 million admissions to community hospitals (159 for every 1,000 persons) resulting in 246 million inpatient days of care.[2] In addition to their traditional role as providers of inpatient care, hospitals have also rapidly expanded their outpatient services to the extent that they currently accommodate more than 175 million visits annually.

What has brought about these significant increases? An attempt is made here to track year-to-year variation in hospital expenditures, the product of hospital costs, and quantity of care received. Multiple regression analysis has been used to estimate the contributions of selected explanatory variables during the period 1950–73.

The focus of the analysis is on the annual changes in per capita spending for community hospital care. Community hospitals—defined to include all non-Federal short-term general and other special hospitals—account for the vast majority of total hospital outlays—77 percent in 1973. The remaining Federal and long-term institutions behave somewhat differently than community hospitals, and their inclusion would complicate the attempt to explain expenditure trends. In addition, community hospitals have been the major focus of many of the changes undergone in hospital care in the past two decades, and analysis of their behavior is therefore of most interest to health economists and policymakers.

The United States hospital system provides some of the most technologically sophisticated medical care available in the world today. Many of the developments in the form of new treatment procedures have been beneficial to society,[3] but they have also been expensive. The average cost of a day of hospital care is now well over $100. Total spending for hospital care in this country this year will amount to more than $200 for every man, woman, and child. This amount is double the average spent in 1968 and more than eight times that in 1950.

Included in the regression equations, described subsequently, are the major factors that can be expected to affect the level of spending for hospital care. As noted, these factors may in turn be stimulated by exogenous phenomena such as income and insurance coverage, but in this model the focus has been only on the immediate causes of increased outlays.

Five factors have been included in both regression equations: The cost of labor, prices for goods and services, labor inputs, nonlabor inputs, and per capita utilization. All are entered in the form of first differences (or, in one case, annual percentage changes) to minimize the strong time effect generally present in a time series (whereby the magnitude of the observed value in one year is a strong predictor of that observed in the following year). The use of first differences has other advantages.[4] A time variable has been inserted in the second equation to capture any remaining unexplained variation attributable to the passage of time. For prediction purposes, the model is a reduced-form equation, combining the interactive effects of supply and demand.

There is no consensus among economists on the specific content of the underlying structural equations from which this reduced-form equation is in theory derived. It can be assumed that they are extremely complex, incorporating elements such as the production function, demand

[2] "Hospital Indicators," *Hospitals*, Journal of the American Hospital Association, midmonth issues.

[3] Within this technology, dramatic examples of lifesaving or life-improving developments such as renal dialysis have appeared, but the value of certain treatment procedures is disputed by some (see, for example, A. L Cochrane, *Effectiveness and Efficiency—Random Reflections on Health Services*, The Nuffield Provincial Hospital Trust, 1972). Analysis of the social or economic benefits derived from this technology is beyond the present scope, and no value judgments have been included or should be inferred

[4] Daniel B Suits, "Forecasting With an Econometric Model," *American Economic Review*, March 1962, page 112.

for and supply of factor inputs, and consumer demand for health care, with different competitive conditions among the markets. The resulting reduced-form coefficients are likely to be biased and inconsistent, but they represent an attempt to predict expenditure changes based on changes in a selected set of explanatory variables. As long as the basic structure underlying these variables does not change, the predictions will hold. It is hoped that any biases are small.

Definition of Regression Variables

Factor prices.—The prices paid by hospitals for labor, services, and supplies are mainly a function of the state of the economy, although the mix of items purchased and skills of personnel employed reflect specifically the hospital's function as a provider of medical care and have changed with the passage of time.

The price paid by hospitals for labor mainly reflects prevailing wage levels in the surrounding community, although it can also be affected by other factors such as unionization, minimum-wage legislation, and the relative scarcity of certain skills sought by the hospital. For this model, wage rates were measured by the annual absolute changes in payroll expenses per full-time-equivalent hospital employee.

A measure of average wages paid to hospital employees, such as the one used in this model, generally reflects the cost of labor to hospitals. It has, however, one significant drawback: It also tends to incorporate any changes taking place within hospitals in the skill mix of its personnel. Although not much data are available to document such changes, some evidence indicates that the trend in recent years has been toward an increasing proportion of lower-skilled employees.[5] If such is the case, the measure used here will tend to understate the impact of the rising cost of labor.

For nonlabor items such as food, fuel, equipment, and supplies, the price paid by hospitals is again mainly a function of the general economic environment. Inflation in the general economy will have a direct impact on the cost of hospital care. The rapid inflation experienced recently in the price of such essentials as food and fuel has already been felt in increased outlays for hospital care. The cost-reimbursement mechanism, through which the majority of hospital expenditures are financed, assures that the inflation in both labor and nonlabor prices will be directly reflected in the form of higher outlays for hospital care.

Nonlabor factor prices were measured in this model by percentage changes in the consumer price index (CPI) of the Bureau of Labor Statistics. Although the CPI is made up of a different marketbasket of goods and services than that purchased by hospitals, detailed investigation by Martin Feldstein[6] led to the conclusion that price trends in hospital purchases are more closely related to the CPI than to other price indicators such as the wholesale price index.

Real inputs.—In addition to keeping pace with inflation, hospitals are providing a different product today than they did in the past. In response to a variety of stimuli, hospitals have substantially increased both the labor and nonlabor inputs into a day of care. These increased inputs, which often reflect technological changes, have affected both the quality and quantity of care delivered.

Labor inputs in this model are measured by the absolute changes in the average number of personnel employed for every 100 hospital census. Since 1950, this rate has nearly doubled, rising from 178 in the earlier year to more than 300 in 1973. The types of personnel hired range from trained technicians needed for new types of therapy to professional or clerical workers on the hospital administrative staff. In some cases, they substitute for additional capital equipment; in other cases they accompany it.

Nonlabor inputs encompass a wide variety of services and supplies added to a day of hospital care. Since 1950, hospitals have increased the sheer numbers of facilities and services available as well as the relative sophistication of their mix. They have also tended to use new as well as existing services more intensively. One example

[5] Martin S. Feldstein, *The Rising Cost of Hospital Care*, Information Resources Press, 1971.

[6] Martin S. Feldstein, "The Quality of Hospital Services: An Analysis of Geographic Variation and Intertemporal Change," in M. Perlman, ed., *The Economics of Health and Medical Care*, John Wiley & Sons, 1974.

of the changing nature of hospital care is the development of intensive care units. In 1960, only 10 percent of community hospitals had intensive care units. Thirteen years later, more than 60 percent had them. Since the average charge per bed in an intensive care unit is more than twice that for routine care in a semiprivate room, such changes can have a substantial impact on hospital expenditures.

In the regression equations, real nonlabor inputs are measured by the yearly increase in nonpayroll expenses per patient day, deflated by the CPI. This figure reflects a broad range of developments, including additional facilities, service intensity, and substitutions of capital for labor—through conversion to the use of disposable products, for example.

Quantity of care.—Inflation and increases in real inputs have helped to increase the cost of a day of hospital care. In addition, however, Americans are receiving relatively more days of hospital care today than they did in the past. In 1950, for example, patient days in community hospitals (adjusted for the volume of outpatient visits) numbered 1 day per capita; in 1973, this rate was more than 1.3 days or one-third more. Although the introduction and widespread use of new drugs during this period reduced some of the need for hospitalization, the almost simultaneous development of new medical techniques that could only be applied in the hospital increased the demand for hospital care for a different set of diagnoses, many of them formerly untreatable. Some believe that inpatient hospital care is overutilized and that, for some patients, less expensive institutional or outpatient services could safely be substituted. Nevertheless, the fact that more care is being used must be taken into account in any analysis of expenditures for hospital care.

In this model, patient days per 1,000 population, adjusted to take into account the volume of outpatient visits, are the measure of utilization. This measure is really a confluence of supply and demand factors, since demand for hospital care is influenced by the existing bed supply. In the past 20 years, the supply of community hospital beds has grown faster than the population—from 3.3 per 1,000 population in 1950 to 4.2 in 1973. Milton Roemer and others have presented evidence that increases in hospital bed supply lead to greater utilization of hospital care.[7] Patient days, therefore, measure the yearly levels of hospital use, given an expanding bed supply. Any residual effects of time or of omitted variables correlated with time are captured by the time trend inserted in the second regression equation.

It was expected that each of the foregoing variables would help to account for year-to-year changes in expenditures for hospital care. The actual input data are presented in tables 1 and 2.

Impact of the Sources of Increase

All variables in the two equations were entered as first differences or percentage changes. The "ordinary least squares" method was used to estimate the coefficients. The equations were linear, with the model in the following form:

$$\Delta HE = a + b_1 \Delta FPL + b_2 \Delta FPNL + b_3 \Delta RIL + b_4 \Delta RINL + b_5 \Delta PD + e$$

where HE = Per capita hospital expenditures
FPL = Factor prices (labor)
$FPNL$ = Factor prices (nonlabor items)
RIL = Real labor inputs
$RINL$ = Real nonlabor inputs
PD = Patient days

(Equation 2 includes an additional term b_6 *TIME*, where *TIME* is a dummy variable representing a time trend)

Changes in per capita hospital expenditures were therefore postulated to be a function of changes in selected contributory factors.

As shown in table 3 and chart 1, the factors included in the equations explained nearly all of the yearly variation in per capita expenditures for hospital care ($\bar{R}^2 = .94$ without the time variable; $\bar{R}^2 = .96$ when the time variable is included). As expected, each variable has a significant, positive impact on annual expenditure changes. In the subsequent discussion of precise impacts, the results of equation 1 will be used.

An increase in factor prices—both labor and nonlabor—produces an increase in per capita

[7] These conclusions are summarized in Herbert E. Klarman, *The Economics of Health*, Columbia University Press, 1965, pages 140–1.

TABLE 1.—Basic data for hospital expenditure model: Factor prices, real inputs, and utilization for community hospitals, calendar years 1950–73

Calendar year	Expenditures in community hospitals		Payroll expense per full-time-equivalent employee	All items, CPI (1967=100)	Full-time-equivalent employees per 100 census	Nonpayroll expenses per patient day		Adjusted patient days [2]	
	Total (in millions)	Per capita				In current dollars	In constant 1967 dollars [1]	Total (in thousands)	Per 1,000 population
1950	$2,238	$14 84	$1,817	72 1	178	$6.76	$9.38	144,733	959.83
1951	2,514	16.58	2,054	77.8	171	7.12	9.15	147,350	971.97
1952	2,708	17 60	2,221	79.5	175	7.69	9.67	151,140	982.12
1953	3,060	19.54	2,370	80.1	183	8.09	10.10	154,316	985.45
1954	3,286	20.58	2,439	80.5	198	8.55	10.62	155,308	972.53
1955	3,622	22 23	2,563	80 2	203	8.86	11.05	161,954	993.78
1956	3,948	23 78	2,622	81.4	207	9 30	11.43	169,726	1,022.11
1957	4,419	26 13	2,717	84 3	211	10 28	12.19	174,782	1,033.54
1958	4,929	28 62	2,877	86.6	218	11 06	12.79	180,182	1,046.20
1959	5,348	30 51	3,068	87.3	223	11.43	13.09	184,692	1,053.71
1960	6,063	34 04	3,240	88.7	226	12 15	13.70	191,207	1,073.35
1961	6,609	36.48	3,349	89.6	235	13.44	15.00	195,638	1,080.02
1962	7,196	39.18	3,507	90 6	237	14.04	15.50	203,467	1,107.74
1963	8,046	43.14	3,639	91.7	241	14.90	16.25	214,985	1,152.78
1964	8,815	46.61	3,864	92 9	242	16.32	17.57	222,894	1,178.45
1965	9,628	50.25	4,072	94 5	246	17.04	18.03	226,300	1,181.08
1966	11,369	58.78	4,097	97.2	261	18 74	19 28	236,155	1,220.94
1967	13,518	69 23	4,476	100.0	265	21.64	21.64	244,915	1,254.28
1968	15,735	79.83	4,918	104 2	272	24.77	23.77	254,370	1,290.48
1969	18,212	91.45	5,380	109.8	280	28.67	26.11	259,150	1,301.31
1970	21,130	104 75	5,921	116 3	292	33.71	28.99	265,355	1,315.48
1971	23,509	115.10	6,530	121.3	301	38.51	31.75	268,640	1,315.25
1972	26,295	127.36	7,062	125 3	310	45.42	36.25	270,474	1,310.07
1973	29,253	140 58	7,383	133.1	315	50 83	38.19	280,320	1,347.13

[1] Deflated by the consumer price index

[2] Outpatient visits estimated for various years, 1950–64 For 1950–63, assumed 4 outpatient visits equivalent to 1 inpatient day.

Source Expenditures based on data in *Compendium of National Health Expenditures Data*, Office of Research and Statistics, Social Security Administration, 1975 edition (forthcoming) Hospital expenses, inputs, and utilization based on data in *Hospitals* (Guide Issues, annual editions) and *Hospital Statistics*, 1972–74 editions, American Hospital Association. Price data from *Consumer Price Index*, Bureau of Labor Statistics Population data for per capita amounts from the Bureau of the Census for the civilian resident population as of July 1 of each year.

expenditure for hospital care. An increase of $100 in annual wages produces, on average, an expenditure increase of $0.90 per capita for that year. In aggregate terms, wage increases granted hospital employees in 1973, which averaged $321 or 4.5 percent, resulted in an increase of $594 million in expenditures for hospital care during that year.

Similarly, the predictive equation implies that each 1-percent increase in the overall CPI will translate into an increase of 60 cents in per capita spending. In 1973, the annual inflation rate amounted to 6.2 percent. That increase meant that an additional $783 million was spent in 1973 just to keep pace with price inflation. By extrapolation to 1974, when the annual inflation rate reached 11.0 percent, the regression results imply that an additional $1.4 billion was spent to maintain the same level of nonlabor inputs supplied the previous year, with all other factors held constant.

Increased quantities of inputs will also raise expenditure levels. An average increase of 1 full-time-equivalent employee a year per 100 hospital census will produce a rise of 27 cents in per capita expenditures. Again, in terms of 1973 changes, the equation predicts that the addition of 5 employees per 100 hospital census resulted in an increment of $1.33 per capita or $276 million in aggregate spending. A real increase of $1.00 per patient day in nonlabor inputs translates into a per capita spending increase of $1.59. The 1973 real increase of $1.94 in this measure, which was in fact the lowest since Medicare was implemented, still resulted in an estimated aggregate increase of $640 million in that year.

Finally, increased utilization will also cause a rise in per capita expenditures. An addition of 10 adjusted patient days for every 1,000 persons (or 2.1 million days in total) will result in a rise of 95 cents in per capita expenditures. In 1973, an additional 37 adjusted patient days of care were supplied for every 1,000 persons; the predicted cost of this added care amounts to $733 million.

The relative importance of factor prices, real inputs, and utilization on per capita hospital expenditures can be summarized by comparison of the beta coefficients for each explanatory variable. Conversion of the estimated regression co-

TABLE 2.—Basic data for hospital expenditure model: Annual changes in factor prices, real inputs, and utilization for community hospitals, calendar years 1950–73

Interval	Per capita expenditures	Payroll expense per full-time-equivalent employee	CPI (percent)	Full-time-equivalent employees per 100 census	Non-payroll expenses per patient day (in constant 1967 dollars)	Adjusted patient days per 1,000 population
1950–51	$1.74	$237	7.91	−7	−$0.23	12.14
1951–52	1.02	167	2.19	4	.52	10.15
1952–53	1.94	149	.75	8	.43	3.33
1953–54	1.04	69	.50	15	.52	−12.92
1954–55	1.65	124	−.37	5	.43	21.25
1955–56	1.55	59	1.50	4	.38	28.33
1956–57	2.35	95	3.56	4	.76	11.43
1957–58	2.49	160	2.73	7	.60	12.66
1958–59	1.89	191	.81	5	.30	7.51
1959–60	3.53	172	1.60	3	.61	19.64
1960–61	2.44	109	1.01	9	1.30	6.67
1961–62	2.70	158	1.12	2	.50	27.72
1962–63	3.96	132	1.21	4	.75	45.04
1963–64	3.47	225	1.31	1	1.32	25.67
1964–65	3.64	208	1.72	4	.46	2.63
1965–66	8.53	25	2.86	15	1.25	39.86
1966–67	10.45	379	2.88	4	2.36	33.34
1967–68	10.60	442	4.20	7	2.13	36.20
1968–69	11.62	462	5.37	8	2.34	10.83
1969–70	13.30	541	5.92	12	2.88	14.17
1970–71	10.35	609	4.30	9	2.76	−.23
1971–72	12.26	532	3.30	9	4.50	−5.18
1972–73	13.22	321	6.23	5	1.94	37.06

Source See table 1.

efficients into standardized form eliminates the effect of the different units of measure and allows the coefficients to be compared directly. Beta coefficients measure the unit change in the dependent variable (per capita hospital expenditures) produced by a unit change in the independent or explanatory variable, with units measured in terms of standard deviations.

This method of analysis underlines the predominance of real nonlabor inputs in explaining the annual change in per capita expenditures for hospital care ($\beta = .396$). The standardized coefficients for the remaining variables are more closely grouped, with labor costs and utilization having slightly more impact than nonlabor prices and labor inputs.

The addition of the time trend in equation 2 increased slightly the proportion of total variation explained by the model. The coefficient of the time variable was positive and significant, although not at the expense of the other variables, which all remained significant. The coefficients of all but one of the explanatory variables were somewhat reduced when the time variable was entered into the equation, indicating that some time effect had been present. In contrast, the coefficient of nonlabor factor prices increased very slightly in equation 2.

In a regression model, the error terms are assumed to meet several requirements. One of the more critical of these requirements is that there be no autocorrelation (correlation of an error term with its own past values), a frequent failing in models based on economic time series. A common test of the hypothesis of "no first-order" linear autocorrelation among the error terms is the Durbin-Watson test for autocorrelation among the residuals (the difference between the observed value of the dependent variable and the value predicted by the model). The computed test statistic (presented in table 3) indicates that, for equation 1, the hypothesis of no autocorrelation can safely be accepted. For equation 2, the hypothesis can be neither accepted nor rejected, but the value of the test statistic lies very close to the acceptance range. It is therefore likely that the error terms in the model do not violate the least squares assumption of no autocorrelation.

PHYSICIANS' SERVICES

Physicians have traditionally been considered the central providers of medical care. They not only provide care directly to patients, but they also determine in large part other types of services and supplies utilized by patients throughout the course of treatment. Expenditures for hospital care and outpatient drugs, for example, are primarily the outcome of physician decisions.

Although many of the key technological developments in medical care have been associated with hospital care, many aspects of physicians' practice have also undergone significant change. Physicians have become increasingly specialized. In 1949, 54 percent of all physicians were in general practice. By 1973, this proportion had dropped to 15 percent, with the remaining 85 percent made up of medical, surgical, and other specialists and subspecialists.[8] Although much primary care formerly performed by general practitioners is now being performed by internists and pediatricians, there is little doubt that this

[8] G. A. Roback, *Distribution of Physicians in the U.S., 1973*, American Medical Association, Center for Health Services and Research and Development, 1974.

TABLE 3.—Regression estimates of effect of annual changes in factor prices, real inputs, and utilization on expenditures for hospital care, calendar years 1950–73

[Dependent variable=annual change in per capita expenditures]

Item	Explanatory variables							Selected statistics
	Factor prices		Real inputs		Utilization, adjusted patient days per 1,000 population	Time trend, dummy variable	Constant	
	Labor, measured in dollars per employee	Nonlabor, percentage change in index	Labor, measured in personnel per 100 census	Nonlabor, deflated dollars per patient day				
	Equation 1							
Estimated regression coefficient [1]	.009 (2 73)	604 (4.09)	.265 (3.95)	1.585 (3 30)	.095 (5 60)	----------	−3.494 (4.84)	$\bar{R}^2$=.94
Beta coefficient [2]	.335	.283	.275	.396	.322	----------	----------	$F(5,17)$=69 57
Mean value	242 00	2 72	5.96	1.25	16 84	----------	1 00	Durbin-Watson statistic=1.93
Standard deviation	166 09	2.07	4.57	1.10	14.94	----------	----------	*SE*=.952
	Equation 2							
Estimated regression coefficient [1]	.006 (2 25)	.608 (5.03)	.220 (3.89)	.983 (2.24)	.064 (3.74)	.194 (3.06)	−3 672 (6.19)	$\bar{R}^2$=.96
Beta coefficient [2]	.237	.285	.229	.246	.218	.292	----------	$F(6,16)$=88.07
Mean value	242 00	2 72	5.96	1.25	16 84	12.00	1.00	Durbin-Watson statistic=1.85
Standard deviation	166 09	2 07	4.57	1.10	14 94	6 63	----------	*SE*=.756

[1] Numbers in parentheses are t-statistics
[2] Computed using the following formula Beta=Estimated regression coefficient • Standard deviation of explanatory variable/standard deviation of dependent variable

increased specialization has had an impact on the quality of physicians' services as well as the amount spent for them.

Another major change has been the shift to corporate practice, particularly in recent years. In 1969, an estimated 5 percent of all private-practice physicians had incorporated; 5 years later, almost 40 percent had done so. Corporate physicians care for 20–40 percent more patients per week on the average than their self-employed counterparts.[9] Surveys also indicate that plans for economic growth of physician corporations should further widen this gap in the future.

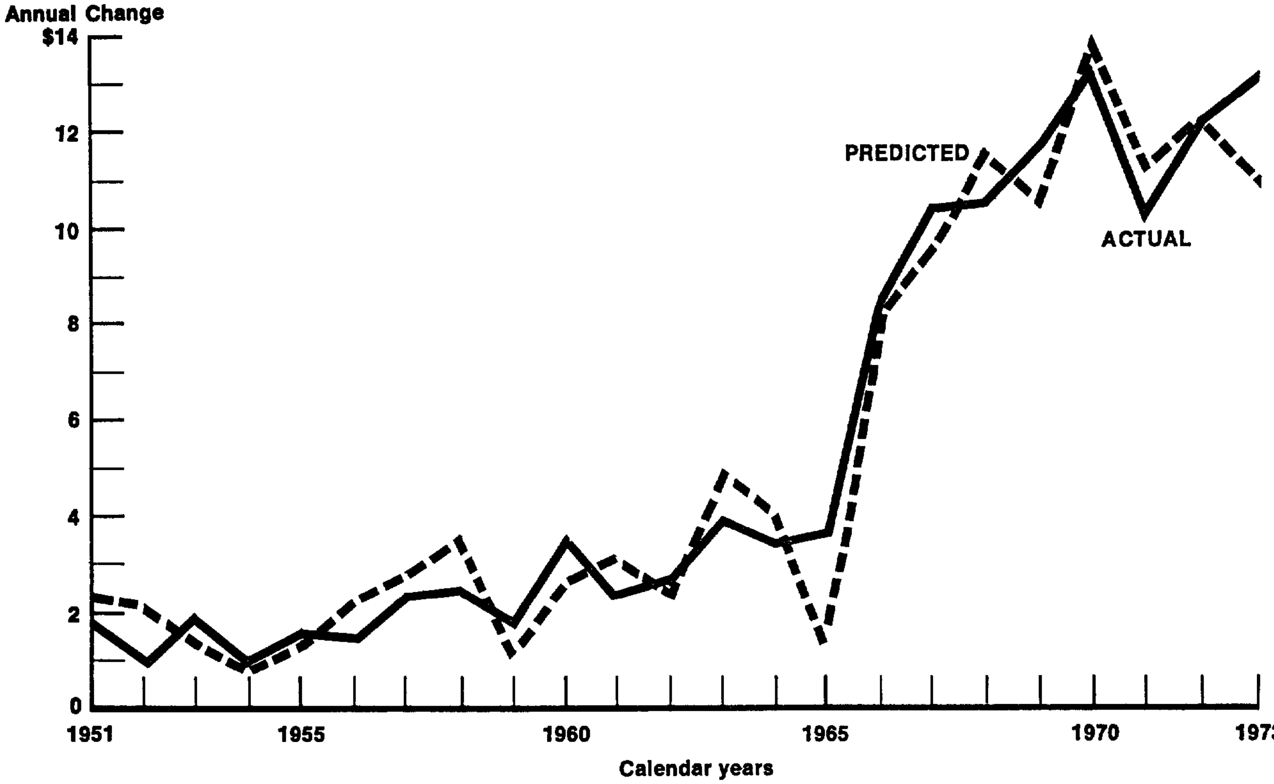
These and many other developments in physician practice have strongly influenced spending for physicians' services, spending that now averages $88 per capita. The per capita expenditure estimates used in this section include only those for the services of private physicians in office-based practice.

In general, far fewer studies have examined the sources of increasing outlays for physicians' services than have analyzed the hospital sector. The paucity of data as well as the inconsistency and unreliability of existing time series severely handicaps any would-be researcher in this important area. These limitations notwithstanding, the results of a study of year-to-year variations in per capita expenditures for physicians' services are presented here. Once again, multiple regression analysis was used to estimate the relative contributions of selected explanatory variables. Lack of data for earlier years, however, meant that the time period for this study—the 16-year period from 1957 to 1973—was somewhat shorter than that for hospital expenditures. In addition, the number and scope of the explanatory variables were much more limited.

In this model, the focus is on annual changes in per capita expenditures for physicians' services, as defined earlier. A linear model was employed, and first differences, or percentage changes, were again used to minimize the effect of time. The regression equation includes some of the major factors expected to influence the level of spending for physicians' services, although it is clear that other factors that may be relevant cannot be readily measured for the period in question. In addition, suspected errors in the data that were available may have influ-

[9] R Craigin Lewis, "What Future for Incorporated Physicians?" *Medical Economics*, November 26, 1973.

CHART 1.—Actual and predicted[1] annual changes in per capita expenditures for hospital care, 1951–73



[1] Values predicted by equation 1.

enced the results. The structure of the physician model roughly parallels that of the hospital model, but variables analogous to all those used in the hospital model frequently could not be derived for physicians. Once again, the model is a reduced-form equation containing supply and demand elements, and the discussion accompanying that aspect of the hospital expenditure model is also applicable here.

Three variables have been included in the regression equations that can be expected to directly affect expenditures for physicians' services. Roughly categorized, these variables are labor and nonlabor factor prices, real inputs, and utilization. A time variable has again been included in the second equation.

Definition of Regression Variables

Factor prices.—Like most entrepreneurs in the economy, physicians establish fees for their services that are based on a variety of considerations. Primary among these is the price of goods and services in the economy in general, which influences both the physician's practice expenses and the purchasing power of his net income. Factor prices, including labor and nonlabor components, were therefore expected to have an impact on per capita expenditures for physicians' services because of their influence on fees charged to patients.

In this model, factor prices are measured by a weighted average of labor and nonlabor prices. Surrogate measures were used since no indexes measuring the cost of precisely the types of personnel hired by physicians or the marketbasket of goods and services purchased by physicians were available. Labor costs were measured by the average hourly wages of workers in finance, insurance, and real estate; this group is the available occupational category most clearly resembling the clerical and nursing staff physicians employ. Nonlabor costs were once again measured by the CPI. Weights were based on the payroll and nonpayroll proportions of total business deductions reported by physicians to the Internal Revenue Service. Because it was felt that lags exist between factor-price inflation and the associated fee increases, a 2-year moving average of the percentage increases in the factor-price index was used.

Real inputs.—Measurement of real inputs provided the most difficult conceptual and practical problem in the model. Variables directly analogous to those used in the hospital model—including real labor and nonlabor components—were not available on an annual basis for physicians' practices. In addition, this analysis is further complicated by the fact that the physician's gross income, in large part, represents payment for his own labor. Changes in the training and experience of the physicians themselves (that is, increased levels of human capital per physician) therefore account for much of the real input.

After adjustment for inflation and utilization, year-to-year increases in expenditures for physicians' services can result from several factors. These changes can reflect the increased specialization of physicians, a shift that carries with it an increase in both labor and nonlabor costs per unit of service. The increased labor cost results from the higher rate of compensation to a higher quality (that is, better-educated) physician. Higher nonlabor costs result from the rise in the number of auxiliary services, such as laboratory tests and X-rays, which often accompany increasingly specialized care.

The expenditure changes can also reflect the higher average price received by physicians per patient visit. It is well known that physicians often make special allowances for patients according to their ability to pay and that, historically, their "customary" charge had generally been higher than the "average" charge received for most services. As private and public insurance coverage has continued to expand, however, physicians' average fees have moved closer to their customary fees. The additional revenue derived from third-party reimbursement, however, cannot appropriately be considered the results of real inputs.

The changes are also the outcome of real inputs similar to those added to a hospital patient day: more personnel, more equipment and supplies, and other technological changes. Although there is evidence that these inputs have increased somewhat within specialties, the most significant changes seem to have taken place as the specialty mix of physicians has shifted. The change in real inputs in the aggregate may therefore be more a function of changes in specialty mix than in the varying quantities of inputs within individual physician practices.

The variable employed in this model as a measure of real labor and nonlabor inputs is the annual change in gross income per physician visit, deflated by the factor-price index and by a specialist index.

Quantity of care.—Physician visits per capita —including hospital, home, and office visits— are used to measure utilization. Like patient days, per capita visits are the outcome of both supply and demand factors. The number of physicians in relation to population has continued to rise, although not all of this increasing number provide patient care.[10] The addition of practicing physicians will almost certainly increase the aggregate number of visits, and at least one study has pointed to the central importance of the physician supply in determining expenditures.[11]

Utilization will not necessarily increase in proportion to the changing physician supply, however. The volume of visits will be affected by such supply factors as specialty mix and geographic distribution of the physician population and such demand factors as morbidity rates and insurance coverage. Any residual effects of time are captured by the time variable inserted in the second regression equation. The input data are presented in tables 4 and 5.

Impact of Sources of Increase

All variables in the two equations were again entered as first differences or percentage changes. Ordinary least squares were again used to esti-

[10] U.S. Public Health Service, National Center for Health Statistics, *Health Resources Statistics*, 1974.

[11] Victor R. Fuchs and Marcia J. Kramer, *Determinants of Expenditures for Physicians' Services in the United States, 1948–68*, U.S. Public Health Service, National Center for Health Services Research and Development, December 1972.

TABLE 4.—Basic data used for physician expenditure model: Factor prices, real inputs, and utilization for physicians in private, office-based practice, calendar years 1956–73

Calendar year	Expenditures for physicians' services		Factor price index (1967=100)				Real inputs			Physician visits [3]	
	Total (in millions)	Per capita	Total (weighted)[1]	Hourly earnings in finance, insurance, and real estate	All items, CPI	Payroll expenses as a percent of total expenses [2,3]	Adjusted amount [4] (deflated)	Business receipts per physician visit	Specialist index (1967=100)[3,5]	Total number (in thousands)	Per capita
1956			78.0	69 0	81.4	27.3				904,317	
1957	$4,419	$26.13	80.7	71.3	84 3	27.6	$8.04	$4 62	71.2	874,410	5.35
1958	4,910	28.51	82.9	73.3	86.6	27.8	8.91	5 35	72.4	924,716	5 08
1959	5,481	31.27	84 0	75.6	87.3	28.2	8.97	5.51	73.1		5.28
1960	5,684	31.91	85 8	78 3	88.7	28.3	8.26	5.50	77.6	971,707	5 45
1961	5,895	32.54	87.2	81.0	89 6	28 3	7.72	5 55	82 4	995,356	5.49
1962	6,498	35.38	88.8	84 1	90.6	28 4	7.28	5 60	86 6	1,076,160	5.86
1963	6,891	36 95	90 4	87 2	91.7	28 8	6 79	5 66	92 2	1,135,830	6.09
1964	8,065	42.64	91.8	89.1	92.9	30 1	7.34	6 37	94.6	1,193,782	6.31
1965	8,745	45 64	93.9	92.6	94 5	31.1	6 70	6 06	96 3	1,310,049	6 84
1966	9,156	47.34	96 7	95.7	97.2	30 9	6.78	6 44	98.2	1,316,219	6 80
1967	10,287	52 68	100.0	100.0	100 0	31 2	7.45	7.45	100.0	1,266,635	6 49
1968	11,099	56.31	105.0	106 6	104 2	31.6	7.22	7.98	105.2	1,343,443	6 82
1969	12,629	63 42	111.0	113.6	109 8	30.8	7 55	9.02	107.6	1,361,050	6 83
1970	14,306	70 92	117.3	119.4	116.3	30.8	7.50	9.60	109 1	1,453,392	7 21
1971	15,835	77.53	123.1	127.1	121.3	30.8	7.73	10.56	111 0	1,462,976	7.16
1972	16,916	81 93	128 0	133 7	125 3	31.7	7.26	10 42	112.2	1,589,649	7.70
1973	18,200	87.46	135 3	139 9	133.1	31.7	6 78	10.45	113 9	1,675,566	8.05

[1] Weighted index=(Percent payroll expenses) (labor price index)+(100 –percent payroll expenses) (nonlabor price index).
[2] Represents percent of physicians' total business deductions attributable to "salaries and wages"
[3] Partly estimated
[4] Represents business receipts per physician visit, deflated by factor price index and specialist index
[5] Index based on proportion of non-Federal private-practice physicians classified as medical, surgical, or other specialists

Source Expenditures from *Compendium of National Health Expenditures Data*, Office of Research and Statistics, Social Security Administration, 1975 edition (forthcoming) Wage and price data from *Handbook of Labor Statistics*, Bureau of Labor Statistics, 1974. Payroll expenses and business receipts from *Statistics of Income—Business Income Tax Returns*, annual issues, Internal Revenue Service Specialist index based on data in *Distribution of Physicians in the United States*, annual issues, American Medical Association Physician visits from *National Disease and Therapeutics Index*, IMS Inc, Ambler, Pa Population data for per capita amounts from the Bureau of the Census for the civilian resident population as of July 1 of each year

mate the regression coefficients. The linear model took the following form:

$$\Delta PE = a + b_1 \Delta FP + b_2 \Delta RI + b_3 \Delta VIS + e$$

where PE = Per capita expenditures for physicians' services
FP = Factor prices
RI = Real inputs
VIS = Per capita physician visits

(Equation 2 includes the additional term b_4 *TIME*, where *TIME* is a dummy variable representing a time trend.)

Table 6 and chart 2 indicate that a substantial portion of the year-to-year variation in per capita expenditures for physicians' services was accounted for by the explanatory variables ($\bar{R}^2$ = .73 without the time variable, $\bar{R}^2$ = .78 with the time variable). The subsequent discussion centers on equation 1, which includes only three explanatory variables.

An increase in factor prices produces an increase in expenditures for physicians' services. An increase of 1 percent a year in the wage/price index for 2 successive years, for example, will increase per capita outlays for physicians' services by $0.97 in the second year. In aggregate terms, the average increase in the factor-price index amounted to 4.8 percent in 1972 and 1973. The regression results imply that the effect of this price increase was an additional $4.70 per capita,

TABLE 5.—Basic data used for physician expenditure model: Annual changes in factor prices, real inputs, and utilization for private-practice physicians, calendar years 1957–73

Interval	Per capita expenditures	Factor prices (percent)		Real inputs	Per capita visits
		First differences	2-year moving average		
1956–57		3.46			
1957–58	$2.38	2 98	3.22	$0.87	–.27
1958–59	2.76	1.33	2 16	.06	.20
1959–60	.64	2 14	1.74	–.71	.17
1960–61	.63	1.63	1.89	–.54	.04
1961–62	2 84	1.83	1.73	–.44	.37
1962–63	1.57	1.80	1.82	–.49	.23
1963–64	5.69	1.55	1.68	.55	.22
1964–65	3.00	2 29	1.92	–.64	.53
1965–66	1.70	2 98	2 64	.08	–.04
1966–67	5 34	3.41	3.20	.67	–.31
1967–68	3.63	5.00	4.21	–.23	.33
1968–69	7.11	5.11	5 06	.33	.01
1969–70	7.50	5.68	5.40	–.05	.38
1970–71	6 61	4.94	5 31	.23	–.05
1971–72	4.40	3 98	4.46	–.47	.54
1972–73	5.53	5.70	4 84	–.48	.35

Source See table 4.

TABLE 6.—Regression estimates of effect of annual changes in factor prices, real inputs, and utilization on expenditures for physicians' services, calendar years 1957–73

[Dependent variable=annual change in per capita expenditures]

Item	Explanatory variables: Factor prices, percentage change in index	Explanatory variables: Real inputs, deflated dollars per physician visit	Explanatory variables: Utilization, visits per capita	Explanatory variables: Time trend, dummy variable	Explanatory variables: Constant	Selected statistics
	Equation 1					
Estimated regression coefficient [1]	.970 (4 38)	3 031 (3 25)	4 673 (2 63)		174 (23)	$\bar{R}^2$= 73
Beta coefficient [2]	.623	671	529			$F(3,13)$=14 19
Mean value	3 21	− 08	.17		1 00	Durbin-Watson statistic=2 20
Standard deviation	1 40	48	25			SE=1 020
	Equation 2					
Estimated regression coefficient [1]	390 (1 08)	3 185 (3 77)	3 745 (2 24)	.215 (1 94)	378 (54)	$\bar{R}^2$= 78
Beta coefficient [2]	.250	.706	.424	.454		$F(4,12)$=14 04
Mean value	3 21	− 08	17	8 50	1 00	Durbin-Watson statistic=2.31
Standard deviation	1 40	.48	25	4 61		SE= 882

[1] Numbers in parentheses are t-statistics

[2] Computed using the following formula· Beta=Estimated regression coefficient • Standard deviation of explanatory variable/standard deviation of dependent variable.

or a total of $978 million in expenditures for physicians' services in 1973.

Changes in real inputs will also have an impact on per capita expenditures. Under the particular measure of real inputs used in this model, as described earlier, gross receipts per physician visit were deflated by price and specialist indexes. Since the variable has been adjusted for the effect of price and the proportion of specialists in the physician population, it can be considered a measure of real price per visit over time to a constant mix of physicians. In other words, it measures the changing inputs per unit of service within physician specialties and takes into account the changes in the quantity of labor expended by physicians themselves or by auxiliary personnel as well as differing quantities of technological inputs.

In general, this constructed variable has exhibited a downward trend, indicating that most of the real inputs that have been employed across all physician practices have been attributable to increasing specialization. With specialty mix held constant, two interpretations of this downward trend are possible.

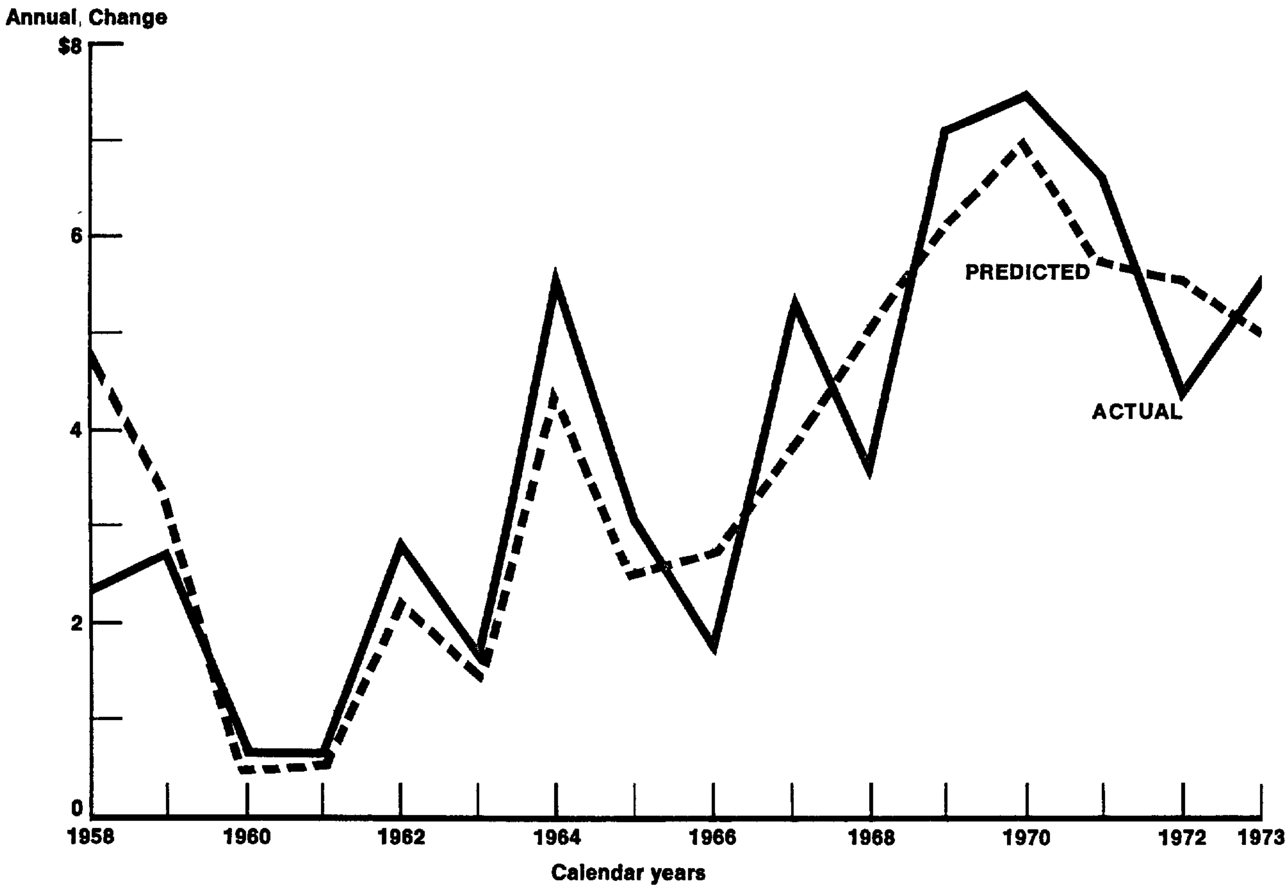
First, it is possible that, within the adjusted physician population, the overall quantity of real inputs per visit has been reduced, and patients are either receiving less care per visit, or, more plausibly, the case mix has changed to reflect increased referral of more complicated cases to specialists. Such a trend would be captured in the specialist index.

According to the second interpretation of the long-term trends, it is likely that physicians are substituting other inputs—such as paramedical personnel or equipment—for their own labor, so that they are spending relatively less of their own time per patient. As the price of their own labor is relatively more expensive, the real price per visit has declined.

Both interpretations are compatible with the observation that the correlation between year-to-year movement in real price per visit and the volume of patient visits is significantly negative (r = —.73).[12] This observation is intuitively

[12] Although here and in other instances independent variables are correlated, multicollinearity is evidently not a problem in either model, at least for equation 1. Ridge regression coefficients obtained from the same input data are fairly stable for the range of values of k, indicating that the magnitude and sign of the ordinary least squares coefficients remain virtually the same even when correlation among the predictor variables is taken into account. For a discussion of the ridge regression technique, see Arthur E. Hoerl and Robert W. Kennard, "Ridge Regression: Application of Nonorthogonal Problems," *Technometrics*, vol. 12, February 1970.

CHART 2.—Actual and predicted[1] annual changes in per capita expenditures by physicians' services, 1958–73



[1] Values predicted by equation 1.

reasonable, if it is assumed that individual physicians attempt to hold their working hours relatively constant.

The annual changes in the real input measure have had a significant impact on annual expenditure changes. A decline of 10 cents in this variable would produce a 30-cent reduction in per capita expenditures. The estimated impact of the changes in real inputs in 1973 was to hold spending for physicians' services to an amount $1.45 less per capita than would have been spent otherwise, with a total "saving" of more than $302 million.

Finally, as expected, an increase in per capita physician visits translates into an increase in per capita expenditures. An average increase of 0.2 visits per person per year—or 41.6 million total visits—would mean a rise of $4.55 in per capita expenditures. The 1973 increase of 0.4 visits per capita produced an estimated $340 million increment in total outlays.

Evaluation of the beta coefficients for the three explanatory variables leads to the conclusion that changes in real inputs have been most significant in explaining annual expenditure changes, as table 5 shows. Almost as significant, however, were factor prices. Per capita visits have had a slightly smaller impact.

When the time trend is inserted in equation 2, the proportion of total variation as explained by the model is slightly higher ($\bar{R}^2 = .78$), but only two of the four explanatory variables are significant. Collinearity between factor prices and the time variable ($r = .80$) apparently prevents the determination of the separate effects of each.

Since the original three variables are of more interest in explaining total variation, the first equation can be regarded as the most useful.

The results of the Durbin-Watson test for autocorrelation among the error terms indicates that the hypothesis of no autocorrelation can be accepted for equation 1. For equation 2, the hypothesis can be neither accepted nor rejected, but the value of the test statistic is again close to the acceptance range.

SUMMARY

The analyses for both types of expenditure emphasize the importance of real inputs in explaining year-to-year variation in per capita spending. For hospital care, the effect of real nonlabor inputs has been pervasive, with about 77 percent of the change in annual per capita expenditure correlated with the change in real nonlabor inputs. For physicians' services, real inputs are as important a contributor to changes in the annual per capita expenditures as are the changes in factor prices paid by physicians.

Labor and nonlabor factor prices are also important in explaining annual expenditure changes. Through either cost-reimbursement or fee-setting mechanisms, increases in wages and prices will be passed on—immediately or eventually—not only to the consumers of medical care but to the population as a whole in the form of higher taxes and insurance premiums.

Finally, utilization was a significant contributor to annual expenditure changes. Particularly for physicians' services, however, its impact was somewhat smaller than that of factor prices and real inputs.

If explanatory variables analogous to those used in the hospital and physician expenditure models were available, they might help to explain some of the year-to-year changes in other institutional and professional medical care services. The results given above, however, cannot reasonably be extrapolated to other expenditure categories not analyzed here. In addition, factors contributing to the increasing expenditures for medical supplies—drugs, eyeglasses, and appliances, for example—are likely to be very different from those affecting the service components. Although substantial sums are spent for all the major medical expenditure categories and more knowledge about each would be useful, hospital care and physicians' services have been and will continue to be the chief focus of health economists.

The various problems encountered in constructing these models have underlined once again the need for further research in both areas. The primary need, however, is for improved data collection. The lack of reliable data—particularly on an annual basis—has severely hindered research into the economic behavior of health institutions and professionals. Although the availability of data has markedly improved in more recent years, still-existing gaps will continue to inhibit future research efforts and to hinder adequate understanding of all aspects of our medical care delivery system.