HOSPITAL COMPENSATION COSTS:

AN ANALYSIS OF

ESCALATION IN ECI WAGE AND BENEFIT COST INDICES

RELATIVE TO PPS PROXIES

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Summary

Under the Prospective Payment System (PPS), the Centers for Medicare & Medicaid Services (CMS) sets Medicare hospital care payments based on escalation in the PPS input price index, or "market basket". As discussed below, the PPS index is a *normative input price index* constructed to reflect the rate at which the costs to hospitals of providing health care—hence prices—would increase absent the widely-acknowledged distortions that affect actual health-care cost and prices.

Compensation costs (wages and benefits) represent the single largest component of the PPS index. For most of the period from 1980 to the mid-1990s, hospital compensation as measured by BLS Employment Cost Indices increased more rapidly than for the wage and benefit component of the PPS. During the mid-1990s, this trend reversed, and hospital compensation increases were lower—presumably reflecting the impact of managed care on hospital labor markets. More recent data, however, seem to indicate that hospital wages and benefit growth are again accelerating, and are now growing more rapidly than labor costs in the economy as a whole. Charts 1 and 2 illustrate the relative pattern of hospital wage and benefit escalation measured by BLS Hospital ECIs and the PPS wage and benefit proxies.

The apparent slow-down in hospital-specific wage and benefit escalation during the 1990s raises the issue of whether the use of normative compensation indices in the PPS rather than actual Hospital ECIs is still appropriate. This report considers three factors that have affected the growth rate differential between hospital compensation costs and wage and benefit costs in the broader US economy as reflected in the PPS proxies:

- ✓ growing demand for hospital services, hence hospital workers, as measured by per capita hospital utilization;
- ✓ increasing prevalence of managed care, and, in particular, the share of HMO plans in overall managed care;
- ✓ variation in economy-wide labor market conditions that affect compensation costs for all workers.

The results of this analysis indicate that the apparent reversal of longer-term trends in relative compensation growth in the latter part of the 1990s can be attributed both to the rapid transition to managed care in the health care sector--suppressing hospital compensation growth--and to the tight economy-wide labor market conditions created by robust macroeconomic growth--accelerating economy-wide compensation growth. Jointly, these factors account for the reversal in the longer-term pattern of greater increases in Hospital ECIs relative to the corresponding PPS proxies.

Because the transition to managed care has all but been completed (at least in the 80% of the population covered by private health insurance) and US economic growth is expected to moderate, the impact of these two factors is expected to be negligible over the next decade. However, long-term growth in the demand for health care in excess of the rate of overall economic growth will almost certainly mean continued increases in

Chart 1. Relative Wage Growth, Hospital ECI and PPS Wage Proxy, 1980-2001. Hospital wage cost escalation outpaced economy-wide wage growth until mid-1990s, when the differential reversed. (Left axis: Hospital ECI less PPS wage proxy growth. Right axis: growth rates of ECI and PPS wage proxy. Hospital Average Hourly Earnings and PPS AHE blend reflect wage differential before introduction of ECI.)

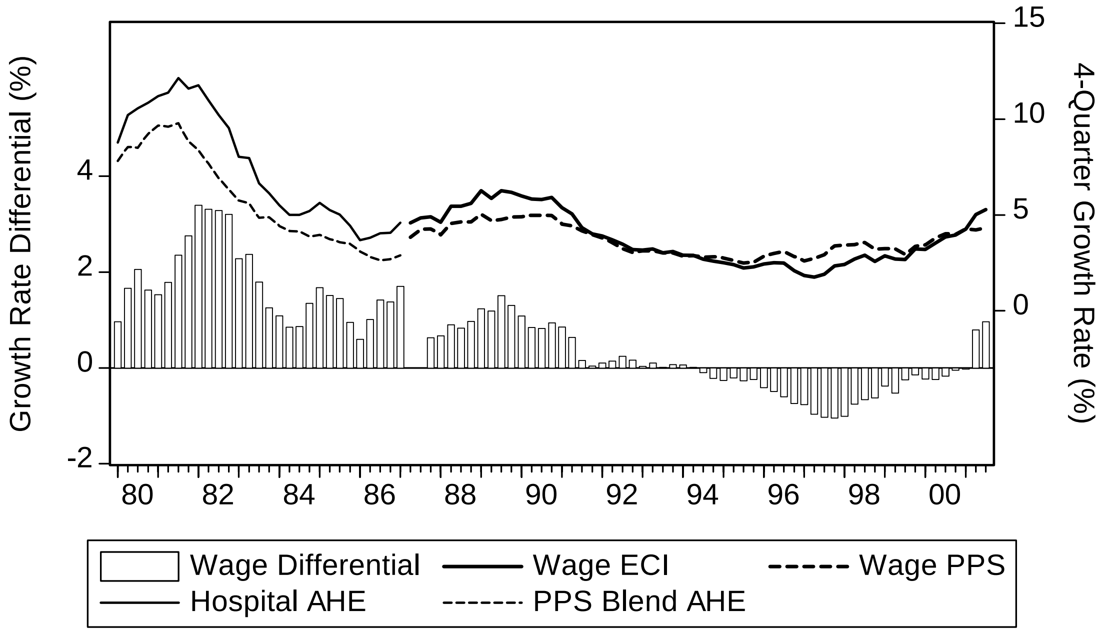
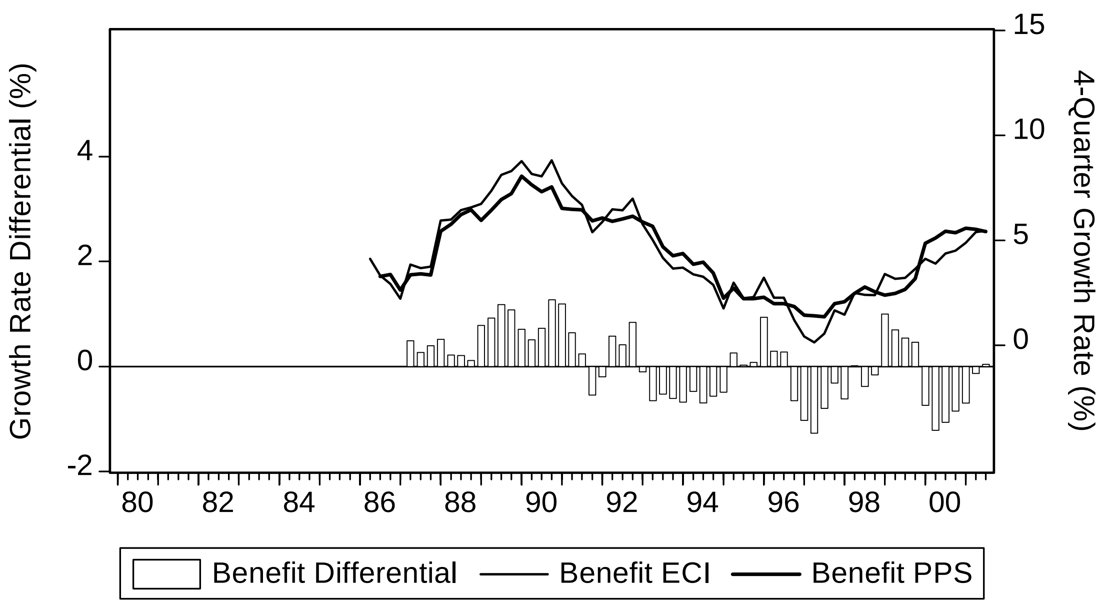


Chart 2. Relative Benefit Growth, Hospital ECI and PPS Wage Proxy, 1980-2001. Although more volatile, the benefit growth differential in favor of hospital workers has been less pronounced. (Left axis: Hospital ECI less PPS benefits proxy growth. Right axis: growth rates of ECI and PPS benefit proxy.)



hospital utilization, implying a corresponding increases in the demand for hospital workers. As a result, the recent surge in hospital compensation as measured by the BLS ECIs is likely to continue for the near term and remain above the PPS proxies, which more nearly track economy-wide rates.

Taken alone, this finding might suggest that the PPS "normative" wage index be retained as the labor cost component of the PPS. From an economic perspective, however, it is important to remain mindful that it is demand for health care that drives health-sector labor costs—not the other way around. Regulatory policy that inflexibly restricts the ability of hospitals to increase wages even as demand for service increases would simply make it increasingly difficult to maintain the workforce required to deliver quality health care. To ensure quality, it may be preferable to accommodate actual labor cost escalations, and simply use the hospital ECI in determining appropriate Medicare reimbursement rates.

The PPS index as a normative input price index

As noted, the PPS index is a *normative input price index*, a concept that requires some explanation. In general, producers maximize profits, given demand and input costs, just as consumers choose goods and services to maximize welfare given prices and income. Under competitive conditions, observed output simultaneously reflects both a welfare maximum for consumers and a cost minimum for producers. An input price index measures the price of efficiently producing a given level of output, so that escalation in the index can be interpreted as the minimum cost of maintaining the welfare-maximizing level of consumption of a particular good or service when prices rise.

However, markets for health care goods and services are widely acknowledged to function imperfectly. One key reason for this is the prevalence of third-party payment by public and private health insurers. Because out-of-pocket expenditures are much less than the actual price, demand for health care is greater than would be the case if consumers directly bore the full cost. Moreover, the complexity of health care technology and the inherent uncertainty about outcomes make it difficult for consumers and providers to fully evaluate the benefits of specific medical options, contributing to excessive utilization of health sector resources. As a consequence of these distortions, demand for health care tends to increase more rapidly than it might under more competitive conditions.

Because health care requires specialized inputs, rapid utilization growth translates into correspondingly strong demand for health-sector capital goods, intermediate inputs, and labor. In particular, health-sector workers often require both special training and licensure, limiting the responsiveness of supply to increased demand. Moreover, health care technology innovations, rather than improving labor productivity as in other sectors, tend to increase requirements for skilled labor, boosting the average wage. Therefore, increases in the amount and technological level of of health care demanded by consumers feed through to health-sector labor markets, tending to drive compensation cost escalation above economy-wide rates.

As a result of health care market distortions, observed health-sector prices have not accurately reflected the "true" cost of providing health care services. In principle, observed health-sector input price increases have two components: one reflects the "true" cost increase that would be required to maintain consumer welfare if health care markets were efficient, and the second represents the windfall gains ("rents") that accrue to health-care providers and input suppliers because of distortions.

Because of this, CMS uses normative input price indices to update Medicare payments. The PPS index (and other CMS input price indices) are based on weights that reflect the input mix actually observed in the health sector, but with price proxies taken from the economy as a whole--where competitive pressures enforce cost and prices efficiency. In other words, the PPS index is an approximation of *what hospital care price changes would be if demand and supply were determined in efficient markets*. In principle, basing Medicare payments on these normative indices means that CMS is subsidizing only that part of health care cost increases that actually reflects increases in consumer welfare.

Compensation costs in the PPS index are represented by wage and benefit indices that reflect the actual occupational distribution of hospital employment at the level of nine broad BLS occupational categories, but—following a "normative" approach--use economy-wide occupational ECIs to represent labor costs. The Professional and Technical Occupation category is an exception, and is split equally between the economy-wide ECI and the ECI for all hospital workers to reflect the fact that some element of hospital compensation reflects industry-specific human capital rather than distortion-induced rents. Table 1 presents the structure of the PPS wage and benefit indices.

Table 1. Composition of the PPS Wage and Benefit Proxies. Compensation represents 61.3% of total hospital costs in the 1992-based PPS index, with wages accounting for 50.2% and benefits for the remaining 11.1%. The PPS wage and benefit proxies reflect hospital employment by major BLS occupational category.

BLS ECI Occupational Category	Index Weight (%)
Professional & Technical	65.8
Hospital Workers Wage & Salary	32.9
All Professional & Technical	32.9
Executive, Admin, & Managerial	9.6
Sales Workers (Private)	0.4
Clerical / Admin Support	12.4
Precision Production, Craft & Repair	1.7
Machine Operators, Assemblers, & Inspectors	0.4
Transportation & Material Moving	0.1
Handlers, Helpers & Laborers	0.1
Service Occupations	9.6
Total	100.0

Factors affecting the hospital labor cost differential during the 1990s.

Because of the high value that individuals in every society put on physical well-being and the fact that most governments subsidize health care, health expenditures (including research and development as well as treatment) are growing faster than GDP in virtually every country of the world. In the US, per capita personal health expenditures have increased over four-fold since 1980, with health care as a whole increasing from 7% to

Chart 3. Demand for Health Care and Hospital Utilization, 1980-2001. Since the mid-1980s, hospital utilization has closely tracked health expenditures. (Right axis: effective hospital days per capita, AHA data. Left axis: current $ health expenditures per capita, CMS NHA data.)

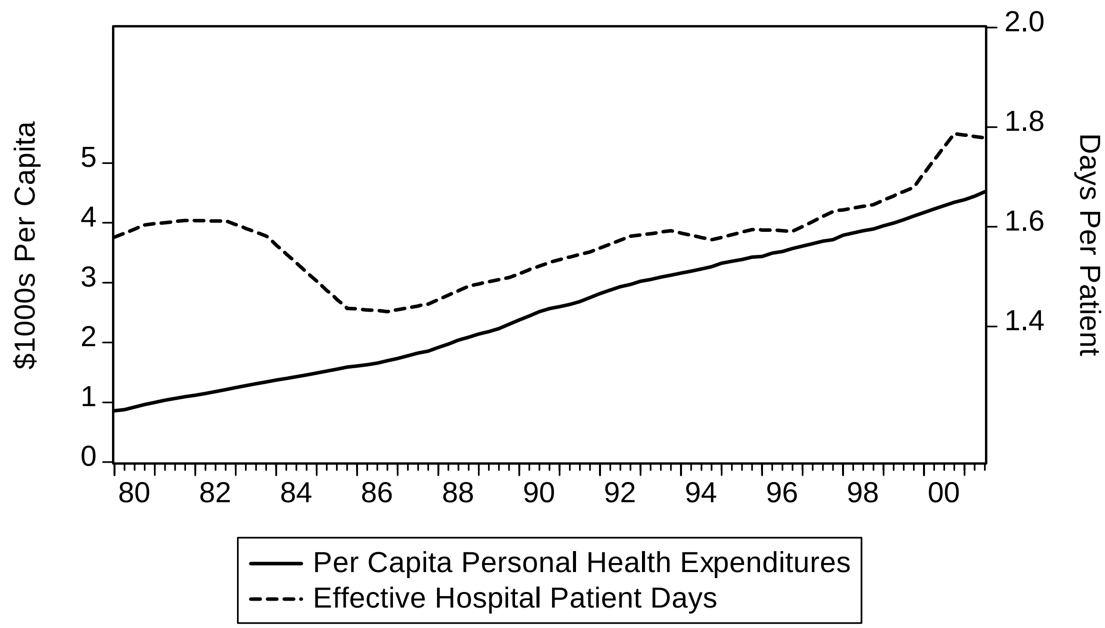
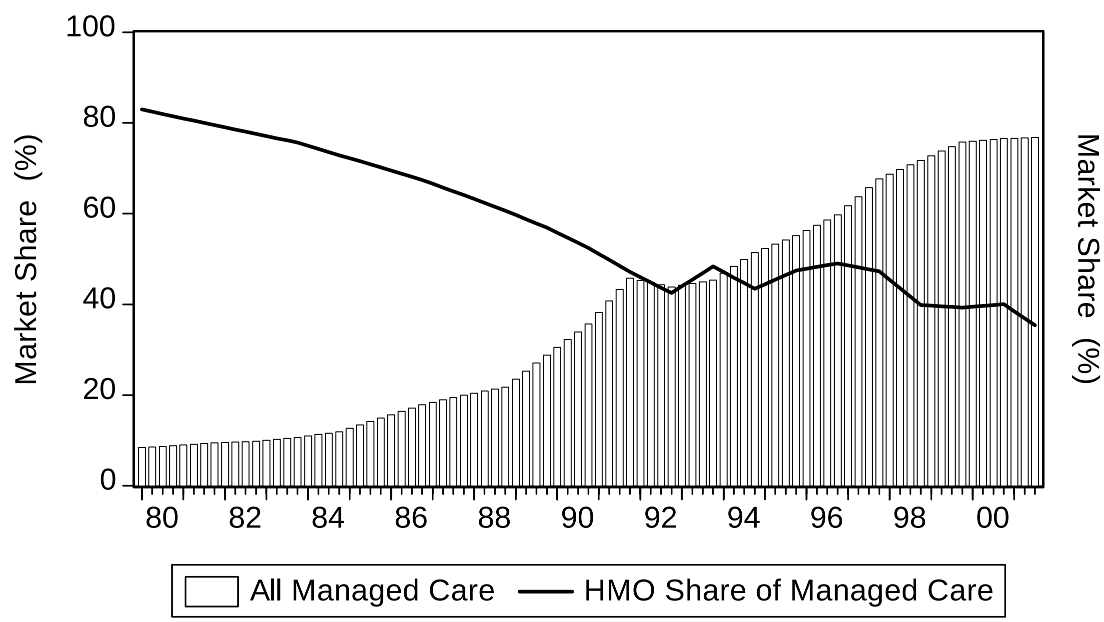


Chart 4. Managed Care Trends, 1980-2001. Although managed care has stabilized at a high share of all health insurance coverage, the HMO share has declined as other options have become available (Managed care penetration ratio and HMO share of managed care, Kaiser data with DRI-WEFA extrapolation before 1987).



13.2% of GDP as measured by the CMS's National Health Accounts. As shown in Chart 3, increases in per capita expenditures in health care are highly correlated with increases in effective hospital patient days (a measure of utilization that includes both inpatient days and outpatient visits converted to equivalent inpatient days). Thus, the fundamental demand pressure that contributed to the more rapid compensation growth in hospitals than in the US economy in the 1980s has continued unabated.

One significant change in the health sector with potentially important consequences for the hospital compensation growth differential has been the transition of private insurance from a fee-for-service basis to managed care. Because employer expenses for worker benefits are deducted from taxable business income, employee health benefits are implicitly subsidized and cost consumers less than equivalent coverage purchased individually. As a result, most private health insurance is employer-provided.

By the start of the 1980s, rapid escalation in health-care expenditures and the cost of providing health benefits to workers prompted business to seek lower cost alternatives to the fee-for-service system. Beginning from very low levels, the penetration of managed care plans increased sharply in the 1980s and throughout the 1990s. According to data from CMS and the Kaiser Family Foundation, by the end of 2001, about 93% of those covered by private health insurance were in managed care plans, and 78% overall when Medicare and Medicaid are included.

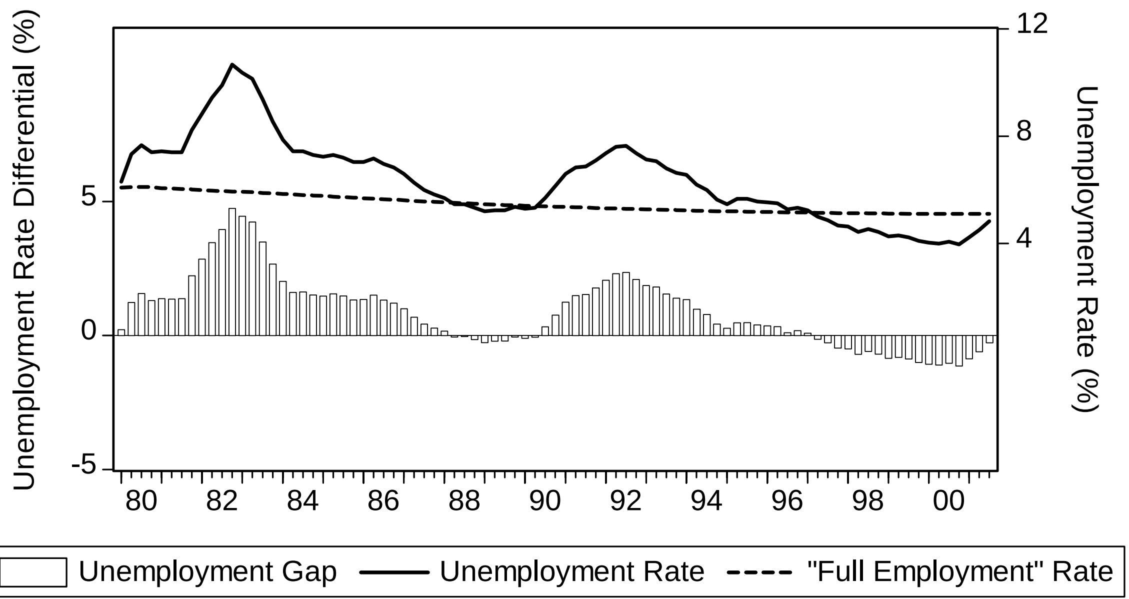
Along with increasing predominance of managed care, changes in the mix of alternative managed-care delivery models have affected the wage growth differential. Initially, Health Maintenance Organizations (HMOs) represented the most widely implemented approach. Although HMOs have been effective in controlling costs, Preferred Provider Organizations (PPOs) and Point of Service (POS) plans have increased their share of total managed care at the expense of HMOs as consumers have opted for greater choice among providers and treatment alternatives. Indeed, an apparent anti-HMO "backlash" has resulted in an even sharper decline in the HMO share of managed care health insurance in the last few years. Chart 4 illustrates the increasing prevalence of managed care overall, and the declining share of HMOs.

There seems little doubt that managed care has squeezed at least some inefficiency out of the US health care system, but the impact on health care cost growth may be due more to the shift from fee-for-service to managed care than the ability of managed care to control growth in costs. Thus, it seems to be the *transition* from relatively high levels of per-patient resource use under the fee-for-service regime to lower levels under managed care has slowed demand for labor and other inputs, moderating the escalation in hospital and other health-sector compensation relative to the economy as a whole.

Finally, the booming US economy also influenced the hospital compensation growth differential during the late 1990s. Following a rather slow recovery from the 1990-1991 recession, the US entered a period of rapid economic expansion fueled by technology-linked investment and a virtuous cycle of high profits, increasing stock-market wealth, and strong consumer demand, in turn spurring further investment.

As the boom continued, strong demand for labor reduced unemployment rates to levels not previously experienced since the 1960s. By the latter part of the decade, the actual

Chart 5. Economy-Wide Labor Market Conditions, 1980-2001. A strong economy in the 2nd half of the 1990s drove actual unemployment below the level associated with long-term "full employment" economic growth. (Left axis: US unemployment rate less DRI-WEFA estimate of "full employment" unemployment rate.)



unemployment rate had fallen below the 4% mark—much less than the "full employment" unemployment rate (a measure of what the unemployment rate would be in the absence of business-cycle effects), as illustrated in Chart 5. Reflecting tight labor markets, economy-wide compensation growth accelerated.

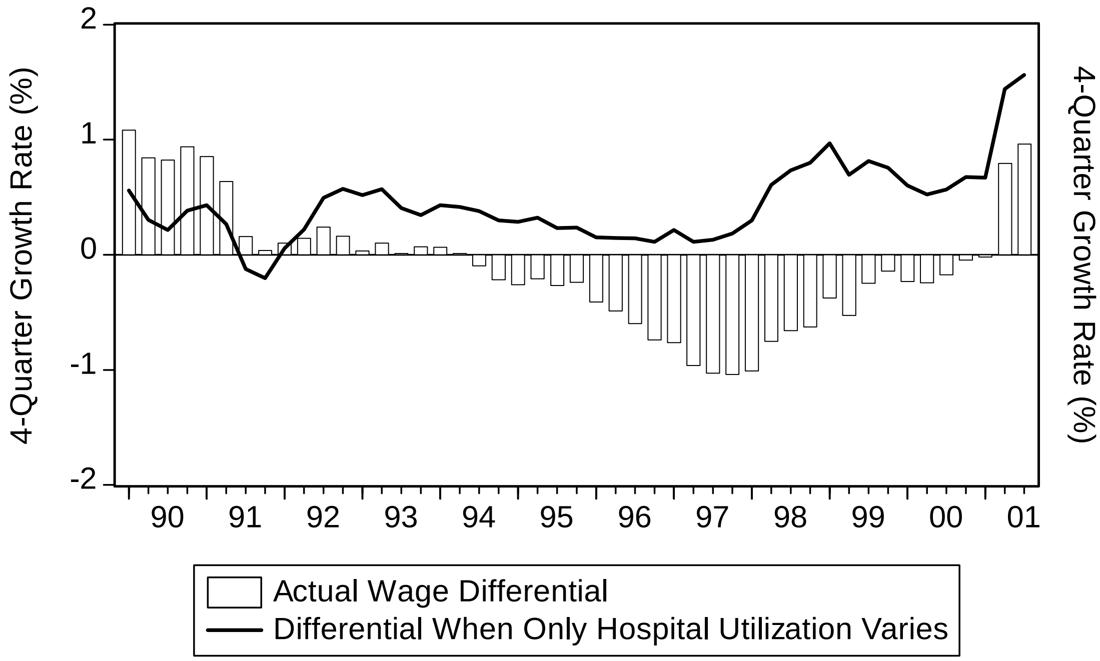
To summarize, it seems plausible that the late-1990s reversal of the long-standing differential in compensation growth favoring hospital workers reflected the interaction of these three factors. In this view, the transition to managed care slowed hospital compensation growth and a booming US economy accelerated wage and benefit escalation in other sectors, with the combined effect offsetting the impact of sustained increases in the demand for health care and hospital utilization. As a result, the formerly positive hospital compensation differential turned negative (see Chart 1).

An important implication of this analysis is that the effect may well have been temporary. With managed care penetration stabilizing at high levels, the one-time shift to a lower-cost delivery system will no longer offset the sustained effect of effect of ever-increasing health care demand. Moreover, the end of the late-1990s boom suggests that compensation growth in the economy as a whole may well moderate. Therefore, the recent acceleration of hospital compensation relative to economy-wide rates may signal that reversion to a positive compensation growth differential has already begun.

Disentangling the dynamics of the hospital compensation growth differential.

To clarify the relationships among these factors and suggest their future consequences, DRI•WEFA has developed an econometric model of the Hospital ECI wage and benefit growth relative to the PPS wage and benefits indices based primarily on economy-wide compensation data. This model incorporates the effects discussed above, including the demand for health care and hospital utilization, managed care and HMO market penetration, labor market conditions in the US economy as a whole, and, additionally, the interactions between wages and benefits in total compensation.

Chart 6. Actual Wage Differential and Simulated Differential when only Hospital Utilization Varies, 1990-2001. Controlling for economy-wide economic growth and managed care penetration shows that the wage growth differential favoring hospital workers would have remained positive rather than become negative as observed if driven by increasing hospital utilization trends alone (DRI-WEFA model simulation.)

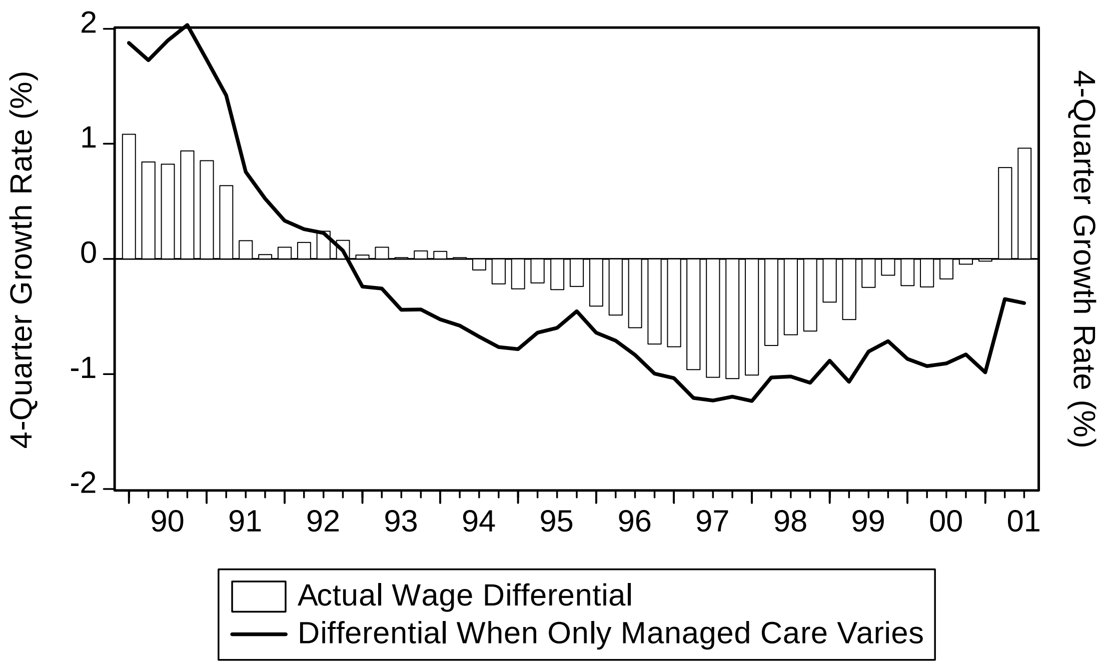


As detailed in the Statistical Appendix, the model is based on quarterly time-series from 1986 (when BLS introduced the Hospital ECIs) through the third quarter of 2001 and information on managed care compiled by CMS, as well other official statistical data. It is worth emphasizing that the methodology used to estimate the parameters of the model takes full account of the complicated dynamics of these processes. Indeed, as Charts 1 and 2 suggest, the compensation growth rates and growth differentials seem to be non-stationary time series, so that the effect of shocks may persist indefinitely. Nonetheless, the results indicate stable stationary relationships between the growth differentials and their determinants that validate the analysis presented in this report.

For the wage differential, the statistical analysis strongly confirms the significance of all three factors. Increases in hospital utilization, measured as effective patient-days per capita, increase the rate of growth in the hospital wage ECI relative to the PPS wage proxy. Conversely, increases in the managed care penetration ratio reduce the wage growth differential, as do increases in the HMO share of total managed care.

As expected, increases in the actual unemployment rate relative to a measure of the "full employment" unemployment rate also boost the hospital wage differential, although this effect is transient. Since the health-sector is less cyclically-sensitive than the economy as a whole, the wage differential will vary over the business cycle.

Chart 7. Actual and Simulated Wage Differential with Managed Care Varying, 1990-2001. Controlling for economy-wide economic growth and hospital utilization trends shows that the wage growth differential favoring hospital workers would have been even more negative than observed if driven by increases in managed care penetration alone (DRI-WEFA model simulation.)



There is also evidence of a long-term negative trade-off between hospital wage and benefit levels relative to the workers in the economy as a whole. Thus, a higher benefit differential is offset to some degree by a lower wage differential, suggesting that labor market conditions affect total compensation growth, but worker preferences may affect the mix between wages and benefits.

Whereas health sector variables are most important in determining the wage growth differential, overall labor market conditions play more of a role in determining the benefit differential. This may reflect a tendency for benefit packages to be shaped by general compensation practices rather than sector-specific labor market conditions. Therefore, while increasing hospital utilization has a temporary impact on the benefit growth differential, over the longer term, the differential tends to reflect overall labor market conditions. Because benefits play a smaller role in the PPS, the discussion henceforth focuses on wage effects.

Simulations of the model over the sample period provide more concrete illustrations of the *ceteris paribus* impact of health care demand, managed care, and economy-wide labor market conditions on the wage differential. In Chart 6, managed care (both the managed care penetration ratio and the HMO share) and overall labor market effects are held constant to highlight the impact of increases in hospital utilization. As the chart clearly indicates, the difference between growth in the hospital wage ECI and the PPS wage proxy would have been positive and trending higher over the sample period had the two other factors not offset the impact of increasing health care demand.

Chart 8. Actual and Simulated Wage Differential with Hospital Utilization Varying, 1990-2001. Controlling for hospital utilization and managed care trends shows that the wage growth differential favoring hospital workers would have declined if driven by economy-wide variation in labor market conditions, but less than observed (DRI-WEFA model simulation.)

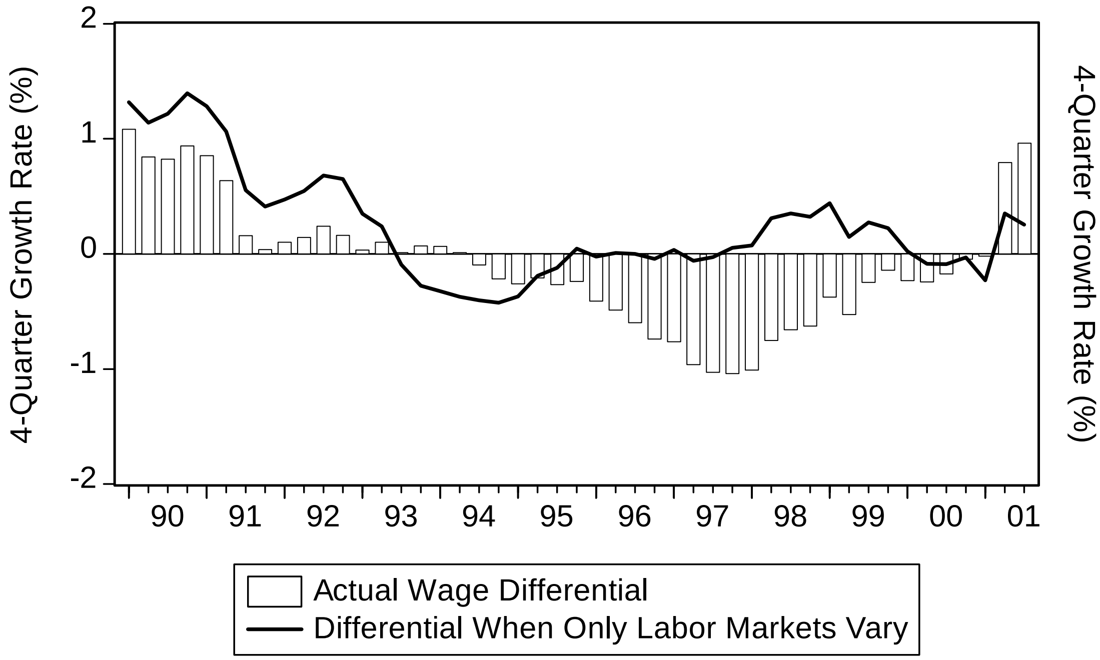


Chart 7 controls for hospital utilization and overall labor markets to isolate the impact of managed care, indicating that managed care trends by themselves would have resulted in a much larger negative wage differential than actually observed. This effect peaks in the late 1990s and begins to unwind by the end of the sample period, as increases in the managed care penetration ratio taper off and the HMO share drops due to “backlash”. Finally, Chart 8 controls for hospital utilization and managed care, illustrating how overall labor market conditions buoyed economy-wide wages in the PPS proxy relative to the Hospital ECI during the 1990s economic boom, contributing to the erosion of the ling-standing premium for hospital workers.

Implications for hospital compensation in the future.

Given the relationships implied by the model, what might be expected for the hospital wage and benefit differentials in the future? It seems clear that continued increases in the demand for health care in general, and hospital utilization in particular, will be the major determinant of future hospital wage and benefit growth differentials. Over the longer term, cyclic variation in economy-wide labor market conditions will tend to cancel out, with little net effect. Moreover, penetration of managed care is near saturation in private insurance markets, and there are no major policy initiatives pending that would spur major changes in public sector managed care. Therefore, potential changes in the managed care market mix seem to represent the greatest source of future uncertainty.

Chart 9. Projected Wage Differential with "High HMO" and "Low HMO" Scenarios, 1980-2012. Under baseline forecast assumptions, the historical wage growth differential in favor of hospital workers may well be restored in the future, although trends in HMO market share can affect the size of the gap (DRI-WEFA model projections.)

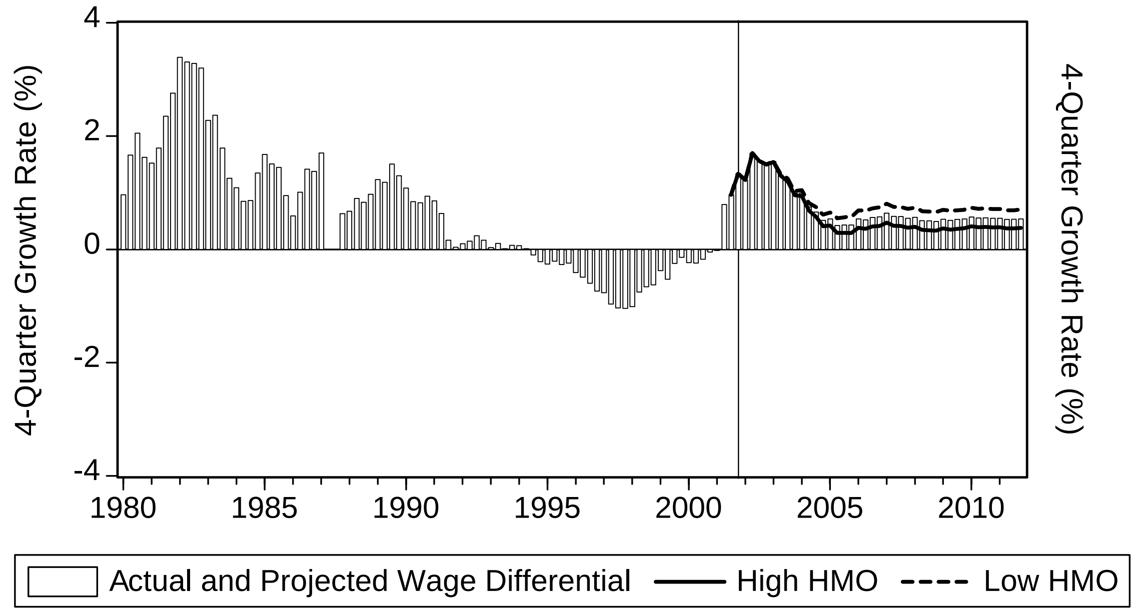
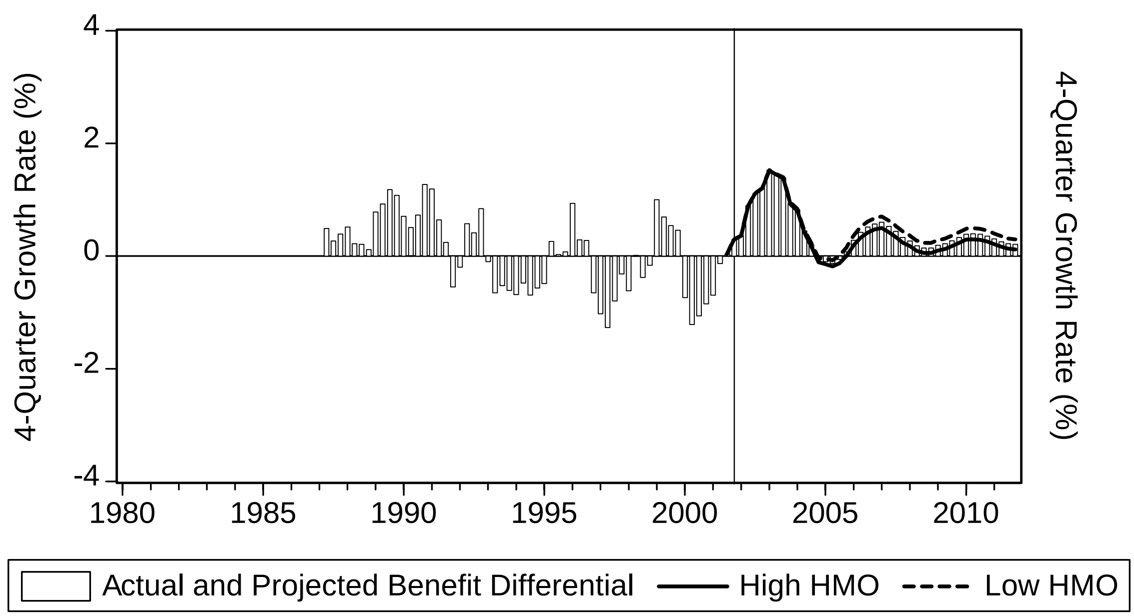


Chart 10. Projected Benefit Differential with "High HMO" and "Low HMO" Scenarios, 1980-2012. Although trends in HMO penetration will affect the size of the gap, the hospital benefit growth differential is also expected to return (DRI-WEFA model projections.)



To account for potential changes in the HMO share of managed care, the model simulates three scenarios through 2011. In the baseline, the HMO share of managed care remains at the current 34% level, continues its long-term decline in the “Low HMO” scenario, reaching 25%, and bounces back to 44% in the “High HMO” scenario. Chart 9 presents the projections for the wage differential and Chart 10 presents the results for benefits. These projections indicate that, under all three scenarios, wage and benefit differentials will continue their recent surge, and then gradually drift back toward a stable differential. In each case, the differential is positive, indicating that Hospital ECIs for wages and benefits can be expected to grow more rapidly than the corresponding PPS proxies over the longer term.

Conclusion

This analysis examines the recent determinants of the hospital compensation differential—the difference between wages and benefits as measured by Hospital ECIs and the “normative” PPS proxy indices based on economy-wide occupational data. The key finding is that the reversal of the long-standing positive differential favoring hospital workers during the 1990s is very likely to be temporary. Reflecting expected continued increases in the demand for health care and the derived demand for health-sector workers, hospital wages and benefits are likely to generally grow more rapidly than economy-wide compensation over the next ten years.

This finding might seem to suggest that the PPS “normative” wage and benefit indices should be retained as the labor cost component of the PPS. However, it is important to keep in mind that demand for health care drives demand for health-sector workers, hence escalation in labor costs—*not* the other way around.

Much of the long-term growth in U.S. health care demand reflects increases in average income and outcome-improving, but costly, new health technology. By reducing the price health-care consumers actually pay far below the cost of providing the services, however, the third-party payment system increases demand above efficient levels. Policies that attempt to control health costs by simply constraining the ability of providers to pay for the labor, materials and capital inputs required to meet demand risk undercutting the quality of health care. In fact, there is mounting evidence that labor shortages in key health occupations, such as nursing, have begun to impact hospitals.

The recent “backlash” against HMO limits on health care utilization seems to make it clear that consumers are not willing to accept further restrictions on access to care. In order to meet consumer quality expectations, hospitals and other providers must be able to pass through the cost of providing these services. In this context, the continued use of the PPS wage and benefit proxies would be counterproductive. Thus, to ensure continued high quality in government-paid health care, it may therefore be preferable--even if more costly--to replace the current compensation proxies with the actual hospital wage and benefit ECIs in the PPS hospital input price index.

Finally, while the transition to managed care provided a welcome respite for health-care cost inflation, it seems clear that further efforts to control costs must almost certainly focus directly on consumer decisions when and how intensively to utilize health sector resources. One obvious strategy is to make consumers responsible for a greater share of treatment costs, thereby encouraging more efficient use of health sector resources. Indeed, private-sector providers are developing a “defined contribution” approach to health insurance that will impose much higher copayment rates on consumers, along with “tiered” options that scale health-care services to willingness to pay. Thus, as with the PPS system and the advent of managed care, ever-increasing health care costs continues to spur innovation in the U.S. health care system.

STATISTICAL APPENDIX

Data and Variable Definitions

The historical sample covers the period from the second quarter of 1986, when the BLS Hospital ECIs were introduced, through the third quarter of 2001. Official US government statistics used in this study, including BLS employment and unemployment data, BEA national accounts data, and Census Bureau estimates and projections of the population are drawn from DRI•WEFA databases. Data on hospital utilization is from the American Hospital Association, on managed care is from the Kaiser Family Foundation, and various measures of Medicaid and Medicare spending is from the National Health Accounts have been provided by CMS.

Projections cover the period from the fourth quarter of 2001 through the fourth quarter of 2011. Forecasts of selected concepts are drawn from proprietary DRI•WEFA forecasts and from CMS forecasts of National Health Care Expenditures. Table A1 lists the basic concepts included in the model.

Table A1. Model Concepts. Data definitions and sources.

JECIWSCVHOSNS	BLS Hospital Wage ECI (1987=1)
JECIBCVHOSNS	BLS Hospital Benefit ECI (1987=1)
JPPSWSNS	CMS PPS Wage Proxy (1987=1)
JPPSBNS	CMS PPS Benefit Proxy (1987=1)
RUC	BLS Civilian Unemployment Rate
RUFE	DRI-WEFA "Full-Employment Unemployment" Rate
MGD	Managed Care Penetration Ratio
HMO	HMO Penetration Ratio
PATD	Effective Hospital Patient Days
N	US population

The ECIs are published by BLS and the PPS indices are produced by DRI•WEFA for CMS using hospital input-cost weights developed by CMS. For ease of comparison, these variables have been rescaled to average 1.00 in 1987. The "full employment" rate (RUFE) is DRI•WEFA's estimate of the unemployment rate that prevails when GDP on its long-term trend growth path, given demographics and other structural labor market factors.

The managed care variables MGD and HMO are estimates of the proportion of the insured population covered by managed care programs and HMOs, respectively, including publicly-funded Medicare and Medicaid programs. They are constructed as a weighted averages of the private sector ratios reported in Kaiser Family Foundation surveys and the CMS estimate of the public-sector HMO coverage ratios, with CMS estimates of the publicly and privately insured population as weights. Strictly for illustrative charts, DRI•WEFA extrapolated these data back to 1980 using CMS data.

The variable PATD measures hospital resources used in treatment as "effective" patient days. This measure is derived from AHA data by assuming that revenue per unit of time is approximately equal for in- and outpatients. Given total inpatient days, outpatient visits, and the corresponding revenue flows, an estimate of the implied fraction of a patient-day for each outpatient visit can be calculated (about 0.3 days) and used to estimate effective outpatient days and the overall total NPATD. Results are not very sensitive to the particular value of the estimate of effective days per outpatient.

To minimize the effects of trend on the statistical estimation, trended variables are measured in logarithms. Because some data are seasonally adjusted and some not, growth rates are calculated as four-period log-differences to minimize the effect of seasonality, so that for variable X, the expression

$$grX = \log(X/X(-4)) = \log(X)-\log(X(-4)).$$

denotes its four-quarter growth rate in the statistical tables. Because growth-rate measures can distort the impact of share variables, those included as levels and change is measured as simple differences, so that

$$dX = X-X(-4).$$

Finally, four-quarter moving averages are used to minimize the statistical effect of converting annual insurance coverage data to quarterly frequency (to match wage information) by linear interpolation, so that

$$MA\_X = (X+X(-1)+X(-2)+X(-3))/4.$$

Using these conventions, transformed variables appearing in the model are defined in Table A2.

Table A2. Model Transformations. Model variables defined in terms of basic data.

RWS	log(JECIWSCVHOSNS/JPPSWSNS)
dRWS	RWS-RWS(-4)
RB	log(JECIBCVHOSNS/JPPBSNS)
dRB	RB-RB(-4)
RRUC	RUC/RUFE
grRRUC	log(RRUC/RCUC(-4))
dMA_MGD	MA_MDG-MA_MGD(-4)
MA_RHMO	MA_HMO/MA_MGD
dMA_RHMO	MA_RHMO-MA_RHMO(-4)
MA_NPATD	MA_PATD/N
grMA_NPATD	log(MA_NPATD/MA_NPATD(-4))

Finally, note that the conceptual dependent variables for the model--log growth rate differentials--can be expressed explicitly in terms of the differences in the relative level of hospital to PPS indices. For example, where ECI and PPS stand for the hospital and PPS proxy versions of a concept,

$$R = \log(ECI/PPS)$$

implying

$$dR = \log(ECI/PPS) - \log(ECI(-4)/PPS(-4))$$

$$= \log(ECI) - \log(PPS) - \log(ECI(-4)) + \log(PPS(-4)) = \log(ECI/ECI(-4)) - \log(PPS/PPS(-4))$$

$$= grECI - grPPS.$$

Stating the model in terms of the relative wage and benefit ratios (RWS and RB) and their first-differences offers an important advantage by making it much simpler to consider the dynamics of the wage and benefit differentials in terms of both rates of change and levels through an Error-Correction specification.

An Error-Correction Approach to Model Specification

As an initial step in the analysis, Dickey-Fuller unit-root tests for stationarity were conducted on all variables in first-difference or growth-rate form. In every case, test statistics indicated that the null hypothesis of a unit root could not be rejected--all the dynamic time series considered in this analysis seem to be non-stationary.

It is well-understood that simply differencing non-stationary series until they are stationary risks losing important information about their relationship. Indeed, non-stationary variables can be linked in economically meaningful relationships—for example, unit-root variables may drift together in approximately fixed proportions consistent with economic theory. The macroeconomic consumption function linking consumer expenditures and disposable income is one example, and the relationship between hospital compensation relative to economy-wide measures and health-sector demand and insurance market characteristics considered in this analysis seems to be another. In contemporary parlance, variables in such a relationship are said to be "cointegrated."

While it is possible to estimate such relationships consistently with ordinary least squares, ignoring the short-term dynamic disturbances to the equilibrium relationship risks biased estimates of model parameters. Current practice favors the Error Correction (EC) approach, which embeds the hypothesized equilibrium relationship stated in levels in a dynamic adjustment relationship expressed in first-difference terms. For example,

$$dy = \boldsymbol{\alpha} d\mathbf{X} - \eta(y(-1) - \gamma\mathbf{X}(-1)) + \boldsymbol{\varepsilon}$$

imbeds the equilibrium relationship $0 = -y + \gamma\mathbf{X}$ in a difference equation with the interpretation that shocks causing discrepancies between y and its equilibrium value $\gamma\mathbf{X}$ feed back to dy in a dynamic adjustment process. The parameters of the model can be estimated from the regression model

$$dy = \boldsymbol{\alpha} d\mathbf{X} - \eta y(-1) + \boldsymbol{\beta}\mathbf{X}(-1) + \boldsymbol{\varepsilon}$$

and the parameter of the equilibrium relationship estimated as $\gamma = -\boldsymbol{\beta} / \eta$.

This general approach is used to quantify the relationship between the hospital wage and benefit growth differentials and the factors that can potentially account for their changing patterns over time. Each growth differential is modeled as the sum of a short-term adjustment process, involving contemporaneous and lagged differences or growth rates of the differentials themselves and explanatory variables, with a hypothetical equilibrium relationship that links relative compensation levels, health-sector market characteristics, and overall labor market conditions.

Estimation Methodology and Results

This study follows a strategy of "general to specific" specification testing. The EC specification is a two-equation system, with one equation for the difference in wage growth as measured by the Hospital ECI and the PPS proxy, and another for the corresponding benefit differential. Keeping in mind that all differences and growth rates are defined over four quarters, the adjustment process for each growth differential includes its own lagged values, contemporaneous and lagged values of the other differential, and current and lagged values of the growth rates or differences of the health-sector and labor market variables, with four lags initially included. The equilibrium relationship is represented by the levels of the hospital ECI relative to the PPS concept, the relative level of the other compensation component, and the levels of the explanatory variables, all lagged four quarters. Variables are eliminated by "testing down" to find a final specification that seems to best satisfy both statistical goodness-of-fit and stationarity criteria and conceptual relevance.

To ensure robustness, the analysis considers a variety of estimation methods, ranging from single-equation regressions, a several system estimators, and a vector autoregression approach. In general, modified Dickey-Fuller tests indicated that specifications including only level variables (the equilibrium relationship) did not yield stationary relationships, whereas those including differences (the adjustment process) generally did, supporting the EC approach. Qualitatively, most-specifications produced similar in- and out of sample simulation results.

The simulation results described in this report are generated by a dynamic structural model employing a Generalized Method of Moments estimator (similar to three stage least squares) to take account simultaneous feedback between wage and benefit differentials, which play an important role in the process.

Although the dynamic response of hospital compensation differentials are the primary focus of this study, the implied equilibrium relationships determining the level of hospital ECIs relative to the PPS proxies are of some interest, and are presented in Table A3.

Table A3. Estimated equilibrium relationships among model variables. Rows represent the estimated dynamic effects and implied steady-state "equilibrium" relationship for Wage and Benefit differentials. Columns are independent variables.

	Wage Diff.	Benefit Diff.	Hospital Utilization	Managed Care	HMO Share	Unemp. Gap
Wage Differential	-0.176	-0.086	0.116	Effects	-0.040	
Implied Equilibrium	-1.000	-0.487	0.659	-0.315	-0.228	
Benefit Differential	0.522	-0.914				0.005
Implied Equilibrium	0.571	-1.000				0.006

Noting that the log-ratio dependent variables can be interpreted as approximating the percentage difference between the ECI and PPS index values, the equilibrium parameters can be easily interpreted. For example, an increase in the ECI for benefits relative to the PPS of one percent implies about a 1/2 percent (-0.487) decline in the wage ECI relative to the PPS, while a one-percent increase in hospital days per capita implies an increase of 2/3 percent (0.659). Similarly, a one-percentage point increase in the HMO share of managed care generates roughly a 1/3 percent decline in the ECI wage index relative to the PPS. Quantitatively, these estimates highlight the finding that hospital utilization has the most important impact on relative health-sector compensation, both directly through its impact on wages and indirectly via the effect of wages on benefits. Detailed estimation results are presented in Table A4 and Table A5.

Table A4. GMM Estimation Results for Wage Differential. Statistical summary.

```
System NEWWAGE: Equation 1: dRWS
============================================================
Variable          Coefficient Std. Error t-Statistic  Prob.
============================================================
dRB                  0.084784   0.012807   6.620118   0.0000
dRWS(-1)             0.172548   0.038215   4.515184   0.0000
dRWS(-2)             0.242250   0.034882   6.944775   0.0000
grMA_NPATD           0.028930   0.003187   9.077010   0.0000
grRRUC               0.005375   0.000782   6.871749   0.0000
dMA_MGD             -0.022358   0.002110  -10.59471   0.0000
dMA_RHMO            -0.019888   0.001727  -11.51605   0.0000
RWS(-4)             -0.176298   0.009961  -17.69809   0.0000
RB(-4)              -0.085793   0.014221  -6.032976   0.0000
log(MA_NPATD(-4))    0.116264   0.004831   24.06474   0.0000
MA_MGD(-4)          -0.055616   0.002367  -23.49616   0.0000
MA_RHMO             -0.040220   0.001656  -24.28387   0.0000
============================================================
Estimation Method: Generalized Method of Moments
Sample: 1987:4 2001:3
Included observations: 56
Kernel: Bartlett,  Bandwidth: Fixed (6),  No prewhitening
Linear estimation after one-step weighting matrix
R-squared            0.972989    Mean dependent var 0.000879
Adjusted R-squared   0.966236    S.D. dependent var 0.006648
S.E. of regression   0.001222    Sum squared resid  6.57E-05
Durbin-Watson stat   1.761880
============================================================
     Augmented Dickey-Fuller Unit Root Test on RES_dRWS
============================================================
ADF Test Statistic -3.723669     1%   Critical Value*-3.5625
                                 5%   Critical Value -2.9190
                                 10% Critical Value  -2.5970
============================================================
*MacKinnon critical values for rejection of hypothesis of a unit
root.
```

Table A5. GMM Estimation Results for Benefit Differentials. Statistical summary.

```
System NEWWAGE: Equation 2 dRB
============================================================
Variable          Coefficient Std. Error t-Statistic  Prob.
============================================================
============================================================
dRWS                0.496410   0.075945   6.536436   0.0000
dRB(-1)             0.318723   0.055895   5.702132   0.0000
dRB(-2)             0.270377   0.045305   5.967935   0.0000
dRWS(-1)           -0.419449   0.080620  -5.202771   0.0000
grMA_NPATD)         0.110049   0.012135   9.068744   0.0000
grRRUC              0.009778   0.001787   5.472784   0.0000
RB(-4)             -0.914275   0.046942  -19.47663   0.0000
RWS(-4)             0.522223   0.024629   21.20390   0.0000
log(RRUC(-4))       0.005413   0.001595   3.393833   0.0010
============================================================
Estimation Method: Generalized Method of Moments
Sample: 1987:4 2001:3
Included observations: 56
Kernel: Bartlett,  Bandwidth: Fixed (6),  No prewhitening
Linear estimation after one-step weighting matrix
R-squared           0.788075    Mean dependent var 0.000310
Adjusted R-squared  0.752002    S.D. dependent var 0.006799
S.E. of regression  0.003386    Sum squared resid  0.000539
Durbin-Watson stat  1.389753
============================================================
     Augmented Dickey-Fuller Unit Root Test on RES_dRB
============================================================
ADF Test Statistic -3.108255     1%   Critical Value*-3.5625
                                 5%   Critical Value -2.9190
                                 10% Critical Value  -2.5970
============================================================
*MacKinnon critical values for rejection of hypothesis of a unit
root.
```