

## Health Care Studies From the 2007 ASSA Meetings

THE BUREAU of Economic Analysis (BEA) organized two health care-related sessions for the annual Allied Social Sciences Association meetings, held in Chicago last January. These sessions brought together academic experts and BEA researchers to discuss issues related to the development of national health accounts. Among the academic participants were Joseph P. Newhouse (Harvard University), who chairs a National Academies panel on national health accounts, and Allison B. Rosen (University of Michigan), who is working with David M. Cutler (Harvard University) to develop a prototype set of health accounts. Other participants included key researchers in the area of health economics: Ernst R. Berndt (Massachusetts Institute of Technology), David O. Meltzer (University of Chicago), and Jack E. Triplett (Brookings Institution).

In this special feature of the SURVEY OF CURRENT BUSINESS, BEA includes studies discussed in the session titled “Beyond Drug and Hospital Costs: Comprehensive Accounting for Health Care,” moderated by BEA Director Steve Landefeld.

- “Measuring Medical Care Productivity: A Proposal for U.S. National Health Accounts,” by Allison B. Rosen and David M. Cutler (page 54). This paper maps out a strategy for developing a set of health accounts that will help answer questions about changes in the state of the population’s health, on the roles of medical and non medical factors in those changes, and on the cost-effectiveness of potential interventions.
- “Medicare Part D and Prescription Drug Prices,” by Ernst R. Berndt and Richard G. Frank (page 59). This paper provides an assessment of the implications of the Medicare Prescription Drug, Improvement and Modernization Act for price indexes published by the Bureau of Labor Statistics (BLS).
- “A Different Application for Productivity Measures, or Has the Difficulty of Measuring Physician Productivity Caused the Federal Deficit To Be Mismeasured?” by Joseph P. Newhouse and Anna D.

Sinaiko (page 72). The paper discusses problems in measuring physician productivity and argues that the lack of precision in the productivity assumptions underlying Medicare fees could have adverse effects on measures of the federal deficit.

- “Measuring the Output of Health Care in the United States,” by Michael S. Christian, formerly of BEA, now with the Wisconsin Center for Education Research (page 78). The paper offers an overview of the types of measures that one might consider including in a health satellite account. It provides two examples that illustrate the range of possibilities: Calculations of direct volume measures for hospitals and estimates of the value of home and volunteer time for health-related services.

The second session that BEA sponsored was titled “Approaches for Measuring the Cost of Health Care Services.” These papers focused on existing approaches and potential pitfalls in measuring health care costs by disease. Those studies are summarized on page 55.

BEA is currently exploring the creation of health care accounts and is a sponsor of the National Academies’ Committee on National Statistics’ proposed study on the design of the national health accounts.

BEA’s long-term goals include the following:

- Harmonize medical care in the national income and product accounts with the Centers for Medicare and Medicaid Services’ national health expenditure accounts. This would help provide a common set of metrics.
- Provide measures of expenditures by disease to provide data needed to assess the benefit of treatments.
- Work with BLS to further improve medical care prices. Improved price indexes will better account for reductions in costs that arise from substitution across treatment classes and, thus, help to identify how much of the increase in medical expenditures is increased quantity versus price of treatment.
- Develop a set of product-based deflators that may be used to deflate expenditures by product class, as is currently reported in the accounts, in a manner consistent with the disease-based price index.

### The Cost of Health Care Services

The Bureau of Economic Analysis (BEA) organized a session at the annual Allied Social Sciences Association meetings in January 2007 that focused on the challenges of tracking the cost of health care services. Studies presented at this session discussed methods to track the cost of treating disease in ways that account for changes in costs when there are changes in treatment protocols.<sup>1</sup> Consider how the treatment for depression has migrated from talk therapy to combinations of talk therapy and new prescription drugs. Talk therapy tends to be expensive (over \$100 per visit) relative to drug therapy (\$1 per day). So, to the extent that patients have switched to a lower-cost alternative, the cost of treating depression has fallen. Unfortunately, official price indexes will not in general capture cost reductions that arise from substitution of treatments across treatment classes because they track changes in the cost of talk therapy (office visits) separately from changes in the cost of drug therapy (prescription drugs). Problems in existing measures and suggested alternative approaches have been discussed in the context of cataracts, heart attacks, and several mental conditions.<sup>2</sup>

One approach to measuring costs by disease involves using medical claims data and assigning each claim to a particular disease or condition, usually using commercially provided computer algorithms that aim to identify episodes of illness. The U.S. Committee on National Statistics of the National Academies of Sciences studied the relative merits of this approach and recommended that such price indexes be constructed to provide perspective on official statistics.<sup>3</sup>

Two papers in the session applied this approach to measure the cost of treating disease. **Ana Aizcorbe**, of BEA, and **Nicole Nestoriak**, formerly of BEA, (“Tracking Changes in Health Care Costs Using Episode-Based Price Indexes: Issues and Estimates”) used a large claims database that included definitions for episodes of illness to assess whether the type of substitution bias studied in the academic literature is important across a wide range of diseases. They used the entire sample of data to construct two types of price indexes—one that uses “treatment of disease” as the good and another that uses “types of treatment” as the good. To the extent that substitution across treatment types is relevant for diseases other than the

ones that have been studied, one would expect to see faster price growth in the treatment-based index than in the disease-based index. Their preliminary finding is that the issue does indeed appear to be important across a broad range of diseases, though the robustness of this finding to different cuts of the data, slightly different definitions for the indexes, and so on needs to be fully explored. Working under contract to BEA, economists at Analysis Group are conducting a parallel examination using an alternative set of claims data. **Alan White**, **Jaison Abel**, and **Adam R. Castor** (“Use of Claims Data in Constructing Price Indexes for Medical Services”) provided a progress report of their study; their work so far points to treatment substitution as an important driver of declines in the cost of treating illness, confirming the preliminary results of Aizcorbe and Nestoriak.

BLS research economist **Ralph Bradley’s** discussion (“Improving Medical Price Indexes”) highlighted numerous important caveats to these preliminary findings. Although these claims data sets contain hundreds of millions of observations, Bradley pointed out numerous potential problems that must be taken into account when comparing different price measures using these data. Among these, “noise” in the data appears to be particularly problematic. In earlier work, Bradley conducted similar explorations using Medstat data and found that although the two price indexes showed numerically different growth rates for prices, those differences were not statistically significant.<sup>4</sup> This is a potentially important issue that must be addressed to provide a gauge on the reliability of price indexes obtained from claims data.

**Allison B. Rosen** and **David M. Cutler** took a different approach in their paper, “Trends in Disease Costs in the United States.” They constructed estimates of cost by disease by linking data from the national health expenditures accounts, which do not have information on diseases, to several national expenditure surveys that do, including the Medical Expenditure Panel Survey, the National Medical Expenditure Survey, and the Medicare Current Beneficiary Survey. To allocate costs into particular diseases, they developed an empirical cost model that estimates the relationship between individual health care costs and the presence in the individual of particular diseases and conditions. Allison Rosen’s discussion of the preliminary results from this novel approach highlighted the importance of measuring health care services by tracking the cost of treating disease rather than tracking the cost of different types of treatments.

1. This issue has long been recognized as a potential problem. For a recent example in the context of mental health, see Ernst R. Berndt, Alisa B. Busch, Richard G. Frank, and Sharon-Lise Normand, “Real Output in Mental Health Care During the 1990s” (working paper no. 11557, Washington, DC: National Bureau of Economic Research, August 2005); <[www.nber.org/papers/w11557](http://www.nber.org/papers/w11557)>.

2. For examples of these studies, see David M. Cutler and Ernst R. Berndt, eds., *Medical Care Output and Productivity*, Studies in Income and Wealth, vol. 62 (Chicago: University of Chicago Press, 2001).

3. See Charles L. Schultze and Christopher Mackie, eds., *At What Price: Conceptualizing and Measuring Cost-of-Living and Price Indexes*, (Washington DC: National Academy Press, 2002): 178–190.

4. Their study used data from 40 episode types, chosen at random, in two Northeast cities: X. Song, W.D. Marder, O. Baser, R. Houchens, J.E. Conklin, and R. Bradley, “Can Health Care Claims Data Improve the Estimation of the Medical CPI?” (paper presented at the National Bureau of Economic Research Conference on Research in Income and Wealth, Vancouver, BC, June 28, 2004 and at the National Bureau of Research Summer Institute, Health Care Program, August 6, 2004).

# Measuring Medical Care Productivity

## A Proposal for U.S. National Health Accounts

By Allison B. Rosen and David M. Cutler

**M**EASURING productivity is a central challenge in medical care, as it is in all other service industries. Medical care is particularly important, however, because of the enormous share of gross domestic product (GDP) that it takes. The United States spent \$2 trillion dollars, or 16 percent of GDP, on health care in 2005 (Catlin, et al. 2007). This compares with a median of 8.5 percent among other Organisation for Economic Co-operation and Development countries. Further, the productivity of U.S. health care is suspect. While some studies have suggested that productivity growth is reasonable in aggregate (Cutler and McClellan 2001; Cutler, Rosen, and Vijan 2006), others argue that there is substantial waste at the margin (Fisher et al. 2003). If we are to understand and improve the productivity of our health care spending, a more systematic approach to tracking productivity in the health care sector is needed.

This article discusses a proposed framework for measuring productivity in medical care via the creation and use of national health accounts. Such accounts would provide a comprehensive picture of population health in relation to health care spending within an integrated framework in which consistent definitions, measurement tools, and analytic conventions are used.

### The challenges of productivity measurement in health care

Productivity is difficult to measure in every industry. Output indices for computers and automobiles have been changed many times over the years, for example. But medical care is particularly problematic for one

fundamental reason: Consumer purchasing decisions are not a reliable guide to true value.

The conceptual basis for productivity measurement in virtually all industries is hedonic analysis (Griliches 1971). People are assumed to buy goods when they value them and not to buy them when they do not. Thus, the value of quality change can be inferred from the amount that people are willing to pay for that change. With a price for quality thus defined, productivity can be found as the residual growth in total spending not accounted for by pure price increases.

In medical care, however, the link between purchase and value is not clear. Many consumers do not know which services they need; the doctor is both an advisor and a service provider. As a result, physician reimbursement and ethics might affect consumption decisions as much as value and cost. And even when consumers know what they need, they tend to be very well insured for medical care services. For these reasons, most health care analysts do not assume that purchase decisions will reflect the true value of the good.

At the level of health insurance, it might be possible

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to use hedonic analysis (Fixler 1996). For example, relating insurance premiums to enrollment choices might be used to back out the value of medical advances. But insurance choices are affected by other features as well, including the age distribution of the enrollees in the purchasing group. Nor is it clear that consumers understand everything that is in an insurance plan, especially for services they do not yet need. Just how stringent are the mental health limits? Are the nephrologists in the plan good ones? These types of questions are essential in rational purchasing, but they are not well known by consumers.

As a result, our research, along with most other work in the field, uses a direct approach to measuring productivity. We measure the output of the medical care industry—health—and use medically informed decision models to determine the productivity of different inputs (medical care and public health, for example). In essence, we will determine the production function for health empirically and use that to estimate the productivity of the key inputs. We describe in the remainder of this article how we will do this.

### National health accounts: A conceptual basis

National accounts play a central organizing role in economic measurement. The national income and product accounts (NIPAs) are the most well-known accounts. They give the total GDP as well as its division into major categories (consumption, investment, government spending, and net exports) across a range of industries. Further, the accounts permit the analysis of productivity changes by dividing spending increases into prices and quantities.

The NIPAs are organized around market activity; any activity where money changes hands is included in the accounts. However, it has long been recognized that GDP is not a measure of welfare. Most importantly, nonmarket activities such as personal investments in one's own health and the environment are not included in GDP. To measure the costs and benefits of such activities, there have been repeated suggestions to establish "satellite" accounts that encompass all of these activities.

Satellite accounts derive their name from the fact that they would orbit around the NIPAs, overlapping with them in market activity and supplementing them in nonmarket activity. A recent report from the Committee on National Statistics recommended establishing satellite accounts for health, home production, the environment, education, and government/nonprofits (National Research Council 2005).

Table 1, taken from *Beyond the Market: Designing Nonmarket Accounts for the United States* (National

Research Council 2005), shows how a satellite health account might be structured. Like the NIPAs, a satellite national health account would have inputs and outputs. The first input to health is medical care. While most medical services are priced, some inputs, such as volunteer labor for the chronically ill elderly, are not. Other inputs include the time one invests in one's own health (for example, exercise and sleep), other consumption items (food, tobacco, and alcohol, for example), research and development, and the quality of the environment. The fundamental output of the health system is health. Health includes both length and quality of life, which can be conceptualized jointly as quality-adjusted life expectancy (QALE) and expressed either in years or dollars (Murphy and Topel 2006).

In addition to health benefits, changes in a person's health can affect the financial circumstances of others. Improving the health of working age people increases employment and tax revenue; extending the life of very elderly people leads to greater social security spending. While these financial externalities are outputs in a final satellite account, we begin development of an expanded set of health accounts by focusing on health.

Constructing a set of national health accounts involves three steps. First, we need a global measure of population health. Second, we need to measure spending and health at the relevant "industry" level. In the case of health, the appropriate industry is the disease or medical condition, since this is the level at which people seek care and treatment decisions are made. Third, we need to link spending and health outcomes at the disease level through detailed disease models.

### Health measurement

Population health measurement is a complex science with a rich tradition in the medical literature. A variety of assessment techniques rooted in expected utility theory have been used to measure health status. Several health assessment surveys have been conducted, providing related data on population health and health trends over time. None of these foundations is exactly what is needed, but all are important building blocks.

**Table 1. Conceptual Model of Satellite National Health Accounts**

Inputs	Outputs
Medical Care Market labor/capital Volunteer labor	Health status Longevity Quality of life
Time invested in own health Other consumption items Research and development Quality of the environment	Financial externalities

We decompose population health into two parts: Mortality and quality of life. Mortality data are available from vital statistics. All deaths are recorded with great accuracy. Linking mortality to different diseases is less straightforward, however. Cause-of-death data is known to be inaccurate for many conditions (Zumwalt and Ritter 1987). To obtain more accurate mortality data, we will match the spending and health data described below with data on date of death. This will allow us to estimate regression models for death as a function of acute and chronic diseases and other socio-demographic information.

Data on various indicators of quality of life are available in a number of health assessment questionnaires, which are discussed below. The challenge in assessing quality of life in the United States is not so much lack of data as lack of consensus on an appropriate measure. We describe our approach, acknowledging that others may be appropriate as well. We first assess overall quality of life based on survey self-reports. We then assess the symptoms and impairments that individuals report and relate the two using regression analyses. Finally, we relate the symptoms and impairments to the diseases of interest. This allows us to track changes in quality of life over time as a function of changes in the prevalence of diseases or in the prevalence of symptoms and impairments associated with these diseases. Because we place quality of life on a 1 (for perfect health) to 0 (for death) utility scale, we can combine length of life with quality of life to form a single measure of health, quality-adjusted life expectancy (QALE). More details are available in Stewart and others (2006).

### Medical spending

We know well what we spend on medical care; the actuaries at the Centers for Medicare and Medicaid Services (CMS) track aggregate medical expenditures in great detail in a series of national health expenditure accounts (NHEAs). These accounts, maintained since 1960, provide a comprehensive list of expenditures for health care-related goods and services.

However, the NHEA data are reported as aggregate spending by payer and service category, and they do not report spending at the disease level. To provide this disease-level data, we link three national expenditure surveys to the NHEAs. The Medical Expenditure Panel Survey (MEPS) and its precursor survey, the National Medical Expenditures Survey (NMES), both collected by the Agency for Healthcare Research and Quality (AHRQ), represent the civilian noninstitutionalized population. Both surveys include expenditure data as well as rich survey data on several aspects of health (including quality of life and the presence of diseases) and

health care utilization. To provide data on the institutionalized population and larger sample sizes for the general Medicare population, the Medicare Current Beneficiary Survey (MCBS), collected annually by the CMS, is used to replace the Medicare eligible population in NMES and MEPS. The MCBS is a nationally representative survey of aged, disabled, and institutionalized Medicare beneficiaries, which includes information on health care utilization and expenditures as well as information on health status and the presence of diseases.

Building on the methods of Meara, White, and Cutler (2004) and Selden and others (2001), we match spending by payer and service type in MEPS, NMES, and MCBS to NHEA service totals. We adjust reported spending from the national surveys so that spending by payer and service category sums to that reported in the NHEAs. These individual data matched to national totals allow us to estimate medical spending by disease.

We also need to define the diseases of interest. The manner in which we define disease categories builds on work done at AHRQ. In particular, AHRQ classified all medical claims (or survey-based self-reports of diseases) into 262 mutually exclusive conditions using the Clinical Classification Software (CCS) (Elixhauser, Steiner, and Palmer 2007). For our purposes, this level is too disaggregated, since many categories have relatively low prevalence in national claims data, and a few would have relatively similar clinical manifestations. The CCS can be collapsed into 18 much broader categories (for example, infectious diseases, mental disorders, and injuries); however, this level is too aggregated for our purposes, with very heterogeneous categories. We therefore regroup the 262 categories into 65 clinically meaningful groups. A typical group is HIV/AIDS or diabetes.

After determining whether an individual has a disease of interest, we regress costs—or a variation, such as the logarithm of costs—on the individual's disease profile. The resulting coefficients give the cost associated with each disease, controlling for the other health conditions that a person has.

It is worth noting that our approach builds on, but is somewhat different from, prior cost of illness studies. In that literature—which was pioneered by Dorothy Rice (Rice 1966) and colleagues and is still prominent (Hodgson and Cohen 1999; Druss et al. 2001; Thorpe, Florence, and Joski 2004)—each medical claim is assigned to a disease, and total spending is found by adding claims within the disease category. The difficulty with this prior approach is that many claims have multiple diagnosis codes; is an ACE inhibitor taken by a person with diabetes who has had a heart attack being taken for the diabetes or the heart

attack? Our approach will determine the share of spending associated with each without an arbitrary assignment rule.

### Disease models

The final step is to develop detailed disease models that relate health inputs to outputs. These models will allow us to infer the value of medical care at the disease level. We can then add across diseases to estimate the productivity of medical care as a whole.

There is a rich tradition of forming disease models in other disciplines that we will draw on for this goal, including substantial work in decision sciences and industrial engineering. A comprehensive catalogue of such models spanning over 25 years of the medical literature is maintained by a team of investigators at Tufts Medical School as an Internet-based resource (available at <[www.tufts-nemc.org/cearegistry/data/default.asp](http://www.tufts-nemc.org/cearegistry/data/default.asp)>). These models range from simple explanatory models of a single therapy for a single disease (for example, antibiotics for childhood ear infections) to broad policy models that consider several services simultaneously (for example, the prevention and management of coronary heart disease). However, there is no consistent set of modeling conventions that would allow these models to be merged together to provide a picture of the health care sector as a whole.

Building on this rich base, we will develop disease models using a consistent set of definitions and methodologic conventions. These more detailed disease models may help us identify clear targets for more nuanced policy interventions. Further, they will be designed specifically to fit into the larger framework of expanded health accounts in order to allow for comparisons of alternate resource allocation strategies across the whole health sector (rather than limited to a single disease).

### Conclusions

The task we have laid out is ambitious. We are working with people around the country and will do so for a number of years. In addition, the collaboration and cooperation of several of our national data collection agencies will be critical to the success of these endeavors.

The obvious question is whether this work is worth the cost. We believe it is. A little history about the national income and product accounts indicates why. Today, we recognize these accounts as one of the singular achievements of economic science. In their introductory textbook, *Economics*, Paul Samuelson and William

Nordhaus observed “While the GDP and the rest of the national income accounts may seem to be arcane concepts, they are truly among the great inventions of the twentieth century.” Former Commerce Secretary William M. Daley called national economic accounts “the Commerce Department’s greatest achievement of the 20th century.” Governments use national economic accounts to manage monetary and fiscal policy. Businesses use them to make investment and hiring decisions. Families use them, generally indirectly, in setting savings and consumption goals.

While the national income and product accounts are justly famous, it is surprising how recent an invention they are (see, for example, Moynihan 1999 and Fogel 2000). During World War I, there were substantial, unresolved debates about how civilian and military needs could coexist. After the War, a few economists decided to make a more quantitative assessment of the American economy to help with future economic planning efforts. The leaders in this group were Wesley Mitchell of Columbia and Edwin Gay of Harvard Business School who founded the National Bureau of Economic Research to coordinate those efforts. By 1930, the work on national accounting was led by Simon Kuznets. In the early 1930s, it became apparent that the United States was in a major downturn. The magnitude of the downturn was not known, however. In 1932, Congress passed a resolution directing the Secretary of Commerce to calculate and report national income in 1929, 1930, and 1931. Simon Kuznets joined the Commerce Department to construct such estimates, and after 2 years of work, the Department published the requested data. Those estimates were refined over the next few years and continue today.

Our knowledge of the health economy today is about where the measurement of national economic activity was in 1932. Health is very important; some aspects are good, but many are not. We want to know how we are doing in aggregate and what we can do to improve health. Initial steps to measure health care productivity taken today will allow us to learn how best to improve these accounts over time so that they may evolve, as the national income and product accounts have, into a complex system of true national *health* accounts with which to track the productivity of our ever-growing national investment in health care.

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## Medicare Part D and Prescription Drug Prices

By Ernst R. Berndt and Richard G. Frank

CONGRESS passed initial versions of the Medicare Prescription Drug, Improvement, and Modernization Act in late June 2003. This landmark legislation provided for a prescription drug benefit for all Medicare beneficiaries over age 65 and for individuals under age 65 who have certain disabilities. This new prescription drug benefit is called Medicare Part D. The House and Senate versions of the bill differed, and after considerable negotiations and maneuvering, the House passed a unified version of the bill by a 220–215 vote on November 22, 2003. On the next day, the Senate passed the legislation by a 54–44 vote. On December 8, 2003, President George W. Bush signed the final conference committee version into law. The Medicare Part D prescription drug benefit was fully implemented on January 1, 2006.

The congressional and public debate on the merits of this legislation was extensive and heated. Controversy surrounded issues such as what would the effects of moral hazard on prescription drug demand and prices be? How should the Federal Government exercise its considerable buying power? How restrictive or broad should formularies be? How much competition should there be among private plans offering benefits? How high would monthly premiums be, and how would they vary with benefit design? And of course, how much would this new program cost?

Medicare Part D has been with us now for over a year. What has happened? In terms of assessing its impact on prescription drug prices, there are at least three important considerations on which we focus in this

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paper. First, how has the Bureau of Labor Statistics (BLS), the source of official government price statistics, monitored and measured prices paid by consumers (the Consumer Price Index (CPI)), as well as prices received by manufacturers from sales to the first point in the distribution chain (Producer Price Indexes (PPIs) subsequent to the implementation of Medicare Part D? Specifically, what measurement changes and assumptions were required in order to assess the impact of part D on consumers' and producers' prices? Second, given provisions of the part D legislation and the BLS procedures for measuring prices, what do we as economists expect regarding the impact of part D on consumers' and producers' prices? And third, what price changes have been observed by the CPI and the PPIs leading up to and then following full implementation of the part D legislation on January 1, 2006?

### Background history and literature

Over the years, as U.S. public policy has led to expanding health insurance coverage, policy analysts have evaluated not only government and elderly out-of-pocket expenditures on health care but also the price and quantity components of these expenditures.

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Related concerns have focused attention on the overall price inflation experienced by the elderly versus the nonelderly and more specifically on relative prices paid by the elderly, versus the nonelderly for health care goods and services.

For at least seven decades, the BLS Medical CPI (MCPI) has grown about half again as fast as the overall CPI; between 1927 and 1996, for example, the MCPI rose at an average annual growth rate of 4.59 percent, compared with 3.24 percent for the CPI (Berndt and others 1998a and 1998b). In the 11 years since then, between January 1996 and January 2007, these average annual growth rates were 3.91 percent for the MCPI and 2.49 percent for the CPI. Congressional concern over these differential rates of inflation has involved a number of initiatives.

Prior to the introduction of Medicare in July 1966, the Social Security Administration anticipated that the existence of the new insurance might have an impact on medical care prices. Therefore, in the summer of 1965, the administration arranged with BLS to collect supplementary prices for three surgical procedures and two in-hospital medical services that were particularly prevalent among the elderly though not necessarily limited to them. The three surgical procedures were cholecystectomy (removal of the gall bladder), prostatectomy (removal of the prostate gland), and fractured neck of femur (hip surgery), and the two in-hospital services were acute myocardial infarction (treatment of heart attack) and cerebral hemorrhage (stroke). Among the major results of this study, as stated in a report to the President and summarized by Dorothy P. Rice and Loucele A. Horowitz, was the finding that the index of the five in-hospital surgical and medical procedures that were particularly significant for the aged did not increase as rapidly during 1966 as the combined index for physicians' fees regularly priced for the CPI (Rice and Horowitz 1967, 28; U.S. Department of Health, Education and Welfare 1967).<sup>1</sup>

Several decades later, in response to a mandate contained in the 1987 amendments to the Older Americans Act of 1965, the BLS created an experimental price index for elderly consumers (CPI-E). The CPI-E employs differential expenditure weights for the elderly (defined as households headed by persons aged 62 and older) and the nonelderly based on data from the Consumer Expenditure Survey (CES), but the CPI-E assumes that within each category weight, the distribution of prices, the outlets in which consumers buy, the

use of coupons, and the availability of discounts, as well as the quality of the items purchased, are the same for the elderly and as for the nonelderly (U.S. Department of Labor, Bureau of Labor Statistics no date). From 1982 through 1996, the CPI-E for the elderly grew 67.9 percent, while the CPI rose 62.5 percent, implying that over that 15-year period, the average annual growth rate of the CPI-E, at 3.77 percent, was slightly greater than the 3.53-percent growth rate of the overall CPI (Berndt and others 1998a and 1998b). In the 11 years since then, between January 1996 and January 2007, the averages have been 2.68 percent and 2.49 percent, respectively. The larger health care expenditure weights for the elderly, along with greater measured medical price inflation, account almost entirely for the difference in the growth rates between these two series. In this context, one qualifying note emphasized by the Boskin Commission was that medical care prices are likely to have overstated inflation by not fully accounting for improvements in quality (U.S. Senate Finance Committee 1996). If this is correct, then as Moulton and Stewart have noted "A reduced rate of inflation for medical care would mitigate and perhaps eliminate any difference between the CPI-E and the official CPI" (Moulton and Stewart 1997, 21).<sup>2</sup>

Relatively little research has focused on price differentials between the elderly and the nonelderly for health care goods or services.<sup>3</sup> Among various medical care goods and services, pharmaceuticals have become an increasingly important component of the medical care armamentarium. Moreover, prescription drugs are likely to be one case in which within stratum consumption patterns of the elderly likely differ substantially from those of the nonelderly.

Berndt and others (1998a and 1998b) have examined whether prescription drug price inflation in the 1990s differed between the elderly and the nonelderly, when age-related substrata variations in consumption were taken into account. They examined prices at three alternative points in the distribution chain and reported three sets of findings.

First, at the initial point in the distribution chain involving manufacturers' sales to wholesalers, retailers, and hospitals—transactions that are monitored and reported by various BLS PPIs—there is essentially no age-related aggregate price differential despite very significant differences in the baskets of drugs ultimately destined for use by the elderly and the nonelderly. Specifically, using prescription drug data from the National Disease and Therapeutic Index

1. Rice and Horowitz report that the December 1965–December 1966 average annual growth rates ranged from 2.5 percent for cholecystectomy to 6.9 percent for prostatectomy, and the combined index for physicians' fees regularly priced for the CPI rose 7.8 percent (Rice and Horowitz 1967, 25).

2. For additional discussion, see the various articles in Sharpe (2006).

3. In this context it is worth noting that because of Medicare reimbursement policies to physicians and hospitals, the elderly purchase much of their health care under administered prices.

survey, maintained by IMS Health, to record elderly and nonelderly number of prescriptions by therapeutic class and applying these proportions to the BLS PPI weights by therapeutic class, the authors found that the PPI for pharmaceuticals destined for ultimate use by the elderly increased from 1.000 in 1990 to 1.331 in 1996, while that for the nonelderly rose a virtually identical amount, from 1.000 to 1.329, over the same 6-year period.

A second finding focused on an intermediate point in the distribution chain involving acquisition prices of retail pharmacies for purchases primarily from wholesalers as measured by the IMS retail prescription audit; these retail sell-in transactions take place at a point in the distribution chain that is in between the PPI and CPI and is not monitored by BLS price measurement programs. The authors focused on three therapeutic areas—antidepressants (used twice as intensively by the nonelderly, at 4.69 percent, as by the elderly, at 2.35 percent), broad and medium-spectrum antibiotics (also used about twice as intensively by the nonelderly, at 15.79 percent, as by the elderly, at 7.44 percent), and calcium channel blockers (for hypertension, used about three times more intensively by the elderly, at 6.18 percent, as by the nonelderly, at 2.01 percent). The authors found that between 1990 and 1996, retail acquisition price inflation for antidepressants destined for use by the elderly, at 7.02 percent, was less than that for ultimate use by the nonelderly, at 10.9 percent. Further research revealed that the elderly disproportionately used older generic drugs whose prices rose less rapidly than branded drugs during this time period. For antibiotics, however, especially from 1992 to 1996, the reverse occurred—the antibiotics price index for the elderly increased 7.74 percent, while that for the nonelderly rose only 2.40 percent. Additional research suggested that the greater elderly price inflation since 1992 appeared to reflect the more rapid growth in the elderly's use of the newest, branded drugs for which bacterial resistance was generally less likely. Finally, for the calcium channel blockers, there was essentially no difference in price inflation between 1990 and 1996—10.0 percent for the nonelderly and 11.1 percent for the elderly.

Data constraints prevented Berndt and others (1998a and 1998b) from undertaking a comparable analysis of retail sell-out prices across various therapeutic classes. Instead, the authors confined their analysis to sales by retail pharmacies to consumers and other payors (monitored by the IMS method-of-payment survey) to the antidepressant therapeutic class. Over all age groups, between 1991 and 1996, gross margins for antidepressants sold by retail pharmacies (sell-out prices relative to sell-in prices) fell about 3.5

percent, in part because of the growth of managed care and pharmaceutical benefit manager firms during that timeframe. Additional research found that young consumers appeared to have enjoyed most of the benefits of the increased buying power of managed care, for gross margins on the antidepressants they purchased fell by 3.8 percent. In contrast, for the antidepressants purchased by the elderly who are disproportionately large users of generic drugs, retail margins actually increased slightly.

These results suggest that no general age-related pattern of price inflation differentials for prescription pharmaceuticals is likely to emerge. Instead, the empirical significance of brand versus generic consumption, use of new versus old drugs, and various age-related quality attributes (once-a-day versus multiple daily dosages, extent of adverse interactions with other drugs, and seriousness of side effects and adverse reactions) must most likely be examined on a class-by-class basis before any general conclusions can be reached.<sup>4</sup> Moreover, even these class-specific variations may change with time, particularly when major institutional and market changes take place.

An example of such a major legislative development is the Medicare Prescription Drug, Improvement, and Modernization Act, which was passed by the U.S. Congress in 2003 and which mandated a Medicare Part D prescription drug benefit for the elderly and disabled, beginning on January 1, 2006.

### **Medicare Part D: Timelines, essential features, and BLS price measurement**

#### **Legislative history and essential features**

The Medicare Prescription Drug, Improvement and Modernization Act (Medicare Modernization Act) was introduced into the House of Representatives on June 25, 2003, sponsored by Speaker Dennis Hastert. After an initial electronic vote failed, several Republicans changed their vote, and early on the morning of June 27, 2003, it passed by a 216–215 vote. The Senate passed its version of the bill by a 76–21 vote on June 26, 2003. The bills were then unified in a conference committee and came back to the House for approval on November 21, 2003. After various legislative maneuvers and vote changes by congressional representatives, around 5:30 a.m. on November 22, 2003, the House passed the unified bill by a 220–215 vote. The Senate's consideration of the conference report was less heated but still controversial, and the bill finally passed the Senate by a 54–44 vote on November 23, 2003.

4. The cost-effectiveness of medications in certain classes likely varies by patient age. Triplett (1999) links price indexes to cost-effectiveness analyses.

President Bush signed the bill into law on December 8, 2003 (Wikipedia 2006).

Under provisions of the Medicare Modernization Act of 2003, a prescription drug benefit was created as Part D of Medicare, to become available beginning January 1, 2006, whereby Medicare beneficiaries (including those disabled and under age 65) would receive a statutorily defined standard prescription drug benefits after a \$250 annual deductible, would pay 25 percent of costs up to \$2,250, 100 percent of costs between \$2,250 and \$5,100 (a gap of \$2,850, commonly referred to as the “donut hole”), and 5 percent of costs above \$5,100. Plans were granted freedom to construct alternative benefit designs that were actuarially equivalent to the standard benefit, such as no deductibles and tiered copayments rather than 25 percent coinsurance (Cubanski and Neuman 2006). Expected monthly premiums were estimated to be about \$37, with variations depending on copayment structures, formulary design, and retail pharmacy network benefit provisions.

As a temporary and transitional step to assist beneficiaries more immediately with their prescription drug purchases, the Medicare Modernization Act of 2003 also created a program whereby Medicare-approved discount cards were issued to beneficiaries for use beginning on June 1, 2004. These cards were to help seniors purchase prescription drugs at reduced prices until the full part D benefit was implemented in January 2006. The discount cards did not provide actual insurance benefits but instead were cards issued by Medicare-approved private-sector entities (pharmacies, pharmacy benefit management firms, insurers), giving Medicare beneficiaries approximately a 15–20 percent discount on out-of-pocket cash prices for prescription drugs; discounts were on the steeper end for generic drug purchases (U.S. Department of Labor, Bureau of Labor Statistics 2006). Subsidies were also made available to some low-income beneficiaries. Other important dates were October 1, 2005, the first day for private companies to release details of their individual plans, and November 15, 2005, the first day that individuals could enroll in a part D prescription drug plan.

One other significant aspect of the Medicare Modernization Act of 2003 concerned those individuals over age 65 who had been receiving prescription drug benefits under state Medicaid programs and those under age 65 with certain disabilities. These “dually eligible” beneficiaries saw responsibility for purchasing their prescription drugs transferred from Medicaid to the Medicare Part D program, effective January 1, 2006. It is estimated that these dually eligible individuals accounted for about 29 percent of all part D enroll-

ees (Cubanski and Neuman 2006, exhibit 5, page w8). Under the Medicaid “most-favored-nation” rules, manufacturers have been required to offer Medicaid the lower of the “best” price they sell to the private sector or a discount of 15.1 percent below the average manufacturer price for branded drugs, whichever is lower.<sup>5</sup> Under Medicare Part D, however, pharmaceutical manufacturers instead negotiated prices with private prescription drug plans (PDPs) (Frank and Newhouse 2007). Manufacturers’ prices charged to PDPs were exempt from the “most-favored-nation” pricing calculations.

### Medicare Part D price monitoring by the BLS

Given the substantial lead time between initial legislative approval in June 2003 and final full implementation of Medicare Part D in January 2006, the various BLS price measurement programs had considerable time to adapt their data collection and aggregation procedures as necessary to reflect changing prices associated with implementation of Medicare Part D.

Since the PPI measures prices only at the first point in the distribution chain (for pharmaceuticals, most commonly from manufacturers’ sales to wholesalers and large retail chains), price changes directly realized by Medicare Part D beneficiaries are out of scope—the PPI does not identify and monitor prices paid by final purchasers, such as the elderly at retail or mail order. For the PPI, therefore, implementation of Medicare Part D required no significant changes in the data gathering protocols. Instead, the PPI continued to introduce new branded and generic drugs as supplemental samples into its sample of price quotes on an annual basis.<sup>6</sup>

In contrast to the PPI program, the BLS CPI program faced a number of serious challenges in adapting its price measurement protocols to capture price changes resulting from the introduction of the transitional Medicare discount card and then the launch of the full Medicare Part D program. Because the Centers for Medicare and Medicaid Services (CMS) Web site contained a pricing utility set up explicitly for beneficiaries to determine how the various discount card plans compared with each other in terms of drugs covered and their prices, beginning in October 2004, the CPI flipped a portion of its existing sample—the senior cash-discounted portion that had been receiving about a 10-percent discount—from discounted

5. For details, see Morton 1997; Frank 2001.

6. For a discussion of supplemental sampling and other details on the PPI, see Berndt, Griliches, and Rosett 1993; Berndt and others 2000, 2001. We have benefited from correspondence with Frank Congelio in the BLS PPI program regarding recent supplemental sample introductions.

cash to Medicare discount card, where the sample recorded an average additional discount of 15 percent off retail and mail order cash prices; these quotes were then employed in the aggregate index calculations (U.S. Department of Labor, Bureau of Labor Statistics 2006). As of December 2004, the BLS had been collecting 1,111 price quotes for prescription drugs (U.S. Department of Labor, Bureau of Labor Statistics 2005). Since CMS ceased supporting the pricing utility that yielded the Medicare discount card price quotes in November 2005, for November and December 2005, the BLS estimated these price quotes as being approximately 25 percent off the full cash price quotes they continued to collect.<sup>7</sup>

To account for the introduction of Medicare Part D in January 2006, the BLS CPI program employed a variant of the directed substitution rule by which the product characteristics of the new item were already known and determined (rather than going through the entire disaggregation process). In particular, the CPI recorded the price changes that occurred for the same prescription as it switched from being paid with a Medicare-approved discount card (December 2005) to the full Medicare Part D benefit price (January 2006). The latter was calculated by taking quotes from a single nationally offered private prescription drug benefit plan that conveniently allowed direct pricing via an online pricing utility.<sup>8</sup> In cases where the national part D plan only offered the generic equivalent of a brand drug covered by the discount card plan, the CPI recorded the price change between the brand discount card and the generic part D price. Note that only the changes from the discount card to part D were captured by the BLS CPI and that the quoted changes are those based on a single national plan.<sup>9</sup> In particular, the CPI program has not attempted to capture price quotes of formerly uninsured cash, or partly insured, customers who subsequently obtained part D coverage. Similarly, since direct substitution procedures were employed, any switches from retail to mail order that occurred because of part D private prescription drug plan benefit design were also not captured by the CPI.

Because a portion of the Medicare-approved discount cards that came into the CPI sample in 2004 was rotated out of the sample and was not adequately re-

placed through rotation, BLS augmented its Medicare-approved discount card sample to match CMS' estimate that approximately 3.7 percent of the U.S. population had been issued such cards. This was accomplished by the BLS randomly assigning part D quotes to their existing sample. As a result, the part D sample may not mirror a market snapshot that would have emerged had the BLS initiated the part D drugs from the pharmacy based on their traditional "last 20" prescription method. We note in passing that in the future, when BLS initiates a new sample frame, it will finally be able to measure and directly compare prescription drug prices paid by the elderly through Part D with purchase prices paid by the nonelderly. These new data could yield some very interesting research findings and in principle, could be incorporated into the CPI-E.

Coincidentally, the BLS CPI program has been wrestling with how to incorporate prescription-only to over-the-counter (Rx-to-OTC) switches into its medical care CPI, which includes both types of drugs. Two very prominent recent Rx-to-OTC switches have involved Claritin for the treatment of allergies (switch approved November 27, 2002) and Prilosec OTC for the treatment of frequent heartburn (approved June 20, 2003) (U.S. Food and Drug Administration 2003, 2002). Conversations with BLS CPI personnel reveal that when there is an Rx-to-OTC switch, the BLS treats the initial price of the OTC variant as the final price of the Rx version, and then it treats subsequent OTC price changes as only affecting the OTC price index. Note that since the BLS CPI is based on a Laspeyres aggregation framework, which has the property of reproducible aggregation, the Laspeyres aggregate of an Rx price index and an OTC price index is numerically equivalent to a Laspeyres index aggregated simultaneously over all Rx and OTC products.<sup>10</sup> A related pilot project is under way at the BLS CPI program, involving the creation of separate brand and generic CPIs for prescription pharmaceuticals. Currently, the BLS only publishes an aggregate of prescription pharmaceuticals.

### **Expectations regarding impact of Medicare Part D on BLS price measures**

As we have written elsewhere, we believe the BLS faces enormous challenges in reliably measuring price inflation for health care goods and services, including prescription drugs.<sup>11</sup> The introduction of Medicare Part D benefits likely increases these challenges and difficulties for the BLS. What are reasonable

7. We are not aware of any empirical analyses substantiating the average 25-percent discount off of full cash price for these consumers.

8. Cubanski and Neuman (2006) report that 10 organizations captured 72 percent of the part D enrollment, primarily in low premium plans and those associated with name recognition. Two organizations—UHC-Pacific (United) and Humana—dominated, together accounting for 45 percent of part D enrollment.

9. We are unaware how the CPI program deals with varying copayments, deductibles, and rebates.

10. This assumes of course that the OTC and Rx weights are adjusted appropriately in month two after the switch.

11. For example, see Berndt and others 2000; Berndt and others 2001.

expectations regarding how the introduction of Medicare Part D affected price inflation as measured and reported by the pharmaceutical CPI and PPI? Four points are worth noting.

First, prior to the implementation of Medicare Part D, about 25 percent of the elderly had been paying cash prices for prescription drugs for the entire year.<sup>12</sup> As of January 1, 2006, these individuals became eligible to enroll in Medicare Part D and benefit from the lower prices negotiated on their behalf by private prescription drug plans (Frank and Newhouse 2007). Because undoubtedly, not all of those who were eligible actually enrolled (estimates are that slightly more than 90 percent of those eligible obtained creditable coverage (Cubanski and Neuman 2006)), as we have seen, the price declines experienced by those individuals who did enroll will not have been captured by the CPI. In this sense, to the extent such transaction types are not being captured, growth in the prescription drug CPI has been overstated. Looking to the future, although some Medicare Part D transactions will have been uncovered by the Consumer Expenditure Survey (CES) data (none from 2005, but presumably those from the 2006 CES), the resulting new CES weights will be set as of December 2007 for use beginning finally with the January 2008 CPI.

Second, we expect the introduction of new or additional insurance to increase demand due to moral hazard. Danzon and Pauly (2002) have estimated that between 25 percent and 50 percent of the total growth in U.S. prescription drug spending between 1987 and 1996 can be attributed to increased drug insurance coverage by employers and Medicaid. On the other hand, since as noted earlier, a substantial portion (between 25 percent and 40 percent) of new Medicare Part D beneficiaries had previously been paying cash prices, branded manufacturers now faced a reduced demand from the cash-paying segment of consumers. Which of these two effects dominates—increased demand from moral hazard versus reduced number of cash-paying customers—is not obviously *a priori*. Whether the combined demand function over cash-paying and new Medicare Part D insured individuals shifted outward or inward is in theory ambiguous and is therefore an empirical matter. Also unclear are expectations regarding the timing of any price changes. Specifically, whether price increases occurred on or after the time of the implementation of Medicare Part D or in anticipation of it depends on numerous factors beyond the scope of this paper.

Third, as noted above, switching dually eligible indi-

viduals from Medicaid coverage, which entailed “most-favored-nation” pricing to Medicare private prescription drug plans (PDPs), which are not subject to the Medicaid mandatory rebates, provided the PDPs with less bargaining power than the state and Federal Medicaid purchasers had previously been able to exercise. Recall that it is estimated that 29 percent of the Medicare Part D enrollees had previously been dually eligible (Cubanski and Neuman 2006, exhibit 5, page w8). To the extent that this has occurred, we might expect prices of drugs disproportionately used by the previously dually eligible individuals to increase more rapidly than other drugs, at least as measured by the PPI. Below we comment on the therapeutic drug classes that are likely to be more intensively utilized by previous dually eligible individuals.

Fourth and finally, in their negotiations with CMS regarding formulary design, the PDPs were constrained by CMS to include a minimal number of (often at least two) drugs with preferred status in each therapeutic class and in some cases, such as the antidepressants, all drugs (Huskamp, et al. 200; Huskamp 2003). Since payers’ buying power relative to manufacturers stems in large part from payers’ ability to either exclude drugs entirely from their formulary or at least banish them to the third tier with the highest copayment, this broad formulary policy constrained the buying power of the PDPs, and may have led to reduced rebates and increased prices.

Together, these four considerations suggest that potentially offsetting impacts on prices are associated with the passage and then the implementation of Medicare Part D legislation. The net effect of these various impacts is in theory ambiguous, and is therefore an empirical matter. Moreover, given the 30-month timespan between the June 2003 initial passage of the legislation and its full implementation in January 2006, it is also unclear what to expect in terms of the timing of any price changes—price changes in anticipation of the full implementation of the Part D benefit could be larger or smaller than those following its implementation. However, what is clear is that we expect PPIs in therapeutic classes, including drugs disproportionately used by previous dually eligible individuals, to increase more rapidly than PPIs for drugs in other classes.

### Results: Trends in BLS measures of pharmaceutical CPI and PPI price inflation

We now move on to a discussion of trends in BLS measured price inflation, with a particular focus on dates surrounding developments in Medicare coverage of prescription pharmaceuticals. We begin with the CPI and focus on five time periods over the last 11 years.

12. If beneficiaries that paid cash prices for part of the year are counted this figure may be as high as 40 percent (Frank and Newhouse 2007).



The first two periods are (1) January 1996–January 2000 (the early history) and (2) January 2000–June 2003 (June 2003 was the month in which initial House and Senate versions of the Medicare Prescription Drug, Improvement, and Modernization Act were passed). We then divide the following 30-month time period until the January 1, 2006, implementation of Medicare Part D into two equal 15-month time intervals: (3) June 2003–September 2004 and (4) September 2004–December 2005. We then focus on the year following the implementation of the Medicare Part D program: (5) December 2005–December 2006. For each of these time periods, we compute average annual growth rates.

**Results: The CPIs**

As we noted earlier, the set of price quotes interpreted as reflecting Medicare Part D transactions is based in part on the BLS’ flipping Medicare discount card quotes on to Medicare Part D, based on online price quotes from a single national private prescription drug plan’ Web site and in part on randomly taking certain existing price quotes and converting them to a part D comparison over time. The latter set of quotes may, however, have not originally been those of elderly individuals, and thus the composition of prescriptions in the part D subsample may not be representative of that for the overall elderly population enrolled in part D.

In table 1, we compare the distribution of prescriptions by therapeutic drug class in the overall sample of prescription drug CPI quotes with that in the part D

**Table 1. Distribution of Prescriptions by Therapeutic Class in the Overall and Medicare Part D Samples, January–October 2006**  
[Percent]

Therapeutic class	Prescription share	
	Overall sample	Part D sample
Analgesics .....	8.10	14.63
Anesthetics .....	9.67	0.00
Antidotes .....	1.16	0.00
Antimicrobials .....	9.88	9.76
Cardiovascular .....	14.3	17.07
Central nervous system .....	11.99	7.32
Gastrointestinals .....	5.26	4.88
Hematologics .....	1.79	2.44
Hormones .....	10.2	9.76
Immunologics .....	0.11	0.00
Metabolics/nutrients .....	9.57	14.63
Neurologics .....	3.47	4.88
Oncolytics .....	0.32	0.00
Ophthalmics .....	1.47	0.00
Otics .....	0.21	0.00
Respiratory tract .....	9.04	9.76
Skin/mucous membrane .....	2.00	2.44
Unclassified/miscellaneous .....	1.47	2.44
<b>Total .....</b>	<b>100.00</b>	<b>100.01</b>

subsample over the January–October 2006 timeframe. There are six therapeutic classes in which there are zero part D quotes—the prescription shares of these classes except for anesthetics (at 9.67 percent) in the overall sample are quite small, and together, the six zero-share part D classes account for 12.94 percent of the overall sample prescriptions. Not surprisingly, in the cardiovascular and metabolics/nutrients classes, the elderly part D share is considerably larger than in the overall sample; in contrast, for central nervous system and analgesics, the elderly part D share is smaller than in the overall sample.

Average annual growth rates of various CPIs are presented in table 2 over the five time intervals discussed above. In the first row, we provide average annual growth rates of the “all items–urban” CPI, and in the second row, the experimental or elderly CPI (E-CPI) for “all items–urban.” The E-CPI grows slightly more rapidly than the “all items” CPI, with the differential ranging from about 0.10 percent to 0.22 percent and having no distinct time trend. Previous literature has attributed this differential to the larger share of medical care expenditures for seniors along with above-average inflation for medical care.

**Table 2. Annual Average Growth Rates of Alternative Consumer Price Indexes (CPIs)**  
[Percent]

CPI	Jan. 1996–Jan. 2000	Jan. 2000–June 2003	June 2003–Sept. 2004	Sept. 2004–Dec. 2005	Dec. 2005–Dec. 2006
All items–urban .....	2.250	2.450	2.690	2.900	2.540
CPI-E–all items–urban .....	2.404	2.674	2.910	3.003	2.687
Medical care .....	3.206	4.324	4.297	4.103	3.563
CPI-E–medical care ...	3.158	4.468	4.380	3.893	3.297
Medical care services	3.201	4.675	4.821	4.498	4.094
Medical care commodities .....	3.157	3.142	2.677	2.913	1.816
Prescription drugs .....	4.132	4.254	3.602	3.751	1.856

In the third row of table 2, we show average annual growth rates for the overall medical care CPI, and in the fourth row, the medical care E-CPI, which differ to the extent that the elderly and nonelderly shares of the components (medical care commodities, medical care services, hospital and related services, and health insurance) of overall medical care differ, and these components experience varying rates of inflation. In three of the five time intervals, the medical CPI-E grows slightly less rapidly than the overall medical CPI, and the reverse occurs in two time periods. Over the 11-year timeframe between January 1996 and January 2007, the medical CPI-E grew at an average annual growth rate of 3.905 percent, virtually identical to the overall medical CPI, at 3.913 percent.

Rows five and six provide average annual growth

rates separately for medical care services and medical care commodities; the BLS does not compute experimental CPI-Es at this level of aggregation, only overall CPIs. In each of the five time intervals, average annual growth rates of medical care services (which includes physicians,' dental, hospital and nursing home and adult day care services) are greater than those of medical care commodities (prescription and OTC drugs and medical supplies), with the differential since 2000 ranging between 1.0 percent and 2.3 percent and tending to become larger in more recent times.

Finally, in the last row of table 2, we provide average annual growth rates for prescription drugs, which include medical supplies. Between 1996 and 2005, annualized price inflation for prescription drugs ranged from about 3.6 percent to 4.3 percent, but in 2006 following the implementation of Medicare Part D, it fell to about half its previous rate, to 1.856 percent.

In summary, in recent times, there appears to have been a substantial decline in the rate of growth of the CPI for prescription drugs, particularly following the implementation of the Medicare Part D benefit in January 2006.

### Results: The PPIs

We now turn to a consideration of the PPIs for pharmaceuticals. Recall that the PPI monitors prices received by the manufacturer (net of discounts and prompt payment price reductions) from sales to the first point in the distribution chain, which for pharma-

ceuticals is usually either wholesalers or large retail chains. Participation by manufacturers in reporting to the BLS is voluntary; participation rates have been around 65 percent. Although considerable pharmaceutical manufacturing takes place in Puerto Rico, from the vantage of the BLS PPI program, Puerto Rico is not part of the United States.<sup>13</sup>

The BLS PPI for pharmaceuticals includes both prescription and OTC products. Medicaid purchases are explicitly out of scope for the CPI (because they are government purchases), but for the PPI, the identity of the ultimate consumer is irrelevant; thus, the PPI will incorporate prices paid by among others, Medicaid purchasers (that is, state governments and the CMS). In principle, the pharmaceutical PPI also tracks changes in prices that occurred when Medicare-Medicaid dually eligible individuals switched to the Medicare Part D program in January 2006, although the types of transactions are defined quite narrowly and at best, changes in weights occur only at annual intervals.

We report average annual growth rates for various pharmaceutical PPIs in table 3 for five time intervals: (1) June 2001–June 2003 (because some price series did not begin until June 2001); (2) June 2003–September 2004 (the first 15 months after initial passage of the Medicare Part D legislation); (3) September 2004–December 2005 (the final 15 months before the

13. For further discussion on details regarding the pharmaceutical PPI, see Berndt, Griliches, and Rosett (1993).

**Table 3. Average Annual Growth Rates of Alternative Producer Price Indexes (PPIs)**

[Percent]

PPI	June 2001 through June 2003	June 2003 through Sept. 2004	Sept. 2004 through Dec. 2005	Dec. 2005 through Dec. 2006	Jan. 2000 through Dec. 2006
All pharmaceuticals .....	4.23	4.38	5.42	3.90	4.12
Analgesics—prescription.....	3.49	3.59	1.36	4.92	4.41
Antibiotics—broad and medium spectrum .....	3.31	5.31	5.35	3.71	4.63
Anticoagulants.....	2.05	4.70	0.22	0.09	-5.47
Antispasmodic/antisecretory .....	3.75	3.43	22.84	5.13	7.33
Other digestive or genito-urinary preps .....	3.73	2.74	2.44	4.19	n.a.
Bronchial therapy .....	6.23	4.10	1.94	-0.90	3.52
Other prescription respiratory preparations .....	7.98	6.20	6.94	4.54	n.a.
Cancer therapy products .....	5.46	0.30	3.71	2.53	4.39
Other neoplasms, endocrine system, and metabolic diseases, including hormones.....	10.92	7.29	11.06	11.66	8.63
Cardiovascular .....	3.95	4.60	4.04	3.88	3.90
ACE inhibitors .....	1.78	1.70	0.38	0.00	n.a.
Other cardiovascular.....	5.74	6.32	6.90	6.63	n.a.
Insulin/antidiabetes.....	6.09	9.47	6.99	-8.99	4.28
Multivitamins—prescription and over the counter (OTC).....	0.80	0.81	-0.20	1.63	1.30
Other prescription vitamins and nutrients.....	3.88	2.81	3.28	2.90	n.a.
Psychotherapeutics .....	5.79	6.13	8.69	7.66	5.89
Antidepressants.....	10.99	6.26	14.59	10.09	10.21
Other psychotropics, including tranquilizers .....	2.81	6.01	3.85	5.45	n.a.
Other central nervous system and sense organs .....	-5.13	5.74	5.76	2.61	n.a.
Skin prescription preparations.....	4.19	13.32	3.97	6.84	n.a.

n.a. Not applicable because the BLS series begins in June 2001.  
ACE Angiotensin-converting enzymes

implementation of Medicare Part D in January 2006); (4) December 2005–December 2006 (to monitor changes associated with the first year of the implementation of Medicare Part D); and (5) January 2000–December 2006 (for some price series, data from the beginning of this decade). We remind readers that the PPI is a sample of products selected using probabilities proportional to sales; while we mention particular brand products in various therapeutic classes below, we have no information regarding whether those specific brands are in the PPI sample.

The first row in table 3 indicates that the overall pharmaceutical PPI has grown at about 4.1 percent annually since 2000, with slightly larger annual growth at 5.4 percent in the 15 months leading up to the implementation of Medicare Part D;<sup>14</sup> since December 2005, growth has returned to just under 4 percent. There is considerable heterogeneity in average annual growth rates, both across time intervals and among therapeutic classes. Prices of prescription analgesics (pain medicines), for example, only grew at a 1.4-percent annual rate in the 15 months leading up to the implementation of Medicare Part D, but then they grew at a much larger 4.9-percent annual rate following its implementation.<sup>15</sup> By contrast, prices of anticoagulants grew at a 4.7-percent annual rate between June 2003 and September 2004, but since then, they have grown at 0.1–0.2 percent annually.<sup>16</sup>

The antispasmodic/antisecretory market class includes drugs for the treatment of heartburn (such as the H<sub>2</sub>-antagonists and proton pump inhibitors—brands like Zantac, Prilosec and Nexium). This category has experienced particularly volatile price growth—averaging around 3.5 percent annually from June 2001 to September 2004, then grew at a very high annual rate of 22.8 percent up through December 2005,<sup>17</sup> and continued to grow at a 5.1-percent annual rate since then.<sup>18</sup> In table 1, this class of drugs would be in the gastrointestinal category, and data there suggest that the prescription drug share of gastrointestinal drugs is approximately the same for the elderly and nonelderly. We know of no data on whether this class of drugs is consumed disproportionately by the previously dually eligible individuals.

Returning to table 3, we see that cancer therapy products (where utilization might be expected to be disproportionately by the elderly, though typically covered by Medicare Part B for many years) had an aver-

age annual growth rate of about 4.4 percent over the entire January 2000–December 2006 timeframe. In the 15 months leading up to the January 2006 implementation, prices rose at an annual rate of 3.7 percent and since then, at a slightly smaller rate of 2.5 percent. By contrast, the class entitled “other neoplasms, endocrine system and metabolic diseases, including hormones” includes a number of antiosteoporosis drugs for postmenopausal women, and thus its utilization is likely to be disproportionately by the elderly.<sup>19</sup> As seen in table 3, over the entire January 2000–December 2006, price growth has been relatively high in this class, averaging 8.6 percent annually; between September 2004 and December 2005, it increased at an average annual growth rate of 11.1 percent, and most recently, it continued at a relative high average annual growth rate of 11.7 percent.

Of particular interest in the context of Medicare-Medicaid dually eligible individuals are psychotherapeutic drugs, which are used disproportionately by Medicaid beneficiaries.<sup>20</sup> For the entire class of psychotherapeutic drugs, price growth accelerated from about 6 percent annually between June 2001 and September 2004, to about 8 percent annually since then.<sup>21</sup> The next row in table 3 indicates that this price acceleration was particularly marked in the antidepressant subclass of psychotherapeutic drugs. For antidepressants, the average annual growth rate between September 2004 and December 2005 was 14.6 percent, more than twice that during the previous 15 months at 6.3 percent;<sup>22</sup> this average annual growth rate has fallen since the implementation of Medicare Part D, but it is still substantial at 10.1 percent in 2006.<sup>23</sup> Interestingly, average annual growth rates are lower, albeit still considerable in the subclass of psychotherapeutics designated as “other psychotropics, including tranquilizers,” which includes the second generation atypical antipsychotic drugs for treatment of schizophrenia and bipolar mania disorder. In recent years, the medical literature has identified several medications within

19. From table 1, we see that the class of “hormones” has roughly an equal share of around 10 percent for both the elderly and the nonelderly. The hormones class also includes contraceptives, however, which are not generally used by the elderly. Clearly, the hormone class is heterogeneous.

20. For example, see Newhouse (2004); Duggan (2005); Frank, et al. (2004).

21. Almost all of the September 2004–December 2005 inflation took place between June and July 2005.

22. The PPI for antidepressants increased by 19.1 percent between June and July 2005.

23. The antidepressant price growth is somewhat surprising. Prozac, the leading selling antidepressant, lost patent protection and experienced generic entry beginning August 2, 2001; yet from table 3, we see that between June 2001 and June 2003, prices in this subclass grew at an average annual rate of almost 11 percent. Similarly, the branded antidepressant Zoloft lost patent protection and experienced generic entry beginning June 30, 2006.

14. About a third of this inflation occurred between June and July 2005.

15. About half of this increase occurred between June and July 2006.

16. A 41-percent decline in this PPI occurred between December 2000 and January 2001. BLS officials indicate this was due to entry by generic drugs.

17. About half of this increase occurred between April and May 2005.

18. Most of this increase took place between June and July 2006.

this class as being associated with side effects of weight gain and diabetes, and their cost-effectiveness over earlier less costly products has been called into question.<sup>24</sup> For this aggregate class of other psychotropic drug, prices grew at an average annual growth rate of around 6.0 percent between June 2003 and September 2004, they grew at a slower annual rate of 3.9 percent in the 15 months leading up to the implementation of part D, and since then, they have grown at an annual rate of 5.5 percent.

In summary, therefore, although there is considerable heterogeneity over time intervals and among therapeutic classes, there is evidence based on PPI trends suggesting that some prescription drugs likely disproportionately used by the elderly (for example, the anti-osteoporosis drugs for postmenopausal women) and by the Medicaid-Medicare dually eligible individuals that are now covered by Medicare Part D (such as various types of psychotherapeutic drugs) have experienced very considerable price growth leading up to and following the implementation of the new Medicare Part D benefit. A common, but clearly not uniform, pattern is that price increases in the 15 months leading up to the implementation of the part D benefit in January 2006 were greater than those observed since its full implementation in January 2006. Although at a much higher level of aggregation, this PPI evidence is consistent with preliminary findings from Frank and Newhouse (2007) that are based on more detailed brand data, which are discussed below. However, there is also substantial PPI price growth during these time periods for the antispasmodic/antisecretory class of drugs—drugs that are not likely to be used disproportionately by the elderly. More research will be needed to clarify these early findings.

### Results from an additional data source

We have explored additional heterogeneity in the price response to passage of the Medicare Modernization Act by examining price movements among branded prescription drug products in the top 50 in U.S. sales, based on detailed research where these drugs have been stratified by the age composition of their purchasers.<sup>25</sup> We have constructed pharmaceutical PPIs (Laspeyres and Fisher indexes) for this entire sample of drugs and for various subsets. Using IMS Health data that track sales of prescription drugs from manufacturers and wholesalers to drug stores, we selected brand name drug products from among the top 50 in U.S. sales that

had no generic competition. From among these, we identified two cohorts of drugs that together included eighteen products. The first consists of a set of drugs where 55 percent or more of the sales of the drugs were likely to have been to people over age 65 (the sales shares by age are based on data on physician drug mentions provided from surveys of physician office visits conducted by IMS Health).<sup>26</sup> The second group is made up of drugs where less than 35 percent of the sales are likely to have been to people age 65 or more.<sup>27</sup> From these data, we calculated monthly prices and quantity of sales based on extended units. The period observed begins in June 2003 and extends through June 2006.

Using these data, we constructed six price indexes that are analogous to PPIs but that are at a much more disaggregated level. Specifically, we calculated fixed-weight Laspeyres and chained Fisher indexes for each of the two cohorts defined by the age of the purchasers, as well as an overall index for all 50 drugs. This yields six price index series. The six indexes are displayed in chart 1. The fixed-weight Laspeyres indexes—L-elderly, L-nonelderly, and L-all drugs—refer to the drugs disproportionately used by the elderly, the nonelderly, and the entire set of 50 drugs, respectively; the corresponding chained Fisher indexes are designated F-elderly, F-nonelderly, and F-all drugs, respectively.

Chart 1 reveals that the two PPIs calculated for the drugs in the nonelderly purchasers cohort grew at lower rates than the cohort of drugs where the majority of purchasers were over age 65. Thus, by June 2006 there was a 5.3 percentage point difference in the final value of the Fisher index for the elderly and the non-elderly drugs (F-elderly and F-nonelderly). The index for the elderly cohort ended between 3 and 4 percentage points higher, depending on the index, than the corresponding index for all 50 drugs.

Together, these data suggest that prices of prescription drugs likely used to treat people over 65 years of age, and thus are more likely to have been influenced by the passage and implementation of Medicare Part D legislation increased more rapidly than did drug prices for prescription drugs likely used to treat the general population.

### Concluding remarks

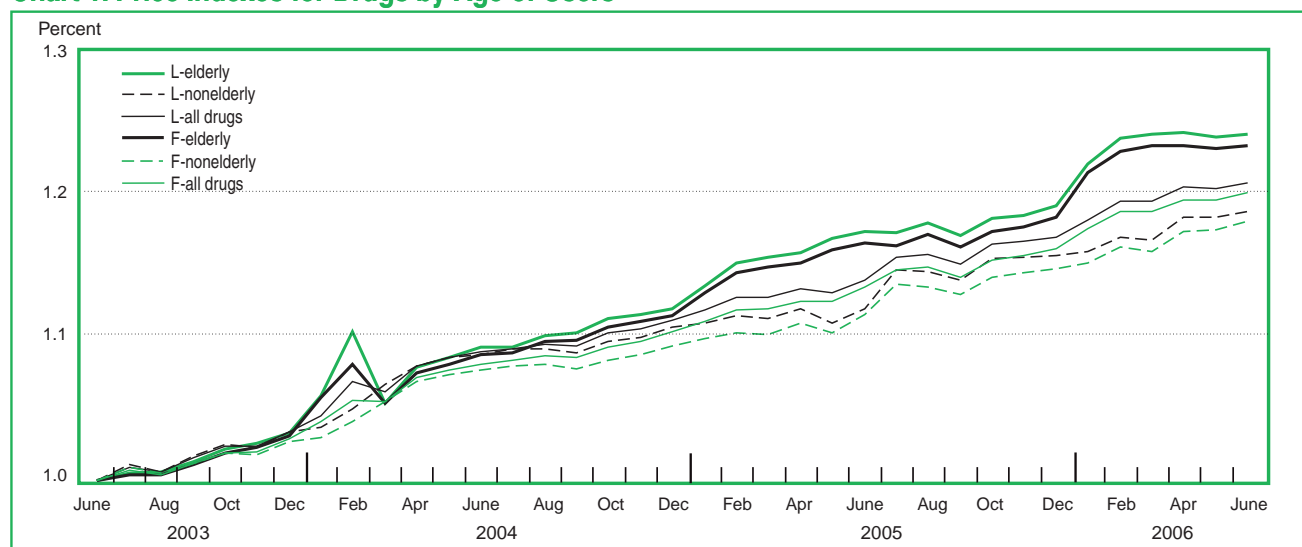
The implementation in January 2006 of the Medicare Modernization Act that provided for Medicare Part D prescription drug benefits for the elderly created

24. For example, see Freedman, et al. (2006); Lieberman, et al. (2005); Polsky, et al. (2006); Rosenheck, et al. (2006).

25. This research has previously been discussed in greater detail in Frank and Newhouse (2007).

26. Included in this group were the branded drugs Aricept, Flomax, Xalatan, Forteo, Coreg, Plavix, Fosomax, Actonel, Norvasc, and Evista.

27. This group includes Advair, Prevacid, Nexium, Singulair, Aciphex, Zoloft, Effexor, and Wellbutrin XL (this last drug was dropped from most analyses since a generic version of the molecule was also on the market).

**Chart 1. Price Indexes for Drugs by Age of Users**

monitoring challenges for Government statistical agencies, such as the BLS. It has also created the opportunity for the BLS eventually to assess any differences in prices paid by the elderly and by the nonelderly for the same branded or generic prescription drug. Although the implications of the Medicare Modernization Act for the PPI program were relatively minor, those for the CPI program were greater and more complex. The CPI program did not attempt to capture price quotes of formerly uninsured cash-paying or partly insured consumers who subsequently obtained part D coverage or for those switching from retail to mail order because of part D. Hence, it is likely that the CPI for prescription drugs overstated actual inflation between 2005 and 2006. Nonetheless, it is notable that the CPI for prescription drugs grew only by 1.9 percent between December 2005 and December 2006, roughly half the annualized 3.8-percent rate in the previous 15 months.

With respect to the various pharmaceutical PPIs, theoretical predictions regarding the price impacts of Medicare Part D are generally ambiguous, since the moral hazard increase in demand could be offset by the reduction in the number of cash-paying consumers. There is some evidence suggesting that drugs disproportionately used by the elderly (for example, antiosteoporosis drugs for postmenopausal women) and by the Medicaid-Medicare dually eligible individuals subsequently covered by Medicare Part D (for example, psychotropic drugs) experienced considerable price growth leading up to and following the implementation of Medicare Part D. Although the evidence

is not uniform, a common observed trend is for price increases in the 15 months leading up to the implementation of Medicare Part D to be greater than in the previous 15 months following initial passage of the enabling legislation, and in the year following full implementation.

Using data from a different source, IMS Health, on the 50 top selling brands stratified by age of purchaser, we report evidence consistent with the notion that between June 2003 and June 2006, price increases for drugs likely used primarily by the elderly were larger than were those for prescription drugs likely used primarily by the nonelderly.<sup>28</sup>

The implications of changes in purchasing arrangements for drugs used by Medicare beneficiaries and the resulting price impacts stemming from the implementation of part D are just now beginning to be observed. A great deal of new data will soon be emerging, which will facilitate research on the impacts of institutional changes on both out-of-pocket prices paid by consumers and on revenues received by prescription drug manufacturers (analogous to CPIs and PPIs for prescription drugs). This new learning is likely to be important for the interpretation of the continued evolution of health care price indexes and for the evaluation of public policies.

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28. See Frank and Newhouse (2007) for further details.



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## A Different Application for Productivity Measures, or Has the Difficulty of Measuring Physician Productivity Caused the Federal Deficit To Be Misestimated?

By Joseph P. Newhouse and Anna D. Sinaiko

THOSE interested in measuring economy-wide productivity often have an overall welfare context in mind, and those interested in measuring productivity in particular industries may have issues around technological change in mind. A rather unusual context for productivity measures is the Medicare administered pricing system.

### Background

In fiscal year 1984, Public Law 98–21 authorized Medicare to implement what became known as the Prospective Payment System (PPS) to reimburse hospitals for inpatient stays. Prior to 1984, Medicare had paid hospitals a percentage share of the hospitals' total patient care costs equal to the Medicare share of inpatient days. The PPS was a higher powered contract that reimbursed hospitals a lump sum per stay, with the lump sum amount varying by diagnosis and to some degree with the procedure performed.<sup>1</sup>

To oversee this administered price system on its behalf, Congress authorized the creation of an ongoing commission, the Prospective Payment Assessment Commission (ProPAC), that would annually recommend to the Congress how much the lump sum(s) should be increased, or "updated." Section 1886(e)2 of P.L. 98–21 instructed the ProPAC, in making its update recommendation, to "take into account changes in the hospital market basket (an input price index), *hospital*

1. There were a small percentage of outlier cases that continued to be reimbursed an additional amount for additional services. See McClellan, 1997.

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*productivity* (emphasis added), technological and scientific advances, the quality of health care provided in hospitals (including the quality and skill level of professional nursing required to maintain quality care), and long-term cost effectiveness in the provision of inpatient hospital services."

This instruction proved difficult to implement. Each year, the ProPAC duly estimated the components enumerated in the above paragraph, including productivity, but only the estimate of the hospital market basket component was data driven, while the remaining items were left to the judgment of the commissioners.

In 1997, the Congress merged the ProPAC with its sister commission for physician payment, the Physician Payment Review Commission, to form the Medicare Payment Advisory Commission (MedPAC). MedPAC retained the responsibility for making annual update recommendations to the Congress. In 2002, the Commission formally abandoned the above framework for updating Medicare hospital payments; instead, each year, it made two determinations as a predicate for its update recommendation to the Congress: Was current spending at a level adequate for an efficiently run hospital to provide care at the desired standard of quality? And what increase would be needed in the succeeding year to maintain quality at the desired standard? Thus, productivity was not singled out as a specific factor to be accounted for in the recommendation. The Congress continues to take the MedPAC update recommendation, along with the recommendation from the administration, and legislate a payment rate for the following year. Medicare spending on hospitals is not small change; it is projected to be \$205 billion in calendar year 2007, about three-quarters of which is for inpatient services.<sup>2</sup>

As with hospital services, Medicare also operates an

2. See Centers for Medicaid and Medicare Services, <[www.cms.hhs.gov/NationalHealthExpendData/downloads/proj2006.pdf](http://www.cms.hhs.gov/NationalHealthExpendData/downloads/proj2006.pdf)>, (accessed May 31, 2007) and Medicare Payment Advisory Commission (2006).

administered price system for physician services. Though a lesser amount than hospital services, the Congressional Budget Office estimates payments for physician services will be \$63 billion in fiscal year 2007, nearly half a percent of gross domestic product (GDP).<sup>3</sup> Unlike hospital services where MedPAC and implicitly Congress have abandoned the formal consideration of productivity, the updates for physician fees or unit prices do explicitly consider productivity. Also, unlike hospital services, updates for physician services by law come from an explicit formula. The exact formula is complicated because of lags, but its intent is to set fees so as to achieve a fixed amount of total spending on physician services.<sup>4</sup> This is accomplished by lowering unit prices for physicians as the quantity of services that they collectively deliver rises in order to achieve the spending target. The formula that determines the change in the spending target each year accounts for changes in input prices, real GDP growth, the change in the number of beneficiaries, and the cost of any legislated changes in benefits, for example covering mammograms.

Importantly for our story, the formula that determines the spending target deducts private, nonfarm business multifactor productivity from the estimated change in the input price index on the grounds that not to do so would double count productivity gains and thus pay physicians more than intended. The logic is that the input price index, as a measure of factor prices, over the long run rises at roughly the rate of economy-wide productivity, but that the quantity of services physicians bill to Medicare, such as office visits or surgical operations, also rises as physician productivity in producing them rises. Hence, if there were no deduction, productivity would be double counted.<sup>5</sup> This formula has been in place since 1998, although an analogous formula has been in place since 1992.

3. See Congressional Budget Office (CBO), "Fact Sheet for CBO's March 2006 Baseline: Medicare," <[www.cbo.gov/budget/factsheets/2006b/medicare.pdf](http://www.cbo.gov/budget/factsheets/2006b/medicare.pdf)>, (accessed November 3, 2006).

4. For the details of the formula, see Centers for Medicaid and Medicare Services, <[www.cms.hhs.gov/SustainableGRatesConFact/Downloads/sgr2007f.pdf](http://www.cms.hhs.gov/SustainableGRatesConFact/Downloads/sgr2007f.pdf)>, (accessed May 31, 2007).

5. Because real GDP growth also rises at the rate of multifactor productivity, the formula actually triple counts productivity, but because of a legislated floor on how much payments can fall in any one year, real GDP growth is irrelevant to current updates, though it is potentially relevant to future updates since the difference between the formula's result and the legislated floor is carried forward in determining future updates.

### Which measure of productivity?

Assuming economy-wide and physician productivity differ, one can ask conceptually which measure is intended to be netted out from physician payments. We think one's view on this question turns on whether the deduction is meant to be an adjustment to an input price (physician wages) or to an (intermediate) output price (that is, the service, such as an office visit, that Medicare pays for).

We assume that the intent in setting prices is to emulate the outcome of a competitive economy. If the adjustment is assumed to be to an input price, one would conceptually want to net out a measure of the growth in physician productivity in producing services, assuming one could measure that. One would then be left with the standard result for a competitive economy, and fees or physician wages would rise at the rate of economy-wide labor productivity weighted by the labor share.

Because Medicare is actually paying for an (intermediate) output, however, it seems to us that the adjustment is better treated as an adjustment to an output price rather than to an input price. In a competitive economy, the percentage change in output price,  $d(\text{output price})/\text{output price}$ , equals

$$\frac{d(\text{output price})}{\text{output price}} = \frac{d(\text{unit cost})}{\text{unit cost}} - \frac{d(\text{productivity})}{\text{productivity}},$$

where  $d(\text{unit cost})/(\text{unit cost})$  is the change in an input price index for the unit cost of the product and  $d(\text{productivity})/\text{productivity}$  is the change in multifactor productivity for the product.

The current physician input price index can be construed as an approximation to the  $d(\text{unit cost})/(\text{unit cost})$  term. The index is a mixture of a sector-specific input price index for inputs used by physicians other than their own time and an economy-wide wage index for physician time inputs. Thus, the approximation is assuming the economy-wide wage index measures the cost of the physician input.

Because we have historically not had a sufficiently precise physician-specific measure of productivity, the actual productivity adjustment,  $d(\text{productivity})/(\text{productivity})$ , is measured as private, nonfarm business multifactor productivity over a 10-year period. The obvious question is how good that approximation is to a physician-specific measure?

### Biases in the measurement of physician productivity

Unfortunately, it is exceedingly difficult to measure physician productivity. Two recent efforts to measure physician productivity strongly suggest difficulties (Triplett and Bosworth 2004; Ho and Jorgenson 2006).<sup>6</sup> Both estimated physician productivity to be negative, which as Ho and Jorgenson say, is logically possible but suspicious.

Why is measurement so difficult? Four factors complicate any physician-specific productivity measurement and likely serve to bias measured productivity down. The first is adjusting for quality change. Recent work on productivity in medical care has taken the unit of output to be the treatment for a disease or medical problem, partly on the grounds that it is more straightforward to adjust for quality change in this context (Abraham and Mackie 2005; Berndt, et al. 2000; Cutler and Berndt 2001; Newhouse 2001). Adjusting for quality change in the context of the 6,600 specific physician services that Medicare pays for is much harder. Consider an example of new, more costly imaging equipment that allows more accurate diagnosis. This would in principle change the quality of a physician visit. If the price index for physician visits used in the calculation of productivity failed to account for this change in quality, it would overstate the price increase and hence understate the gain in productivity.

The standard method for quality adjustment using hedonics is problematic in this context for two reasons. First, Medicare uses administered pricing, making the assumption that the observed price reflects quality differences as valued by consumers doubtful. Indeed, there is much current attention to introducing “pay-for-performance” into Medicare pricing on the grounds that Medicare payments historically have not recognized quality differences among providers (Kahn, et al. 2006). Second, there is a conceptual issue around using hedonics in this context, one that has an analog in national income accounting. Virtually all income accounting is based on a Hicksian definition of income, which is the maximum that can be spent in a period while maintaining the capital stock at a constant level (Nordhaus 2002). In practice, the Hicksian definition treats income as consumption plus capital accumulation and is limited to goods traded through the market. Thus, it measures production during a certain period. As Nordhaus observes, it is difficult to extract

any welfare significance from this measure.<sup>7</sup>

An alternative definition of income comes from Irving Fisher who defines income as that amount that would give constant utility from consumption and other determinants of utility. In effect, this concept defines income as the consumption equivalent of current assets plus current and future technologies or alternatively, as the maximum amount a current generation could consume while ensuring that all future generations have utility at least as high as the current generation.

As Nordhaus (2002) observes, the Fisherian alternative is particularly important in the case of life-extending medical technology because Hicksian measures do not value extension of life. For example, two countries could have the same per capita income but different life expectancies. If so, the country with the longer life expectancy would surely be regarded as having greater welfare, since common sense suggests individuals prefer to survive, and in practice, individuals trade consumption for changed probabilities of survival, for example, by taking riskier jobs that pay higher wages. The problem, of course, is that the longer life expectancy is not directly valued in the market. Nordhaus also suggests that quality-improving, but nonlife-extending, innovations do not raise new conceptual issues because in principle, they have a market value. Although that is correct, they do raise the practical issue of how to value them if hedonic adjustment cannot be used.

A second difficulty with measuring physician productivity also comes from Medicare’s use of administered prices. Productivity may change because of learning-by-doing (for example, as surgeons become more proficient at an operation, time required may drop and clinical results may improve), but Medicare’s fee for that procedure may not sufficiently decrease—often, it will not decrease at all—to reflect the changed production circumstances. In particular, the method for updating fees for specific services (as opposed to the overall level) appears biased toward recognizing services whose prices should increase rather than decrease (Medicare Payment Advisory Commission 2006). As a result, the standard assumption in productivity measurement that a factor is paid its

6. A recent third effort by Charles Fisher was presented at a meeting in Washington, DC, on October 18, 2006, and is currently in press (Fisher 2007).

7. Nordhaus (2001a) considers the ability of measures of productivity growth to reflect economic welfare and shows that the ideal measure of multifactor productivity growth is a weighted average of the productivity growth rates of different sectors, and that the indices used in the appropriate measure are chain indices of productivity growth rather than differences in the growth rates or indices of outputs and inputs. This result depends on an assumption that all goods are priced at their marginal cost, something known not to hold in health care because of the presence of insurance as well as administered supply prices.



marginal product is a strong assumption in this context. The failure of prices to register productivity gains means measured productivity is understated.

A third issue is the constant addition of new codes for new services. Over the 2000–2005 period, the number of nonduplicated codes that Medicare used rose by over 6 percent.<sup>8</sup> New goods in a price index pose well-known measurement problems, and in practice, any gain in the physician's ability to prevent or treat disease from the introduction of the new product is unmeasured. This too would mean the measured rate of productivity increase is understated.

A fourth factor is the inability to measure hospital capital and labor that affects the productivity of physician services delivered in the hospital, such as a change in the number of nurses or the installation of cardiac catheterization capability. About a quarter of Medicare spending on physician services comes from physician services to hospitalized patients, and another 15 percent goes to patients treated in the hospital outpatient department or in the emergency room.<sup>9</sup> In addition to possible changes in nurse staffing, changes in the number of residents (physicians in training who do not separately bill Medicare) likely affect physician productivity. For example, during the period 1985–97 when Medicare subsidized the hiring of residents, the number of residents rose 30 percent (Newhouse and Wilensky 2001), while the number of days of hospital care fell 31 percent. Although the increased number of residents presumably increased physician productivity, the effect of omitting other hospital labor and capital inputs on physician productivity in the hospital obviously depends on whether those inputs are increasing or decreasing.

A second effect of omitting hospital inputs arises because the site of many services has been shifting to the outpatient sector. For example, surgical procedures that used to require a several day stay in the hospital to recover now are done in a minimally invasive fashion on an outpatient basis. Ulcers, which used to be treated surgically, are now treated with antibiotics on an outpatient basis. The fall in the number of days of hospital care cited in the previous paragraph reflects the magnitude of that shift. As a result, the influence of unmeasured hospital capital and labor inputs has probably been declining. This would have biased up measured productivity.

8. Frederick Ensor, Centers for Medicare and Medicaid Services, private communication, December 15, 2005.

9. See table 58 at <[www.cms.hhs.gov/MedicareMedicaidStatSupp/LT/itemdetail.asp?filterType=none&filterByDID=-99&sortByDID=1&sortOrder=ascending&itemID=CMS060372](http://www.cms.hhs.gov/MedicareMedicaidStatSupp/LT/itemdetail.asp?filterType=none&filterByDID=-99&sortByDID=1&sortOrder=ascending&itemID=CMS060372)>, (accessed November 8, 2006). The data are from 2002. We are indebted to Kevin Hayes of the MedPAC staff for alerting me to this source.

Except for the ambiguity with respect to unmeasured hospital inputs, the remaining factors all bias down estimates of physician productivity. For that reason it is not surprising that both Ho and Jorgenson (forthcoming) and Triplett and Bosworth (2004) arrived at a negative estimate of physician productivity.

Before leaving this issue, we note that the actual formula uses an aggregate input price index that applies to all physicians, whereas changes in unit costs and productivity almost certainly vary across specialties. As a result, the actual formula is almost certainly nonneutral across specialties. The changes in unit costs and productivity may vary across local markets as well, but Medicare has traditionally ignored that variation.

Lacking a reliable measure of physician-specific productivity, one might have more confidence in the formula's use of an economy-wide measure to approximate physician productivity if most industries clustered around the average, but unfortunately, this is not the case in manufacturing. The last row of table 1 shows a considerable variance in multifactor productivity across manufacturing sectors measured for approximately 10-year periods. Triplett and Bosworth (2004) found a similar result within the service sector.

**Table 1. Annual Growth Rates in Multifactor Productivity by Manufacturing Industry**  
[Percent]

	1962–72	1970–80	1980–90	1989–99
<b>Manufacturing sector</b>				
Food and kindred products .....	0.9	0.2	0.2	0.1
Tobacco manufactures .....	0.1	-1.0	-5.9	-3.0
Textile mill products .....	2.7	2.4	2.1	1.8
Apparel and related products .....	0.7	1.5	0.5	0.9
Paper and allied products .....	1.7	0.1	0.4	0.5
Printing and publishing .....	0.4	-0.3	-0.8	-1.2
Chemicals and allied products .....	2.4	-1.1	1.6	0.3
Petroleum refining .....	0.7	-0.3	0.1	0.4
Rubber and miscellaneous products .....	1.0	-0.4	1.6	1.2
Leather and leather products .....	-0.1	0.7	-0.1	0.7
Lumber and wood products .....	1.9	0.4	2.4	-1.3
Furniture and fixtures .....	0.9	1.3	0.3	0.8
Stone, clay, glass and concrete products .....	0.9	-0.5	1.7	0.9
Primary metals industries .....	0.4	-0.6	0.3	1.3
Fabricated metals products .....	0.5	-0.3	0.6	0.3
Industrial and commercial machinery .....	1.0	1.0	3.5	4.4
Electronic and other electrical equipment .....	2.8	1.8	3.3	6.4
Transportation equipment .....	1.3	0.0	0.7	0.6
Instruments .....	1.7	1.3	1.6	0.7
Miscellaneous manufacturing .....	1.7	-1.1	2.1	0.0
<b>Addenda:</b>				
<b>Mean</b> .....	<b>1.2</b>	<b>0.3</b>	<b>0.8</b>	<b>0.8</b>
Standard deviation .....	0.8	1.0	2.0	1.9
<b>Coefficient of variation</b> .....	<b>0.7</b>	<b>3.8</b>	<b>2.4</b>	<b>2.4</b>

Note. Percent change at a compound annual rate.

Source: "Aggregate and Two-Digit SIC Manufacturing Industries Multifactor Productivity Tables," Bureau of Labor Statistics, (May 2001). The table is accessible at <[www.bls.gov/web/prod3 supp.toc.htm](http://www.bls.gov/web/prod3 supp.toc.htm)>.

### So what?

In recent years the formula in the law appears to have fallen into disuse. Since 2002, it has produced the result that the unit prices or fees Medicare pays physicians should fall a little over 4 percent annually. In 2002 the Congress did let physician fees fall by the amount indicated by the formula, but in every year since then the Congress, fearing physicians would begin to not accept Medicare patients, has overridden the formula and either raised fees a small amount (in 2003–2005 and 2007) or kept them constant in nominal terms (in 2006). Because the law requires that such overrides be carried forward and accounted for in future updates, the cumulative amount of the difference between what the formula indicated and the actual updates is now 28 percent.<sup>10</sup> In other words, under current law, Medicare physician fees should be 28 percent lower than they are.

One reason why the formula is spewing out negative updates could be errors in the measurement of productivity. If the economy-wide productivity measure was overstated by 1 percentage point annually relative to a true physician-specific measure, that would cumulate over a decade to a little more than a 10-percent error, or more than a \$6 billion underpayment annually, and conversely if it was understated by that amount. A probably larger quantitative cause of the 28-percent value is beneficial innovations in medicine that add expense but that Congress wishes to make available to beneficiaries. The formula effectively assumes the cost of these innovations rises at the rate of real GDP, but long-run rates of increase in health care spending have exceeded the growth of GDP in all developed countries, a phenomenon generally ascribed to welfare increasing technological change in medicine (Newhouse 1992; Fuchs 1996; Cutler 2004). Nonetheless, if physician productivity were not as large as economy-wide productivity, the use of economy-wide productivity could be playing a role.

But even if some of the cuts in physician fees indicated by the current formula are attributable to an excessive deduction for productivity (that is, if physician productivity is less than economy-wide productivity), it seems unlikely to us that we will have an estimate of physician productivity that is serviceable enough to be used in the formula anytime soon. In the meantime, the current formula is in trouble because no one believes that Medicare physician fees could be cut 28 percent without large numbers of physicians becoming

unwilling to see Medicare beneficiaries, a politically impossible situation. The cuts of more than 4 percent per year, however, are part of the Federal baseline budget because that budget reflects current law;<sup>11</sup> hence, jettisoning the formula effectively adds to the Federal deficit in a nontrivial way.

As pointed out above, most current work by economists on medical productivity focuses on medical care as a whole, not specific intermediate inputs such as physician services. It is easier to handle many of the measurement problems in that context, but adopting such an approach in the Medicare payment context would require that Medicare pay some entity by the disease or episode rather than the specific service, such as a brief office visit or an appendectomy. In fact, Medicare pays health plans in something approximating that fashion, but health plans enroll fewer than 20 percent of Medicare beneficiaries. In traditional Medicare, which enrolls the remainder of the beneficiaries, such an approach has historically not been feasible politically because of the autonomy of physicians; that is, physicians have always insisted that they be paid independently of other inputs. More generally, none of the providers of intermediate inputs wants to be a subcontractor to a supplier of another intermediate input.

In sum, the fees that Medicare pays physicians depend in part on a measure of productivity. Ideally that would be a measure of physician productivity, but we have not had a serviceable measure of physician-specific productivity. In lieu of such a measure, Medicare uses a measure of private, nonfarm business multifactor productivity to approximate physician productivity. If the productivity of physicians in producing the specific services for which Medicare pays has increased less than economy-wide productivity, the “increases” in physician fees assumed in the Federal budget are too low (and conversely, if any error is in the other direction). In other words, the inability to measure physician productivity in a satisfactory fashion translates into errors in projecting future Medicare spending on physician services and hence errors in forecasting future Federal deficits.

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10. See Centers for Medicaid and Medicare Services, <[www.cms.hhs.gov/SustainableGRatesConFact/Downloads/sgr2007f.pdf](http://www.cms.hhs.gov/SustainableGRatesConFact/Downloads/sgr2007f.pdf)> (accessed May 31, 2007).

11. See Congressional Budget Office (CBO), “Fact Sheet for CBO’s March 2007 Baseline: MEDICARE,” <[www.cbo.gov/budget/factsheets/2007b/medicare.pdf](http://www.cbo.gov/budget/factsheets/2007b/medicare.pdf)> (accessed May 31, 2007).

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## Measuring the Output of Health Care in the United States

By Michael S. Christian

THE HEALTH sector is one of the largest sectors of the U.S. economy. In 2004, the U.S. economy produced \$1.855 trillion in health-related goods and services, accounting for 15.8 percent of gross domestic product.<sup>1</sup> A sector of this size must be accurately measured and appropriately understood if national economic accounts are to be credible.

In this paper, I describe two avenues of research in health accounting: The construction of a satellite account for health-related home and volunteer production and the calculation of direct volume indexes for health care services. Continued work in health accounting will improve the quality of the national accounts and deepen understanding of a crucial sector of the U.S. economy.

### Accounting for home and volunteer production

The construction of an account for home and volunteer production of health care services has become substantially more possible in recent years as a result of two innovations. The first is the publication of *Beyond the Market: Designing Nonmarket Accounts for the United States* (National Research Council 2005), a report by the National Research Council that offers a useful set of recommendations from a blue-ribbon panel of economists for producing such an account. The second is the American Time Use Survey (ATUS), a joint project of the Bureau of Labor Statistics (BLS) and the Census Bureau. The ATUS surveys adult Americans about time usage; in 2004, it surveyed nearly 14,000 people. It includes weights that can be used to estimate the number of hours spent by all Americans age 15 and older on specific activities over the entire year.

1. The author's calculations are from tables 1.1.5, 2.4.5, 3.17, 5.4.5B, and 5.5.5 in the national income and product accounts.

Following the recommendations of *Beyond the Market* and using data from the ATUS and other sources, I constructed a concise account for home and volunteer production of health-related services in the United States in 2004. The account is presented in table 1. It values the output of the home and volunteer health sector in 2004 at \$314 billion. When this sum is added to the \$1.855 trillion estimate of market output in the health sector in the national income and product accounts (NIPAs), the combined market, home, and volunteer output of the health sector in 2004 is \$2.170 trillion. Of this combined total, 86 percent is market production, and 14 percent is home and volunteer production.

In this account, home and volunteer health sector

**Table 1. Market, Home, and Volunteer Output in U.S. Health Sector, 2004**

[Billions of dollars]

NIPA health expenditures.....	1,855.3
Personal consumption expenditures .....	1,670.4
Medical care services, including insurance .....	1,395.7
Drug preparations and sundries .....	251.3
Ophthalmic products and orthopedic appliances.....	23.4
Gross private domestic investment.....	79.5
Hospitals, special care, and medical buildings .....	29.6
Medical equipment and instruments .....	49.9
Government consumption and gross investment.....	105.4
Nondefense health consumption expenditures .....	88.6
Nondefense health gross investment.....	16.8
Home and volunteer health production .....	314.3
Labor component.....	291.0
Health-related care for self.....	158.1
Health-related care for others .....	26.7
Sports, exercise, and recreation .....	71.4
Public health volunteer activities.....	2.7
Travel related to medical services.....	22.8
Travel related to sports, exercise, and recreation.....	9.3
Capital component.....	23.3
Total market, home, and volunteer health production .....	2,169.6

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output is measured from the income side. This is done by estimating the “shadow” payments that would have been necessary to employ the factors used to produce home and volunteer health-related services. I measured shadow payments to two factors: Labor and capital. The volume of labor is measured with the ATUS, and the price of labor—the shadow wage—is measured with summary data from the Occupational Employment Statistics (OES) survey, which is conducted by BLS, and with data from the Current Population Survey (CPS), another joint project of BLS and the Census Bureau. Shadow payments to capital are measured using data from the fixed assets tables of the Bureau of Economic Analysis (BEA).

Measuring the labor component of health-related home and volunteer production involves two steps: Measuring the amount of time spent on health-related activities and valuing the time so that it can be measured in monetary terms. Using the ATUS, I measured the number of hours spent by adults in 2004 on six types of activities: Health-related care for self; health-related care for others; participation in sports, exercise, and recreation; public health volunteer activities; travel related to medical services; and travel related to participation in sports, exercise, and recreation. Time spent in all six of these activities is assumed to make some contribution to health-related home and volunteer production.

Health-related care for self includes time spent on health-related self-care, on personal care emergencies, and on using and waiting for medical care services. According to the ATUS, adults in the United States spent 11.7 billion hours on these activities in 2004. Since it is generally not possible to hire another person to do these activities, this time should be valued at the op-

portunity cost of one’s own time. This can be measured as the posttax wage that one earns or would earn in market work. I imputed this wage (henceforth “own wage”) for each person in the ATUS using the average posttax wage of people of the same sex, age, and education in the March 2005 CPS.<sup>2</sup> At own wages, total time spent on health-related care for self is valued at \$158.1 billion.

Health-related care for others includes activities related to household and nonhousehold children’s health, providing medical care to and obtaining medical care services for household and nonhousehold adults, and waiting associated with caring for household and nonhousehold adults. A total of 2.91 billion hours were spent on these activities by adults in 2004. Since it is possible to hire others to do these activities, this time can be valued at a market rate. According to OES summary statistics, the hourly wage of home health aides was \$9.13 in May 2004 and \$9.23 in November 2004. I chose to average the two and assume that the cost of hiring someone else to care for others is \$9.18 per hour. At this wage, the value of the 2.91 billion hours spent caring for others is 2.91 billion times \$9.18, which equals \$26.7 billion.

Participation in sports, exercise, and recreation covers time spent on a wide range of activities. It includes obviously healthy activities, such as running and swimming, as well as less physically taxing pursuits, such as billiards and darts. Adults spent 24.5 billion hours on these activities in 2004. Since it is impossible to hire someone to run or swim for you, time spent on these activities must be valued at own wage. Using own wage values, this approach values the time spent on sports, exercise, and recreation at \$357.1 billion. Not all of this \$357.1 billion, however, should count toward home production of health-related services because not all sports, exercise, and recreation are done for health-related purposes. People also participate in these activities for their own enjoyment, and some of the value of the time spent on these activities is given up in exchange for enjoyment rather than health. I assumed that 20 percent of participation in sports, exercise, and recreation is health related. Under this assumption, the contribution of time spent on sports, exercise, and recreation to a home health sector account is 20 percent of \$357.1 billion or \$71.4 billion.

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2. I measured the pretax wage in the CPS as personal earnings divided by hours worked, which is the product of weeks worked and hours worked per week. The posttax wage is the pretax wage multiplied by one minus the marginal tax rate. There are seven age groups (15–17, 18–24, 25–34, 35–44, 45–54, 55–64, and 65+) and five education groups (no high school diploma, high school diploma, some college, 4-year degree, and graduate degree). People in the 15–17 age group are not split into separate education groups, and people in the 18–24 age group with college degrees are not split between people with 4-year and graduate degrees. The average wage is calculated as a weighted average across people by hours worked.

Public health volunteer activities include donating blood and providing medical services as a volunteer. Since it is possible to hire other people to do this, the 296 million hours that adult Americans spent on these activities were valued at the \$9.18 hourly wage of home health aides, leading to a monetary value of \$2.7 billion. Travel related to medical services is valued in the same way as health-related care for self, at own wage; this approach values the 1.6 billion hours spent on this activity at \$22.8 billion. Finally, travel related to sports, recreation, and exercise is valued for the health accounts in the same way as participation in sports, recreation, and exercise: At own wage times 0.20 to reflect the presumed share of time spent on these activities for the purpose of health. For health-accounting purposes, this approach values the 3.1 billion hours spent on travel related to sports, exercise, and recreation at \$9.3 billion.

Summing the monetary values of time spent in the six kinds of health-related activities described above values the total labor component of home and volunteer health-related production at \$291.0 billion.

The capital component of health-related home and volunteer production is the shadow rent on the stock of health-related durable goods owned by households. The only obviously health-related durable goods category in the NIPAs is ophthalmic products and orthopedic appliances. The shadow rent paid on this stock can be calculated as the product of the value of the stock itself and  $(r + \delta) / (1 + r)$ , where  $r$  is the risk-free interest rate and  $\delta$  is the depreciation rate of ophthalmic products and orthopedic appliances. BEA's fixed assets tables estimate the stock of ophthalmic products and orthopedic appliances at the end of 2003 at \$67.9 billion and the depreciation rate at 27.5 percent. If we assume the risk-free interest rate is 2.5 percent, the rental value for 2004 of the yearend 2003 stock is  $(.30/1.025)67.9 = \$19.9$  billion. However, this is not the rental value of the complete stock available in 2004, as \$23.4 billion in new production of ophthalmic products and orthopedic appliances was added to the durable goods stock in 2004. If we assume that this new production was added to the stock at the midpoint of 2004, the rental value of new production for 2004 is  $.5(.30/1.025)23.4 = \$3.4$  billion. Adding up the rental values of previously existing stock and of new production yields a total rental value of \$23.3 billion for ophthalmic products and orthopedic appliances for 2004; this is also the total capital component of health-related home and volunteer production. Adding the labor and capital components together yields a total value for health-related home and volunteer production of \$314.3 billion.

The account presented in table 1 suggests that the home and volunteer health sector is small and labor-intensive. It is less than a fifth the size of the market health sector, and more than 90 percent of its shadow income is accounted for by labor. About half of it is accounted for by time spent providing health care to oneself and receiving medical services for oneself. Less than 10 percent of it is accounted for by time spent providing care to others or volunteering for the purpose of public health.

Future work on the topic of household accounts will include expanding it to include more years. One straightforward expansion is the inclusion of all years for which the ATUS is available; currently, the ATUS is available for 2003, 2004, and 2005. Another possibility for future work is the recalculation of the health account under alternative assumptions, particularly about the value of time and about the contribution of various activities toward health-related home and volunteer production. For example, the labor component of home and volunteer production would be larger if time spent providing medical care to others was valued at the mean hourly wage across all health care support occupations—\$11.17 in May 2004 and \$11.30 in November 2004—rather than the lower wage of home health aides. Alternative calculations would help check the robustness of the initial estimates presented here.

### Direct volume measurement of hospital inpatient services

In the United States, the health sector is mostly private, and market prices are available for most health care services. Price deflation is therefore a feasible option for calculating the real output of health care services in the United States, and it is the approach used in the NIPAs. Even in the presence of prices, however, direct volume measurement of health care services is a feasible and interesting alternative.

One component of health care services that lends itself very well to direct volume measurement is hospital inpatient services. The volume of hospital inpatient services is particularly easy to measure because of two data sets from which a time series of hospital discharges can be constructed: The National Hospital Discharge Survey (NHDS), which is produced yearly for the National Center for Health Statistics (NCHS) of the Centers for Disease Control (CDC), and the Nationwide Inpatient Sample (NIS), which is produced for the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality (AHRQ). Both the NHDS and the NIS include data about hospital discharges and about the status of the discharge (alive, dead, to another hospital, for



example). The NIS also includes data about total charges for the hospital stay. Indexes for the volume of inpatient hospital services in the United States are presented in chart 1.<sup>3</sup>

Volume indexes for 1995–2003 produced from NIS data are presented in the first panel of chart 1. The bottom index is a simple count of discharges, normalized to 100 in 1995. The middle index is a Fisher index of

discharges classified by Clinical Classifications Software (CCS) diagnosis. Discharges for each CCS diagnosis are weighted by mean charges for that diagnosis. The Fisher index, unlike the simple count index, is not based on the complete set of 259 CCS diagnoses; instead, it is an index of discharges for a subset of 246 diagnoses that account for 99.6 percent of discharges in 1995 and 99.8 percent of discharges in 2003. The 246 CCS diagnoses are the set of diagnoses for which there are complete series for discharges and mean charges in the summary NIS data tables that are published by AHRQ over the period 1995–2003.<sup>4</sup>

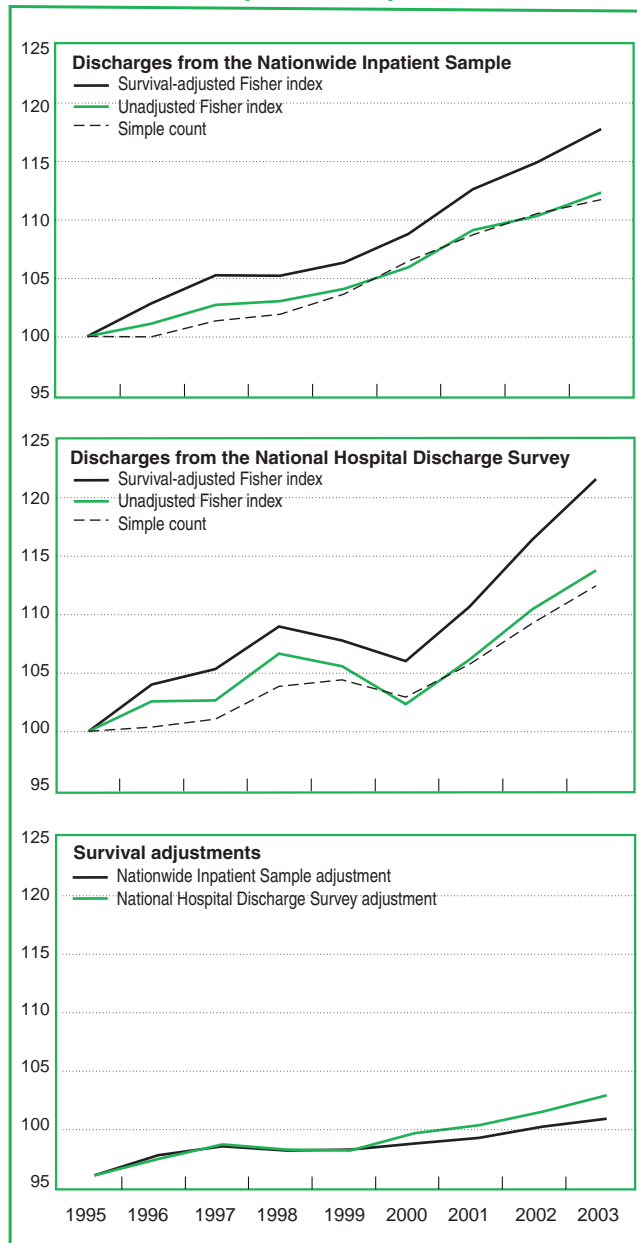
The top index in the first panel of chart 1 is a Fisher index of discharges that has been adjusted for changes in survival rates for a subset of 175 CCS diagnoses. The survival rate is defined as the percentage of discharged patients who are alive at the time of discharge. The 175 CCS diagnoses are the set of diagnoses for which complete time series data on survival rates are published in AHRQ’s NIS summary data tables for 1995–2003. The other 71 CCS diagnoses are still included in the Fisher index, but there is no survival adjustment for them.

The survival rate adjustment borrows heavily from Dawson and others (2005). The adjustment is relatively simple: When using a Fisher index to calculate changes in volume between periods  $t$  and  $t + 1$ , replace the volume of discharges for diagnosis  $i$  in period  $t + 1$ ,  $q_{it+1}$ , with the adjusted volume of discharges  $(a_{it+1}/a_{it})q_{it+1}$ . If  $s_{it}$  and  $s_{it+1}$ , the survival rates for diagnosis  $i$  in periods  $t$  and  $t + 1$ , are both greater than 0.85, the adjustment  $a_{it+1}/a_{it}$  is set to  $(s_{it+1} - 0.8)/(s_{it} - 0.8)$ . This adjustment is based on the assumption that these diagnoses, if untreated, will reduce quality of life to 80 percent of its predisease state. If either  $s_{it}$  or  $s_{it+1}$  are less than 0.85, the adjustment  $a_{it+1}/a_{it}$  is equal to  $s_{it+1}/s_{it}$ . These diagnoses presumably lead to death if untreated. If  $i$  is one of the 71 CCS diagnoses for which survival data are not published, the adjustment  $a_{it+1}/a_{it}$  is set to 1.

Comparison of the three indexes based on the NIS suggests that adjusting for the composition of hospital discharges by diagnosis—the effect of using a Fisher index rather than a simple count of discharges—has a very small effect on growth in the volume of hospital inpatient services. The simple count of discharges grows at an annual rate of 1.4 percent over 1995–2003, while the Fisher index grows at an annual rate of 1.5 percent. On the other hand, the effect of adjusting for changes in survival rate is quite large; the annual

3. The indexes presented in chart 1, in particular the Fisher indexes, are similar to those for government hospitals in Christian and others (2006).

**Chart 1. Value of Inpatient Hospital Services**



4. These data are available at the HCUP Web site at <hcup.ahrq.gov>.



growth rate of the survival-adjusted Fisher index is 2.1 percent.

A similar trio of indexes produced from NHDS data is presented in the second panel of chart 1. The bottom index is a simple count of hospital discharges. The middle index is a Fisher index of hospital discharges classified by Diagnosis Related Group (DRG). The number of discharges by DRG is from the NHDS data, but mean charges by DRG, which are used as weights in the Fisher index, are from summary NIS data published by AHRQ. The discharge volume data in the NHDS and the mean charges data in the NIS are probably not a perfect match; there are likely to be some differences between the coding of individual patients by DRG between the NHDS and the NIS.<sup>5</sup>

Because the definitions of DRGs change over time, several DRGs were combined to create consistent time series of discharges and mean charges over time. Mean charges were averaged across the combined DRGs using the number of discharges by DRG in the NIS as weights. The combinations yielded a time consistent set of 505 DRGs. Of the 505 combined, time consistent DRGs, complete time series over 1995–2003 for number of discharges in the NHDS and mean charges in the NIS are available for 445 DRGs. The Fisher indexes presented in the second panel of chart 1 only include discharges from this subset of 445 DRGs, which accounts for 97.3 percent of NHDS discharges in both 1995 and 2003.

The top index in the second panel of chart 1 is a Fisher index from the NHDS data for the same 445 DRGs with adjustments for changes in survival rates for all 445 DRGs. The survival rates were calculated from NHDS data. The mechanics of the survival adjustment are the same as the mechanics of the adjustment used for the Fisher index based on NIS data presented in the first panel of chart 1, except that the survival adjustment is made for all diagnoses rather than for a subset of diagnoses.

Comparison of the three NHDS-derived series in the second panel of chart 1 is very similar to comparison of the three NIS-derived series in the first panel. The simple count of NHDS discharges grows at an annual rate of 1.5 percent, the unadjusted Fisher index grows at a rate of 1.6 percent, and the survival-adjusted Fisher index grows at a rate of 2.5 percent. As before, this suggests that adjusting for the composition of discharges has a very small effect on the growth of a direct

volume measure of inpatient hospital services. It also suggests that adjusting for patient survival rates has a much larger positive effect.

The third panel of chart 1 plots changes in the quality of inpatient hospital services that can be accounted for with changes in patient survival rates. The quality index is equal to the ratio of the survival-adjusted Fisher index and the unadjusted Fisher index normalized to 100 in 1995. Because there are two pairs of Fisher indexes—one derived from NIS data and one derived from NHDS data—there are two series for inpatient hospital services quality. The NIS series suggests that when only survival rates are taken into account, the quality of inpatient hospital services improved by a total of 4.8 percent over the 8 years between 1995 and 2003. The NHDS series suggests a slightly larger improvement of 6.8 percent. Although the NHDS series grows more quickly than the NIS series, the year-to-year changes in the two series follow roughly the same pattern; the correlation coefficient between the two is 0.98 in levels and 0.79 in first differences.

One of the most interesting aspects of the direct volume indexes presented above is their measurement of health care services by diagnosis rather than by procedure. This approach has several advantages. In particular, it interprets technological changes that allow particular diagnoses to be successfully treated with fewer procedures and with lower cost procedures as reductions in the price of health care. However, the ability of the indexes above to capture price reductions of this kind is impaired by the limitation of the indexes to inpatient hospital services. The ideal diagnosis-based index would measure the volume or price of successful treatments for individual ailments across all health care goods and services: Inpatient hospital services, outpatient hospital services, visits to doctors' offices, prescription drugs, and so on. Such an index would interpret a much wider range of cost-saving technological improvements as price decreases; for example, technological changes that allow diagnoses that were formerly treated with expensive inpatient hospital stays to be treated with less expensive outpatient treatments would be measured as price decreases. This is an obvious avenue for future work that is already being pursued by many researchers; Aizcorbe and Nestoriak's (2006) work on episode-based health care pricing in particular bears mention.

## Conclusions

The development of accounts for health-related home and volunteer production and the construction of direct volume indexes for health care services are only two of many possible avenues for research into health

5. The NHDS data used were downloaded from the Inter-University Consortium for Political and Social Research (ICPSR) Web site at <[www.icpsr.umich.edu](http://www.icpsr.umich.edu)>. The exception is the 1996 data for which the NHDS data at ICPSR had a DRG coding problem; a version without the DRG coding problem available at the Centers for Disease Control Web site was used instead.

accounting. Other possible avenues include improved measurement of health care prices, alternative measures of changes in the quality of health care, and measurement of the stock of health itself. Research on the wide range of issues related to accounting for health will improve the accuracy and usefulness of national accounts and will enrich public understanding of the health sector.

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