Assessment of Cost Trends and Price Differences for U. S. Hospitals

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"In a market with differentiated products [such as a hospital market], different price levels are neither necessary, nor sufficient, to demonstrate the exercise of market power."
– Federal Trade Commission Working Paper No. 294[2]

Executive Summary

This paper is the second in a series examining issues that have a bearing on the development of new and innovative healthcare delivery arrangements, such as Accountable Care Organizations ("ACOs"), medical homes and other arrangements that require greater clinical and/or financial integration among caregivers (hospitals and physicians).

The first paper, "A Critique of Recent Publications on Provider Market Power" ("Critique"), examined claims made in two publications widely cited as support for limiting caregivers' flexibility to develop or expand innovative delivery arrangements with exaggerated claims of provider market power. These publications focused on differences in prices among hospitals in two states, linking higher hospital prices to insurers directly to market power. Both ignored or rejected other explanations for price differences, such as differences in the prevalence of disease or illness and numerous other tangible factors. The Critique concluded after rigorous analysis that neither publication lends any credible support for such claims.

This second paper, "Assessment of Cost Trends and Price Differences for U.S. Hospitals" ("Cost Trends"), provides an in-depth examination of the costs hospitals incur in providing patient care and why those costs may differ among various types of hospitals, as well as the relationship of costs to prices. The key findings demonstrate that hospital prices are directly related to the costs of providing services to patients and their communities, including wages, capital investment, and the level and specialization of services. Thus, Cost Trends should dispel un- or poorly-supported claims that differences in hospital prices are attributable automatically to market power. Perhaps more importantly, the research demonstrates a link between improving care coordination, cost reduction and, lower prices.

A brief summary follows.

HOSPITAL COSTS – NATIONAL TRENDS

From 2000 through 2009, hospital revenues closely tracked cost increases, meaning that hospital margins did not increase appreciably. Both revenues and expenses per adjusted admission increased by roughly 5% per year.

Frequently Used Terms

Adjusted admissions:	includes inpatient admissions and outpatient visits, with a conversion for the latter to make it comparable to inpatient admissions.
Cost:	hospital expenses.
Level and type of care:	refers to the overall medical complexity and severity of illness of the patients treated, as well as the mix of services delivered by a provider.
Margin:	the difference between hospital revenues and hospital costs as a percentage of hospital costs; it is used synonymously with "profit" margin.
Price:	hospital revenue per inpatient discharge or per adjusted admission.
Revenue/Reimbursement:	payments or revenues from insurers, Medicare and other payors for hospital services, net of contractual allowances and discounts.
Spending:	the sum of all payments made by all payers for hospital services, it is used synonymously with 'expenditure' throughout.

Viewed in the larger context of national healthcare expenditures, hospital care accounted for a steady proportion of national healthcare expenditures over the past decade of slightly more than 30% and is expected to maintain that level over the next decade. Not surprisingly, labor costs accounted for more than half of hospitals' total expenses. Labor costs grew by between 5 to 8% a year from 2002 to 2009.

An increasingly significant issue for hospitals is the growth in the patients covered by the federal Medicare program or a state Medicaid program; these patients now constitute more than 60% of all admissions. Neither program pays the full cost of care. Medicare paid 99.1% of costs in 2000, but by 2009 paid only 90.1%; Medicaid paid 94.5% in 2000, but by 2009 paid only 89.0%. Likewise, uncompensated care – free or reduced cost care for patients who need financial assistance or shortfalls from patients unable to pay for care – amounts to 6% of total hospital expenses. Some of these costs of providing under- or uncompensated care are reflected in the hospital costs absorbed by other payors.

PRICE DIFFERENCES – AN ANALYSIS

Extensive analyses of hospital costs derived from five years of data from thousands of hospitals across the country and extensive data on costs, level and type of care, and community-specific information demonstrate that hospital revenues and costs track each other closely, and that there

are numerous, identifiable sources of costs that explain prices and price differences. These analyses confirm that unsupported claims of market power cannot be used to explain price differences among hospitals.

The key findings are as follows:

- Hospital prices are directly related to an array of costs associated with labor and capital costs, and the level and type of care received by the patients treated by the hospital.
- Up to 72% of the differences across hospitals in non-Medicare prices can be explained by factors that include case mix, regional costs, hospital investments in capital and other improvements, type of hospital, and other tangible factors. These factors also explain up to 83% of differences across hospitals in all-payor prices (which include Medicare), further validating the importance of cost and services as the sources of price differences.
- A variety of factors likely account for the remaining differences, chief among which are the costs associated with providing higher quality care. These factors also include costs imposed by different state regulations, different cost-containment strategies employed by hospitals, and errors or inconsistencies in the data. There is no reason to believe that the remaining differences are due to market power. This conclusion is entirely consistent with a Working Paper by the Federal Trade Commission's Bureau of Economics concluding that in hospital markets different price levels are neither necessary nor sufficient to demonstrate the exercise of market power.[3]

INTRODUCTION AND SUMMARY

This paper is the second in a series of empirical studies examining healthcare cost trends and prices, and the factors that explain hospital prices, as well as differences in prices across hospitals.

HOSPITAL COST TRENDS

National healthcare expenditures are comprised of a wide array of categories, including hospital and physician services, home healthcare, and pharmaceuticals. Hospital care accounted for a steady proportion of aggregate national healthcare expenditures over the past decade – approximately 30% – and is expected to do the same over the next decade. The sectors in which expenditures are growing most rapidly include home healthcare, prescription drugs, and program administration and net cost of private health insurance.

Trends in hospital revenues and costs over the past decade show that labor costs, which include salaries and benefits for physicians, nurses, technicians, and numerous other personnel, account for a large proportion of overall hospital costs, as well as total cost increases over the past decade. Non-labor costs also have increased, and include pharmaceuticals, professional fees, and maintenance of and additions to plant and capital, including technology.

There has been a flattening of inpatient admissions and a continued increase in outpatient visits. The composition of inpatient admissions has changed, with Medicare and Medicaid admissions increasing to about 60% of total admissions. Reimbursement from Medicare and Medicaid does not fully cover the costs of caring for those patients. In addition, uncompensated care, which refers to free or reduced cost care for those in financial need or care for which no payment was received, averages about 6% of hospital expenses. While the shortfalls from caring for patients without sufficient compensation to cover costs require hospitals to absorb and address some of those costs, some must be offset by other sources of revenue, including private payors, in order for the hospital to remain viable.[4]

Evaluating cost and revenue trends, per "adjusted admission"[5] from 2000 through 2009, shows that, at the national level, hospital revenues closely tracked cost increases, each increasing by roughly 5% per year. These trends and their resulting margins show that revenues are closely tracking costs, and that costs are key factors driving hospital price increases.

Hospital cost trend analyses also show that prices vary across regions depending on underlying cost differences among regions, such as differences in labor costs. For example, higher labor costs in a region result in higher expenses and, consequently, higher revenues per adjusted admission. Similarly, costs vary among hospitals within or across regions depending on patients' severity of illness, mix of government and commercial payors, and range of services offered and hospital-specific factors such as higher staffing ratios or the use of more expensive technologies. Thus, differences in prices can be explained by underlying differences in the costs of providing care at specific hospitals or in specific areas.

PRICE DIFFERENCES – AN ANALYSIS

These findings are confirmed by extensive empirical analysis of price differences across hospitals and the many cost-related and other factors that may explain differences. This includes an analysis

of the extensive literature on spending and differences in hospital spending, which confirms that many of the factors explaining differences in spending levels across regions or hospitals are related to the costs of providing care, which, in turn, directly affect its price. For example, the literature shows that much of the spending variation between two regions can be explained by the differences in regional costs and in the prevalence of disease or illness.

In focusing directly on factors that explain commercial prices, we analyzed a comprehensive set of explanatory factors and an extensive national sample of thousands of acute care hospitals for a five-year period.[6] Specifically, we developed extensive data on hospital, community, financial, and patient characteristics.[7] In doing so, this paper represents the first comprehensive study that attempts to explain the sources of price differences at the national level for commercial insurers.

The analyses confirm that cost-based factors are important in explaining hospital prices and price differences. While it is not possible to capture all of the factors that could affect price, such as higher quality, those included in the econometric analyses explain up to 72% of the differences in non-Medicare prices.[8] These results are highly explanatory, and there is no reason to believe that the remaining differences are due to the exercise of market power.

The key finding of these analyses is that hospital prices are directly related to an array of cost factors associated with regional costs, labor costs, capital investments, and level and specialty of services. The fact that prices closely track costs suggests that efforts to improve the efficiency with which care is delivered, and to coordinate and improve the quality of care, should reap benefits in the form of both lower costs and lower prices.

ASSESSMENT OF COST DRIVERS AND TRENDS IN HEALTHCARE AND THE HOSPITAL SECTOR

Hospital care accounts for a steady proportion of national expenditures on healthcare, approximately 30%, and is projected to remain at this proportion for the next decade. Over the past decade, increased expenditures on labor explain a substantial proportion of overall cost increases experienced by hospitals. In addition, hospitals are facing a growing need to cover shortfalls from insufficient Medicare and Medicaid reimbursement, uncompensated and charity care, and new compliance-related costs for new technologies such as electronic health records. Moreover, reimbursement shortfalls have increased in significance with the increasing proportion of inpatient admissions from Medicare and Medicaid. Overall, hospital revenues have closely tracked cost increases at the national and regional level. This indicates that, on average, hospital margins have not increased substantially.

SPENDING ON HOSPITAL CARE IN THE CONTEXT OF OVERALL HEALTHCARE EXPENDITURES

A useful starting point for evaluating cost trends for hospitals is to put them in the context of broader healthcare costs and trends. Hospital services are one aspect of healthcare expenditures.[9] As the following table shows, there are many different expenditure categories accounting for total national healthcare costs.[10] As of 2009, healthcare expenditures accounted for 17.6% of the Gross Domestic Product (GDP). Of a total of $2,486 billion in expenditures on healthcare at the national level in 2009, hospital care accounts for $759 billion, or 30.5%. Other major categories include professional services, including physician and clinical services (27.1%), prescription drugs and other medical products (13.2%), nursing home and home health (8.3%), and investment (6.3%).

National Health Expenditures, 2009

Spending Category	2009	% of NHE
National Health Expenditures (billions)	$2,486.3	
Health Consumption Expenditures	2330.1	93.7%
Personal Health Care	2089.9	84.1%
Hospital Care	759.1	30.5%
Professional Services	674.9	27.1%
Physician and Clinical Services	505.9	20.3%
Other Professional Services	66.8	2.7%
Dental Services	102.2	4.1%
Other Health, Residential, and Personal Care	122.6	4.9%
Nursing Home and Home Health	205.3	8.3%
Home Health Care	68.3	2.7%
Nursing Home Care	137	5.5%
Retail Outlet Sales of Medical Products	328	13.2%
Prescription Drugs	249.9	10.1%
Other Medical Products	78.2	3.1%
Durable Medical Equipment	34.9	1.4%
Other Non-Durable Medical Products	43.3	1.7%
Program Administration and Net Cost of Private Health Insurance	163	6.6%
Government Public Health Activities	77.2	3.1%
Investment	156.2	6.3%
Research	45.3	1.8%
Structures & Equipment	110.9	4.5%
U.S. Population (millions)	307	
National Health Expenditures Per Capita	$8,098.7	
Gross Domestic Product (billions)	$14,119.0	
National Health Expenditures as a Percent of Gross Domestic Product	17.6%	

Sources: CMS, Office of the Actuary, National Health Statistics Group; and U.S. Department of Commerce, Bureau of Economic Analysis and Bureau of the Census.

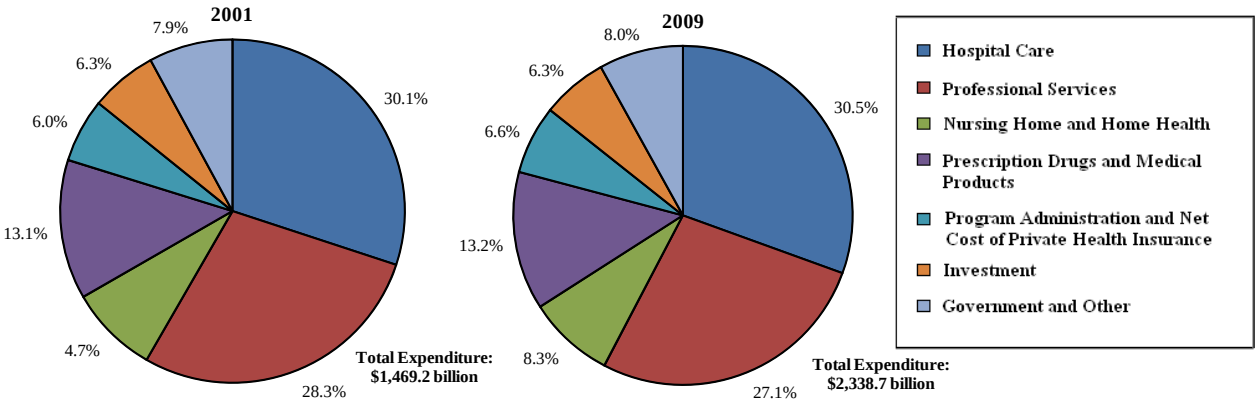
Hospital expenditures held relatively steady as a proportion of total healthcare expenditures from 2001 to 2009 (approximately 30% of total healthcare expenditures).[11] The largest percentage change in expenditure was for Home Health Care, which represents about 3% of total expenditures. Other categories have grown faster than hospital care; these include prescription drugs, and program administration and the net cost of private health insurance.

National Health Expenditures, 2001 and 2009

Spending Category	2001	2001 Share of NHE	2009	2009 Share of NHE	2001-2009 Percent Change	2001-2009 Dollar Change	% of 2001-2009 Dollar Change
National Health Expenditures (billions)	$ 1,495.3	100.0%	$ 2,486.3	100.0%	66.3%	$ 991.0	100.0%
Health Services and Supplies	1401.4	93.7%	2330.1	93.7%	66.3%	928.7	93.7%
Personal Health Care	1264.1	84.5%	2089.9	84.1%	65.3%	825.8	83.3%
Hospital Care	449.4	30.1%	759.1	30.5%	68.9%	309.7	31.3%
Professional Services	422.9	28.3%	674.9	27.1%	59.6%	252	25.4%
Physician and Clinical Services	314.7	21.0%	505.9	20.3%	60.8%	191.2	19.3%
Other Professional Services	40.6	2.7%	66.8	2.7%	64.5%	26.2	2.6%
Dental Services	67.5	4.5%	102.2	4.1%	51.4%	34.7	3.5%
Other Health, Residential and Pers. Care	70.7	4.7%	122.6	4.9%	73.4%	51.9	5.2%
Nursing Home and Home Health	125.2	8.4%	205.3	8.3%	64.0%	80.1	8.1%
Home Health Care	34.4	2.3%	68.3	2.7%	98.5%	33.9	3.4%
Nursing Home Care	90.8	6.1%	137	5.5%	50.9%	46.2	4.7%
Retail Outlet Sales of Medical Products	196	13.1%	328	13.2%	67.3%	132	13.3%
Prescription Drugs	138.7	9.3%	249.9	10.1%	80.2%	111.2	11.2%
Other Medical Products	57.4	3.8%	78.2	3.1%	36.2%	20.8	2.1%
Durable Medical Equipment	25.1	1.7%	34.9	1.4%	39.0%	9.8	1.0%
Other Non-Durable Medical Products	32.3	2.2%	43.3	1.7%	34.1%	11	1.1%
Program Administration and Net Cost of Private Health Insurance	89.8	6.0%	163	6.6%	81.5%	73.2	7.4%
Government Public Health Activities	47.5	3.2%	77.2	3.1%	62.5%	29.7	3.0%
Investment	94	6.3%	156.2	6.3%	66.2%	62.2	6.3%
Research	28.5	1.9%	45.3	1.8%	58.9%	16.8	1.7%
Structures & Equipment	65.5	4.4%	110.9	4.5%	69.3%	45.4	4.6%

Source: CMS, Office of the Actuary, National Health Statistics Group.

Total National Health Expenditure by Component, 2001 and 2008

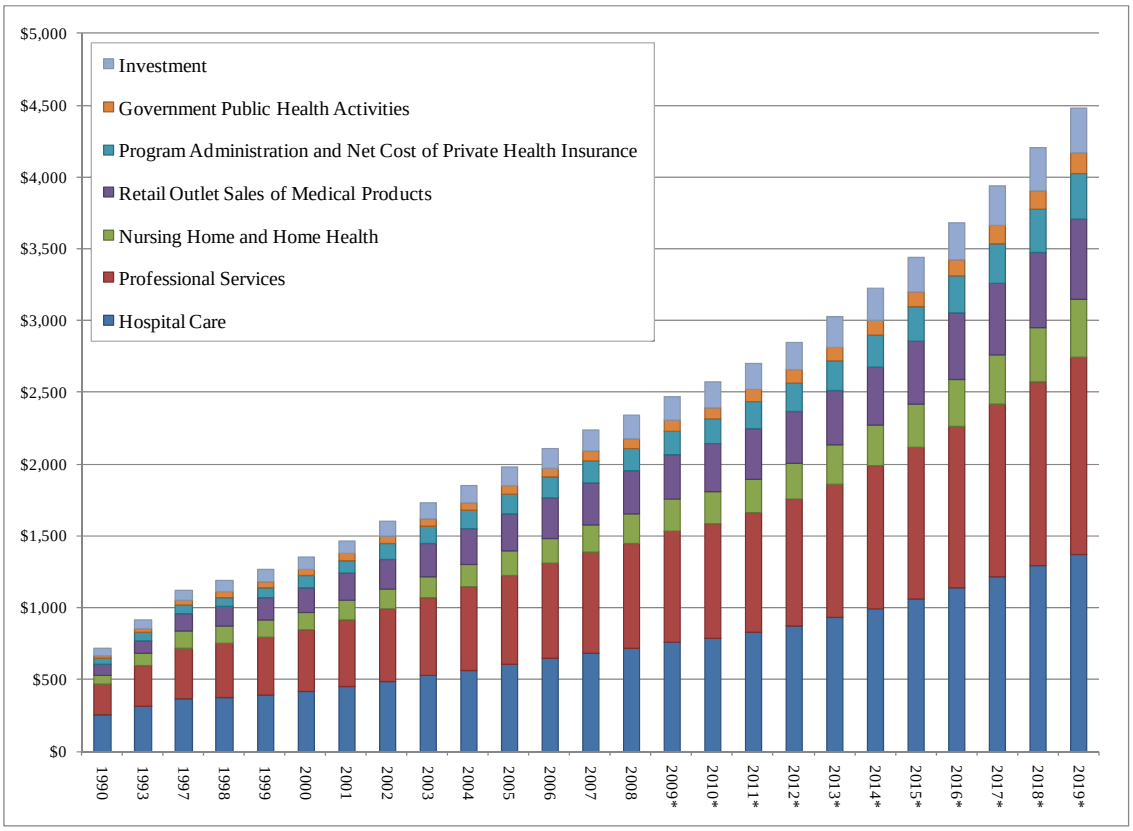


Sources: CMS, Office of the Actuary, National Health Statistics Group.

Healthcare expenditures have increased over the past decade, and are projected to increase between 2009 and 2019 by approximately 80%.[12] The projections from CMS for future expenditure increases are consistent with recent experience. They show that all major categories are expected to increase at similar rates over this period.[13] In particular, expenditures for hospital

care are projected to account for 30.7% of the increase, which is similar to its current share of total expenditures.[14] The following chart shows the historic and projected increases in total national health expenditures along with the breakdown among the top seven categories.

National Health Expenditures by Component ($ Billions)



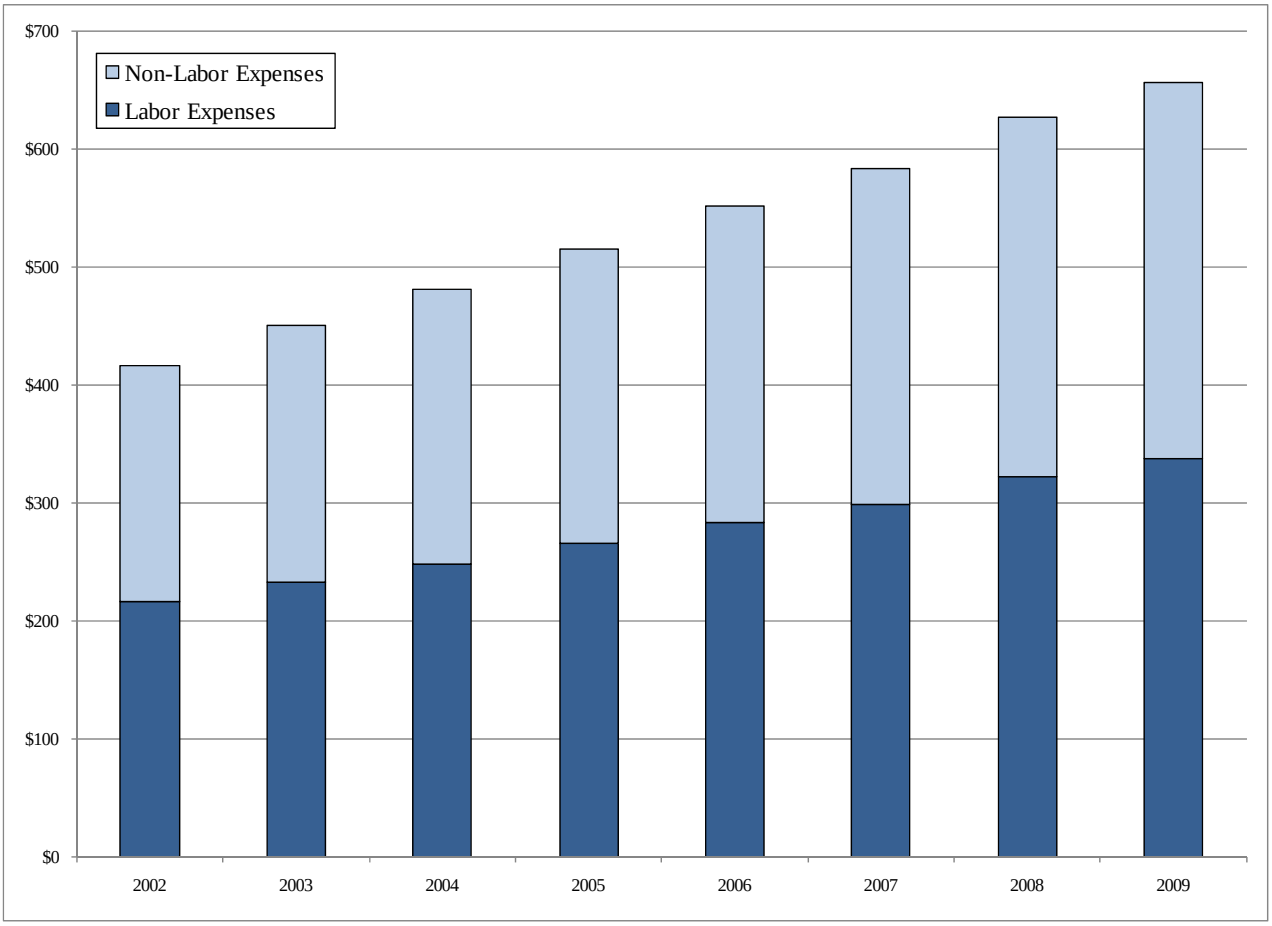
Note: Years 2009 and on (*) are projected by CMS.
Source: CMS, Office of the Actuary, National Health Statistics Group.

COST TRENDS WITHIN THE HOSPITAL SECTOR

We next examine the factors that account for cost changes within the hospital sector, and focus on cost and utilization. In particular, we examine both changes in underlying input costs and/or the demand for services as possible sources of increased total spending. This updates analyses conducted by Guerin-Calvert et al., 2003.

The chart below tracks total hospital expenses and the breakdown between labor and non-labor expenses between 2002 and 2009. Labor expenses account for over half of total expenses. Both labor and non-labor expenses grew around 50% over the period, with annual growth rates between 5% and 8%. Non-labor costs include a wide variety of different expenses, with the largest categories involving other products (such as food and medical instruments), prescription drugs, and professional fees.[15]

Total Hospital Expenses and Labor Expenses ($ Billions): National, 2002-2009



Source: Analysis of AHA Annual Survey data for community hospitals.

Hospitals in all regions across the country have faced increased costs. One notable cause is the emergence and widespread diffusion of new medical technologies.[16] A specific area of cost increase relates to electronic health record ("EHR") systems. These systems require upfront costs to initiate and ongoing costs in re-training staff and evaluating and updating the system once implemented. However, by assisting in the coordination of care between providers, aiding clinical decision-making, and more accurately monitoring performance, research suggests that EHR systems have the potential to both lower costs and improve quality.[17]

Under the *American Recovery and Reinvestment Act of 2009* ("ARRA"), hospitals that have implemented health information technology ("IT") systems meeting "meaningful use" criteria will be eligible for incentive payments from Medicare and Medicaid. The ARRA also includes penalties for failing to meet these requirements by 2015. The timelines will put pressure on hospitals to select, test, and implement the best EHR system for their needs within tight timeframes.[18] Recent surveys of hospitals show access to capital (tax-exempt bonds, in particular) to be a significant challenge, and many hospitals have put information technology purchases on hold as a result.[19] Preliminary evidence suggests that implementation of EHR systems may be occurring at a more rapid pace for hospitals belonging to healthcare systems, which may be explained by access to capital, purchasing efficiencies, and broad opportunities to share information.[20]

GENERAL TRENDS THAT AFFECT HOSPITALS' OPERATIONS AND COSTS

Consistent with national population trends, total hospital admissions grew by 7% between 2000 and 2009. Since 2004, however, hospital admissions have remained virtually flat, in part due to a shift of some services to outpatient venues. Medicare and Medicaid admissions account for an increasing share of total admissions. In particular, Medicaid admissions have grown at a rapid pace – 36% between 2000 and 2009.

Hospital Admission Trends, 2000-2009

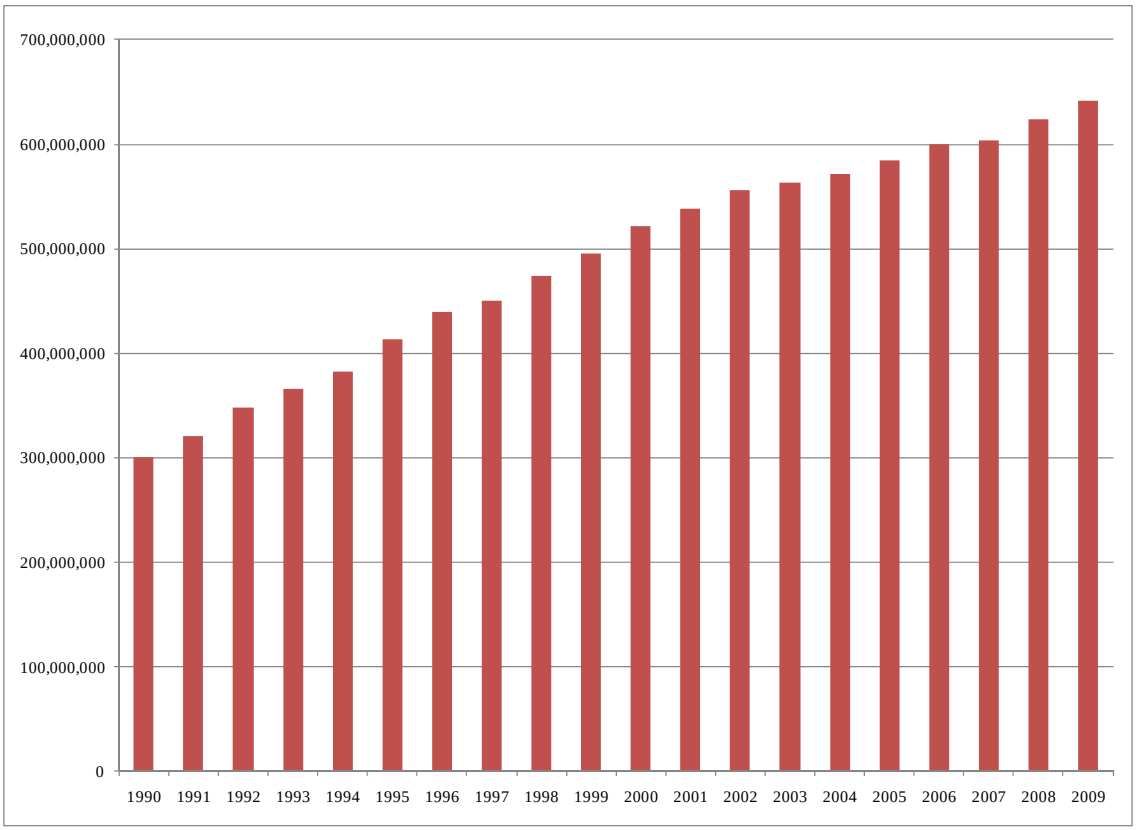
Year	Total Admissions	Medicare Admissions	Medicare Admissions as % of Total	Medicaid Admissions	Medicaid Admissions as % of Total	Outpatient Visits
2000	33,089,467	13,567,553	41.0%	5,210,907	15.7%	521,404,976
2001	33,813,589	13,884,333	41.1%	5,462,091	16.2%	538,480,378
2002	34,478,280	14,197,195	41.2%	5,903,648	17.1%	556,404,212
2003	34,782,742	14,163,774	40.7%	6,121,649	17.6%	563,186,046
2004	35,086,061	14,498,549	41.3%	6,321,973	18.0%	571,569,334
2005	35,238,673	14,769,486	41.9%	6,475,521	18.4%	584,428,736
2006	35,377,659	14,716,159	41.6%	6,590,939	18.6%	599,553,025
2007	35,345,986	14,689,388	41.6%	6,693,701	18.9%	603,300,374
2008	35,760,750	14,912,904	41.7%	6,870,817	19.2%	624,098,296
2009	35,527,377	14,964,804	42.1%	7,074,220	19.9%	641,953,442

Source: Analysis of AHA Annual Survey data for community hospitals.

Payment shortfalls from Medicare, Medicaid, and uncompensated care add increasing pressure on hospital finances. Medicare and Medicaid admissions now account for more than 60% of total admissions. The AHA estimates that Medicare payment-to-cost ratios fell from 99.1% in 2000 to 90.1% in 2009.[21] Similarly, Medicaid payment-to-cost ratios fell from 94.5% in 2000 to 89.0% in 2009. Moreover, AHA data show that uncompensated care costs represent approximately 6% of total hospital expenses.[22]

Trends in the number of outpatient visits for all U.S. hospitals continued to show increases. While not as pronounced as in the 1990s, outpatient visits continue to grow, increasing more than 23% between 2000 and 2009.

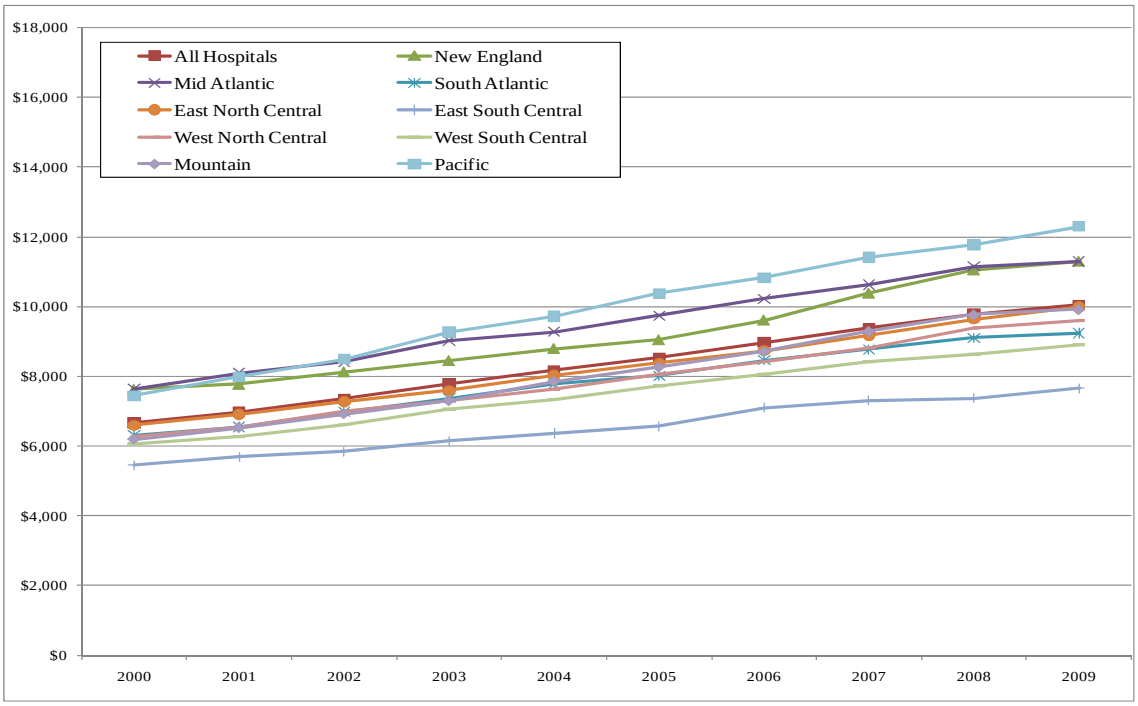
Number of Outpatient Visits, 1990-2009



Source: Analysis of AHA Annual Survey data for community hospitals.

In order to examine differences in hospital expenses across regions, we make use of data that examines average expenses per adjusted admission. As shown in the figure below, while the level of hospital expenses may vary due to regional differences in input costs such as wages, costs in all regions followed a similar upward trend over the past decade.

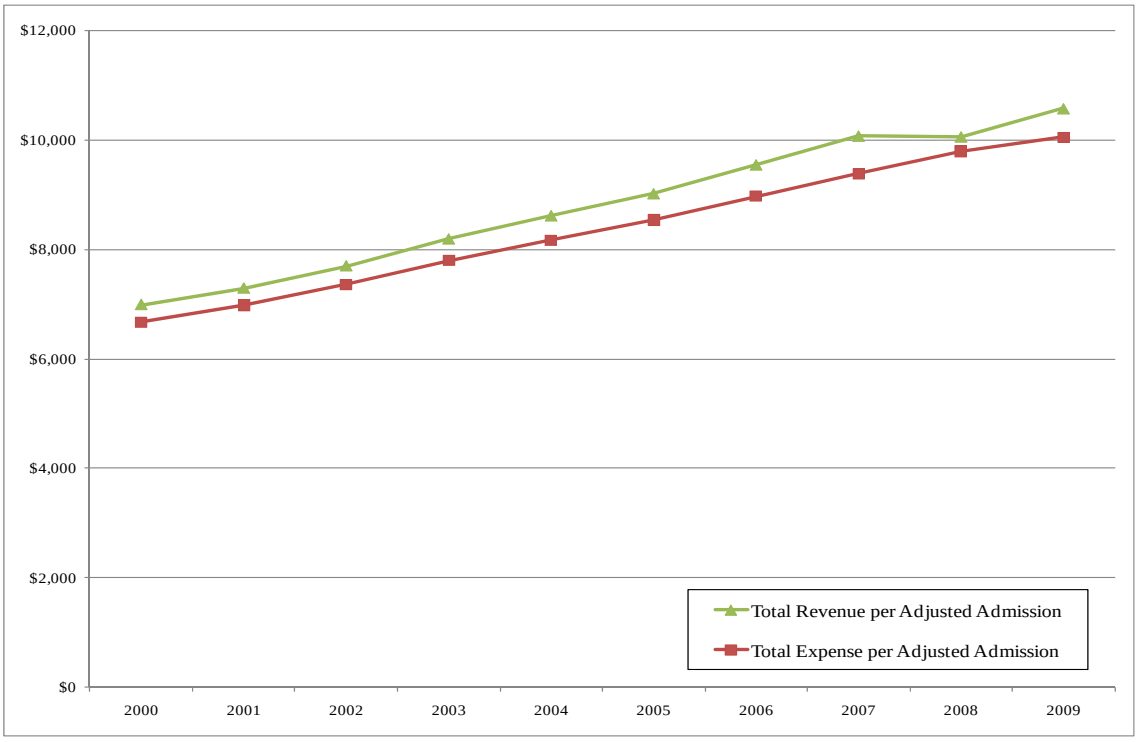
Total Expenses per Adjusted Admission by Region: National, 2000-2009



Source: Analysis of AHA Annual Survey data for community hospitals.

Overall, hospital revenues have closely tracked cost increases, as shown in the figure below. Both revenues and expenses grew by 51% between 2000 and 2009, which implies an average annual growth rate of roughly 5%.

Total Revenue and Expense per Adjusted Admission, 2000-2009



Source: Analysis of AHA Annual Survey data for community hospitals.

EMPIRICAL EVALUATION OF FACTORS EXPLAINING PRICE DIFFERENCES ACROSS U.S. HOSPITALS

OVERVIEW AND SUMMARY OF CONCLUSIONS

Hospital costs and revenues per adjusted admission are tracking each other closely at the national level. These trends also suggest that *differences* in prices across hospitals or regions could well be explained at least in part by *differences* in costs. The multitude of factors associated with higher costs, such as salary levels, utilization of nursing and other staff, costs of delivering higher complexity care and services, extent of payment shortfalls, and higher technology costs could be factors that explain cost differences among hospitals within the same region, or even the same city, and in turn may serve to explain differences in average prices per admission across hospitals.

In this section, we examine extensive data on thousands of hospitals to evaluate these factors and whether they explain price differences, and specifically price differences for commercial insurers across hospitals. We do so by:

- Building from the extensive empirical literature on hospital spending and the factors that contributed substantially to explain differences across regions in spending. We rely on this literature just as a starting point, because it focuses on Medicare and not on commercial insurers, and because it focuses on spending, which includes both price measures and the quantity of services provided. Nonetheless, because this literature explores and tests numerous cost-based factors that explain differences in spending, these same factors have the potential to explain differences in prices.
- Extending the preliminary model begun in the Critique[23] to a range of more extensive models using hospital, community, financial and other variables, and a national data set of thousands of hospitals over a five-year period to test empirically the sources of price differences.

Our goal was to develop an understanding of the myriad factors that could potentially affect hospital prices to commercial insurers, and to identify those that are most important and relevant.[24]

Our key findings are:

- Hospital prices are directly related to an array of cost drivers associated with labor costs, capital investments, and the level and type of care.
- While it is difficult due to data limitations and the complexity of healthcare to capture all relevant factors in our models and explain all differences, our results show that the factors that we can measure are statistically important and explain price differences; factors such as case mix, regional costs, hospital characteristics, resource utilization, characteristics of the population, and other factors explain a very large proportion – up to 72% of the differences in hospital prices for non-Medicare services across the U.S., and a large proportion of the variability in Medicare and all-payor prices.
- Our empirical analyses provide logical explanations for higher hospital prices in some regions or for some hospitals relative to neighboring ones in the same regions. Moreover, the strength of the empirical results confirms that it is inappropriate to ignore these factors in any discussion of price differences.

As in all empirical studies, some variability in the data cannot be explained by the model; a variety of factors likely account for this remaining variability. These factors include the costs associated with providing higher quality care, costs imposed by different state regulations, differences in the cost-containment strategies employed by hospitals, and errors or inconsistencies in the data. As a matter of economics, it is incorrect to assume that any residual price differences reflect some form of inefficiency or market power.

REVIEW OF STUDIES

We started our analysis with a review of the existing literature on factors that explain differences across hospitals. We found that the literature on price differences was very limited, but there was a more extensive literature on spending differences. Although these studies have used different data, models, and variable specifications, with varying results, there is a common set of factors (variables) that tend to explain healthcare prices and/or spending:

- Case mix: healthcare prices and spending are closely linked to the mix of services and general level and type of care delivered by each provider. Researchers have typically used Medicare's case mix index ("CMI") or have conducted the analysis at the Diagnosis-Related Group ("DRG") level to capture how the service mix affects prices and spending.
- Costs: these variables capture regional differences in input costs – in particular, labor costs. In addition, hospital-specific costs, such as labor and capital expenditures, may be used to capture the degree of complexity in hospital services not captured by case-mix variables.
- Demographics: the literature shows that the overall use of healthcare services and the prevalence of certain conditions can vary according to age, sex, race, and other socioeconomic variables such as income level and insurance status.
- Health status: in addition to demographic variables, health status variables can be used to capture the relative sickness of the population. Researchers have used primarily behavioral variables (*e.g.*, share of smokers) and variables that reflect the incidence of specific conditions (*e.g.*, diabetes).
- Provider characteristics: these variables capture certain factors that affect hospital costs (*e.g.*, mission-related costs of teaching hospitals, uncompensated care). Researchers have also used variables that reflect service complexity (*e.g.*, specialty beds, organ transplants, and the relative supply of healthcare resources).
- Payor characteristics: these variables have been used in studies that attempt to explain healthcare outcomes through variables that identify payor mix and other payor characteristics.

Researchers use combinations of these variables in regression models that are able to identify which variables show statistical correlation with hospital prices and how much of the variation in hospital prices can be explained by all the variables in combination (without double counting the explanatory power of the variables). While no one study incorporates all these variables in a single model, as models become more sophisticated (*i.e.*, include a larger array of these variables), they are able to explain more of the variability in prices and spending. We briefly summarize the key findings from the extensive literature that focuses on differences in healthcare spending, costs, and prices as well as quality. Appendix A contains a summary of selected studies and the explanatory variables used in those studies.

Studies Focused on Medicare Spending

Several studies have analyzed regional differences in Medicare spending – a measure that includes both Medicare prices (payment rates) and the quantity of services provided. Most of these studies adjust regional spending by some measure of regional costs, for example, the indices used by CMS to adjust payment rates for each region.[25] Since these studies look at overall spending, which is affected by utilization, the models tend to include a large number of variables that attempt to capture demographic characteristics, such as age, sex, race, income, and urbanization, and health status of the population, including self-reported health status, share of smokers, mortality rates, and incidence of certain conditions. They also include variables that measure the supply of medical resources in the region, including the percentage of primary care physicians and the availability of teaching hospitals. In some cases, they also include payor-side measures, such as the share of the population in managed care plans, Medicaid, and uninsured.

While there are some important differences among the results of the individual studies, the results show that differences in Medicare spending can be explained in large part by: (i) differences in Medicare payment rates for each region (including Medicare adjustments to specific hospitals, for example, for teaching, rural, and disproportionate share ("DSH") hospitals); (ii) differences in patients' demographic characteristics; and (iii) differences in the health status of the population. This reflects that areas with high spending are frequently characterized by sicker populations.

Studies Focused on Non-Medicare Patients

Only a few studies have analyzed differences in non-Medicare costs or prices, largely because more data are available for Medicare's fee-for-service program than for non-Medicare services. These studies use the Medicare Cost Reports to obtain data for non-Medicare inpatient services, or use private payor data limited to a particular region.

These studies explain differences in hospital prices or costs using measures of regional costs, such as the cost indices provided by CMS, and either adjust for case mix or analyze the data at the DRG level. Since they analyze hospital-level data, the datasets used may not include demographic and health status information for the population served at each hospital, which is not generally available. Instead, they use variables that attempt to capture the level and type of hospital complexity, such as CMI and teaching intensity, and measures of specialty care and sophisticated clinical services, such as open-heart surgery and organ transplants. They also use as explanatory factors such as urban/rural indicator variable, Medicare outlier payments, and the shares of patients treated under Medicare and Medicaid.

Studies Focused on Quality of Care

We also reviewed studies that explore whether regions and hospitals with high prices or spending are associated with higher quality of care. In contrast to other explanatory variables, the analysis of quality is particularly limited by the absence of well-defined measures and a methodological limitation that arises from the fact that severely ill patients disproportionately choose high-quality hospitals. As a result, health outcomes such as mortality rates cannot be used to make inferences regarding hospital quality without taking into account the differences in the severity of illness of the patients treated at each hospital.

Although some researchers have developed more elaborate methodologies to overcome these limitations, these types of studies require additional data (such as patient-level data by discharge) and cannot readily be extended to cover the entire sample of U.S. hospitals.

However, it should be noted that these more sophisticated methods yield significantly different results from the standard methods that use only simple measures of hospital quality. This confirms that failure to properly adjust for severity of illness is likely to lead to substantial bias in measuring hospital quality. Likewise, the apparent absence of correlation between price and common measures of quality could be the result of measurement and specification issues, as opposed to an actual lack of relationship. Appendix A summarizes key findings from the literature that focuses on provider quality.

ECONOMETRIC EVALUATION OF PRICE DIFFERENCES ACROSS U.S. HOSPITALS

Overview

In this section, we extend the preliminary model begun in the Critique to a range of more extensive models that identify the factors that account for differences in prices across hospitals. This required adapting the approaches used in the literature to incorporate price measures rather than spending measures, and to examine, where possible, commercial prices. We also expanded the modeling from a single state to the entire country, and built a database of more than 3,400 hospitals. This required development of data on region or area-specific measures of labor costs, demographics, and health status variables.[26] A detailed listing of the data developed is provided in Appendix B.

In developing models, we relied on commonly accepted methods to capture fundamental relationships that explain prices. One measure routinely employed is the R-squared value, which is a measure of how well the model explains the observed variability in the data; a higher R-squared value implies that the model explains more of the variability in the data. Another measure is whether the relationship between a given factor and the item under investigation – price in this case – is statistically significant.[27] Thus, we measure relevance and importance by whether the specific economic factor shows a statistically significant relationship with hospital prices and evaluate whether taken together these factors explain a substantial proportion of the variation in hospital prices.

We first used the key variables from the Critique to explain differences in hospital prices, namely case mix, teaching intensity, and share of Medicare/Medicaid discharges. Then, we enriched the analysis by moving from these basic variables to models that examine the effects of multiple factors, including those discussed in the previous section. We include in the model explanatory variables that reflect regional costs, additional hospital characteristics, resource utilization, demographic and health status variables, and inpatient costs reported by hospitals. We do this sequentially to better understand the explanatory power of each set of factors. In total, we present five models.

Price measures

As in the Critique, we use measures of hospital inpatient prices based on the Medicare Cost Report data. The Medicare Cost Reports provide revenue and discharge data, by hospital, from which we can estimate average hospital inpatient revenues (per discharge) for Medicare and non-Medicare patients. As such, the calculated "prices" reflect average hospital inpatient revenues per discharge.

This measure reflects average inpatient prices and, to some extent, the hospital's resource utilization per discharge. It does not reflect, however, overall resource utilization or healthcare spending by hospital.[28]

We use formulas from the healthcare literature to estimate these non-Medicare prices.[29] We calculate a hospital-level discount factor (*i.e.*, the payment discount over charges) to estimate total inpatient revenues, and then subtract Medicare revenues to obtain non-Medicare revenues. One important caveat is that this methodology implicitly assumes the same discount factor for inpatient and outpatient services.[30]

To our knowledge, this is the first study that attempts to explain non-Medicare price differences across all U.S. hospitals.[31] In addition, in order to test the results of this non-Medicare price formula, we use an alternative measure of average prices for all payors that includes Medicare and non-Medicare patients. This price measure requires fewer assumptions, as it is based on total hospital discharges and charges (adjusted by the hospital's discount factor). With both measures of prices (non-Medicare and all-payor), we show that a large proportion of the price differences can be explained by those factors identified in the healthcare literature. The data and methodology are further described in Appendix B.

Data

We use data from federal fiscal years 2004 through 2008, as provided in the Medicare Cost Reports. This allows us to analyze price differences across U.S. hospitals for a sample of five years. In estimating cross-sectional variation, the econometric model first averages all variables from each hospital over the five-year period and then performs a linear regression across these hospital-level averages.[32] We further analyze the data to exclude extreme values and apparent data errors (*see* Appendix B). As a result, the final dataset contains approximately 3,400 hospitals with information for between one and five years (on average, the data include four years per hospital).[33]

Regressions Models and Results

The availability of a large sample of hospitals allows using models that include a large number of explanatory variables relative to state-level studies in which only a few explanatory variables can be used. The table below summarizes the explanatory variables used in each model and the share of the variability in non-Medicare prices explained by each model (the full regression results are shown in Appendix C). The table also includes the explanatory power of the model for all-payor prices (Medicare and non-Medicare patients).

The first model includes certain key variables that reflect case mix, teaching intensity (measured by the number of interns and residents per bed), and the share of Medicare and Medicaid discharges. In addition, due to the regional nature of this study, we included a measure of regional costs – the wage index currently used by CMS to set Medicare payments.[34]

> ***Results:*** Overall, these few variables explain approximately 48% of the variability in non-Medicare prices. In particular, case mix and wage index are strongly correlated with non-Medicare prices and statistically significant. The table below also shows that, when applied to average prices for all payors, these variables explain 67% of the price variation.[35] The share of Medicare discharges tends to be positively correlated with prices and the share of Medicaid discharges tends to be negatively correlated with prices.[36]

Some researchers have raised the concern that the prices set by a hospital and the wages of its physicians may affect the Medicare wage index (that is, high prices may contribute to increase hospital wages but may not be caused by them). To confirm that regional costs affect hospital prices, we tested the results under two alternative formulations: (1) using the average or the minimum Medicare wage index for the entire Core-based Statistical Area (CBSA); and (2) using instead a general cost of living index. These measures are unlikely to be affected by a particular hospital's or hospital system's prices. In both cases, the results were similar to the model that uses the Medicare wage index. This confirms that exogenous factors that affect hospitals' costs contribute to explain hospital prices.[37]

The second model includes all the variables in the first model plus certain variables that reflect hospital characteristics: rural hospitals, Medicare DSH revenues per bed, Medicare outlier operating payments, and the average cost of uncompensated care per discharge.[38] In addition, the model includes the number of organ transplants per bed – a measure used to capture specialized capacity and medical complexity,[39] and the share of outpatient charges over all patient charges (inpatient and outpatient). The latter attempts to capture whether the formula used to calculate non-Medicare prices is affected by the presence of different discount factors for inpatient and outpatient charges.

> ***Results:*** From these sets of variables, outlier payments and the share of outpatient services show the strongest correlation with prices. Prices appear to decrease with DSH payments and increase with rural status, outlier payments, and the number of organ transplants (and these results are statistically significant).[40] Prices also appear to increase with the amount of uncompensated care.[41] Overall, this second model explains about 56% of the variability in non-Medicare prices.[42] For all-payor prices, the model explains about 73% of the price variation.

The third model adds to the previous model variables that reflect resource utilization. This includes total assets (as reported in the hospital's balance sheet) per bed, a measure of utilization (annual discharges per bed), and hospital size (number of beds).

> ***Results:*** Prices are strongly correlated with the total hospital assets per bed. This shows that higher hospital capital expenditures, such as in buildings and equipment, are associated with higher prices. The coefficients for hospital utilization and size are negative and statistically significant, which shows that – after controlling for other factors – average hospital prices tend to be lower at large hospitals and hospitals with high utilization. Overall, the addition of these variables increases the explanatory power of the model to 61%. For all-payor prices, the model explains 77% of the price variation.

In the fourth model, we expand the set of explanatory variables to include demographic variables from the Area Resource File (ARF) for metropolitan areas or CBSAs. These variables reflect the general population age, sex, race, the percentage of the population in poverty, and the percentage of population uninsured. We also include health status variables from the Behavioral Risk Factor Surveillance System (BRFSS). This includes data from a sample population related to health risk behaviors, from where we calculate the percentage of smokers, heavy drinkers, and persons with a checkup in the last two years (*see* Appendix B for more detail on these data sources).

> ***Results:*** With these variables, the model explains 63% of the variability in non-Medicare prices and 77% of the variability in all-payor prices. It has been observed that the population's demographic characteristics and health status explain some of

the differences in healthcare *spending*. However, demographic and health status variables add relatively little explanatory power to this model (in the order of 2% to 3%), and tend to show small coefficients with little statistical significance.

There are two potential explanations for this outcome. First, these metrics may not affect hospital *prices* by the same degree they affect healthcare *spending*. This is because demographic and health status variables are likely to capture how frequently the patient needs treatment or how sick the patient is, but not necessarily any differences in the use of resources during an admission or in the prices insurers pay for the same procedure. The second reason relates to data limitations. The ARF and BRFSS data are aggregated by metropolitan area, not by hospital. This creates the problem of matching hospital patients with the population in each area. But hospitals receive patients from outside the metropolitan area in which they are located. In addition, different hospitals in the same area may receive patients with different demographic and health characteristics. The model developed here is not able to capture these factors.[43]

We also tested an alternative model (shown as Model 4b in Appendix C) that includes preliminary measures of hospital quality (as discussed in the previous section, there are certain methodological limitations to the use of these variables). This model includes measures of hospital mortality rates and readmission rates calculated by CMS for Medicare beneficiaries. Overall, mortality rates show a small positive correlation with hospital prices and readmission rates show a small negative (but significant) correlation with hospital prices. Another variable used in this preliminary model is the *US News & World Report* hospital rankings. These rankings include hospital rankings for 16 specialties, which include a total of approximately 150 hospitals. Although this variable shows positive correlation with prices, it is not statistically significant in this model. Overall, mortality/readmission rates and hospital rankings did not contribute significantly to explain the variability in hospital prices (the model explains about the same variability in non-Medicare prices (63%) with or without these preliminary quality measures).

The fifth model includes a measure of the average inpatient cost per discharge, as reported by the hospitals in the Medicare Cost Reports. Although prices and costs are interrelated (making it difficult to assume that costs are driving prices but prices do not affect costs) it is informative to assess whether prices are related to costs.

***Results**:* Prices show strong correlation with costs (approximately 75% correlation). When added to the regression model, this cost measure appears as a statistically significant variable that increases the explanatory power of the model to 72% for non-Medicare prices and 83% for all-payor prices. This suggests that prices are closely related to the average cost per discharge.

SUMMARY OF EMPIRICAL RESULTS AND DISCUSSION

The table below summarizes the results from these models for non-Medicare and all-payor prices, and shows that a large number of factors appear to explain price differences across hospitals, for both non-Medicare and all payor.

Overall, these models explain a large proportion of the differences in hospital prices – up to 72% of differences in non-Medicare prices and up to 83% of differences in all-payor prices. Furthermore, this Report identifies many variables that show a significant statistical relationship

with hospital prices: case mix, labor costs, shares of Medicare and Medicaid, DSH status, outlier payments, uncompensated care, organ transplants, share of outpatient charges, hospital assets, hospital size, and discharges per bed. Demographic, health status, and quality variables may also show correlation with prices, albeit these relationships are statistically weaker.[44]

Model	Explanatory Variables	Percentage of Price Variation Explained by the Model (R-squared Value)	
		Non-Medicare	All Payor
1	Case mix, teaching intensity, share of Medicare and Medicaid discharges, and regional costs (wage index)	48%	67%
2	Model 1 plus rural hospitals, DSH revenues, Medicare outlier operating payments as percentage of total PPS operating payments, uncompensated care per discharge, organ transplants per bed, and share of outpatient charges	56%	73%
3	Model 2 plus total assets per bed, annual discharges per bed, and number of beds	61%	77%
4	Model 3 plus age, sex, race, percentage of the population in poverty and uninsured, percentage of current smokers, heavy drinkers, and persons with a health checkup in the last two years	63%	77%
5	Model 4 plus average inpatient cost per discharge	72%	83%

Note: for non-Medicare prices, the number of hospitals in each model ranges from 3,461 (Model 1) to 3,402 (Model 5). For all-payor prices, the number of hospitals ranges from 3,503 (Model 1) to 3,444 (Model 5).

Unexplained Price Differences

As in all empirical studies, some variation in the data cannot be explained by the model. The unexplained price differences in these models are not unusual for an empirical study of this scale that attempts to explain hospital prices across regions with different populations and state regulations, among other factors. Although the models can be improved with further research and data, we view the explanatory power of the models as substantial for several reasons.

First, the variables used in a simplified model cannot capture all the idiosyncratic factors that affect hospital prices and the intensity of service needed by the population served by hospitals in different regions of the country. In particular, we find that the complexity of hospital quality and quality measures made the estimation particularly difficult. Other explanatory factors that potentially affect hospital prices may have been excluded from the models as well. This includes, for example, state-level health regulations that affect hospital costs and the supply of medical resources in the region, Medicaid rates and eligibility, and private-payor characteristics such as plan size and the share of patients under managed care.

Second, the non-Medicare prices analyzed here are not based on a single-payor formula. Instead, they are based on a combination of prices from several commercial payors, state-level Medicaid

programs, and other payors. The factors that determine those prices can vary by region and according to payor mix in ways not captured by a single model that attempts to explain prices for the entire country. As a result, factors that affect prices in some states may not affect prices in the same way in other states and will not be fully captured without a case-by-case inquiry.

Third, the healthcare sector is going through dramatic changes that affect hospitals. As a result, hospitals are subject to different sources of financial pressure and may respond to them over time through different pricing and cost-containment strategies.[45] These differences likely help explain differences in the data. These differences in the timing and the type of hospital responses will appear as unexplained variation in the data.

Finally, there is always some variability or "noise" in the variables caused by errors in the data. This includes reporting errors in the Medicare Cost Reports, case misclassification and lack of standardization of hospital data, and errors in other data sources. We eliminated apparent data errors by excluding observations with extreme values, but it is not possible to audit the data to eliminate most or all reporting errors. In addition to reporting errors, statistical noise is created when, for example, demographic variables from a metropolitan area are matched to the underlying population served by each hospital. This imperfect match between data sources creates additional variability that cannot be explained by the model.

However, as a matter of economics, it is incorrect to assume, as some researchers have, that any residual price variation not captured by the model reflects some form of inefficiency or market power.

> *"Most real world markets, even those for relatively 'homogenous' products and a market structure inconsistent with significant market power, exhibit significant price variation. These price differences do not prove that the firms have market power."* – FTC Chairman Timothy Muris[46]

The models presented above show that a large proportion of differences in hospital prices can be explained by factors associated with hospital cost drivers that some commentators have ignored, such as case mix, regional costs, payor mix, hospital investments, and other hospital characteristics. Although it is conceivable that differences in prices across markets are the result of differences in market structure or market conditions, the residual price differences in the data can also be the result of an array of idiosyncratic factors and data problems that the model is not able to capture. **There is no basis to conclude that these unexplained factors are related to hospital market power.**

SIDE BOX

Specific Application of the Econometric Models to Hospitals in the Regions Assessed by the "Payment Variation Article"

A recent article, "Wide Variation in Hospital and Physician Payment Rates Evidence of Provider Market Power" ("Payment Variation Article"), presents results of data analyses on price differences across hospitals and physicians and asserts market power as the primary cause.[1] There are a number of issues with the data used in this article, which are based on responses by some insurers that provided payment rates as percentages of calculated Medicare rates. The author acknowledges that each insurer used its own methodology to calculate these percentages but did not make an effort to verify and validate the information received.[2] As a result, there is no way to assess whether the price differences shown in the article are the result of differences in Medicare rates (including Medicare adjustments to specific hospitals), the result of insurers using different methodologies to calculate average rates, the result of differences in payor mix, or even the result of differences in the time periods or services covered.[3] Even if each insurer is internally consistent in compiling the data, differences in payor mix can make the comparisons unreliable.

There is no exploration in the article of the many factors that researchers have found that explain and inform differences among regions – the nature of cases, regional costs, the health status of the population, the share of Medicare/Medicaid populations, the extent to which hospitals deliver uncompensated care, and many more factors. For example, the article does not report any adjustment to the data to consider basic differences in the mix of services delivered by providers.[4]

The article concludes, without any support, that hospitals of nearly any size and location all have "market power." Crucial to its analysis is the fundamentally flawed claim that price differences constitute, by themselves, "evidence" of market power.[5]

We used our econometric models to analyze payment differences in the states and metropolitan areas covered by the article.[6] The results from the analysis of non-Medicare prices in these areas

[1] Ginsburg, Paul B, "Wide Variation in Hospital and Physician Payment Rates Evidence of Provider Market Power," Center for Studying Health System Change, Research Brief, No. 16 (November 2010).

[2] *See* Payment Variation Article, p. 2, Data Source.

[3] The article does not report the time period for the analysis or the services covered in the study. It only reports average inpatient and outpatient payments (relative to Medicare).

[4] The Article acknowledges that some of the price differences might be explained by other factors (Medicare adjustments, Medicaid rates, uncompensated care), but concludes, without any theoretical or empirical basis, that the "degree" of differences suggests that market power is important (*see* p. 7). The Article also acknowledges that payment differences may be the result of insurer concentration (*see* p. 2). However, without further analysis, it concludes that price differences are evidence of *provider* market power.

[5] The absence of a plausible theory of market power leads the author to conclude that hospitals in both San Francisco and rural Wisconsin, hospitals that are highly regarded, hospitals that are part of a system, hospitals in concentrated markets with low rates, and hospitals in unconcentrated markets with high rates, all have market power. When an actual "market" is not sufficient, the author claims that smaller "submarkets" are the source of market power. *See* Payment Variation Article, p. 3.

are largely similar to those we report in Section III for the entire sample of U.S. hospitals. First, the regions included in the Payment Variation Article show similar variation in non-Medicare prices to those of other U.S. regions.[7] Second, combining all hospitals in these regions, the models from the previous section explain approximately the same proportion of difference in non-Medicare prices as for the entire sample of U.S. hospitals.[8]

In addition to its data limitations, the Payment Variation Article fails to take into account several factors that explain differences in hospital prices. These factors have been extensively discussed in the healthcare literature and shown to explain a large share of the differences in prices across U.S. hospitals – including the specific regions analyzed by the article. Instead, the article incorrectly concludes that these price differences constitute "evidence" of market power.

[6] The article analyzed eight regions identified as having wide variation in payments: Los Angeles (CA), San Francisco (CA), Miami (FL), Atlanta (GA), Indianapolis (IN), Cleveland (OH), Richmond (VA), Milwaukee (WI), and rural Wisconsin.

[7] We use the coefficient of variation to measure overall price dispersion (the sample standard deviation divided by the sample mean). For 2008, the coefficient of variation is 52% for all U.S. hospitals, 50% for hospitals in the states included in the Payment Variation Article, and 52% for the metropolitan areas included in the article. Results are similar for other years in the dataset.

[8] Although results vary at the state level, a simplified model explains a large proportion of the differences in non-Medicare prices within each state. Because the state-level analyses are based on fewer hospitals than the analyses that combine all states, for this analysis we need to use a simplified model with fewer explanatory variables. The variables used are: CMI, teaching intensity, shares of Medicare and Medicaid discharges, rural indicator, outlier operating payments, uncompensated care, outpatient share, assets per bed, and wage index (for California only).

[1] This report benefited substantially from the assistance of Jeffrey Raileanu and Matthew Schmitt of Compass Lexecon. This report made use of healthcare literature, data from the Centers for Medicare & Medicaid Services ("CMS"), and AHA data. The views and opinions presented are solely those of the authors and do not necessarily reflect the views of organizations with which the authors are or have been affiliated. The co-authors have worked on a number of healthcare matters for a variety of healthcare entities, including providers, health plans, government, and associations. A summary of the healthcare experience is available at www.compasslexecon.com.

[2] Haas-Wilson, Deborah, and Christopher Garmon, "Two Hospital Mergers on Chicago's North Shore: A Retrospective Study," Bureau of Economics, Federal Trade Commission, *Working Paper*, No. 294 (2009), p. 9.

[3] *Id.*

[4] The practice of "cost shifting" has been long documented in the healthcare literature. A summary is provided by Dobson, Allen, Joan DaVanzo, and Namrata Sen, "The Cost-Shift Payment 'Hydraulic': Foundation, History, and Implications," *Health Affairs*, Vol. 25, No. 1 (2006) ("Dobson et el., 2006"). A recent study by Milliman Inc. suggests that hospitals may use different degrees of cost shifting or cost management to compensate for Medicare payment rates. *See* Milliman Inc., "High Value for Hospital Care: High Value for All?" Report commissioned by the National Business Group on Health (March 2010) ("Milliman Inc., 2010").

[5] AHA defines adjusted admissions as inpatient admissions plus an estimate of revenue-equivalent admissions attributed to outpatient services. Revenue per adjusted admission data are available from AHA and provide one measure of "price." Similar measures of "price" are used in this paper, and include average revenue per discharge.

[6] Non-Medicare hospital services and prices are examined as a proxy for services provided to patients covered by commercial insurance and prices paid by commercial insurers. We developed measures of hospital inpatient prices based on the Medicare Cost Report data, which provide a means to assess prices for Medicare as well as non-Medicare inpatient services. The Medicare Cost Reports provide revenue and discharge data, by hospital, from which we can estimate *average hospital inpatient revenues* (per discharge) for Medicare and non-Medicare patients. Non-Medicare patients include patients covered by commercial payors, Medicaid, other government payors, and self pay. Therefore, we use the term "price" in this report to refer to our calculated average hospital inpatient revenues per discharge. This measure reflects average inpatient prices and, to some extent, the hospital's resource utilization per discharge.

[7] We also informed our analyses by reviewing the literature on hospital quality. While quality measures are very complex and difficult to capture in econometric models, the empirical analyses suggest that numerous other factors explain the observed differences in hospital prices.

[8] We address in Section III how we measure price differences. Our empirical analyses of Medicare prices and all-payor prices confirm the robustness of the modeling for non-Medicare prices, and the key explanatory factors. This is because many of the identified factors are expressly used by Medicare as proxies for costs, and reimbursements for Medicare vary based on these factors.

[9] National Health Expenditure Account data is published by CMS and is available at: https://www.cms.gov/NationalHealthExpendData/.

[10] Throughout the text, the terms "expenditures" and "spending" are used synonymously.

[11] The analysis uses 2001 for comparison to provide an update of analyses conducted in 2003. *See* Guerin-Calvert, Margaret E., David Argue, Paul Godek, Barry Harris, and Stephanie Mirrow, "Economic Analysis of Healthcare Cost Studies Commissioned by Blue Cross Blue Shield Association," February 2003 ("Guerin-Calvert et al., 2003").

[12] Analysis of the CMS "National Health Expenditure Projections 2009-2019" file, last accessed January 14, 2011.

[13] Some other categories of total spending, such as Home Health Care, are projected to grow at faster rates, while others, such as Medical Products outside of prescription drugs, are projected to grow at slightly lower rates.

[14] CMS introduced minor changes in the categorization of health expenditures in its release of 2009 data. As a result, the expenditures categories from its previous projections for 2009-2019 are not directly comparable to the expenditure categories in the 2009 data. Nonetheless, hospital care accounts for approximately the same share of total expenditures over the projected period 2009-2019.

[15] *See, e.g.*, AHA, Trendwatch Chartbook 2010, Chart 6.10.

[16] *See, e.g.*, "Technological Change and the Growth of Health Care Spending," Congressional Budget Office, January 2008. Summarizing academic literature on healthcare spending, the report concludes that "the general consensus among health economists is that growth in real health care spending was principally the result of the emergence of new medical technologies and services and their adoption and widespread diffusion by the U.S. health care system" (p. 6).

[17] For a concise summary, *see* RAND, "Health Information Technology: Can HIT Lower Costs and Improve Quality?" (2005). For more detail, *see* the CMS website at https://www.cms.gov/EHRIncentivePrograms/.

[18] American Hospital Association, "The Road to Meaningful Use: What it Takes to Implement Electronic Health Record Systems in Hospitals" (2010).

[19] American Hospital Association, "Report on the Capital Crisis: Impact on Hospitals" (2009).

[20] For example, Li, Bahensky, Jaana, and Ward (2008) find that small hospitals (25 beds or less) are more likely to be at a further stage of EMR adoption if owned by a multihospital system, even after controlling for structural capacity measures such as the number of operating rooms and FTE staff. Similarly, the 2008 AHA Annual Survey Information Technology Supplement collected data on computerized system capabilities for nearly 4,000 hospitals. For each capability specified (*e.g.*, CPOE for medications, electronic clinical documentation of discharge summaries, etc.), hospitals reported the level of implementation. Across the full range of computerized system capabilities, hospitals belonging to a healthcare system were more likely to have implemented computerized systems.

[21] Analysis of AHA Annual Survey data for community hospitals, 2000-2009. AHA calculates payment-to-cost ratios based on (i) actual Medicare and Medicaid payments received by hospitals (including payment adjustments such as DSH and IME), and (ii) estimated Medicare and Medicaid costs. Costs are estimated from Medicare and Medicaid gross charges multiplied by hospital's overall cost-to-charge ratio (*i.e.*, total reported expenses divided by gross patient and other operating revenue). *See* AHA, "Underpayment by Medicare and Medicaid," Fact Sheet, December 2010.

[22] Estimated uncompensated care costs are available at: http://www.aha.org/aha/research-and-trends/health-and-hospital-trends/2010.html, (last accessed January 31, 2011).

[23] Guerin-Calvert, Margaret E., and Guillermo Israilevich, "A Critique of Recent Publications on Provider Market Power," October 4, 2010 ("Critique").

[24] As mentioned above, as a "price" measure, we calculate three price measures using Medicare Cost Report data: average hospital inpatient revenues for Medicare, non-Medicare, and all payors.

[25] Some studies adjust for case mix while others calculate overall per-capita health spending.

[26] We focused our statistical analysis on explanatory variables commonly used in the literature. Due to the limitations described above, our models do not make direct use of quality measures. However, other explanatory variables may indirectly capture quality effects related, for example, to hospital size, volume, case mix, and other hospital-level characteristics.

[27] A result is considered statistically significant if it is unlikely to have occurred by chance. We refer to statistical significance at the 5% level. This means that that there is 5% (or less) probability that the observed relationship could have happened by coincidence.

[28] In a letter addressing our Critique, the Massachusetts Assistant Attorney General incorrectly claims that the Medicare Cost Reports do not contain payment data from commercial payors and "only contain hospital-reported costs." This is incorrect. The Medicare Cost Reports contain data on hospital charges and revenues for Medicare and all payors, from which we are able to estimate average prices for non-Medicare payors, as described in more detail below. *See* Letter from Thomas O'Brien, Assistant Attorney General, The Commonwealth of Massachusetts, Office of the Attorney General, December 8, 2010, p. 2.

[29] We use the formula provided by Dafny (2009) to estimate average non-Medicare revenues per discharge. *See* Dafny, Leemore S., "Estimation and Identification of Merger Effects: An Application to Hospital Mergers," *Journal of Law and Economics*, Vol. 52, No. 3 (2009), p. 531 and fn. 13 ("Dafny, 2009").

[30] This is because non-Medicare inpatient revenues have to be estimated from the revenue data provided for all the hospital's patient services (that is, for both inpatient and outpatient services). Another limitation of the Medicare Cost Reports is that the calculated non-Medicare prices represent an average for commercial payors, Medicaid, other government, and self pay. As such, our price variable may show more variation than what would be observed from actual hospital prices for inpatient services, because it includes other types of payment. This may limit the ability of the model to explain price differences. For example, if a hospital has a large share of outpatient services, and revenues for these services are subject to higher discounts over charges (relative to inpatient services), our calculation will tend to reflect lower inpatient revenues relative to those from hospitals with a smaller share of outpatient services.

[31] The data used in the regression analyses are limited to general short-term and specialty hospitals under Medicare's Prospective Payment System (PPS). For other hospitals, the Cost Reports do not provide detailed data to calculate non-Medicare prices, and CMI data are not available from the CMS website.

[32] This is known as the "between" estimator in the panel data methodology.

[33] Approximately 200 hospitals were dropped because of insufficient data (these represent approximately 2% of non-Medicare discharges). This includes approximately 27 Kaiser Foundation Hospitals that are dropped because they do not provide data on total inpatient charges in the Medicare Cost Reports.

[34] The wage index is defined at the Core Based Statistical Area (CBSA) level and adjusted for hospital specific factors such as occupational mix. We also included a time-trend variable to reflect any minor differences across hospitals due to differences in the fiscal years covered.

[35] The teaching intensity variable, although statistically significant in the model for all payors, is not significant in this model formulation for non-Medicare prices (*see* Appendix C for additional detail). This coefficient also depends on the region and/or states under analysis.

[36] The statistical significance of the Medicare and Medicaid discharges varies depending on the model.

[37] We use the Medicare wage index in the model because it is available for more hospitals (in particular, those outside urban centers for which cost of living data are not available).

[38] Outlier payments are not reported by CMS for hospitals in Maryland (Maryland hospitals are not reimbursed under Medicare's Inpatient Prospective Payment System). As a result, 45 Maryland hospitals are not included in this model and the models that follow. Also, note that the results of the first model do not change significantly if we exclude Maryland's hospitals (which are subject to the state's rate regulation).

[39] *See* Koenig, Lane, Allen Dobson, Silver Ho, Jonathan M. Siegel, David Blumenthal, and Joel S. Weissman, "Estimating the Mission Related Costs of Teaching Hospitals," *Health Affairs*, Vol. 22, No. 6 (2003) ("Koenig et al., 2003").

[40] Note that DSH payments are not statistically significant in the fifth model discussed below. Also, as part of Medicare's reimbursements, DSH payments are positively correlated with Medicare prices (and statistically significant).

[41] Uncompensated care and the share of Medicare discharges are positively correlated with prices. This finding is consistent with the empirical findings on cost shifting from Dobson et al., 2006, and others. Since Medicaid and commercial discharges are both included in our measure of non-Medicare prices, we cannot test the presence of cost shifting between Medicaid and commercial payors.

[42] Results from this model are largely unchanged if one uses dummy variables to identify DSH and teaching hospitals, or if one uses the Medicare DSH and IME adjustment percentages, as reported in the PPS Impact Files, instead of calculating these amounts per discharge. In addition, these variables do not exhibit high colinearity with the shares of Medicare and Medicaid discharges introduced in the first model.

[43] Another limitation of the BRFSS data is that for certain areas the sample of respondents is too small to be considered statistically reliable.

[44] There is more than 50% correlation between Medicare and non-Medicare prices. As noted in the Critique, similar variables explain Medicare average inpatient revenues (or "prices" in our model). Overall, the models shown above explain about 90% of the variability in Medicare prices. Certain variables that determine Medicare's reimbursements show strong correlation with prices. This includes case mix, wage index, teaching intensity, DSH, outlier payments, among other variables.

[45] A study by Milliman Inc. identified cities with low per-capita hospital revenues for both Medicare and commercial payors, as well as cities in which hospitals had low Medicare revenues but relatively high commercial revenues. Milliman Inc. could not identify common factors such as cost drivers or market characteristics for either group. It concludes that hospitals may use different degrees of cost shifting or cost management to compensate for Medicare payment shortfalls. *See* Milliman Inc., 2010.

[46] *See* FTC Chairman Timothy Muris, "Improving the Economic Foundations of Competition Policy," Section III, Part B, January 15, 2003. The literature in economics discusses price dispersion in the context of product differentiation, costly information, technological progress, and price discrimination. *See, e.g.*, Levya, David M., and Michael D. Makowskyb, "Price Dispersion and Increasing Returns to Scale," *Journal of Economic Behavior & Organization*, No. 73 (2010); and Telser, Lester G., *Economic Theory and the Core*, The University of Chicago Press (1978), chapter 7.

Appendix B: Data and Methodology

A. Centers for Medicare & Medicaid Services ("CMS") Cost Reports

We use Centers for Medicare and Medicaid Services Cost Reports ("Medicare Cost Reports" or "Cost Reports") to obtain, for each hospital, aggregate estimates of Medicare and non-Medicare average inpatient revenues per discharge. These reports also provide additional information on discharges, hospital characteristics, and Medicare payments. Below is a summary of the main information provided by the Cost Reports:

- Hospital information: type of hospital, type of control, urban/rural, teaching, DSH status, number of beds, interns and residents, solid organs transplants, etc.
- Discharge data: inpatient discharges and outpatient visits (total, Medicare, and Medicaid)
- Total hospital patient charges (inpatient and outpatient) and total revenue
- Total Medicare charges, total costs, inpatient revenues, and other Medicare payments (*e.g.*, DSH, IME, SCH/MDH)
- Hospital costs: average hourly salaries, full-time equivalent staff, uncompensated care, total hospital operating cost, and balance sheet data

One limitation of the Cost Reports is that they do not provide actual payments for inpatient services from each payor. They only provide payment data on total patient services (that is, for both inpatient and outpatient services) and Medicare. Another limitation is that they provide inpatient discharges for Medicare, Medicaid, and a total for all payors. Consequently, one can only calculate discharges for an "other" category that would include third party payors, managed Medicare and Medicaid, self pay (and bad debt), and other payors. The reports are based on each hospital's fiscal year (approximately 90% of the hospitals have fiscal years ending in June, September, or December). Observations that reported time periods other than a full year were dropped.

The data used in the regression analyses are limited to general short-term and specialty hospitals under Medicare's Prospective Payment System (PPS) in the 50 states and the District of Columbia.[1] For other hospitals, the Cost Reports do not provide detailed data to calculate non-Medicare prices, and CMI data are not available from the CMS website.

Construction of Price Variables[2]

The average hospital inpatient price per discharge can be estimated as:

IP Price (All Payors) = (Total IP Charges * Discount Factor) / Total IP Discharges,

where Total IP Charges include general inpatient routine care charges, intensive care charges, and inpatient ancillary services charges; the discount factor is based on the ratio of total hospital

[1] The state of Maryland has a Medicare waiver which allows the state to set hospital rates for Medicare. These hospitals are also analyzed even though they are not reimbursed under PPS.

[2] Hospitals lacking necessary pieces of the price variables, *e.g.*, the ratio of payments to charges (or discount factor), are excluded. Depending on the price variable, this results in the loss of between 2-3% of all hospitals in the dataset. Most if not all Kaiser Foundation Hospitals in California are excluded as their Cost Report data are insufficient to calculate inpatient charges.

revenues to total charges (inpatient and outpatient); and discharges exclude swing beds, hospice, and skilled nursing facilities.

For Medicare, the Cost Reports provide data on IP charges, payments and discharges. The average Medicare IP price per discharge is calculated as:

IP Price (Medicare) = Medicare IP Payments / Medicare Discharges

In order to obtain a measure of non-Medicare prices, we follow the formula proposed by Dafny (2007).[3] This formula excludes Medicare revenues and discharges from the average IP price calculation:

IP Price (Non-Medicare) =

(Tot. IP Charges * Discount Factor – Medicare IP Payments) / Non-Medicare Discharges,

where the "Medicare IP Payments" subtracted in the numerator include DSH, IME, GME and other revenues from Medicare. Hence, all Medicare payments are excluded from the calculation of non-Medicare prices.

Removal of Extreme Values

Several key variables affecting the estimated price measures (*e.g.*, total discharges, inpatient charges, etc.) and explanatory variables (*e.g.*, beds) are scanned for extreme values, or statistical outliers. For each variable, the mean value of that variable is calculated by hospital across the 5 years in the sample. If a given observation for that hospital departs from the mean by a percentage greater than a specified threshold, that observation is replaced as missing. The mean is then recalculated and the process iterated until there are no remaining extreme values. The threshold is determined by the nature of the variable – for example, the threshold for beds is lower than that for inpatient charges since it is more likely for there to be bigger changes year to year in inpatient charges than in beds. In addition, observations with revenues per discharge of less than $500 or greater than $35,000 were also dropped. Depending on the variable, this process affects anywhere from effectively 0% of the observations up to approximately 2% of the observations. In each case, the observations being replaced as missing were examined to make sure that the process was detecting likely data errors rather than removing substantive data.[4]

B. CMS Hospital Inpatient Prospective Payment System ("PPS") Final Rule Impact Files[5]

The Final Rule Impact Files ("Impact Files") contain information for hospitals reimbursed under PPS (and those in the state of Maryland). In addition to variables specifying the location of each hospital such as region and county, information is also provided on CMI (including transfer-adjusted), beds, resident to bed ratio, DSH adjustment, and various other factors that Medicare

[3] Dafny, 2009, p. 531 and fn. 13.

[4] We note that regression analyses without removing these extreme values lead to essentially similar results, albeit with lower R-squared values due to the additional noise these extreme values add to the model variables.

[5] For more detail, *see*: http://www.cms.gov/AcuteInpatientPPS/01_overview.asp#TopOfPage

uses to adjust PPS payments. As noted above, hospitals with no CMI data (typically non-PPS hospitals) are excluded from the analysis.[6] Key variables that are used from the Impact Files include CMI, Wage Index, and Outlier Payments, described in further detail below.

Case Mix Index (CMI): Individual inpatient discharges are associated with a Diagnosis Related Group (DRG) that classifies patients that use similar hospital resources into the same group (*e.g.*, DRG 7 refers to lung transplants). Each DRG has an associated DRG-weight which reflects the estimated relative costliness of patients in that DRG compared with the average Medicare patient across the country. CMI provides the average DRG weight for the hospital, calculated as the sum of all DRG weights for Medicare discharges divided by the total number of discharges.

Wage Index:[7] For each labor market area, where the areas are defined as Core Based Statistical Areas (CBSAs) and statewide rural areas outside of CBSAs, CMS calculates an average hourly wage as total wage costs divided by total hours for all hospitals in the area. Similarly, a national average hourly wage is calculated. The wage index is defined as the ratio of the area's average hourly wage to the national average hourly wage. Various adjustments to this ratio can be made by CMS for hospitals that, for example, lie near a CBSA border and are determined to face a labor market more appropriately defined by a higher-cost adjacent CBSA. Adjustments are also made for occupational mix.

Outlier Payments:[8] Outlier payments exist to reimburse hospitals for cases with costs that exceed the fixed-loss cost threshold amount, which is determined yearly by CMS and then adjusted by case and hospital for DRG weight, wage index, IME, DSH, etc. For each dollar in cost exceeding the determined threshold, the hospital is reimbursed at a constant rate of between 80-90%, depending on the DRG. Payments are determined separately for operating and capital costs, which are affected by the hospital's operating and capital cost-to-charge ratios and several other adjustments. The Impact Files provide data on outlier payments as a percentage of provider operating/capital PPS payments.

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[6] Approximately 2% of the observations in the Medicare Cost Reports (for short-term general and specialty hospitals) do not have CMI data in the impact files.

[7] For more detail, *see*: https://www.cms.gov/AcuteInpatientPPS/03_wageindex.asp. MedPAC has proposed an alternative wage index measure that smoothes the index between counties, uses wage data from BLS/Census surveys rather than hospital cost reports, and fixes the occupational mix rather than allowing it to vary by hospital. The MedPAC index does not appear to have been made publically available. For more detail, *see*: http://www.medpac.gov/documents/Jun07_EntireReport.pdf.

[8] For more detail, *see*: https://www.cms.gov/AcuteInpatientPPS/04_outlier.asp#TopOfPage. While the CMS impact files typically contain CMI information for Maryland hospitals, outlier payments are not present (due to the different system of reimbursement). Therefore, all regressions including outlier payments exclude all Maryland hospitals.

C. Behavioral Risk Factor Surveillance System ("BRFSS")[9]

The Centers for Disease Control and Prevention (CDC) collects data on a variety of questions related to health risk behaviors, healthcare access, and health status. The data are collected via telephone interview from approximately 350,000 adults a year. Each record in the data is an individual survey, which can be aggregated by county, state, or any areas composed of counties and/or states. Most variables are self reported, and respondents may refuse to answer questions. Data were analyzed for survey years 2000-2009, with each variable calculated across all available surveys over the period. When aggregating to the CBSA level, all non-CBSA counties in a given state are considered part of the "rural" area of the state. The variables used are:

- Current Smoker: defined as those who have smoked 100 cigarettes in their life and smoke either "every day" or "some days" at the time of the survey
- Heavy Drinker: defined as those males who drink an estimated 60 or more drinks every 30 days, and females who drink an estimated 30 or more drinks every 30 days
- Health Checkup: time since last visit to a doctor for a routine checkup (a general physical exam not for a specific injury or illness)

D. Area Resource File ("ARF")[10]

The ARF is published by the Health Resources and Services Administration (HRSA). It is a collection of data from a wide range of sources at the county level. ARF compiles information from the American Medical Association and the American Hospital Association, among other sources. Population characteristics such as income and racial makeup are compiled from Census data. When aggregating to CBSA, all non-CBSA counties in a given state are considered part of the "rural" area of the state. The variables used in the analysis typically measure these characteristics as percentages of the total population in the area – *e.g.*, the percentage of population in the CBSA under age 65 that have health insurance.

E. Quality Data

Risk-adjusted 30-day readmission and mortality rates for heart attack, heart failure, and pneumonia for Medicare beneficiaries are obtained from Hospital Compare data.[11] To estimate these rates, CMS uses Medicare claims data and a risk-adjustment process that controls for factors such as age, gender, and comorbidities. Mortality and readmission rates, however, are not available for all hospitals in our sample. We also included in the dataset indicator variables marking hospitals that appear in the 2010-2011 US News & World Report "Best Hospitals."[12]

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[9] For more information, *see*: http://www.cdc.gov/brfss/.

[10] For more information, *see*: http://arf.hrsa.gov/.

[11] For more information, *see*: https://www.cms.gov/HospitalQualityInits/11_HospitalCompare.asp.

[12] For more information, *see*: http://health.usnews.com/best-hospitals/rankings.

Explanatory Variables

The table below summarizes the explanatory variables used and the source of each variable (the price variables are calculated from the Medicare Cost Reports as described above). Some variables are directly available from the specified source while others are calculated.

Explanatory Variable	Source	Explanatory Variable	Source
Case-Mix Index (CMI)	Impact Files	Average Inpatient Cost per Discharge	Cost Reports
Medicare Wage Index	Impact Files	% Population Black in Hospital CBSA	ARF
Operating Outlier Payments (%)	Impact Files	% Population Hispanic in Hospital CBSA	ARF
Share of Medicare Discharges	Cost Reports	% Population in Poverty in Hospital CBSA	ARF
Share of Medicaid Discharges	Cost Reports	% Population Male in Hospital CBSA	ARF
Teaching Intensity (Interns and Residents per Bed)	Cost Reports	% Population Under Age 65 Insured in Hospital CBSA	ARF
Rural Hospital Indicator	Cost Reports	Average Age in Hospital CBSA	ARF
Share of Outpatient Charges over Total Charges	Cost Reports	% Population Current Smoker in Hospital CBSA	BRFSS
Total Hospital Assets	Cost Reports	% Population Heavy Drinker in Hospital CBSA	BRFSS
Hospital Beds	Cost Reports	% Population with a Health Checkup in Last 2 Years in Hospital CBSA	BRFSS
Total Discharges per Bed	Cost Reports	Mean of 2008 30-day Mortality Rates for Heart Attack, Heart Failure, and Pneumonia	Hospital Compare
DSH amount	Cost Reports	Mean of 2008 30-day Readmission Rates for Heart Attack, Heart Failure, and Pneumonia	Hospital Compare
Organ Transplants per Bed	Cost Reports		
Uncompensated Charges per discharge	Cost Reports	2010 US News & World Report Best Hospitals in any of the 16 Specialties	US News

Conversion of Variables to Logarithmic Form

In the literature reviewed, some researchers convert variables to logarithmic form.[13] For ease of exposition, we convert the price variables and the explanatory variables to logarithmic form. One advantage of this approach is that the coefficients from the regression models (*see* Appendix C) can be interpreted as the percentage change in prices from a 1% change in the explanatory variable.[14]

[13] Logarithms are standard functions used in various scientific formulas. One advantage of converting a variable to logarithmic form is that extreme values are "smoothed out" into smaller scopes. This reduces the possibility that the regression results are driven by a few unusual observations.

[14] The time trend variable and the indicator variables (rural and US News & World Report Best Hospitals indicators) are not converted to logarithmic form.

This transformation does not generally change the explanatory power of the models with respect to the alternative level regressions.[15] In a few cases, the transformation to logarithmic form changes the statistical significance of the variables. For example, mortality and readmission rates show significant correlation with hospital prices in the logarithmic regressions but not in the level regressions. The reverse occurs with the teaching intensity variable and the US News & World Report hospital rankings, which show statistically significant correlation in the level regressions but not in the logarithmic regressions.

[15] The conversion to logarithmic form changes the interpretation of the R-squared values of the regressions. However, considering that the R-squared values are similar to those from level regressions with the same variables, we refer to the R-squared values as the proportion of the price variation explained by the model.

Appendix A: Summary of Literature

This Appendix provides summaries of selected empirical studies that focus on the variation in healthcare spending, costs, and prices. The table below summarizes the explanatory variables used in each study. In addition, we discuss the literature that explores hospital quality.

Studies Focused on Medicare Spending

- Cutler and Sheiner (1999) identify large regional variations in Medicare spending across 212 hospital referral regions.[1] The authors note that these differences may or may not reflect inefficiency. In order to examine the source of regional differences, they conduct a series of regression analyses that measure the extent to which regional differences in Medicare spending can be explained by differences in illness, demographic differences that affect the demand for medical care, or differences in the supply of medical care. They find that variables related to illness explain 66% of the variability in Medicare spending. Demographic factors and variables that reflect medical supply further increase the explanatory power of the model to between 75 and 80%.[2]

- Researchers associated with the Dartmouth Atlas Project have reported in several studies a wide regional variation in Medicare spending.[3] The studies have either focused on price-adjusted Medicare spending by region or samples of patients presumed to be similarly ill across regions, with few adjustments for patients' demographic characteristics and health status. According to the Dartmouth researchers, some of the regional variation is due to differences in prices paid for similar services, and some is due to differences in illness, but large differences remain in terms of the volume of healthcare services received by patients in different regions. These differences in volume are shown in the more frequent use of hospital or physician services, diagnostic tests, and other procedures in some regions. They also conclude that integrated delivery systems offer great promise for improving quality and lowering costs. It remains unclear, however,

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[1] Cutler, David M., and Louise Sheiner, "The Geography of Medicare," *American Economic Association Papers and Proceedings*, Vol. 89, No. 2 (1999) ("Cutler and Sheiner, 1999"). Hospital referral regions are created by grouping zip codes into geographic units where a preponderance of hospital admissions occur.

[2] Some demographic factors (share of the population that is black, Hispanic, female, poor, or rich) increase the explanatory power of the model to approximately 70%. It should be noted, however, that the data used in this study already adjusts spending by age, race, sex and differences in Medicare payment rates by region. This reduces the apparent explanatory power of the demographic variables. In terms of medical supply, areas with large shares of for-profit hospitals and specialists appear to have higher spending, although the authors note that these variables are potentially endogenous (for example, high medical spending among sick populations may contribute to increase the supply of specialists but may not be caused by it).

[3] *See* Fisher, Elliott S., Julie P. Bynum, and Jonathan S. Skinner, "Slowing the Growth in Health Care Costs – Lessons from Regional Variation" *The New England Journal of Medicine*, Perspective (February 2009); "The Policy Implications of Variations in Medicare Spending Growth," The Dartmouth Atlas of Health Care (2009). *See* also Fisher, Elliott S., David E. Wennberg, Therese A. Stukel, Daniel J. Gotlieb, F.L. Lucas, and Etoile L. Pinder, "Implications of Regional Variations in Medicare Spending - Part I," *Annals of Internal Medicine*, Vol. 138, No. 4 (2003) ("Fisher et al., 2003"); and Fisher, Elliott S., David E. Wennberg, Therese A. Stukel, and Daniel J. Gottlieb, "Variations in The Longitudinal Efficiency of Academic Medical Centers," *Health Affairs* (2004) ("Fisher et al., 2004").

whether the observed differences in utilization respond to unobservable patient characteristics—as reflected in the demographic and health status variables used in other studies, graduate medical education and other Medicare payments, provider and/or payor characteristics (*e.g.*, supplemental coverage), or inefficiency.

- In a more recent study, Zuckerman et al. (2010) analyzed regional Medicare spending per beneficiary.[4] The study finds that the observed geographic differences in spending could be explained in large part by differences in patients' demographic characteristics and health status. Demographic characteristics reduced the magnitude of the unexplained differences by about 50% (measured as the difference between the first and fifth quintiles of the distribution). Variables reflecting health status of the population further reduced the unexplained differences to 33%.[5] Zuckerman et. al (2010) conclude that previous findings may exaggerate the importance of regional differences in Medicare spending if these differences are in part due to unmeasured patient characteristics.[6]

- Reschovsky et al. (2011) conducted a beneficiary-level analysis with additional explanatory variables to capture demand factors, such as patient characteristics and health status, and supply factors, such as the number of hospital beds, physicians and the availability of other healthcare resources.[7] Consistent with Zuckerman el at. (2010), this study finds that the large majority of Medicare service use can be explained by health status and patient demographics, with supply factors being insignificant or weakly related to service use.

- The Medicare Payment Advisory Commission ("MedPAC") analyzed regional differences in Medicare spending and Medicare service use.[8] MedPAC's analysis adjusts raw Medicare spending per region to obtain a measure of Medicare "use" of services (*i.e.*, a measure of the "quantity" of services delivered). To do this, MedPAC first adjusts Medicare spending for differences in Medicare payment rates (*e.g.*, regional wages and

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[4] As in Cutler and Sheiner (1999) the data are adjusted by Medicare standardized prices but could not be adjusted to remove Medicare payments for DSH and teaching hospitals. *See* Zuckerman, Stephen, Timothy Waidmann, Robert Berenson, and Jack Hadley, "Clarifying Sources of Geographic Differences in Medicare Spending," *The New England Journal of Medicine,* Special Article (2010) ("Zuckerman et al., 2010").

[5] Other variables reflecting income and the supply of healthcare resources did not add significant explanatory power to the model.

[6] In their study, Zuckerman et al. (2010) show that the results from simple models that only incorporate some baseline health characteristics and demographic variables are similar to earlier results obtained by Sutherland et al. (2009) and Dartmouth researchers. *See* Sutherland, Jason M., Elliott S. Fisher, and Jonathan S. Skinner, "Getting Past Denial—The High Cost of Health Care in the United States," *The New England Journal of Medicine,* Perspective (September 2009); and Fisher et al., 2003.

[7] Reschovsky, James D., Jack Hadley, Cynthia B. Saiontz-Martinez, and Ellyn R. Boukus, "Following the Money: Factors Associated with the Cost of Treating High-Cost Medicare Beneficiaries," *Health Services Research* (article online in advance of print - February 2011). This study uses standardized cost as a measure of service use. This measure includes the full reimbursement from Medicare, other insurers and patient payments, eliminates geographic payment differences that account for input price variation, and adjusts for other Medicare payments such as DSH and graduate medical education.

[8] "Regional Variation in Medicare Service Use," Medicare Payment Advisory Commission, Report to the Congress (January 2011).

special payments to teaching, DSH, and rural hospitals) and then adjusts spending levels for differences in beneficiaries' health status, demographics, and other factors. After these adjustments, variation in spending across regions drops from 55% to 30% (measured as the difference between the 90th and 10th percentile of the distribution). MedPAC finds that this variation in service use is still substantial. Nonetheless, about 46% of Medicare beneficiaries live in areas that have a service use within 5% of the national average and approximately 85% live in areas with a service use within 15% of the national average.[9] This variation in service use does not imply waste or inappropriate hospital practices. For example, although this study takes into account Medicare adjustments such as GME/IME and DSH, it is generally understood that teaching hospitals will use more services (*e.g.*, more scans), not only more personnel. This may not be fully captured by the IME adjustment, but still recognized through higher Medicare spending. The study also notes that differences in service use could result from other factors that affect beneficiaries' care-seeking tendencies, such as the availability of supplemental insurance, ease of access, and others. Finally, MedPAC notes that although growth in service use also varies by region, it is not positively correlated with the level of service use. In fact, MedPAC finds a slightly negative correlation between service use and service growth.

- The Congressional Budget Office (CBO) also provides a review of the literature on regional differences in Medicare spending.[10] It concludes that prices of healthcare services and the population's health status are important in explaining geographic variation. According to the CBO review, other demographic characteristics and patients' treatment preferences appear to explain a small amount of the geographic variation and a substantial portion of the variation remains unexplained.

Studies Focused on Non-Medicare Patients

- Koenig et al. (2003) analyzed all-payor hospital inpatient costs using the Medicare Cost Reports.[11] The authors estimate an average inpatient cost per discharge for approximately 3,500 U.S. hospitals. Their model includes several of the explanatory variables used in this Report. It includes case mix, the Medicare wage index, urban/rural indicator variables, the shares of Medicare and Medicaid hospital days, special care days, and Medicare outlier payments. In addition, the model includes explanatory variables that distinguish among three types of mission-related costs for teaching hospitals: (i) graduate medical education, (ii) biomedical research, and (iii) the maintenance of standby capacity for complex and highly specialized cases.[12] The results show that academic medical

[9] Looking at the extremes values of the distribution of service use, MedPAC finds that the area with the greatest service use (Miami, FL) has nearly twice the level of service use as the region with the lowest service use (LaCrosse, WI). MedPAC raises concerns that these differences could stem from overuse and possibly fraud and abuse by some providers.

[10] "Geographic Variation in Health Care Spending," Congressional Budget Office (February 2008), ("CBO Report, 2008"). Although this study was published in 2008, it should be noted that it used Medicare data from 2004 and before, and most of the literature reviewed in the study is from before 2004.

[11] Koenig et al., 2003.

[12] As it is done in other studies and this Report, the authors use the number of hospital interns and residents per bed as a measure of the hospital's teaching intensity. In order to obtain measures of the

centers and other teaching hospitals do more research and have more standby capacity than nonteaching hospitals. In addition, teaching hospitals tend to have higher case mix and labor costs. For academic medical centers, variables related to case mix and regional costs account for 26% of the total inpatient cost and the combined mission-related activities account for an additional 28% of the total inpatient costs. They also find that the maintenance of standby capacity represents the largest mission-related cost for teaching hospitals.

- While not including regression analyses, a report from Milliman Inc. calculates average costs and prices for California hospitals.[13] Cost estimates are based on operating costs (for all payors) and average prices are estimated from allowed charges for commercial inpatient discharges. The report takes into account geographic differences in costs through Medicare's inpatient adjustment factors and adjusts for case mix by making use of APR-DRG/SOI benchmarks (All Patient Refined Diagnosis Related Group/Severity of Illness). The results are not adjusted for charity care and teaching intensity, which are shown separately in the report. Milliman notes that the indices obtained do not take into account whether hospitals with greater than average charity care, Medi-Cal, or Medicare patients obtain contributions to their costs from commercial insurers. In addition, the report does not attempt to adjust for demographic factors, health status, or any other measure of severity within APR-DRG. Given these limitations, the report focuses on presenting calculated indices to compare and understand inpatient hospital costs and prices in California. It does not highlight any high-cost hospitals and does not provide policy recommendations.[14]
- Wu (2009) analyzed managed-care per-diem payments to hospitals in Massachusetts.[15] The main data for this study were obtained from a public employer's claims dataset. The model used to explain hospital payments included standard demographic variables, DRG-level effects, and hospital characteristics (*e.g.*, major teaching hospitals, ownership type, open-heart surgery facilities, utilization, etc.) The author also included certain health plan characteristics such as size and a measure of the ability to channel patients. The results of this study show that patient characteristics and hospital characteristics explain only very

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hospital's research mission, they use the amount of funding from the National Institutes of Health (NIH), whether the hospital has a general clinical research center, and whether the hospital has a positron emission tomography (PET) scanner. To measure standby capacity, they rely on the number of specialty care beds, the availability of sophisticated clinical services, and the number of solid organ transplants.

[13] "Cost Efficiency at Hospital Facilities in California: a Report Based on Publicly Available Data," Milliman Inc. (October 2007). The California Office of Statewide Health Planning and Development (OSHPD) requires each hospital to submit financial results on a quarterly basis. Milliman Inc. used 2005 data from these files.

[14] In another study, Milliman Inc. identified 16 U.S. cities that had low per-capita inpatient costs for both Medicare and commercial payors, as well as positive hospital margins. However, Milliman Inc. found that these cities had little in common with respect to factors such as hospital market concentration, payor market concentration, wage index, ratio of primary care to specialty care, and the intensity of services provided. *See* Milliman Inc., 2010.

[15] Wu, Vivian Y., "Managed Care's Price Bargaining with Hospitals," *Journal of Health Economics*, Vol. 28 (2009).

limited payment variation. The study suggests that large payors and payors with a better ability to channel patients seem to be able to obtain greater discounts from hospitals.

Studies Focused on Quality of Care

We reviewed studies that explore whether regions and hospitals with high spending are associated with higher quality of care. The analysis of quality is particularly limited by the absence of well defined measures of quality. In addition, a methodological limitation to the analysis arises from the potential *selection bias* in the choice of hospitals. Selection bias occurs when severely ill patients disproportionately choose high quality hospitals.[16] As a result, health outcomes such as mortality rates cannot be compared without taking into account the differences in the severity of illness of the population served.

Several researchers have tried to overcome these data and methodological limitations, with mixed results. Some studies found that quality of care for Medicare enrollees was not better, and was sometimes worse, in high-spending regions.[17] However, studies on cost efficiency suggest that low-cost providers tend to have lower quality and that high-cost providers tend to receive sicker patients.[18] Other studies found positive health outcomes from intensive treatment, for example, at high-volume university hospitals, and report large differences in survival rates.[19]

A number of authors have questioned the validity of some of the quality measures used in these studies.[20] For example, simple measures based on medications received during initial hospitalization cannot capture the full aspects of hospital quality. Hospitals differ in many dimensions and proper measures of qualities that apply, for example, to community hospitals, may not be relevant for tertiary facilities. Hospitals may also differ in their cost structures

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[16] More broadly, patients choose treatments and providers according to their severity of illness, co-morbidity, and other patient characteristics and preferences that may be unobservable to the researcher.

[17] Dartmouth researchers analyzed Medicare spending by region focusing on samples of patients presumed to be similarly ill or by focusing on end-of-life spending. *See* Fisher et al., 2003, and Fisher et al., 2004.

[18] *See* Jha, Ashish K., E. John Orav, Allen Dobson, Robert A. Book, and Arnold M. Epstein, "Measuring Efficiency: The Association of Hospital Costs and Quality of Care," *Health Affairs*, Vol. 28, No. 3 (2009); and Mutter, Ryan L., Michael D. Rosko, and Herbert S. Wong, "Measuring Hospital Inefficiency: The Effects of Controlling for Quality and Patient Burden of Illness," *Health Services Research*, Vol. 43, No. 6 (2008).

[19] *See*, *e.g.*, Gutierrez, Juan C., Noor Kassira, Rabih M. Salloum, Dido Franceschi, and Leonidas G. Koniaris, "Surgery for Rectal Cancer Performed at Teaching Hospitals Improves Survival and Preserves Continence," *Journal of Gastrointestinal Surgery*, Vol. 11, No. (2007); and Verhoef, Christian, Rens van de Weyer, Michael Schaapveld, Esther Bastiaannet, and John Th. M. Plukker, "Better Survival in Patients with Esophageal Cancer After Surgical Treatment in University Hospitals: A Plea for Performance by Surgical Oncologists," *Annals of Surgical Oncology*, Vol. 14, No. 5 (2007).

[20] Shahian et al. (2007) find that cardiac surgery report cards used to assess risk-adjusted mortality and surgery volume tend to be problematic because of case misclassification and lack of standardization. *See* Shahian, David M., Treacy Silverstein, Ann F. Lovett, Robert E. Wolf and Sharon-Lise T. Normand, "Comparison of Clinical and Administrative Data Sources for Hospital Coronary Artery Bypass Graft Surgery Report Cards," *Journal of the American Heart Association*, Vol. 115, No. 12 (2007). The authors also highlight other limitations from the use of risk-adjusted outcomes from report cards. *See* Shahian, David M. and Sharon-Lise T. Normand, "Comparison of "Risk-Adjusted" Hospital Outcomes," *Journal of the American Heart Association*, Vol. 117, No. 15 (2008).

according to their primary missions. Furthermore, hospitals may just concentrate on those activities that are more commonly measured.[21]

In addition, data on Medicare spending may be misleading because Medicare payments are disproportionately high in states that have a large social burden, poorer quality, and low healthcare spending overall.[22] But if one considers total health spending, states with more health spending per capita tend to have better-quality care.

Some researchers have developed more sophisticated statistical tools to incorporate the fact that patients who select different hospitals (or treatments) are likely to have different health characteristics, some of which are unobservable to the researcher. These studies use patients' distances to alternative hospitals as independent predictors of how intensively the patient will be treated. The central assumption in this method is that patients close to hospitals with high volume and capability to perform certain procedures are more likely to get the treatment, independently from their health status. The researcher can then compare outcomes such as mortality rates for patients that appear to be identical in their health status and demographics, but some get more intensive treatment because they live closer to a hospital that offers the treatment. This method is also based on the observation that patients tend to choose hospitals that are closer to where they live. Hence, after controlling for all the demographic characteristics of the population, this method would predict that hospital A is of higher quality than hospital B if patients residing near hospital A have lower mortality than patients residing near hospital B.

In an earlier study that used this methodology, McClellan et al. (1994) shows positive outcomes from the incremental use of more invasive procedures on Medicare patients.[23] Using a similar methodology, Geweke et al. (2002) find that the smallest and largest hospitals provide the highest quality, and patients with high severity of illness are disproportionately admitted to high quality hospitals.[24]

Gowrisankaran and Town (1999) highlight that these econometric methods yield significantly different results from the standard methods, even after controlling for demographic information

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[21] Dranove et al. (2003) show findings that suggest that healthcare report cards give doctors and hospitals incentives to "game" the system and decline to treat more difficult, severely ill patients. *See* Dranove, David, Daniel Kessler, Mark McClellan, and Mark Satterthwaite, "Is More Information Better? The Effects of 'Report Cards' on Health Care Providers," *Journal of Political Economy*, 2003, Vol. 111, No. 3 (2003).

[22] *See* Cooper, Richard A., "States With More Health Care Spending Have Better-Quality Health Care: Lessons About Medicare," *Health Affairs*, Vol. 28, No. 1 (2009).

[23] *See* McClellan, Mark, Barbara J. McNeil, and Joseph P. Newhouse, "Does More Intensive Treatment of Acute Myocardial Infarction in the Elderly Reduce Mortality? Analysis Using Instrumental Variables," *The Journal of the American Medical Association*, Vol. 272, No. 11 (1994).

[24] Geweke, John, Gautam Gowrisankaran, and Robert J. Town, "Bayesian Inference for Hospital Quality in a Selection Model," Econometrica, Vol. 71, No. 4 (2003). Gowrisankaran et al. (2006) use a similar methodology to assess whether increased hospital volume lower mortality. *See* Gowrisankaran, Gautam, Vivian Ho, and Robert J. Town, "Causality, Learning and Forgetting in Surgery," *working paper* (January 2006).

and co-morbidities.[25] This confirms that failure to properly adjust for severity of illness is likely to lead to substantial mismeasurement of hospital quality.

[25] *See* Gowrisankaran, Gautam and Robert J. Town. "Estimating the Quality of Care in Hospitals Using Instrumental Variables," *Journal of Health Economics,* Vol. 18 (1999).

Selected Literature on Spending and Price Differences

Study	Dependent Variable	Explanatory Variables Considered					
		Regional costs	Case Mix	Demographics	Health Status	Provider Characteristics/Supply of Resources	Payor Characteristics
Cutler et al. (1999)	Per-capita Medicare spending	Costs outside the medical sector		Race, sex; Income and education.	Shares of smokers, obese, hypertensive, and sedentary; Measures of illness based on rates of hospitalization for hip fracture, heart attacks, strokes, gastrointestinal bleeding, and surgery for lung or colon cancer; Age-adjusted mortality rates; Timing and causes of death.	For-profit and government owned; Supply of beds and physicians; Proximity to medical schools; Specialization rate; Medical residents.	Non-elderly population on managed care; Uninsured population.
Koenig et al. (2003)	All-payor inpatient cost	Medicare wage index and urban/rural variable	CMI; Special care, nursery, and swing-bed days.		Medicare outlier payments	Interns and residents per bed; Level of NIH funding, general clinical research center, and (PET) scanner; Specialty care beds, sophisticated clinical services, solid organ transplants, AIDS/HIV programs, psychiatric emergency care; SPECT scanner, and trauma level I.	
Milliman Inc. (2007)	Commercial inpatient hospital payments	Medicare inpatient adjustment factors	APR-DRG/SOI adjustment			Identifier for major teaching hospitals (based on residents per bed and IME amounts)	
CBO Review of Studies (2008)	Per-capita Medicare spending	Prices of health care services; Special hospital payments.		Age, sex, race; Income and education; Urbanization; Individual preferences; Dual beneficiary.	Mortality and illness rates; Health status; Smoking and health risk behaviors; Obesity, air pollution.	Physicians per capita; % of PCP; Supply of medical providers.	Managed care enrollment; Medicaid eligibility.
Wu (2009)	Per-diem payment from managed care plans for adult non-elderly population		DRG dummies	Age, sex; Income.		Major teaching hospitals; Open-heart surgery facilities; Cardiac catheterization lab/angioplasty facilities; Hospital size, ownership type; Excess capacity.	Plan size; Ability to channel patients.
Dartmouth Atlas Project*	Per-capita Medicare spending by region; End-of-life expenditure.	Standardized Medicare prices	CMI	Age, sex, race, income, education; Urban/rural residence; Employment; Marital status; Supplementary insurance.	Self-reported health; Incident illness (myocardial infarction, hip fracture, colorectal cancer); Comorbid conditions (previous revascularization or MI, congestive heart failure, diabetes, history of angina, peripheral vascular disease, smoker, COPD, other); Functional status, mortality.	Hospital beds and physicians; Teaching hospitals; Medical specialists.	
Zuckerman et al. (2010)	Per-capita Medicare spending	Standardized Medicare prices		Age, sex, race; Urban/rural residence; Income; Supplementary insurance.	Self-reported health status: smoking, body-mass index; Previous diagnosis of diabetes, hypertension, myocardial infarction, coronary heart disease, another heart problem, stroke, or any nonskin cancer; Changes in health status: person died in year, or new diagnosis in listed conditions; Proxy respondent.	Beds and physicians per 1000 elderly persons; % of PCP; Teaching hospital; Medical residents per bed.	
MedPAC (2011)	Per-capita Medicare spending	Medicare wage index; Practice cost indexes.	CMS HCC risk scores	Age and sex	Health status (CMS HCC risk score); disability; institutional status; dual eligibility (enrollment to Part A and B).	Rural; GME, IME, DSH, CAH, and outlier payments.	
Reschovsky et al. (2011)	Medicare service use	Medicare wage index; Medicare relative fee variable.	Hierarchical Coexisting Conditions (HCC) risk-adjustment model variables	Age, sex, race; Imputed income; Dual beneficiary.	Patient qualified as disabled; Changes in patient residence or services in multiple census divisions; Patient long-term institutionalized, or died during following year.	Physician characteristics: race, gender, years in practice, board certified or international graduate. Clinical specialty, inadequate time in office; timely communication and financial incentives; Market characteristics: physicians, hospital beds, and skilled nursing facility beds per resident, percentage of specialists and teaching hospitals beds, home agency and hospice employment, for-profit entities, and rural markets; Care fragmentation and hospital concentration.	Share of revenue from Medicare, Medicaid, Medicare Advantage and capitation.

Sources: Cutler, David M., and Louise Sheiner, "The Geography of Medicare," *American Economic Association Papers and Proceedings*, Vol. 89, No. 2 (1999); Koenig, Lane, Allen Dobson, Silver Ho, Jonathan M. Siegel, David Blumenthal, and Joel S. Weissman, "Estimating the Mission Related Costs of Teaching Hospitals," *Health Affairs*, Vol. 22, No. 6 (2003); "Cost Efficiency at Hospital Facilities in California: a Report Based on Publicly Available Data," Milliman Inc. (October 2007); "Geographic Variation in Health Care Spending," Congressional Budget Office (February 2008); Wu, Vivian Y., "Managed Care's Price Bargaining with Hospitals," *Journal of Health Economics*, Vol. 28 (2009); Zuckerman, Stephen, Timothy Waidmann, Robert Berenson, and Jack Hadley, "Clarifying sources of Geographic Differences in Medicare Spending," *The New England Journal of Medicine*, Special Article (2010); "Regional Variation in Medicare Service Use," Medicare Payment Advisory Commission, Report to the Congress (January 2011); Reschovsky, James D., Jack Hadley, Cynthia B. Saiontz-Martinez, and Ellyn R. Boukus, "Following the Money: Factors Associated with the Cost of Treating High-Cost Medicare Beneficiaries," *Health Services Research* (article online in advance of print - February 2011).

* Dartmouth Atlas Project includes the following studies: Fisher, Elliott S., Julie P. Bynum, and Jonathan S. Skinner, "Slowing the Growth in Health Care Costs – Lessons from Regional Variation" *The New England Journal of Medicine*, Perspective (February 2009); "The Policy Implications of Variations in Medicare Spending Growth," The Dartmouth Atlas of Health Care (2009); Fisher, Elliott S., David E. Wennberg, Therese A. Stukel, Daniel J. Gotlieb, F.L. Lucas, and Etoile L. Pinder, "Implications of Regional Variations in Medicare Spending - Part I" *Annals of Internal Medicine*, Vol. 138, No. 4 (2003); and Fisher, Elliott S., David E. Wennberg, Therese A. Stukel, and Daniel J. Gottlieb, "Variations in The Longitudinal Efficiency of Academic Medical Centers," *Health Affairs* (2004).

Appendix C: Regression Results

A. Non-Medicare Prices

	Dependent Variable		
	Avg. Non-Medicare IP Price per Discharge		
Explanatory Variables	**Model 1**	**Model 2**	**Model 3**
Case-Mix Index (CMI)	1.705***	1.155***	1.070***
	(0.042)	(0.050)	(0.052)
Medicare Wage Index	1.097***	0.760***	0.554***
	(0.056)	(0.057)	(0.055)
Teaching Intensity (Interns and Residents per Bed)	-0.015	-0.219***	-0.227***
	(0.065)	(0.070)	(0.067)
Percentage of Medicare Discharges	0.034*	0.084***	0.056***
	(0.019)	(0.019)	(0.018)
Percentage of Medicaid Discharges	-0.038***	-0.022*	-0.017
	(0.010)	(0.012)	(0.012)
Time Trend (December 2004=1)	-0.018	-0.013	-0.002
	(0.011)	(0.010)	(0.010)
Rural Hospital Indicator		0.062***	-0.020
		(0.019)	(0.018)
DSH amount per Bed		-0.019***	-0.010***
		(0.002)	(0.002)
Operating Outlier Payments (%)		0.218***	0.187***
		(0.013)	(0.013)
Uncompensated Cost per Discharge		0.020***	0.019***
		(0.003)	(0.003)
Organ Transplants per Bed		0.349***	0.215*
		(0.129)	(0.121)
Percentage of Outpatient Charges over Total Charges		-0.264***	-0.490***
		(0.023)	(0.024)
Total Hospital Assets per Bed			0.254***
			(0.012)
Total Discharges per Bed			-0.299***
			(0.024)
Hospital Size (Beds)			-0.093***
			(0.012)
Constant	8.402***	9.036***	8.161***
	(0.093)	(0.126)	(0.172)
Total Observations	15,098	14,872	14,870
Number of Hospitals	3,461	3,415	3,415
R-Squared Value	48%	56%	61%

Notes: Variables in logarithmic form. Standard errors in parentheses.

* Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level.

	Dependent Variable		
	Avg. Non-Medicare IP Price per Discharge		
Explanatory Variables	**Model 4**	**Model 4b**	**Model 5**
Case-Mix Index (CMI)	1.013***	0.973***	0.348***
	(0.051)	(0.053)	(0.049)
Medicare Wage Index	0.608***	0.621***	-0.044
	(0.076)	(0.077)	(0.069)
Teaching Intensity (Interns and Residents per Bed)	-0.187***	-0.149**	-0.665***
	(0.067)	(0.071)	(0.060)
Percentage of Medicare Discharges	0.061***	0.068***	0.008
	(0.019)	(0.019)	(0.017)
Percentage of Medicaid Discharges	-0.026**	-0.025**	-0.006
	(0.012)	(0.012)	(0.010)
Time Trend (December 2004=1)	0.002	0.005	-0.023***
	(0.010)	(0.010)	(0.009)
Rural Hospital Indicator	-0.012	-0.012	-0.001
	(0.021)	(0.021)	(0.018)
DSH amount per Bed	-0.008***	-0.008***	-0.006***
	(0.002)	(0.002)	(0.002)
Operating Outlier Payments (%)	0.179***	0.177***	0.051***
	(0.013)	(0.013)	(0.012)
Uncompensated Cost per Discharge	0.020***	0.020***	0.014***
	(0.003)	(0.003)	(0.002)
Organ Transplants per Bed	0.179	0.108	0.232**
	(0.118)	(0.137)	(0.103)
Percentage of Outpatient Charges over Total Charges	-0.543***	-0.556***	-0.127***
	(0.025)	(0.025)	(0.025)
Total Hospital Assets per Bed	0.232***	0.227***	0.092***
	(0.012)	(0.012)	(0.012)
Total Discharges per Bed	-0.304***	-0.298***	0.027
	(0.024)	(0.024)	(0.023)
Hospital Size (Beds)	-0.084***	-0.086***	0.022**
	(0.012)	(0.012)	(0.011)
Average Age in Hospital CBSA	-0.617***	-0.617***	-0.629***
	(0.127)	(0.127)	(0.111)
% Population Male in Hospital CBSA	0.069	-0.001	-0.163
	(0.356)	(0.356)	(0.310)
% Population Black in Hospital CBSA	0.000	0.004	0.004
	(0.009)	(0.009)	(0.008)
% Population Hispanic in Hospital CBSA	-0.068***	-0.066***	-0.044***
	(0.012)	(0.012)	(0.010)
% Population in Poverty in Hospital CBSA	-0.121***	-0.120***	-0.147***
	(0.038)	(0.038)	(0.033)
% Population Under Age 65 Insured in CBSA	-0.021	0.002	-0.134
	(0.159)	(0.159)	(0.139)
% Population Current Smoker in Hospital CBSA	0.051	0.055	0.077**
	(0.035)	(0.035)	(0.030)
% Population Heavy Drinker in Hospital CBSA	0.110***	0.106***	0.047**
	(0.021)	(0.021)	(0.019)
% Population with Checkup in Last 2 Yrs in CBSA	-1.026***	-1.007***	-0.906***
	(0.157)	(0.157)	(0.137)
Mortality Rates (average for heart attack, heart failure, and pneumonia - 2008)		0.162**	
		(0.064)	
Readmission Rates (average for heart attack, heart failure, and pneumonia - 2008)		-0.287***	
		(0.110)	
2010 US News Best Hospital in Any Specialty		0.058	
		(0.046)	
Average Hospital IP Cost per Discharge			0.944***
			(0.029)
Constant	15.295***	15.923***	7.063***
	(1.974)	(1.998)	(1.738)
Total Observations	14,833	14,833	14,833
Number of Hospitals	3,402	3,402	3,402
R-Squared Value	63%	63%	72%

Notes: Variables in logarithmic form. Standard errors in parentheses.

* Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level.

B. All-Payor Prices

	Dependent Variable		
	Avg. All-Payor IP Price per Discharge		
Explanatory Variables	**Model 1**	**Model 2**	**Model 3**
Case-Mix Index (CMI)	1.323***	0.960***	0.953***
	(0.024)	(0.028)	(0.028)
Medicare Wage Index	0.887***	0.675***	0.564***
	(0.032)	(0.032)	(0.031)
Teaching Intensity (Interns and Residents per Bed)	0.323***	0.180***	0.189***
	(0.037)	(0.039)	(0.037)
Percentage of Medicare Discharges	0.047***	0.080***	0.060***
	(0.011)	(0.011)	(0.010)
Percentage of Medicaid Discharges	-0.016***	-0.015**	-0.010
	(0.006)	(0.007)	(0.006)
Time Trend (December 2004=1)	0.034***	0.035***	0.043***
	(0.006)	(0.006)	(0.006)
Rural Hospital Indicator		0.048***	-0.004
		(0.011)	(0.010)
DSH amount per Bed		-0.009***	-0.003**
		(0.001)	(0.001)
Operating Outlier Payments (%)		0.142***	0.128***
		(0.007)	(0.007)
Uncompensated Cost per Discharge		0.009***	0.009***
		(0.002)	(0.002)
Organ Transplants per Bed		0.273***	0.190***
		(0.072)	(0.067)
Percentage of Outpatient Charges over Total Charges		-0.183***	-0.317***
		(0.013)	(0.013)
Total Hospital Assets per Bed			0.145***
			(0.007)
Total Discharges per Bed			-0.200***
			(0.013)
Hospital Size (Beds)			-0.071***
			(0.006)
Constant	8.307***	8.794***	8.497***
	(0.053)	(0.071)	(0.094)
Total Observations	15,464	15,233	15,231
Number of Hospitals	3,503	3,457	3,457
R-Squared Value	67%	73%	77%

Notes: Variables in logarithmic form. Standard errors in parentheses.
* Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level.

	Dependent Variable		
	Avg. All-Payor IP Price per Discharge		
Explanatory Variables	**Model 4**	**Model 4b**	**Model 5**
Case-Mix Index (CMI)	0.917***	0.901***	0.533***
	(0.028)	(0.029)	(0.027)
Medicare Wage Index	0.655***	0.660***	0.279***
	(0.043)	(0.043)	(0.038)
Teaching Intensity (Interns and Residents per Bed)	0.214***	0.220***	-0.061*
	(0.038)	(0.040)	(0.033)
Percentage of Medicare Discharges	0.064***	0.066***	0.035***
	(0.011)	(0.011)	(0.009)
Percentage of Medicaid Discharges	-0.017***	-0.016**	-0.006
	(0.006)	(0.006)	(0.006)
Time Trend (December 2004=1)	0.044***	0.046***	0.027***
	(0.006)	(0.006)	(0.005)
Rural Hospital Indicator	-0.009	-0.009	-0.001
	(0.011)	(0.011)	(0.010)
DSH amount per Bed	-0.003*	-0.003**	-0.001
	(0.001)	(0.001)	(0.001)
Operating Outlier Payments (%)	0.124***	0.123***	0.048***
	(0.007)	(0.007)	(0.006)
Uncompensated Cost per Discharge	0.009***	0.009***	0.006***
	(0.002)	(0.002)	(0.001)
Organ Transplants per Bed	0.178***	0.119	0.214***
	(0.066)	(0.077)	(0.057)
Percentage of Outpatient Charges over Total Charges	-0.340***	-0.344***	-0.088***
	(0.014)	(0.014)	(0.014)
Total Hospital Assets per Bed	0.134***	0.132***	0.048***
	(0.007)	(0.007)	(0.006)
Total Discharges per Bed	-0.198***	-0.195***	-0.002
	(0.013)	(0.013)	(0.013)
Hospital Size (Beds)	-0.064***	-0.065***	0.000
	(0.007)	(0.007)	(0.006)
Average Age in Hospital CBSA	-0.333***	-0.331***	-0.326***
	(0.071)	(0.071)	(0.061)
% Population Male in Hospital CBSA	0.026	0.004	-0.002
	(0.195)	(0.196)	(0.167)
% Population Black in Hospital CBSA	-0.005	-0.004	-0.002
	(0.005)	(0.005)	(0.004)
% Population Hispanic in Hospital CBSA	-0.039***	-0.038***	-0.024***
	(0.007)	(0.007)	(0.006)
% Population in Poverty in Hospital CBSA	-0.024	-0.022	-0.037**
	(0.021)	(0.021)	(0.018)
% Population Under Age 65 Insured in CBSA	-0.073	-0.061	-0.130*
	(0.089)	(0.089)	(0.076)
% Population Current Smoker in Hospital CBSA	0.038*	0.039**	0.053***
	(0.020)	(0.020)	(0.017)
% Population Heavy Drinker in Hospital CBSA	0.041***	0.040***	0.004
	(0.012)	(0.012)	(0.010)
% Population with Checkup in Last 2 Yrs in CBSA	-0.542***	-0.539***	-0.467***
	(0.088)	(0.088)	(0.075)
Mortality Rates (average for heart attack, heart failure, and pneumonia - 2008)		0.040	
		(0.036)	
Readmission Rates (average for heart attack, heart failure, and pneumonia - 2008)		-0.110*	
		(0.062)	
2010 US News Best Hospital in Any Specialty		0.041	
		(0.026)	
Average Hospital IP Cost per Discharge ($)			0.548***
			(0.015)
Constant	12.474***	12.744***	7.164***
	(1.087)	(1.102)	(0.941)
Total Observations	15,192	15,192	15,192
Number of Hospitals	3,444	3,444	3,444
R-Squared Value	77%	77%	83%

Notes: Variables in logarithmic form. Standard errors in parentheses.

* Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level.

C. Medicare Prices

Explanatory Variables	Dependent Variable Avg. Medicare IP Price per Discharge
Case-Mix Index (CMI)	0.921***
	(0.012)
Medicare Wage Index	0.728***
	(0.013)
Teaching Intensity (Interns and Residents per Bed)	0.788***
	(0.016)
Percentage of Medicare Discharges	-0.079***
	(0.004)
Percentage of Medicaid Discharges	0.032***
	(0.003)
Time Trend (December 2004=1)	0.057***
	(0.002)
Rural Hospital Indicator	0.011**
	(0.004)
DSH amount per Bed	0.005***
	(0.001)
Operating Outlier Payments (%)	0.046***
	(0.003)
Uncompensated Cost per Discharge	0.002**
	(0.001)
Organ Transplants per Bed	0.010
	(0.029)
Percentage of Outpatient Charges over Total Charges	-0.066***
	(0.006)
Total Hospital Assets per Bed	-0.004
	(0.003)
Total Discharges per Bed	-0.043***
	(0.006)
Hospital Size (Beds)	-0.009***
	(0.003)
Constant	9.144***
	(0.040)
Total Observations	15,385
Number of Hospitals	3,468
R-Squared Value	94%

Notes: Variables in logarithmic form. Standard errors in parentheses.
* Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level.

D. Non-Medicare Prices in the Regions Analyzed by the Payment Variation Article

	Dependent Variable		
	Avg. Non-Medicare IP Price per Discharge		
Explanatory Variables	**All U.S. Hospitals**	**States Analyzed in the Article**	**CBSAs Analyzed in the Article**
Case-Mix Index (CMI)	1.070***	0.916***	0.928***
	(0.052)	(0.089)	(0.142)
Medicare Wage Index	0.554***	0.674***	0.881***
	(0.055)	(0.093)	(0.152)
Teaching Intensity (Interns and Residents per Bed)	-0.227***	0.090	0.295*
	(0.067)	(0.125)	(0.160)
Percentage of Medicare Discharges	0.056***	0.157***	0.160***
	(0.018)	(0.033)	(0.053)
Percentage of Medicaid Discharges	-0.017	-0.092***	-0.138***
	(0.012)	(0.020)	(0.032)
Time Trend (December 2004=1)	-0.002	0.001	0.037
	(0.010)	(0.016)	(0.027)
Rural Hospital Indicator	-0.020	-0.006	0.321***
	(0.018)	(0.031)	(0.104)
DSH amount per Bed	-0.010***	-0.010***	-0.003
	(0.002)	(0.004)	(0.006)
Operating Outlier Payments (%)	0.187***	0.153***	0.164***
	(0.013)	(0.020)	(0.032)
Uncompensated Cost per Discharge	0.019***	0.023***	0.009
	(0.003)	(0.005)	(0.008)
Organ Transplants per Bed	0.215*	0.285*	0.226
	(0.121)	(0.168)	(0.231)
Percentage of Outpatient Charges over Total Charges	-0.490***	-0.410***	-0.253***
	(0.024)	(0.041)	(0.061)
Total Hospital Assets per Bed	0.254***	0.207***	0.147***
	(0.012)	(0.020)	(0.032)
Total Discharges per Bed	-0.299***	-0.291***	-0.303***
	(0.024)	(0.040)	(0.066)
Hospital Size (Beds)	-0.093***	-0.095***	-0.037
	(0.012)	(0.021)	(0.035)
Constant	8.161***	8.376***	8.309***
	(0.172)	(0.290)	(0.465)
Total Observations	14,870	4,139	1,267
Number of Hospitals	3,415	942	298
R-Squared Value	61%	62%	65%

Notes: Variables in logarithmic form. Standard errors in parentheses.

* Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level.