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Hospital cost increases continue to attract the attention of policymakers. While the introduction of the Medicare prospective payment system (PPS) in 1983 provided a respite from double-digit hospital cost inflation, most of the savings were due to declines in admission volume. By the third year of PPS, the yearly increase in operating cost per case returned to about 9 percent, where it has remained. From 1985 through 1989, the per case operating cost increase averaged 8.9 percent annually, with an even higher increase in capital costs pushing the average total cost inflation above 9 percent per year.\(^1\)

The magnitude of hospital cost increases has been well documented; however, there have been only limited attempts to date to quantify the factors causing these increases. For several years, the Health Care Financing Administration’s (HCFA’s) actuarial staff has published data that account for the contribution of five factors—population growth, general inflation, medical inflation, utilization, and intensity—to growth in hospital and other provider expenditures.\(^2\) Three of these factors—general and medical inflation and intensity—determine hospital cost per case, which is the focus of this DataWatch, while the other two determine the total number of cases.

In his classic 1974 article, William Dowling proposed a complete although general model of eleven “cost-influencing variables” that determine expenditure levels in hospitals: number of cases treated, length-of-stay, complexity of case-mix, intensity of service, scope of services, amenity level, quality level, efficiency, input prices, investments in human and plant resources, and teaching programs.\(^3\) All changes in hospital costs over time are funneled through one or more of these variables, which vary in the degree to which hospitals exercise management control. HCFA’s model amalgamates the effect of eight of these variables—all but those addressing input price increases and utiliza-
tion into a single measurement. Consequently, the HCFA model is of limited use in analyzing the causes of hospitals’ cost increases per case or in evaluating potential ways to control these increases.

We have developed an expanded model of the factors contributing to increases in hospital operating costs per admission (adjusted for outpatient activity) and applied the model over the 1985–1989 period. We concentrated on the most recent years for which data were available, because this period best reflects the relative influence of the cost factors at play today—factors that will affect future progress in containing costs.

Because our model addresses costs per case, the effects of changes in admission and outpatient visit volume (caused in part by population growth) are not explicitly considered. However, the extent to which volume changes produce marginal cost impacts is captured by our productivity variable. In a manner similar to HCFA’s model, the effects of price inflation in the general economy and price increases unique to hospitals are measured separately. Our analysis breaks new ground by disaggregating the portion of hospital cost increases that HCFA attributes to “intensity” into five components: changes in employee skill-mix, productivity, patient complexity, intensity of services (where the effects of technology are measured), and nonlabor factors.

The additional disaggregation gained by this model will help in assessing how much of observed cost increases are within hospitals’ control. The specific factors considered in this model will be important to policymakers in developing annual payment updates under PPS and even more so under some health care reform proposals. For example, some observers have suggested that cost increases due to intensity of service enhancements should be paid only to the extent that they are needed to meet increased case complexity. Others have suggested that the incremental cost effects of new technology should be covered by productivity improvements and not paid for through payment increases. These data should also be useful to hospital managers as they assess potential avenues for reducing their annual cost increases to stay within budget-driven payment limits. And in the future, the model can be used to gauge the industry’s success in controlling costs through individual cost-influencing variables.

**Conceptual Model**

The genesis of our model, which breaks down the change in hospital operating costs per adjusted admission into seven components, was a formula that establishes total cost per admission as the product of four ratios: services per admission; full-time-equivalent (FTE) employees per
service; salary cost per FTE employee; and total cost relative to salary cost. The first ratio relates to intensity of services, or the service content of the average hospital admission. The second relates to productivity, the number of FTE employees required to produce each service from the preceding ratio. The third addresses salaries, or the salary cost required for each FTE employee from the preceding ratio. The fourth ratio adds an increment for nonlabor costs to the total salary expense. These ratios have been used by the American Hospital Association (AHA) to measure and compare hospital performance through its Monitrend system.4

Refining the model. Our goal was to quantify the four ratios—using a service output measure that considers both the number and complexity of patient care services—and to further refine them. This refinement expanded the four-ratio model implicit in the Monitrend system to seven factors.5 Because we were interested in analyzing increases in hospital costs rather than the absolute level of costs, the entire analysis was conducted in terms of annual percentage changes. Because the staffing for inpatient and outpatient services is usually intermixed, we used an admissions measure adjusted for outpatient activity.

The first refinement was to break down the labor productivity factor (represented as change in services per FTE employee) into two components: change in employee skill-mix and productivity change holding skill-mix constant.6 This approach recognizes, for example, that substituting registered nurses (RNs) for licensed practical nurses (LPNs) to treat the same patient load reduces overall productivity the same as using a greater number of FTE employees for the same output. Second, we divided the intensity-of-services factor (represented as change in services per adjusted admission) into the portion required by increases in the complexity of patients treated and the portion representing expanded service content for patients who are not more severely ill or do not have more complex conditions. We label the former “patient complexity” (or case-mix) change and the latter “intensity-of-service” change. The latter can result from either the use of cost-increasing technological advances or greater use of existing technologies.

The assumption is that, all else being equal, the quantity of staffing will change proportionately and skill-mix will be unaffected. For example, a 1 percent increase in case-mix is expected to produce a 1 percent increase in FTE employees. A change in FTE employees of any more or less would be accounted for in the productivity factor, and any marginal change in skill-mix that occurs when FTE employees increase by 1 percent would be captured in the skill-mix change factor.

The salary factor could be useful alone, but we wanted to expand it to include inflation in the prices of the supplies and services that hospitals
purchase. In the underlying model, nonlabor price increases are covered within the fourth ratio (total costs over salary costs), and so a shift to this variable was necessary. We then divided the resulting hospitalwide input price variable into the portion representing general inflation in the economy and the portion representing price increases for labor and nonlabor inputs unique to health care. These could include the salaries of nurses and other health professionals, the prices of intravenous fluids, or the premiums for malpractice insurance coverage.

Originally, the fourth ratio would capture the effects of all factors causing nonlabor costs to rise. But since price inflation in the services and supplies hospitals purchase was shifted to our input price variable, the nonlabor term was not measured directly. Rather, it is the residual between the total increase in operating cost per case and the increase attributable to all other variables. To the extent that the other variables are measured accurately, the residual will capture the effects of all factors increasing nonlabor costs, except inflation. This includes qualitative improvements in supply items, such as the introduction of hypoallergenic adhesive tape to prevent skin injury, as well as changes in the productivity of supply usage.

With these refinements, and the decision to focus on cost changes, the final model used in the study can be represented as the sum of changes in (1) general economy input prices; (2) hospital-specific input prices; (3) patient complexity; (4) intensity of services; (5) employee skill-mix; (6) nonlabor factors; and (7) service-level labor productivity. Together these factors yield the change in operating cost per admission.

**Data And Methods**

The key data required for the analysis—FTE employees, admissions (adjusted for outpatient activity), total charges, and total operating expenses—were obtained from the AHA annual hospital survey. The service-level productivity and intensity-of-services factors both rely on a measure of total hospital service output. The relative resource intensity of the various service units hospitals produce (including capital, labor, and supply resources) was measured by their posted charges, with an adjustment using the hospitals and related services component of the Consumer Price Index (CPI) to remove the effects of year-to-year price changes. The hospital CPI is a reasonably accurate tool for separating real output growth from hospital price increases because it is also based on hospitals’ posted prices. This concept for measuring output has been used frequently by economists to analyze productivity but has only recently been applied in health policy research. If hospital charges are
used as a proxy for the resources required to produce each service unit—essentially, a relative value scale—an increase will be registered when hospitals provide a greater number of services or when they substitute more complex tests and procedures.\(^7\)

Skill level is represented by the average salary of hospital employees in each of twenty-eight hospital labor categories. For twenty-five of these, the average salary weights were obtained from 1985 and 1989 Bureau of Labor Statistics surveys. Salary levels for the other categories were estimated using a regression model.\(^8\) Labor productivity change was measured with and without adjusting the number of FTE employees for skill-mix, with the difference between the two representing the productivity effect of skill-mix change.

Patient complexity change was estimated using a Prospective Payment Assessment Commission (ProPAC) methodology that estimates the portion of case-mix index change that is “real” (as opposed to resulting from “upcoding”) and adds an increment for change within diagnosis-related groups (DRGs) due to increased severity of illness and other factors. During 1985-1989, upcoding, or “DRG creep,” is estimated to have accounted for over a third of nominal case-mix growth.

The service-level productivity and skill-mix measurements apply only to labor costs. Specifically, the annual changes in these factors are weighted by the national average ratio of labor costs to total operating costs. Measurements of intensity of services and patient complexity change, on the other hand, apply to all operating costs.

The measure of inflation in the general economy is based on the CPI for urban consumers, published by the U.S. Department of Labor, while the measure of hospital-specific inflation uses a modified version of HCFA’s PPS market basket. The modified market basket uses only hospital wages instead of a combination of hospital and economywide wages, and it includes an adjustment to remove the effects of skill-mix change. Both the general and hospital-specific price variables cover October through September fiscal years, to match the AHA annual survey data as closely as possible.

Limitations. There are several limitations on the accuracy of our measurements. It is impossible to account fully for the effect of quality enhancements on the measures of productivity and intensity of services. These measures also rely on hospital charges to represent the relative costliness of various services, even though hospitals consider numerous factors other than cost in setting prices. The adjustment for outpatient activity in the admissions variable, which is based on a comparison of the average charge for admissions and visits, may be similarly biased.

The FTE data have two weaknesses that most likely produce at least a
modest understatement of FTE increases and a corresponding overstatement of productivity performance. The data do not capture the use of contract labor, which has probably increased in recent years, and they do not account for the removal of certain hospital-based physicians from the hospital cost base during the analysis period because they are no longer salaried. In addition, only the number of FTE workers employed on the last day of the year is reported, which does not necessarily represent the labor hours used throughout the year.

The estimates of case complexity change also have two problems. First, the comprehensiveness of medical records documentation, which is used to isolate real change from the effects of upcoding, has undoubtedly improved over time. Our estimates rely on ProPAC’s judgment about the degree to which this factor has affected the empirical evidence of complexity change. Second, the analysis extrapolates Medicare’s estimates of patient complexity change to the general population and applies an inpatient complexity measure to outpatient services (which represent about one-fifth of total hospital volume). In the context of this study, which involves aggregate year-to-year changes, this approach probably is reasonably accurate. Aging may have raised the average complexity of Medicare patients relative to patients under age sixty-five, but the younger population has experienced greater increases in expensive conditions such as acquired immunodeficiency syndrome (AIDS) and trauma. The primary factor responsible for patient complexity increases during the analysis period—the shift of surgical cases from inpatient to outpatient settings—generally results in an increase in the average complexity of both the inpatient and outpatient loads.

The intensity-of-services measure may be biased slightly by hospitals’ shifting diagnostic tests to a point in time sufficiently before admission to avoid being included in the inpatient payment. However, this shift is believed to have occurred primarily in the first two years after PPS began, which precedes our analysis period.

As a result of these limitations, we must assume a margin of error around all of the factors that involve original measurement. However, we believe that the data and analytical techniques are accurate enough to provide an overall picture of the nationwide pattern of hospital operating cost increases. One factor that tends to confirm the accuracy of our measurements is that the changes in the price inflation and productivity-related variables, which are independently measured, added very closely (a residual of 0.7 percentage points per year) to the change in cost per adjusted admission. This is exactly what the underlying formula would be expected to produce.
Changes In Hospital Operating Costs, 1985–1989

The data presented here are the average of four annual percentage changes, covering the 1985-1989 period. Our seven factors have been grouped under three more general headings: inflation (general and hospital-specific), patient care, and hospital inputs.

**Inflation.** The largest single contribution to the increase in hospital operating costs was inflation in the general economy (Exhibit 1). General price inflation accounted for about 40 percent of the average total cost increase. Because hospitals compete with other purchasers for labor and other goods and services, they have little, if any, control over economywide inflation.

Price inflation specific to the hospital industry accounted for about 17 percent of the annual increase in hospital expenses. Inflation is higher for the overall mix of inputs the hospital industry uses, in comparison to most other industries and to the average consumer, because hospitals use proportionately more of inputs with above-average price increases. Two-thirds of hospital-specific inflation arises from rapidly rising wages in labor categories prevalent in hospitals. Most of these increases can be linked to the well-chronicled shortage of RNs and other professional personnel. However, wage rates also grew substantially for some nonpatient-care staff. The AHA’s Monitrend data show that between

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### Exhibit 1
Seven Factors Contributing To Hospital Cost Inflation, 1985-1989

<table>
<thead>
<tr>
<th>Percentage points (average per year)</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input prices, general economy</td>
<td>3.5</td>
<td>1.5</td>
<td>1.9</td>
<td>1.8</td>
<td>0.1</td>
<td>-0.6</td>
</tr>
<tr>
<td>Input prices specific to hospitals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Patient complexity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intensity of services furnished</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Employee skill-mix</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonlabor inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service-level labor productivity</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Source: ProPAC analysis based on data from the American Hospital Association; Data Resources, Inc.; and the U.S. Department of Labor.

Note: The average annual total increase in hospital operating costs was 8.9 percent.
1984 and 1988, the average salary level of personnel in administration, data processing, and medical care evaluation grew as much as the salaries of most patient care departments and rose 30 to 45 percent faster than wages and salaries for all workers nationally.\textsuperscript{11}

The prices of hospital nonlabor inputs also rose faster than prices in the general economy. However, virtually all of the difference occurred in just two categories: pharmaceuticals and malpractice insurance premiums. The price increases of the other categories of goods and services collectively were marginally less than the inflation rate in the general economy. Hospitals have some degree of control over these price increases through their joint purchasing activities. The ability of manufacturers and suppliers of medical services, products, and drugs to pass higher prices on to the hospital sector is in part related to hospitals’ ability to absorb these increases by passing them on to payers.

**Patient care.** Inpatient case-mix rose significantly after PPS was introduced, as the transfer of low-complexity cases to outpatient settings increased the average complexity of the remaining patients. But patient complexity changes have continued to be quite large, averaging about 21 percent of the annual increase in costs per adjusted admission, during the analysis period. These increases reflect aging of the population, medical advances such as transplantation and cancer therapy that create new and complex types of cases, and higher incidence of specific diseases such as AIDS. For the industry as a whole, patient complexity is generally beyond hospitals’ control.

Holding case complexity constant, the intensity of patient care services furnished accounted for 20 percent of the total annual cost increase. ProPAC has sponsored independent research to measure the cost impact of major technological advances, and new technology was found to account for about one-third of the total intensity increase.\textsuperscript{12} The other two-thirds is due to small technological improvements and to changes in practice patterns—a greater number or complexity of services provided for given medical conditions. This cost-increasing effect can still be attributed to technology, but it does not necessarily result from recently implemented technological advancements. No one really knows to what extent greater service intensity has added to the quality of patient care and improved medical outcomes. But there is a growing body of evidence indicating that many tests and procedures are not necessary or at most are of very limited value.\textsuperscript{13}

**Hospital inputs.** Hospitals have a great deal of flexibility in determining the mix of labor, supplies, and services used in furnishing care, and their decisions in this area can significantly influence cost growth. In the early and mid-1980s, hospitals upgraded the skill-mix of their employ-
ees. In particular, RNs were substituted for LPNs and nurse aides, but there also was an increase in the proportion of medical technologists, radiological/nuclear medicine technologists, occupational therapists, physical therapists, respiratory therapists, and dietitians within their respective departments. The only professional categories that did not increase in proportion were licensed pharmacists and medical record administrators. Employing more professionals appeared to have a quality advantage and to have been economically sound, given the relatively low wages these categories of personnel commanded at the time. The longer-term effect, however, was a tighter labor market for such employees and the escalation in the price of hospital labor relative to salaries in the general economy, which was documented earlier.

This trend toward employing a higher proportion of professional personnel stopped in 1986, apparently in response to the developing shortages and rising salary rates. Thus, over our 1985-1989 analysis period, rising skill-mix was not a significant cost-increasing factor (Exhibit 1). Eight percent of the increase in costs per adjusted admission was attributable to nonlabor inputs. As mentioned earlier, we are not able to differentiate between qualitative improvements and changes in the efficiency of supply usage in this factor. These cost-increasing influences were partially offset by hospitals’ ability to produce individual services more efficiently. Service-level labor productivity growth reduced per case costs an average of 0.6 percent per year, but the upgrading of employee skill-mix and nonlabor inputs may have contributed to this efficiency improvement. The net effect of the changes in quantity and quality of labor and nonlabor inputs was an increase in costs of 0.2 percentage points per year, accounting for about 2 percent of the total annual cost increase.

### Trends In Operating Cost Increases

Exhibit 2 compares the first two annual changes (1985–1987) with the last two (1987-1989); the relative importance of certain cost-influencing factors changed between these periods. The average total increase in operating costs per adjusted admission was 8.7 percent per year from 1985 to 1987 and 9.1 percent from 1987 to 1989. Although the total cost increase was rising, the portion of the increase that is at least partially subject to hospital control was actually reduced. The cost increase beyond the level of general inflation in the economy declined from 6.0 percentage points per year to 4.7 percentage points annually (Exhibit 3).

On the surface, it might appear that this improvement was aided
Exhibit 2
Seven Factors Contributing To Hospital Cost Inflation, 1985-1987 And 1987-1989

<table>
<thead>
<tr>
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<tr>
<td>5</td>
<td>4.4</td>
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</tr>
<tr>
<td>4</td>
<td>2.7</td>
<td>1.2</td>
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<tr>
<td>3</td>
<td></td>
<td>1.8</td>
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<tr>
<td>2</td>
<td>1.9–1.8</td>
<td>1.2</td>
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<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0.3</td>
<td>0.0</td>
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<tr>
<td>–1</td>
<td></td>
<td>0.8</td>
</tr>
<tr>
<td>–2</td>
<td></td>
<td>0.4</td>
</tr>
<tr>
<td>–3</td>
<td></td>
<td>–0.6–0.5</td>
</tr>
</tbody>
</table>

Source: ProPAC analysis based on data from the American Hospital Association; Data Resources, Inc; and the U.S. Department of Labor.

Note: The average annual total increase for 1985-1987 was 8.7 percent; for 1987-1989, 9.1 percent.

significantly by increasing patient volume, since adjusted admissions declined almost 2 percent in the first two years and increased about 3 percent in the last two. But the effect of spreading fixed costs such as management salaries over more units of service would likely show up as higher productivity growth during the period of volume increase. In fact, productivity improvement was fairly constant and actually declined slightly, from 0.6 to 0.5 percent annually, in the last two years. The improved industry performance appears to be due instead to progress in controlling increases in intensity of services. These increases were cut in half between the two periods shown in Exhibit 2, declining from 2.5 percentage points in 1986 to 1.8 in 1987 to 0.8 in 1989. ProPAC’s estimates of the cost of implementing major new technologies do not show a corresponding decline over this period, nor do AHA data show that overall length-of-stay declined. Thus we infer that hospitals (and the managed care organizations that contract with them) have had some success in encouraging physicians to make more efficient use of ancillary services through utilization review activities, payment incentives, and credentialing. Hospitals also appear to have cut back on their expenditures for supply upgrades, with this factor dropping from 0.8 to 0.4 percentage points annually. Unfortunately, these savings were partially
offset by higher hospital-specific price inflation (Exhibit 2). Most of this difference resulted from rising salary levels. The use of more professional personnel, particularly RNs, appears to have been a major force in driving up wages and salaries.

Implications For Policy

Because the level of inflation in the general economy has been rising, the results of this analysis imply that hospital cost performance improved in the two final years of the 1980s, even as the increase in cost per case rose slightly. Further, 1990 cost data suggest that at least modest further progress has been made. The cost increase above general inflation was reduced from six percentage points in both 1986 and 1987 to about three percentage points in 1990. This is certainly encouraging, and yet most observers would agree that these increases are still too high to be sustained in the long run. Moreover, hospital cost growth must be considered in a broader context. If it were possible to account for all costs associated with the diversification activities of the 1980s relating to core hospital functions, we would probably find comprehensively measured per case costs rising faster during the analysis period than is implied by data that are confined solely to the hospital corporate entity. In addition, hospital cost increases were undoubtedly constrained after
PPS was introduced, through quicker discharges coupled with postacute care at skilled nursing facilities, home health agencies, and rehabilitation facilities outside of the hospital’s own organizational structure.

The results are useful in assessing general strategies for further containment of operating costs through management and health policy channels. Interestingly, technical productivity improvement does not appear particularly promising for further savings, at least not without major changes in the structure and financing of our health care system. Since the hospital industry has steadily been shaving half a percentage point or more from its cost inflation through labor productivity gains, it may not be realistic to expect much more to be achieved through techniques such as the closing of vacant patient units, service specialization, staffing analyses, and advanced scheduling systems.

Our findings suggest that cost containment efforts should be concentrated on controlling increases in intensity of services. Over the past five years, the productivity gains achieved by the industry have been completely overwhelmed by hospitals’ providing more services per patient, beyond what would be expected to treat a sicker and more complex mix of patients. These additional services have been provided using both new and existing technologies. The industry appears to have made significant progress in constraining intensity growth in recent years, but this progress must be maintained and extended. This effort should be complemented by at least slightly reduced growth in patient complexity in the coming years, since the transition of surgical cases from inpatient to outpatient settings—one of the key causes of complexity increases during the 1980s—has largely been completed.

Gaining further ground in controlling service intensity will require extensive involvement by hospitals and payers in monitoring and influencing physicians’ practice patterns. Toward this end, public policy initiatives may be necessary in at least three areas. The first is continued funding for clinical effectiveness research, through which useful standards for judging length-of-stay and use of ancillary services should evolve. The second is tort reform and other measures designed to limit malpractice liability risk. These policy changes may produce savings directly through reduced malpractice insurance premiums but also are important in minimizing marginal tests and procedures ordered primarily for liability defense purposes. Finally, perhaps the most important and difficult task is to design payment mechanisms that create an incentive for physicians to use hospital resources efficiently, since virtually all patient care services furnished by hospitals are provided at a physician’s direction.

The study results also suggest that lower wage and salary increases may
be an important avenue for future cost containment. For some categories of personnel, such as managers and information specialists, there is some question as to whether the continued increase of compensation rates at a significantly faster pace than in other industries is justified. For health care professionals such as RNs, medical technologists, and physical therapists, the ability to hold down salary increases is tied in part to limiting overall employment demand. Hospitals’ decisions to increase the proportion of professional staff in patient care departments appear to have been a major factor driving up compensation rates. Avoiding any further enrichment of personnel mix, if not scaling back on the use of high-level professional personnel, will be key to avoiding further salary escalation in the future.

Finally, the study suggests pharmaceutical costs as an area for priority attention. While impressive advances in quality of care have been made possible through the availability of new drugs, pharmaceuticals contribute more to hospital-specific price inflation than all other goods and services hospitals purchase combined. At the hospital level, some progress may be possible through expanded shared purchasing programs and use of generic or clinically equivalent substitutes. But the problem clearly extends beyond hospitals and other health care providers. It may ultimately be necessary to place restrictions on pharmaceutical pricing, as several bills introduced in Congress have proposed and as has already been done to some extent for Medicaid, as well as to regulate drug research and development.

The authors thank Jerry Cromwell, Charles Fisher, Greg Pope, and Dena Puskin for contributing to the methodology used through their previous analytical work, and Don Young and Stuart Guterman for helpful ideas and comments on earlier drafts. This paper was presented at a seminar sponsored by the Forum for Health Care Planning, Anaheim, California, 26 July 1991. The conclusions and opinions presented here are not necessarily those of ProPAC.

NOTES

1. Calculated from the American Hospital Association Annual Survey File, licensed to ProPAC. Data cover all community hospitals.
4. Monitrend data are published by the AHA in semiannual reports entitled HAS/Monitrend Data Book. An example of an analysis of intensity using Monitrend data is J. Cromwell and D. Puskin, “Hospital Productivity and Intensity Trends: 1980–87,” Inquiry (Fall 1989): 366–380. The measurement of intensity in Monitrend, however, is biased by the use of physical output counts lacking relative value scaling.
5. The factors explaining changes in hospital capital costs cannot be assumed to mirror
those for operating costs. A similar cost inflation model for capital would be useful, but
developing such a model was outside the scope of this study.
6. The underlying formula measured the inverse of productivity, FTE employees per
admission. This ratio was inverted for ease of interpretation, such that productivity
improvements would be expressed as positive numbers.
7. This basic approach, frequently termed the “deflated revenue method” of estimating
output, has been used in three recent analyses: J. Cromwell and G. Pope, “Trends in
Hospital Labor and Total Factor Productivity, 1981-86,” Health Care Financing Review
(Summer 1989): 39–50; V. Fuchs, “The Health Sector’s Share of the Gross National
8. This regression model was similar to a model developed by J. Cromwell and B. Butrica
under contract to ProPAC (Contract no. T-31415512, Delivery Order no. 11A).
9. Fortunately, most hospital-based physicians who left hospital employment but contin-
ued to provide patient care services did so before the beginning of our analysis period,
the 1985–1986 change. This shift largely resulted from the incentives of PPS.
10. More detailed information on the data, methodology, and limitations of the interme-
diate productivity, skill-mix, intensity of services, and real case-mix change measures
is provided in Ashby and Altman, “The Trend in Hospital Output and Labor Product-
ivity.”
11. The AHA’s Monitrend data were aggregated to the national level by J. Cromwell and
B. Butrica, under contract to ProPAC (Contract no. T-31415512, Delivery Order no.
11C). The average increase in wages and salaries for all workers in the economy is
estimated using the Employment Cost Index Wage and Salary Series-Civilian Work-
12. Annual new technology impact studies were conducted by Project HOPE, Center for
13. M. Chassin et al., “Does Inappropriate Use Explain Geographic Variations in the Use
of Health Care Services?” Journal of the American Medical Association (13 November
Proposal for Action,” Health Affairs (Summer 1984): 6–32; and P. Griner and R. Glaser,
“Misuse of Laboratory Tests and Diagnostic Procedures,” The New England Journal of
14. The trend of rising hospital skill-mix, concentrated in the period 1982-1986, is
documented in Medicare and the American Health Care System: Report to the Congress
15. This finding is documented for registered nurses in G. Pope and T. Menke, “Hospital
Demand for Nurses” (Unpublished paper based on research sponsored by the Health
Care Financing Administration, Contract no. HCFA-500-88-0035, December 1989),
16–18.
16. As discussed in the methodology section, our inability to capture the effects of
hospital-based physicians leaving the hospital employment base and hospitals increas-
ing their use of contract labor probably means that the observed productivity improve-
ment is at least slightly overstated.