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Projections of National Health Expenditures: Methodology and Model Specification

The Office of the Actuary (OACT) in the Centers for Medicare and Medicaid Services (CMS) annually produces 10-year projections of health care spending for categories within the National Health Accounts (NHA). The NHA track health spending by source of funds (for example, private, Medicare, Medicaid) and by type of service (hospital, physician, pharmaceuticals, etc.).

The latest projections were completed before the Medicare Prescription Drug, Improvement, and Modernization Act was signed into law in December 2003. Therefore, the growth path projected for 2004-2013 can serve as a baseline from which the impact of this legislation can be measured.

To produce projections for total National Health Expenditures (NHE), OACT combines projections for Medicare and Medicaid spending (based on actuarial techniques) with projections for private health spending (based on a multi-equation structural econometric model, hereafter referred to as the NHE Projection Model). The NHE Projection Model attempts to capture the causal relationships between major macroeconomic variables and private health spending, as well as interactions among major causal variables within the health sector. The macroeconomic and demographic outlook from the 2003 Trustees Report and the projections of Medicare and Medicaid spending produced by OACT are exogenous inputs into the model. Thus, the NHE projections are conditional on the assumptions inherent in these projections.

The methodology and specification for the NHE Projection Model are presented below. The discussion is organized in the following sections:

I. Data Sources

II. Model Specification

III. Types of Services

IV. Sources of Funding

I. Data Sources

Health Expenditures

All historical data for health expenditures are derived from the NHA compiled by OACT. The NHA is a national level matrix of health spending data by type of service and source of funding. Information on the methodology used in producing these historical estimates can be found at http://www.cms.hhs.gov/statistics/nhe/definitions-sources-methods/. Types of services and sources of funding projected in our model are listed below.

Types of Services

National Health Expenditures
- Health Services and Supplies
  - Personal Health Care
    - Hospital Care
    - Professional Services
      - Physician and Clinical Services
      - Other Professional Services
    - Dental Services
    - Other Personal Health Care
    - Nursing Home and Home Health
      - Nursing Home Care
      - Home Health
    - Retail Outlet Sales of Medical Products
      - Prescription Drugs
      - Durable Medical Equipment
      - Nondurable Medical Products
  - Government Administration and Net Cost of Private Health Insurance
  - Government Public Health Activities
- Investment
  - Construction
  - Research

Sources of Funding

National Health Expenditures
- Private
  - Private Health Insurance
  - Consumer Out-of-Pocket
  - Other Private
- Public
  - Federal
    - Medicare
    - Medicaid
    - Other Federal
  - State and Local
    - Medicaid
    - Other State and Local

Medical Price Indexes

Data sources for medical prices are consistent with those used in the NHA. For most types of services, price indexes are based on the Consumer Price Indexes (CPI) published by the Bureau of Labor Statistics (BLS). However, for nursing home services we use input price indexes compiled by CMS, and for hospital services we use a Producer Price Index (PPI) from BLS.

For our behavioral model, we would ideally have a measure of the transaction price of medical services that is consistent over our estimation interval (1960-2002). Although the CPI offers the best available data, it is generally regarded as somewhat flawed for this purpose in the medical care sector because it fails to adjust for changes in the services incorporated in an item (such as a physician visit) and does not fully capture the effect of discounting from list prices, and is subject to problems in adjustments for quality change and the introduction of new products.[1] While changes have been made to the indexes in the past several years to address these problems, these concerns continue to apply to most of the history of the series.

For inpatient hospital services for 1994-2002, the NHA uses a transaction price (the PPI for hospital services introduced in December 1992) rather than the CPI for hospital and related services. To obtain a measure closer to a transaction price, the PPI uses a methodology that attempts to capture discounts and redefines the "items" included in the index. For years prior to 1994, OACT estimated a transaction price measure based on an adjusted version of the CPI for hospital and related services.

For skilled nursing services, for which no separate price index is available for the time period required, we use input price indexes (IPIs) developed by OACT to track input costs incurred by these providers. IPIs are used as a proxy for output prices based on the assumption that input costs will be a major determinant of output prices. Note, however, that this measure excludes the effect on output prices of productivity change and fluctuating profit margins.

Our price measure for total personal health care spending is a chain-weighted deflator based on the indexes in the table below, with the weight for each index set equal to the share of personal health care expenditures accounted for by that type of service.

[1] Triplett, J.E., *Measuring the Prices of Medical Treatment*, The Brooking Institution, 1999: 1-33.

Derivation of the personal health care expenditure chain-type annual-weighted price index

Industry/Commodity or Service	Price proxy	2002 weight
Personal health care		100.0
Hospital care	PPI, hospitals*	36.3
Physician and clinical services	CPI, physician services	25.3
Other professional services	CPI, professional services	3.4
Dental services	CPI, dental services	5.2
Home health care	CPI, professional services	2.7
Other personal health care	CPI, medical care	3.4
Nursing home care	National Nursing Home Input Price Index	7.7
Prescription drugs	CPI, prescription drugs and medical supplies	12.1
Other non-durable medical products	CPI, internal & respiratory over-the-counter drugs	2.4
Durable medical equipment	CPI, eyeglasses and eye care	1.4

*Producer Price Index for hospitals, U.S. Department of Labor, Bureau of Labor Statistics. Used beginning in 1994 and scaled to 100.0 in 1996. Indexes for 1960-93 are based on a CMS developed output or transaction price index.

Insurance Coverage Data

Private health insurance enrollment data are compiled by OACT using a combination of the National Health Interview Survey (NHIS) and the Current Population Survey (CPS). Presently, the insured population is benchmarked to the 1997 NHIS and is then escalated using the change in the insured population from the CPS. Net enrollment for earlier years was developed using data on gross and net enrollment and percentage of population privately insured, as presented by M. Carroll and R. Arnett in "Private Health Insurance Plans in 1978 and 1979: A Review of Coverage, Enrollment and Financial Experience" and in preceding articles (1970-79).

Total enrollment in Health Maintenance Organizations (HMOs) is based on data from the American Association of Health Plans (AAHP) through 1997. For 1998-2001, enrollment is estimated based on data compiled by Interstudy. Data for Medicare and Medicaid HMO enrollment are compiled by OACT from CMS program data. Private enrollment is estimated as a residual after subtracting Medicare and Medicaid enrollment from total enrollment.

Exogenous Projections

Projections for macroeconomic variables, such as economic growth and economy-wide inflation, and demographic variables, such as the age composition of the population, are derived from the annual projections of the Board of Trustees for OASDI (Federal Old-Age and Survivors Insurance and Disability Insurance). These projections are produced annually by the Social Security Administration (SSA).[2]

[2] Board of Trustees, Federal Old-Age and Survivors Insurance and Disability Trust Funds, *2003 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Disability Insurance Trust Funds,* < www.ssa.gov/OACT/TR/TR03/index.html>.

A projection for disposable personal income (DPI) consistent with the economic assumptions from the 2003 Medicare Trustees Report is generated using the University of Maryland Long Term Interindustry Forecasting Tool (LIFT). The relationship between DPI and GDP is influenced by fluctuations in taxes and government transfer payments, depreciation of capital stock, and retained earnings and transfer payments of private business.

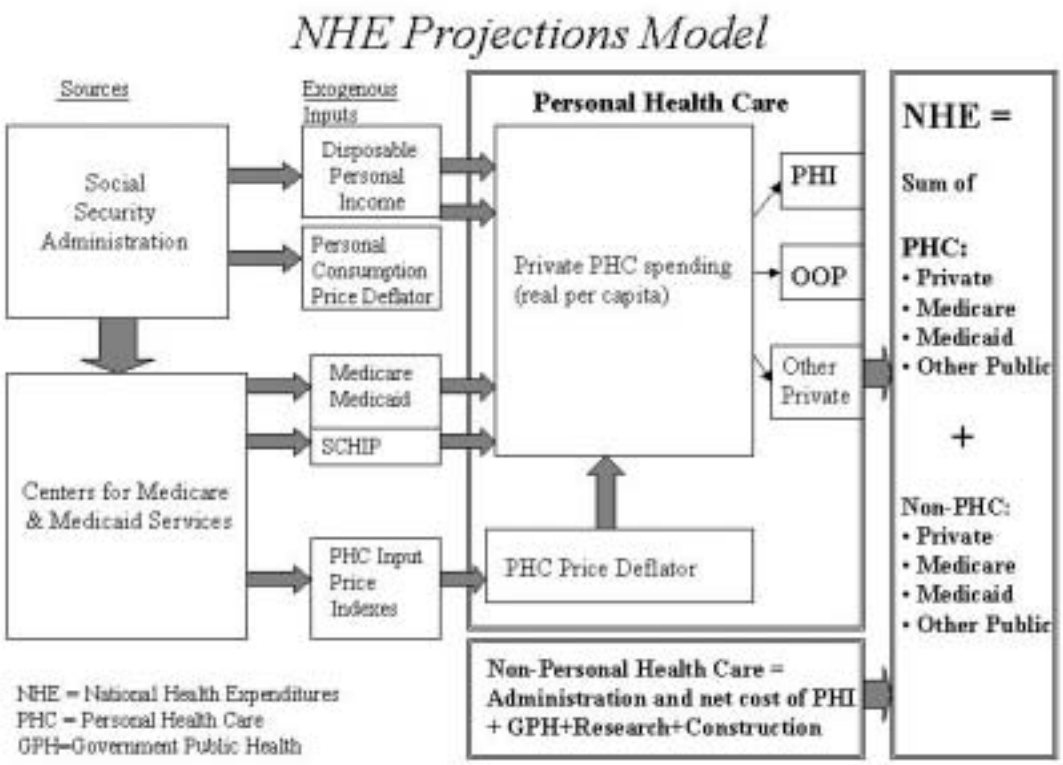
The Board of Trustees for Medicare reports annually to the Congress on the actuarial status of the Hospital Insurance and Supplementary Medical Insurance Trust Funds.[3] These projections, as well as the Medicaid and SCHIP projections, are produced by OACT and are also consistent with macroeconomic and demographic assumptions included in the OASDI Trustees Report.

The latest release of the NHE projections was produced in the fall of 2003. This forecast incorporates projections from the 2003 Trustees Reports issued in the spring of 2003, updated to reflect additional macroeconomic, Medicare and Medicaid data available through November 2003.

[3] Board of Trustees, *2003 Annual Report of the Boards of Trustees of the Federal Hospital Insurance Trust and Federal Supplementary Medical Insurance Trust Funds,* 26 March 2003, <cms.hhs.gov/publications/trusteesreport/2003/tr.pdf>.

II. Model Specification

The structure of the NHE Projection Model for private health spending draws on standard economic theory and the health economics literature. We used these resources not only to develop the model structure, but also to evaluate the parameters resulting from our estimation. This model structure has remained largely consistent since its introduction in our projections released in July 1998. The diagram below provides a schematic view of the aggregate health sector within the NHE Projections Model and shows the linkages among the data sources, exogenous data, the personal health care (PHC) model, the non-PHC output, and the aggregate NHE projections.



The NHE Projection Model is a "top-down" model in that the growth in private health care spending and medical inflation are primarily determined at the aggregate level on the basis of exogeneous projections of macroeconomic variables, actuarial projections of spending for the Medicare and Medicaid programs, and health sector assumptions. Models for spending growth and price inflation for individual types of medical services are estimated and solved separately, based on models similar in specification to the aggregate model. Model solutions for all types of services are then constrained for consistency with the aggregate spending projection.[4] Our choice of projection models reflects our finding that the model is substantially more robust at the aggregate level.[5]

[4] See discussion of sectoral constraints under 'Types of Service'

[5] There are several possible reasons for this finding. First, spending for the different types of services is interdependent, and conceptual and measurement issues with the data make it difficult to convincingly capture complementary and substitutive relationships across types of services. When shifts across services are believed to have occurred on a large scale, it is difficult to accurately capture the effect on patterns of growth. For example, such a shift occurred following the introduction of Medicare's prospective payment system for most inpatient hospital services. However, the manner in which such events are specified affects the coefficients obtained on the

A simple econometric model for projections of private sources of funds (private health insurance, out-of-pocket spending and other private spending) explains change in share of each source of private funding within each type of service (PHI spending on prescription drugs as a share of total spending on prescription drugs).

The core of our aggregate model of PHC spending consists of two behavioral equations [6]:

- Private personal health care spending (real per capita)
- Personal health care price inflation

The key variable in our aggregate model of personal health care spending is real per capita private PHC spending. Our equation for this dependent variable includes three independent variables:

- **Disposable personal income growth (less Medicare and Medicaid, real per capita) (Exogenous)**
- **Relative medical price inflation (PHC) (Endogenous)**
- **Public spending growth (PHC, real per capita) (Exogenous)**

The interpretation and model specification for each of these variables are discussed below.

Disposable Personal Income

Income is defined as real per capita disposable personal income (DPI) less Medicaid and Medicare payments.[7] This is a highly influential variable in our model of private health spending. The importance of this variable is consistent with a large body of literature examining the empirical relationship between national income and health spending. It has been repeatedly shown that variations in GDP, and thus income, account for the majority of international variation in health spending. A number of studies based on time-series cross-country data for Organization of Economic Cooperation and Development (OECD) economies have largely confirmed the importance of this relationship.[8]

In the NHE Projections Model, income has a lagged effect on health spending. This effect is suggested by several characteristics of the market for health services. The critical element is the role of third-party payers. Since private insurers or public payers account for the large majority of health spending, spending is largely insulated from contemporaneous changes in household income. Furthermore, since consumers generally do not pay for their medical expenses directly at the point of purchase, their decisions are not immediately affected in the short term by variations in income.[9]

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model variables. Second, data on relative prices across types of medical services are somewhat flawed for our purposes and are not always consistent across services; thus, obtaining reasonable cross-price elasticities is difficult. Third, health services tend to be purchased as bundles that incorporate types of services extending across several different sectors, while the data are not measured in such a way that we can track the behavior of the market for these linked bundles. Aggregation across all types of medical care partially ameliorates these problems.

[6] Variables are expressed as log differences (growth rates)

[7] The objective is to obtain as nearly as possible a measure of income that applies to the population that accounts for private spending on medical care. Thus we exclude spending for Medicare and Medicaid, which are included in DPI but accrue to a population that is primarily publicly insured.

[8] For a review of this literature, see Gerdtham, Ulf, "International Comparisons of Health Expenditure," *Handbook of Health Economics* (Amsterdam, Elsevier, 2000): 11-53.

[9] Some current period effect can be expected in response to consumer cost-sharing and loss of employment, with the

Conceptually, the effect of income on private health spending could be affected by the decision to purchase private health insurance. Increases in income would encourage the purchase of more generous insurance. However, the current-period response is also dampened by the intermediation of employers. Most insurance is purchased through employers, who respond to the pooled interests of their employees. Employers often offer few choices of health plans, and some offer none, limiting short-term flexibility for employees. Negotiating health insurance contracts on an annual basis also causes a delay in the time it takes to respond to changing labor market conditions and employee preferences. In addition, because the exercise of control over medical expenses by private insurers may require the development of new institutions (for example, managed care organizations) or changes in government regulation of institutions, several years may be required before a response to changes in income can be fully realized.

Public spending decisions can also be expected to respond to changes in income with a substantial lag. Changes in the growth of public spending will be influenced by the underlying health sector variables that drive the cost of services and by changes to the regulations that affect the price and volume of these services. Examples include the incentive effects of the physician fee schedule or prospective payment systems, Federal and state level regulation influencing the nature of insurance coverage (e.g. diverse forms of "patient protection" legislation), or costs associated with medical malpractice liability. Such changes occur over time as lawmakers respond to perceived problems in the financial status of the programs within the limits of what taxpayers are willing to pay for them.

To capture these potential lags, the income term in our model of personal health care spending is incorporated as a moving average over 5 years (from four years previous through the current period).[10] The sum of the coefficients for all lagged periods on this variable is 1.9, which, given our specification, can be interpreted as an income elasticity. This elasticity implies that a 1-percent increase in real disposable personal income, less Medicare and Medicaid spending, results in a 1.9-percent increase in private personal health care spending spread over a period of five subsequent years. This compares with macro-level elasticities of approximately 1.0 to 1.5 in the empirical literature.[11] However, these estimates are generally based on spending by all sources of funding, rather than on private spending alone, and are estimated based on international cross-country time-series data sets. Given the absence of an explicit measure of technological change, it is also likely that this coefficient on income is capturing an interaction effect between income growth and medical innovation.[12]

As discussed above, this income term is intended primarily as a proxy for the influence of a number of separate developments, which occur in response to changes in incomes. These might include changes in the nature and breadth of health insurance coverage offered by employers, the development and evolution of institutional structures for the financing and delivery of medical care (e.g. including the legal environment and organizational structures within the private sector that facilitate the development and diffusion of new forms of coverage), shifts across different forms of managed care, the passage of state and Federal legislation influencing the costs of providing care, and fluctuations in the fraction of the population with health insurance.[13] The implicit theory underlying this variable is that the income effect occur indirectly in the form of changes to the institutions within

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associated loss of employer-provided health insurance.

[10] Estimates that allow coefficients to vary across this five-year period based on a polynomial distributed lag (PDL) show no statistically significant improvement in explanatory power over a moving average.

[11] Getzen, T.E., "Health Care is an Individual Necessity and a National Luxury: Applying Multilevel Decision Models to the Analysis of Health Care Expenditures," *Journal of Health Economics*, 2, 2000: 259-270.

[12] A constant term (sometimes interpreted as a deterministic trend associated with technological change) was found in our model to be negative and insignificant and was therefore dropped.

[13] Explicit measures of managed care based on the inclusion of private sector HMO coverage rates as a proxy for the effects of managed care were found to be insignificant in our model. We believe that this result was associated with problems in the breadth and consistency of the proxy, which does not capture the effects of shifts across forms of managed care over time, changes in the nature of managed care within models of managed care, or spillover effects.

which medical care is provided, rather than at the level of the individual consumer, and that the specific nature of this change cannot be predicted, and (almost always) cannot be accurately measured.

The projection of the income variable is exogenous (an outside input) to our model. Projections of real per capita disposable personal income incorporated in our projections are consistent with exogenous OASDI projections for growth in GDP and the economy-wide personal consumption deflator (see Data Sources section for modeling of link between GDP and DPI). Projections for Medicaid and Medicare spending (subtracted from disposable personal income) are also exogenous, based on OACT projections (see the Data Sources section for a description of all exogenous inputs and source citations).

Relative Medical Price Inflation

Economic theory predicts that consumers allocate their spending on goods and services according to their relative price. However, the existence of third-party payers for medical care again complicates this relationship. Consumers bear only a fraction of the actual price of medical services at the time of purchase. Thus, in short-term consumption decisions, they respond to the out-of-pocket price rather than to the actual price, generally determined by a combination of deductibles, cost-sharing requirements, and out-of-pocket maximums. The price to consumers can be roughly approximated by the fraction of total costs paid out-of-pocket multiplied by the actual price. This was the price variable originally included in our model. We would expect this variable to appear in the model with a negative coefficient.

Medical prices also influence demand for services in two additional ways. First, the price of health insurance is effectively the price of the bundle of medical goods and services an enrollee is expected to consume (plus administrative costs and profits). Thus, consumers' decision to purchase health insurance, through their employers as agents in most cases, and the amount of health insurance purchased, is influenced by the relative price of medical care through its effect on the price of insurance. Demand for health care, therefore, depends upon changes in the actual relative price of medical care as well as the relative price on an out-of-pocket basis. Second, the relative price of medical care affects demand for services across types of medical care through the price sensitivity of health insurers' coverage and provider selection decisions. The nature of this relationship also suggests the possibility of a lag in the response to relative price.

We found that the coefficient on relative price to consumer on an out-of-pocket basis was negative (as expected) but statistically insignificant in our aggregate model. The primary reason for this finding is that we are working with data at a high level of aggregation. The out-of-pocket price to consumer varies substantially across different consumers, which masks the predicted effect in the aggregated data. Another reason is that the price data are somewhat flawed for our purposes–excluding discounts in a few cases–and failing to adjust completely for changes in quality, thus obscuring the relationship.

The variable included in our model is relative medical price inflation unadjusted for changes in consumer out-of-pocket share. This variable was found to have the predicted negative relationship with real per capita private PHC spending, and was significant at the 1-percent level. The estimated relative price elasticity is –0.4, suggesting that a 1-percent increase in the relative price of medical care results in a 0.4-percent decline in real per capita PHC spending. This elasticity is above micro-based estimates of price elasticity of demand for medical care (-0.1 to –0.2 from the Rand Health Insurance Experiment).[14] This discrepancy reflects the fact that micro-based studies use household-level data on the relationship between consumer out-of-pocket spending below out-of-pocket maximums and effective price given coinsurance rates. In addition to issues associated with the use of aggregated data, such estimates do not include sensitivity to changes in insurance premiums (which reflect medical price inflation for all

[14] Manning, W.G., et al., "Health Insurance and the Demand for Medical Care: Evidence from a Randomized Experiment," *American Economic Review*, Vol. 77, No. 3, June 1987.

care delivered).

In the absence of a variable to control explicitly for declines in out-of-pocket share, we have attempted to adjust for the predicted effects of changes in this variable through judgmental adjustments to the model solution.

Medical price inflation is an endogenous variable in our model since it is determined within the NHE Projection Model. In the long term, the growth in the price of medical services and goods should be determined by growth in the relative price of inputs used in production of health services, economy-wide price inflation, changes in profit margins, and the rate of change in total factor health sector productivity. Only the first of these is explicitly included in our model.

The dependent variable in our model is OACT's price deflator for personal health care spending. This is a function of input price inflation[15] (IPI) over the past three years. Coefficients for lagged IPI are fitted on a polynomial, with more than 80 percent of the effect estimated to occur within a year. The effects of other factors (economy-wide price inflation, productivity growth, industry profitability) are captured indirectly through their influence on IPI, and through a first-order autocorrelation adjustment.

Given the potential for price discounting associated with managed care to influence medical price inflation, we also attempted to include an HMO proxy variable in our model for this inflation. However, we found that this variable did not have a statistically significant effect – probably due to flaws in this variable as a proxy for managed care. Problems also may exist because of flaws in our price measures.

Input price inflation is also an endogenous variable in our model. Input price inflation is a function of economy-wide inflation in labor compensation, economy-wide price inflation, and lagged growth in health spending as a share of GDP (one-year lag). Economy-wide labor compensation is an exogenous input to our model, based on the OASDI projections of employment and wage and salary disbursements.

Public Health Spending (PHC)

In our model of growth in real per capita private spending on PHC, growth in real per capita public spending has a negative coefficient. Public and private sector spending are jointly affected by a number of factors. From the supply side, it is probable that the growth rates in the per enrollee cost of providing treatment to persons insured under public and private programs correspond quite closely in the long term – although demographic and institutional differences will produce some variation.

The negative coefficient on this variable in our model reflects in part that neither public nor private spending is expressed in per enrollee terms. Rather, spending is per capita basis – the denominator is total population. The reason for this choice lies in data issues with time series on insured population (private, Medicare, and Medicaid). The time series for private enrollment is defined to include all persons with private coverage. This including Medigap policies, where the primary source of coverage is Medicare. Thus, there is a substantial overlap between the series. In addition, the history for private enrollment stems from multiple sources and is subject to inconsistencies over time due to variations in survey questions. A second issue is that the history of Medicaid enrollment is volatile, due to changes in eligibility for the program. These changes tend to involve the influx of a relatively low per enrollee population (i.e. children and pregnant women) relative to the existing Medicaid population (which is relatively heavily weighted towards the institutionalized). This distorts per enrollee growth. The use of growth on a per capita basis measures means that a shift in enrollment between public and private programs will be associated with a change in per capita spending in the same direction – implying a negative

[15] The input price index used is a weighted average of OACT's input price indexes for hospital services, physician services, home health services, nursing home services, and pharmaceuticals.

coefficient on public spending in our model.

Our model forecasts private spending growth conditional on Medicare and Medicaid spending projections based on the 2003 Trustees Report. We incorporate real per capita public spending as an independent variable in our model of private spending. As discussed above, the balance of the effect of changes in public medical spending on private spending, after accounting for the shared influence of income, medical price inflation, can be expected to be negative. The negative coefficient on public spending in our regression captures two combined effects over the historical period: (1) shifts in coverage out of private and into public programs, and (2) any potential short-term cost shifting between public and private programs.

Public health spending is largely exogenous to our model – based on actuarial projections of Medicare and Medicaid spending, which account for approximately 75 percent of public spending. Medicaid and Medicare spending projections are based on OACT projections. Other public spending is projected endogenously, largely based on current and lagged growth in GDP from OASDI projections (see the Data Sources section for a description of all exogenous inputs to our model and source citations).

Managed Care

In a departure from earlier specifications in some years (1999-2000), the current version of the NHE Projections Model does not include a variable for managed care at the aggregate level. While we believe that the introduction of forms of managed care influenced growth in real per capita spending and price inflation in the mid-1990s, we have found that the proxy previously used to capture this effect to be increasingly flawed.

The proxy used for this purpose was private health maintenance organization (HMO) penetration rate (private population enrolled in HMOs as a fraction of the total privately insured population). This choice of a proxy for managed care enrollment is based on the availability of a consistent time series and required two assumptions: (1) the effect of managed care will vary directly with HMO enrollment, and (2) enrollment in forms of managed care other than HMOs will be correlated with HMO enrollment.

Increasingly, these assumptions can not be assumed to hold. The effect associated with a given change in enrollment is believed to vary over our estimation interval. For example, in the late 1980s, HMOs and other managed care organizations (MCOs) were primarily competing with fee-for-service plans. Since HMOs and other MCOs controlled a smaller share of the market, they were less subject to price competition and had less leverage in price negotiations with providers; therefore, the impact of a given change in HMO enrollment on health spending may well have been smaller in this period than in the mid-1990s. Over the past few years, however, enrollment in MCOs has shifted towards less restrictive plans, increasingly point-of-service (POS) options that give consumers more choice. This phenomenon suggests that our proxy may overestimate the spending reductions associated with our measure during this period. In addition, recent preferred provider organization (PPO) enrollment changes have not been correlated with HMO enrollment changes. As private managed care enrollment exceeds 90%, this will continue to be the case. Attempts to develop a more inclusive proxy based on enrollment in all forms of managed care based on the Kaiser/KPMG survey were not successful due to inconsistencies in the data coverage over time.[16]

We continue to control for the impacts of managed care through several channels. First, we expect that the effects of changing enrollment and varying restrictiveness of managed care will be partially captured through our income term, as changes in the nature of health coverage are one way of responding to changes in willingness to pay for medical services. Second, we have attempted to control for the effects of managed care through our projection of real per capita growth and price inflation in the hospital sector, where this effect is most strongly felt. Finally, we have attempted to take this factor into account in evaluating and judgmentally adjusting the results of our model

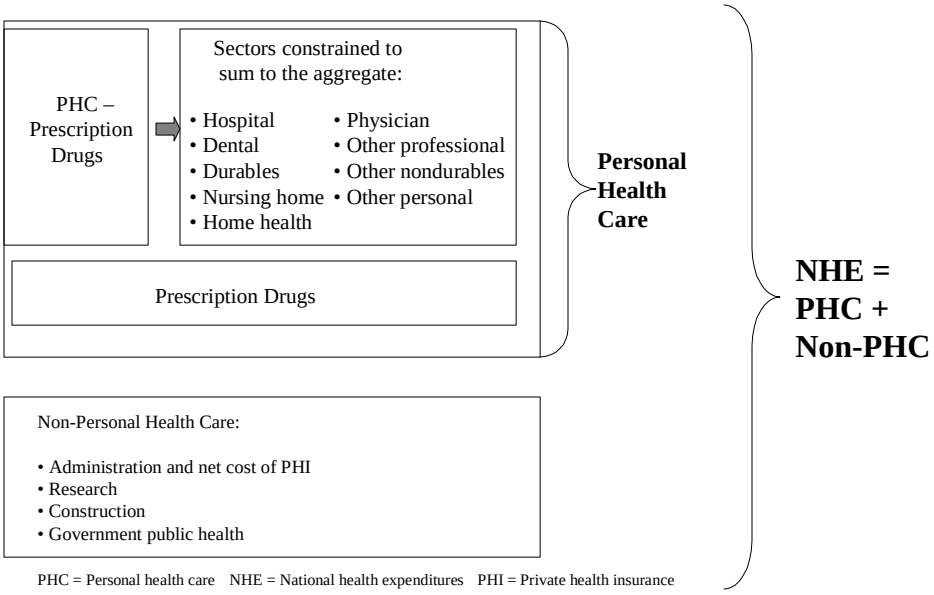
[16] The primary difficulty was associated with a change in the survey coverage from firms with 200 or more employees to including firms with more and less than 200 employees.

solution during the forecasting process.

III. Types of Service

Models for individual sectors of the NHE Projections Model are discussed below. Sectors are broken into personal health care (PHC) and non-personal health care (Non-PHC) categories.

Sectoral Composition of NHE Projections Model



The aggregate model for personal healthcare (PHC) described in the previous section, is composed of ten types of services. Nine of these sectors are constrained so that the sum of types of services is equal to the model solution for total PHC. The exception is the prescription drug sector, which is not constrained because of the need to adjust our projections based on outside research not explicitly incorporated in the model. In general, the aggregation of the unconstrained model solution for the sectoral equations results in a total which is close to the aggregate model projection, so that the normalization process does not involve a major adjustment to the patterns of growth for the individual types of services. The non-personal health care components are unconstrained, but account for a much lower share of NHE than the personal health care components.

Within the constraints imposed by the aggregate model forecast of private spending and medical inflation, we use sector-specific equations to establish projections for real per capita spending growth and relative price inflation for each type of service that make up private health care spending. Only minor changes in specification were made to individual sectoral models, which remain largely unchanged from previous versions.

Real per Capita Spending Growth

Models of real per capita spending growth for the types of services that make up personal health care follow the specification for the aggregate model of PHC. For most sectors, these models have a specification similar to that used for aggregate personal health care. Key structural variables are:

- Disposable personal income growth (less Medicare and Medicaid, real per capita)
- Relative price inflation for the sector

- Public spending growth for the sector (real per capita)

Key differences across the models for different types of services are the lag on the income term, the relative importance of the three variables, the inclusion of dummy variables to capture phenomena specific to the sector, and in a few cases, the inclusion of additional independent variables where relevant.

Exogenous inputs to these models parallel the aggregate: real per capita disposable income less Medicare and Medicaid, and sector specific projections of Medicare and Medicaid spending.

The lag on the income term generally varies with the share of spending that is accounted for by consumers' out-of-pocket expenses: the greater the out-of-pocket share, the shorter the lag, as consumers respond more quickly to changes in their income. We evaluated coefficients on income and price terms for consistency with the aggregate regression results and across sectors; however, the relationship is not precise.

The table below summarizes the independent variables used to model real per capita spending growth for each of the personal health care sectors. For the sectors with the greatest share of NHE, we have provided some additional descriptive information about their sector models.

Sector	Dependent variable	Independent variables
Hospital services	Real private hospital services per capita	Real disposable personal income (lagged 5 years) (+) Relative price(-) Public spending growth (-) Dummy, (1984-)
Physician services	Real private physician services per capita	Real disposable personal income (lagged 5 years) (+) Relative price (-) Public spending growth (-) Dummy, 1983-85 (+)
Other Professional services	Real private other professional services per capita	Real disposable personal income (no lag) (+) Relative price (-) Public spending growth (-) Lagged physician spending (+) Dummy, 1986-88 (+)
Prescription Drugs	Real private drug spending per capita	Real disposable personal income (lagged 2 years) (+) Relative price (-) New drug introductions (+) Direct-to-consumer advertising (+) Dummies, 1975-81 (-), 1999 (+)
Over the Counter Drugs and Other Nondurables	Real private other nondurables spending per capita	Real disposable personal income (lagged 2 years) (+) Relative price (-) Lagged dependent (+)
Durables	Real private durables spending per capita	Real disposable personal income (lagged 2 years) (+) Relative price (-) Public spending growth (-)

Dental services	Real private dental services per capita	Real disposable personal income (no lag) (+) Relative price (-) Dummy, 1981 (+)
Nursing home services	Real private nursing home services per capita	Public spending growth (-) Demographic index (+)
Home health services	Real private home health services per capita	Public spending growth (+) Demographic index (+) Dummy, 1988 (+)

Hospital Services

Real per capita growth in private hospital spending is well explained by the variables in our template model specification. Given the low out-of-pocket share on average for hospital services (inpatient and outpatient), we anticipate a long lag between a change in household income and the time of impact on hospital spending. Our results are consistent with this expectation we estimate coefficients on lagged income growth with a polynomial distributed lag, which indicates the peak effect of income fluctuations occurs with a lag of 3 to 4 years.

The estimated price elasticity of demand is above that for the PHC, significant at the 1% level, and fairly robust to changes in regression interval. This is somewhat surprising given the low out-of-pocket share for hospital services, which would tend to dampen price sensitivity. Attempts to fit an out-of-pocket variable, either in combination with the price term (i.e. effective price to consumers) or separately, were unsuccessful. However, in the hospital sector, this share is low and fairly stable (just over 3 percent for 1995 through 2002) so effects are likely to be small.

Public real per capita spending has negative coefficient as expected, capturing shifts in enrollment between private and public coverage, as well as any short-term cost-shifting effects between private and public payers.

Our current model for real per capita growth in hospital spending does not include an explicit effect for managed care. Managed care is expected to continue to influence growth in hospital spending through both utilization and relative price inflation. However, we have found that our previous proxy for managed care effects to be increasingly flawed for this purpose (see discussion, p. 10) . The combined effect of managed care and the Medicare prospective payment system (PPS) for this sector is represented in the current model as a one-time structural change beginning after the introduction of PPS (from 1984). Current projections include a positive adjustment factor to growth in real per capita hospital spending growth, reflecting diminishing potential for additional reductions in inpatient utilization and relative price inflation relative to the historical period since 1984. Our model for relative hospital price inflation continues to include private sector HMO penetration (change and level) as a proxy for managed care, but also includes adjustments to the resulting projection.

Physician Services

The estimated lag structure for the income term in the physician model indicates an effect which extends over five years, but is evenly weighted across periods (effectively a shorter average lag as compared with the hospital model). The sum of coefficients on all lags of the income term is substantially smaller than for the hospital sector, close to the coefficient in the aggregate model for PHC. Relative price inflation fits only weakly in this model as compared with PHC, and growth in real per capita public spending on physician services has a smaller estimated negative effect than the aggregate model.

In general, our template specification fits real per capita growth in physician spending somewhat less well than hospital spending. This primarily reflects two outlying periods: much higher than predicted growth in 1984-85, and much lower than predicted growth in 1993-96. Absent these periods, the pattern of growth implied by the income and relative price term produces a fairly good fit. Through 1983, the physician share of personal health care spending remains close to flat, drifting slightly downwards (from 24.0% in 1965 to 22.0% in 1983). From 1984 through 1994, the share rises, reaching 26.0% by 1992 before beginning to move downwards to 25.4% by 2001. Without some control for the period of rapid growth in the early 1980s, it is difficult to obtain a model with acceptable fit and reasonable coefficients.

We have included a dummy variable to capture the period of rapid growth from 1983 through 1985, while the faster growth later in the decade is consistent with the income term. Our interpretation of this variable is that it captures a non-recurring substitution effect of professional services for inpatient care. This period saw a major shift in provider incentives associated with the introduction of inpatient PPS under Medicare (spillover effects for private spending) and the initial surge in managed care enrollments. The effect of the inclusion of this dummy is that the resulting model will tend to project a pattern of growth for physician services that is more consistent with the near-stable share of PHC in the pre-1984 and post-1994 data rather than the more rapid growth of the mid-1980s.

Prescription Drugs

Prescription drugs differ in important ways from other types of medical care. First, it is a product, not a service, so the cost structure of the industry differs substantially from sectors such as hospital, physician, or nursing home, where labor costs play a critical role in driving price. Second, historically, prescription drug spending has had a much larger consumer out-of-pocket share than other types of medical care, so that demand tends to be more sensitive to price. Third, factors influencing characteristics of supply and demand have altered in important ways over the past decade, to an even greater extent than has been the case for the health sector as a whole. Fourth, the public sector plays a relatively small role in funding prescription drug spending. We also have access to additional information on supply and demand factors for this sector, in the form of data on new drug introductions, research spending, patent expirations, and direct-to-consumer (DTC) advertising. As a result, our model for prescription drugs is somewhat different from those developed for other sectors.

Our income variable fits with a much shorter lag than we include in our aggregate model. This is the expected result based on the larger share paid on an out-of-pocket basis historically. We use a moving average from the previous to the current year. Relative price inflation also has a strong fit, although, as with the aggregate, we were unable to develop a specification that included an effective price variable (e.g. accounting for variations in out-of-pocket share). Public spending growth is not included as a variable in this model due to its relatively minor role. A dummy variable for the period from 1975 through 1981 reflects our assessment of the impact of splicing data between different sources over this period. Another dummy variable for 1999 is included because 1999 had a much stronger than normal flu season, some evidence of year 2000 stockpiling of drugs, and the introduction of several, extraordinarily successful blockbuster drugs, most notably Celebrex and Vioxx.

Patterns of growth over the most recent ten years of data are by far the most difficult to explain as the effects of several different factors must be disentangled. The out-of-pocket share of spending by consumers dropped sharply as privately insured patients moved into managed care plans that generally have lower co-pays (this phenomena largely did not apply to Medicare beneficiaries, who continued to pay a relatively large share of drug costs out-of-pocket). Also, changes to regulations in 1997 dropped some of the earlier restrictions on television advertising for prescription drugs.

In addition to income and relative price terms, our model for real per capita drug spending includes a three-year moving average of the number of new prescription drugs introduced, and a 3-year moving average of the change in DTC advertising.

Our current model does not include a variable for the effect of variations in consumer out-of-pocket (OOP) share.

This reflects two factors. First, when estimating the model over a regression interval through 1990 (thus excluding the recent sharp decline in out-of-pocket share), this variable is insignificant. Second, due to correlation in the timing of the effects of changes in these variables and the small number of data points, we were unable to develop a specification that included both variables. Rather, we have attempted to control for the impact of changes in OOP share over the projection through judgmental adjustment of the model solution.

Relative Price Inflation by Type of Service

Price inflation for individual types of services was initially modeled based on relative input prices. However, we were unable to obtain theoretically consistent and significant results, probably due to differences across types of services in the definition of both the output price and input price indexes.

Changes in public policy that could be expected to influence relative prices (such as the imposition of price controls in the early 1970s and the introduction of the prospective payment system for Medicare hospital inpatient services in 1983) are captured through the use of dummy variables. Our managed care proxy was also included in selected models (hospital, prescription drugs) since price discounting could have differing effects on price inflation for different medical services.

Variables included in models of relative price inflation are shown below:

Sector	Dependent variable	Independent variables
Hospital services	Hospital price inflation (relative to all medical services)	HMO Penetration (change and level, -) Dummy, 1981 to 1985 (+) Dummy, price controls, 1973 to 1974 (+)
Physician services	Physician services price inflation (relative to all medical services)	Dummy, price controls, 1972 to 1974 (-)
Other Professional Services	Other professional services price inflation (relative to all medical services)	Dummy, price controls, 1972 to 1974 (-) Physician price inflation (-)
Drugs (Prescription)	Drug price inflation (relative to economy-wide)	Relative input price inflation (lagged one year, +) Change in HMO penetration (-) Growth in drug research spending (4 years, +) Dummy, 1993 forward (-)
Dental services	Dental price inflation (relative to all medical services)	Change in HMO penetration (lagged one year, +) Dummy, 1976 Dummy, price controls, 1973 to 1974 (+) Dummy, 1981 to 1985 (-)
Nursing home services*	Nursing home input inflation	

Home health services	Home health price inflation	PHC price inflation

* Projection for nursing home input price inflation is adjusted from projections by Global Insights Inc. for consistency with SSA projections of economy-wide inflation.

Generally, it proved more difficult to achieve a good fit for the relative price regressions for individual sectors than for the real per capita spending regressions. This reflects the combination of flaws and inconsistencies in the price data, and the difficulty in capturing the effects of government policy and institutional change on relative price across types of services. For example, managed care can be expected to influence prices in some sectors (e.g. hospital services) much more than others (dental services), with potentially important effects on relative price inflation for these sectors, but our proxy for capturing managed care effects is flawed (see discussion in Aggregate Health Model section). Dummy variables, are, of course, an imperfect tool for capturing effects of government policy which has effects on relative price (e.g. price controls).

Note, however, that where the regression fit for relative price inflation is not good (e.g. physician) the resulting equation will generate a forecast which tends to track the price inflation forecast for the denominator, which often accounts for a very high fraction of variation. For example, for physician services, the denominator is PHC price inflation, which accounts for 88% of variation in price inflation for physician services from 1960 through 2001.

IV. Sources of Funding

In the current version of our model, we introduced econometric models for change in the composition of private spending across sources of funds (private health insurance, out-of-pocket, and other private). These models attempt to systematically capture some of the trends that had previously been introduced on a judgmental basis following the solution of the model.

Trends in insurance coverage (private, Medicaid, and Medicare enrollment, and the uninsured population) matter since the fraction paid out of pocket differs substantially across these groups. Shifts in enrollment can be expected to have an effect that varies across sectors – the most prominent example being prescription drugs. Changes such as the historical spread of managed care (with the associated pattern of much lower copayments) can also be helpful in explaining history. In addition, current period growth in disposable personal income may have an impact on out-of-pocket spending through its influence on discretionary medical spending.

Our model for private sources of funds is a hybrid between "top-down" (constrain sectors to total) and "bottom-up" (sum across sectors to obtain total) approaches. This reflects an evaluation of the tradeoffs involved. For example, the "top-down" approach eliminates the need to explicitly control for shifts across sectors, and reduces (to some extent) problems with noise in the data. However, a major disadvantage of the top-down approach is that the additional level of aggregation involved may obscure relevant trends, and make it more difficult to adjust projections precisely at the level where information is most available. For example, trends in OOP for prescription drugs have been very important in recent years (e.g. three-tiered copayments). Prescription drugs, physician services, nursing home care, and dental services account for about two-thirds of out-of-pocket spending, but are driven by a different mix of factors. In addition, since OOP share differs markedly across sectors, shifts between sectors (for example, hospital to drug spending) will matter. It is easier to capture these shifts by summation than econometrically at the aggregate level.

Our model includes equations for out-of-pocket and other private spending as a share of total spending for both total PHC and for each type of medical product and services. To encourage consistency across sectors, the projection for PHC is included as an independent variable in sectoral equations. However, the published forecast is set equal to the summation across all sectors. Private health insurance spending for each sector is set as a residual based on forecasts of private spending in the sector and shares of OOP and other private of this total.

The dependent variable in these models is the change in OOP (or other private) spending as a share of total spending.
Our model for change in OOP share for PHC includes a measure of all health insurance enrollments (private, Medicare, and Medicaid) as a share of population, hospital spending as a share of total, and drug spending as a share of total. These two sectors are outliers in terms of out-of-pocket share of total, so that the inclusion of these sectors in the aggregate equation is a rough approximation of the impact of shifts in spending across sectors on the composition of private sources of funds.

Other variables included in the sectoral models include:

- OOP share for PHC
- HMO penetration rate
- Private health insurance enrollment as a share of the population
- Medicare and Medicaid enrollment as a share of the population
- Real disposable personal income

The projections produced by these models are then adjusted based on an evaluation of the model fit and (where available) on additional sources of information (for example, survey results with information on the nature of out-of-pocket payments for employer-provided health coverage).

In addition to our model of private sources of funds, we also project sources of public funds other than Medicare and Medicaid. These sources account for approximately 25 percent of total public spending. Other federal and other state and local spending (exclusive of Medicare and Medicaid spending) are projected based on econometric models similar to those used to project real per capita private spending models. Like our models for private spending, we specify aggregate PHC spending for other federal and other state and local, and then establish sector-level spending within the constraint of the aggregate projection.

Our projection process combines to give us a sound and defensible projection methodology based on accepted econometric and actuarial projection techniques. As with any projection, we are constantly reviewing the accuracy of our projections and working to make improvements in the methodology. Please e-mail DNHS@CMS.gov with any comments, feedback, or suggestions on our NHE Projection Model.