APPENDIX

D

Analysis of Hospital Productivity and Product Change

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This appendix analyzes hospitals' productivity in delivering inpatient care and how the content of inpatient stays has changed over the past 10 years. Generally the output, or product, of inpatient care is thought of as completed stays, best measured as the number of case-mix adjusted discharges. In recent years, however, the service content of the average hospital discharge has changed markedly as lengths of stay dropped sharply, especially for diagnoses associated with extensive use of post-acute care.

As discussed in Chapter 3, the Medicare Payment Advisory Commission's (MedPAC) framework for updating payments under Medicare's prospective payment system (PPS) includes adjustments for productivity improvement and site-of-care substitution. We developed this analysis to help inform our decisions on an appropriate level or range for each of these factors.

The model includes a direct measure of productivity. However, the results of applying that measure to hospitals covered by PPS over time have to be interpreted cautiously because the concept of productivity requires measuring the inputs used to produce a constant product. In practice, holding quality or other aspects of the hospital product constant while measuring changes in input use is not possible. We do consider the potential effect on quality of care, however, in quantifying the

productivity adjustment and formulating an overall update recommendation.

We are not able to measure site-of-care substitution directly; rather, our analysis quantifies the broader concept of hospital product change. All declines in length of stay are measured as product change—whether resulting from acute-care costs being shifted to other providers or from technological innovations that simply shorten the time requirements of inpatient care. This requires us to make a judgment on what proportion of the measured product change represents site-of-care substitution.

The analysis has three components. The first tracks the change in inpatient costs per discharge and average length of stay for both Medicare and all patients. These data exhibit the important role that length of stay declines have played in bringing about the unusually low cost growth of the 1992–1996 period. The next section describes our broader model of the factors contributing to changes in hospital input use. For 1992 to 1996, this model provides two important estimates:

- the net impact of the large drop in length of stay from 1992 to 1996— cut inflation-adjusted costs by 2.4 percent per year, and

- the combined impact of the drop in length of stay and gains in productivity—reduced real costs by 2.7 percent a year.

Medicare data are available only through 1996, but the final analysis presents "leading indicators" that suggest a somewhat different pattern for Medicare costs and length of stay in 1997 and 1998. It appears that the annual changes in Medicare costs per discharge will continue to be negative, and that factors other than declining lengths of stay are beginning to play a more critical role. The last section of the appendix provides information on the data sources and methods for our analysis.

Trends in inpatient costs per discharge and average length of stay

The annual increase in inpatient costs per discharge for all patients has fallen dramatically over the decade ending in 1996, and the trend in length of stay has followed a remarkably similar downward trajectory (see Figure D-1). The average length of stay held roughly constant during the late 1980s, when cost growth hovered around 9 percent. Length of stay began to fall in the early 1990s, and the annual decline reached 4 percent in both 1994 and 1995. Consistently, the rate of growth in per case costs began dropping in 1990 and reached an all-time low of only 0.4 percent in both 1994 and 1995. The trend turned around slightly in 1996—the decline in length of stay was somewhat smaller at 1.8 percent. Again

Annual change in inpatient costs per discharge and average length of stay, Medicare and total, 1986–1996

Percent change
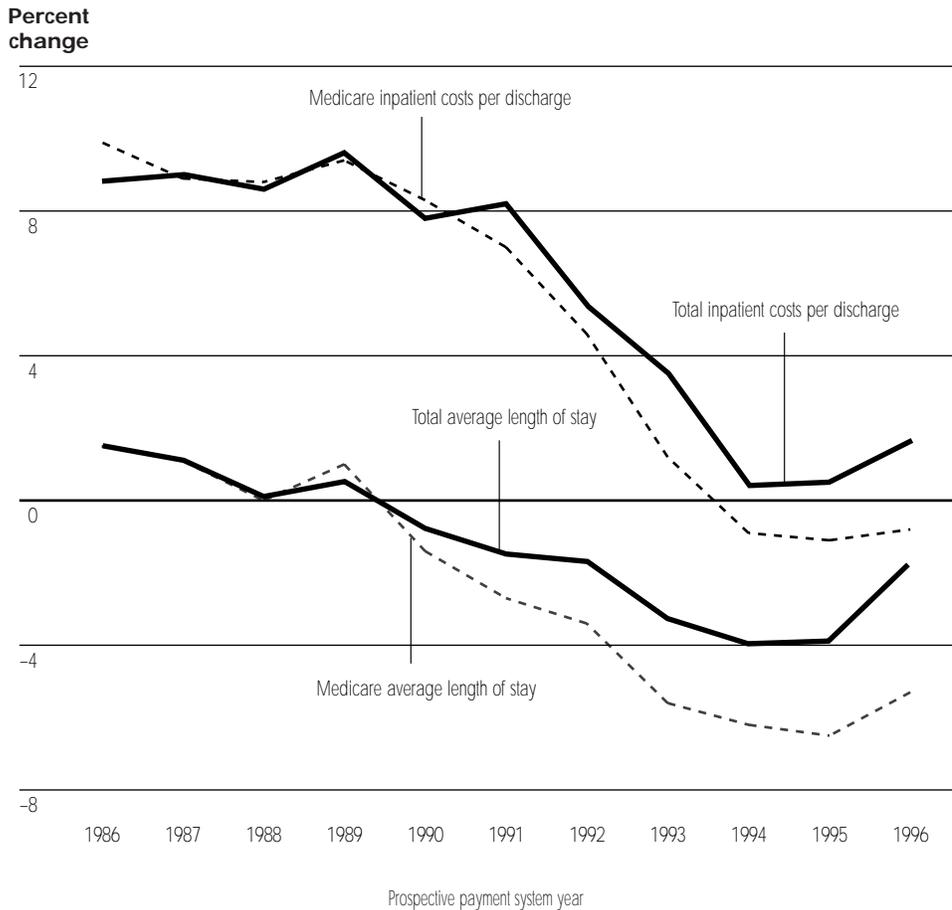
Note: The total inpatient costs per discharge and average length of stay data cover all inpatient services. This includes services delivered in both acute and other inpatient units (for example, hospital-based skilled nursing, transitional care), and care provided to patients covered by all payers as well as to uninsured patients. Both total and Medicare costs exclude graduate medical expenses. Prospective payment system years correspond roughly to federal fiscal years.

Source: MedPAC analysis of Medicare Cost Report data from HCFA.

while length of stay declined by 3.9 percent—a gap of only about 4 percentage points. This trend suggests that cost-reducing factors other than length of stay have come into play. One of these is lower inflation in the general economy, and another is dramatically lower growth in hospital wage levels relative to other industries (Bureau of Labor Statistics 1998). A key question, addressed below, is the extent to which productivity improvement has also played a role.

Expanded model of hospital input use

We have developed a model that sheds light on the influence of hospital product change and the inputs, or resources, required to produce a given product. In the following sections, we briefly describe the model and its relationship to our framework for PPS payment updates and then present the results of the model applied to the period of 1986 to 1996.

Overview of the model

This analysis is based on the equation shown in Table D-1. Hospitals' overall performance is measured as the inputs required to produce each unit of hospital output, or completed stay. Inputs (such as staff hours, food, and medical supplies) are measured as real costs (adjusted for inflation in the prices of hospital inputs). Completed stays are measured as discharges adjusted for real changes in case mix (that is, changes reflecting patient resource needs rather than coding improvements).

The discharge is the ultimate measure of hospital output in the context of PPS, as reflected in the decision to use it as the unit of payment. As discussed above, however, length of stay has been a major factor in the recent slowdown in costs per discharge. To focus on this important factor, we included length of stay as a separate component in the model.

Each hospital stay comprises a set of

following suit, cost inflation rose slightly to 1.5 percent.[1] The strong association between these rates of change provides compelling evidence that falling lengths of stay have been instrumental in bringing about the slower cost growth.

The growth in PPS costs per discharge mirrored that of all-payer costs through 1990 but has been lower in every year since. Beginning in 1994, PPS per case costs actually decreased for three straight years. Once again, average length of stay appears to be the dominant factor in this pattern. In each year from 1990

forward, the drop in PPS length of stay has been greater than that for all payers. At the low point in the cost trend—1994 and 1995—PPS length of stay was falling at a rate of more than 6 percent a year, compared to 4 percent overall.

The difference between the annual changes in per case costs and average length of stay has narrowed over time, however. In 1991, for example, all-payer costs increased by 8.2 percent while length of stay declined 1.5 percent—a difference of almost 10 percentage points. By 1995, cost inflation was down to 0.4 percent

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1   Due to changes in the format of the Medicare Cost Report in fiscal year 1996, an alternate method had to be used for calculating 1995–1996 changes. Consequently, these values are probably not as accurate as those of previous years. See the last section of the appendix for further information.

Average annual change in variables related to productivity growth and change in inpatient hospital product, 1985–1996

Years	Real input use per discharge [a]		Length of stay [b]		Service intensity [c]		Real input use per service unit [c]
	Change in: Inputs / Discharges	=	Change in: Days / Discharges	+	Change in: Services / Days	+	Change in: Inputs / Services
1985 to 1989	2.5%		0.8%		2.2%		−0.3%
1989 to 1992	1.3		−1.3		1.4		1.3
1992 to 1996	−2.7		−3.3		0.9		−0.3

Note: The change in real input use per discharge approximates the sum of the changes in length of stay, service intensity, and real input use per service unit. The relationship is not exact due to rounding and small interactive effects. See the last section of this appendix for additional information on data and methods.

[a] Real input use is measured as inpatient costs per discharge adjusted for price inflation as measured by the hospital market basket. The discharge measure is adjusted for real changes in case mix.

[b] The patient day and discharge measures used in calculating length of stay are both adjusted for real case-mix change.

[c] Services (for example, days of nursing care, surgeries, lab tests) are measured as total inpatient charges adjusted for inflation in service prices as measured by the hospitals and related institutions component of the consumer price index (CPI).

Source: MedPAC analysis of Medicare Cost Report and market basket data from the HCFA, case-mix data from the National Discharge Abstract Survey, and CPI data from the Bureau of Labor Statistics.

services (for example, nursing care, x-rays, and surgeries). The intensity of care provided in the hospital can be represented as the volume of services per day. Hospitals' productivity (unadjusted for quality change) would be measured as the inputs required to produce each unit of services. The production of a hospital discharge, then, can be viewed as combining three components: days per discharge, services per day, and inputs per unit of services. These factors are not independent, however. When the number of days in a patient's stay is reduced and the costs of many services (particularly surgery) are unchanged, the measured intensity of services per day will inevitably increase. Netting the decrease in length of stay and the increase in intensity provides a more accurate indicator of the overall change in hospital product than the change in length of stay alone.

We rely primarily on the measure of real input use per service unit as context for developing our adjustment for productivity improvement. But two important caveats must be kept in mind.

First, when hospitals are able to cut patient stays without a corresponding increase in the use of other Medicare-covered services, the resulting product change might be considered a form of productivity improvement. This would occur, for example, when an endoscopic surgical technique allows patients to be discharged earlier—and at the same level of functioning as previously. In our model, this phenomenon is measured as product change rather than productivity improvement, thus understating hospitals' true productivity gains.

Second, our update framework contains a separate allowance for the increased costs hospitals will incur in implementing new quality-enhancing technologies. Prospectively, the scientific and technological advancement allowance and the productivity adjustment can be considered separately—the first positive and second negative. But when the results are measured retroactively using our model, the service-level input use term will capture the effects of both factors.

Results

Although the rate of change in real input use per discharge has varied considerably from year to year, the general trend has been toward slower growth over time.

When the annual change in this measure is disaggregated into the three components described above—length of stay, service intensity per day, and intermediate input use—three distinct periods emerge in hospitals' transition from a high cost-growth to a low cost-growth industry.

In the first period (1985 through 1989), real input use rose by 2.5 percent per year. Two of the three factors in the model contributed to this outcome: length of stay edged up (0.8 percent a year) while intensity per day accelerated substantially (2.2 percent a year). Most striking is the intensity increase, which may be linked at least partly to the widespread implementation of such expensive diagnostic procedures as computed tomography and magnetic resonance imaging scans. The increases in length of stay and intensity were partially offset by a 0.3 percent annual decline in the real inputs used per unit of services.

The second and third periods (1989 through 1992 and 1992 to 1996) contrast sharply. Real input use per case went up at the more modest rates of 1.3 percent per year in the second period, but then declined by a striking 2.7 percent annually in the third. The most important variable in this performance difference appears to be length of stay reduction, which was modest through 1992 (−1.3 percent per year) but very large thereafter (−3.3 percent a year). The real inputs used in producing services also played a role, however, rising by 1.3 percent per year before 1992 but declining 0.3 percent a year after that.

That input use per unit of output decreased only slightly from 1992 to 1996 may seem surprising when the industry's overall cost growth was the lowest observed in nearly a quarter century. "Diminishing returns to scale" may be the driving factor in this difference. The overall service content of hospital admissions (combining the length of stay and intensity terms) dropped by 2.4 percent a year after 1992 (see Table D-2). With the number of discharges holding fairly steady, this meant that the overall quantity of services hospitals produced fell, and it is difficult to reduce input use per unit of output in the face of declining output.

Average annual change in the components of inpatient hospital product, 1985–1996

Years	Hospital product		Length of stay [a]		Service intensity [b]
	Change in: $\dfrac{\text{Services}}{\text{Discharges}}$	=	Change in: $\dfrac{\text{Days}}{\text{Discharges}}$	+	Change in: $\dfrac{\text{Services}}{\text{Days}}$
1985 to 1989	2.9%		0.8%		2.2%
1989 to 1992	0.2		− 1.3		1.5
1992 to 1996	− 2.4		− 3.3		0.9

Note: The net change in inpatient hospital product approximates the sum of the changes in length of stay and service intensity. The relationship is not exact due to rounding and small interactive effects.

[a] The patient day and discharge measures used in calculating length of stay are both adjusted for real case-mix change.

[b] Services (for example, days of nursing care, surgeries, lab tests) are measured as total inpatient charges adjusted for inflation in service prices as measured by the hospitals and related institutions component of the consumer price index (CPI).

Source: MedPAC analysis of Medicare Cost Report and market basket data from HCFA, case-mix data from the National Discharge Abtract Survey, and CPI data from the Bureau of Labor Statistics.

Recent changes in costs per discharge and length of stay

The data needed to quantify the real input use model are available only through 1996 because they are dependent on the availability of Medicare Cost Reports. However, the American Hospital Association's (AHA) National Hospital Panel Survey is useful in assessing more recent developments, despite differences in the construct of the measures used.

The AHA data suggest the industry's performance in fiscal 1997 and 1998 may have changed in two important ways (see Figure D-2). First, the annual growth in total expenses per adjusted admission has fallen to a new low—just 0.2 percent in both years. At the same time, the decline in length of stay for patients over age 65, although still substantial, was less than half the drop of recent years—only 3.1 percent in 1997 and 2.0 percent in 1998.[2]

These changes suggest that factors other than length of stay could now be playing a more prominent role in holding down costs. Reduced input use per discharge appears to have been the primary factor; a measure of labor input use (adjusted admissions per full-time equivalent employee) reached the highest level ever recorded in 1997, and then rose again in 1998 (AHA 1998).

Data and methods for measuring input use and product change

This summary of methodology documents the sample and data source used in quantifying our model of hospital input use and defines the time periods involved. The final sections explain the approach used in developing each of the primary variables (inputs, discharges, patient days, and services).
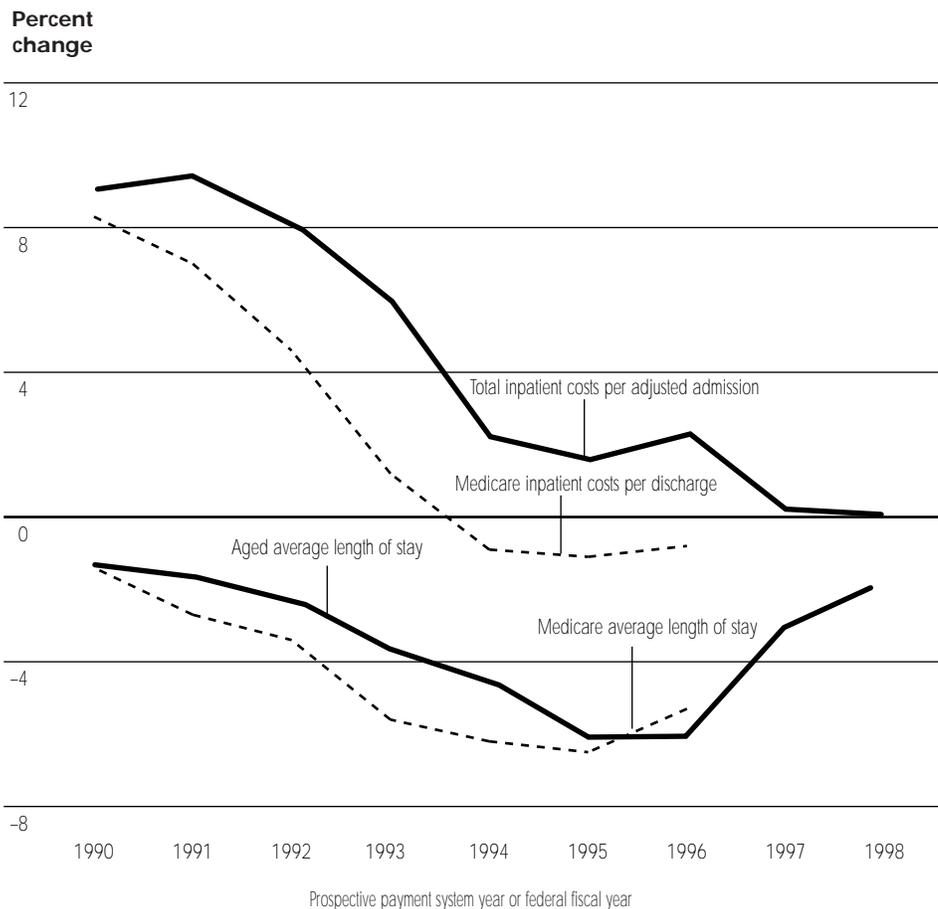
Sample and data source

All four of the terms in the equation (shown in Table D-1) are based on the same sample of hospitals and use data from the Health Care Financing Administration's (HCFA) Medicare Cost Report file. A two-year cohort was identified for each measurement of annual change. Each cohort included all hospitals eligible for payment under PPS for which the required data (passing MedPAC edit checks) were available in both years.

Prospective payment system years

The study is based on "PPS years," a convention HCFA introduced when PPS was implemented in 1984. Each year includes cost reports filed for hospital fiscal years beginning at any time during a particular federal fiscal year. This means that a PPS year will bridge two federal fiscal years. Previous analysis has shown that the discharges represented in PPS year data are about equally split between the two applicable federal years. For example, the 1995 PPS year includes data for hospital fiscal years beginning as early as October 1994 and ending as late as September 1996. The price index data used in developing our inputs and services measures had to be recalculated to match HCFA's data organized according to these PPS years.

Inputs

Inputs are items used in producing patient care (for example, staff time, food, supplies, equipment). These items are valued at their real cost to the hospital; that is, their actual cost adjusted for price inflation. The cost measure is total inpatient costs, which include services delivered in both acute and other inpatient units (such as hospital-based skilled nursing or transitional care) and care provided to patients covered by any payment source. Direct graduate medical education expenses were excluded because they are devoted primarily to producing education rather than to patient care. This new measure, which MedPAC staff developed last year, avoids the need to rely on a measure that reflects outpatient as well as inpatient costs.

The price adjustment is based on HCFA's market basket index, which measures inflation for the inputs hospitals use in producing inpatient services through a series of price proxies. The version of the market basket used in PPS payment policy reflects a combination of wage increases for hospital workers and workers in other industries. For purposes of this study, MedPAC staff modified the market basket to reflect hospital wages exclusively.

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2   While the reduced rate of decline in length of stay shown in Figure D-2 is for the aged population, the same phenomenon is seen in the length of stay for all patients.

Annual change in costs per discharge and average length of stay through 1998

**Percent
change**

Total inpatient costs per adjusted admission

Medicare inpatient costs per discharge

Aged average length of stay

Medicare average length of stay

Prospective payment system year or federal fiscal year

Note: The total expenses per adjusted admission and aged length of stay data (from the American Hospital Association) are based on community hospitals (which include some facilities excluded from prospective payment) and government fiscal years. The Medicare inpatient costs per discharge and Medicare length of stay data (from HCFA) are based only on hospitals paid under prospective payment and on prospective payment system years.

Source: MedPAC analysis of data from the American Hospital Association's National Panel Survey and Medicare Cost Report data from HCFA.

Discharges

This is a count of all discharges from PPS hospitals' acute care and long-term care units, adjusted for real changes in case mix. Unfortunately, a comparable discharge variable could not be constructed for 1996 due to a change in the format of the Medicare Cost Report. Consequently, the change in discharges had to be estimated using data from the AHA's Annual Survey of Hospitals. While the AHA's measure is identical, some degree of bias resulted from differences in the sample of hospitals available from the annual survey and cost report files.

The case-mix adjustment is based on

all payers' data from a sample of about 400 hospitals from the National Hospital Discharge Survey. The survey aggregates acute care discharges by DRG, and then we applied Medicare's DRG weights (which are recalibrated annually) to create yearly case-mix index values.

The last step estimated the portion of the annual case-mix index change that was real; that is, reflecting changes in patient resource requirements rather than improvement in DRG coding or medical records documentation. This determination drew on past estimates of the proportion of Medicare case-mix index change that was real, which were informed by a RAND recoding study funded by HCFA and the

Prospective Payment Assessment Commission (ProPAC). Generally, ProPAC's work found that the proportionate effect of improved coding and medical records documentation has been most pronounced following changes in the structure of DRGs and has declined over time. The current analysis found that real case-mix change for all patients has followed a more stable path than that for Medicare patients alone.

Patient Days

Like the discharge measure, the patient days variable reflects all patients in the acute care and long-term care units of PPS hospitals, adjusted for real case-mix change.

Services

The services measure reflects all units of service for which a charge is applied. This includes days of room and board and nursing care, as well as various ancillary services (for example, surgery, X-rays, physical therapy procedures). MedPAC's measure is calculated as total charges adjusted for inflation in service prices. The increase in a hospital's total charges from one year to the next will generally reflect three types of changes:

- providing a greater number of services,

- substituting more costly services (for instance, an MRI exam in place of a traditional X-ray), and

- raising service prices.

Once the effect of price increases has been removed, the measure will reflect change in the other two factors, which together determine the hospital's total volume of services.

The Hospitals and Related Institutions component of the CPI, which is published by the Bureau of Labor Statistics (BLS), was used for the price adjustment. The hospital CPI is based on a sample of service units in about 350 hospitals, with the data taken from each hospital's price master. While BLS's decision to base the hospital CPI on charges is well suited for the purposes of this study, a charge-based index does a poor job of measuring inflation in the cost of hospital care. A new method was implemented effective January 1, 1997.

References

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Bureau of Labor Statistics. News: employment cost index–September 1998. Washington (DC), U.S. Department of Labor. September 1998.