Research Spotlight
The Supply Side of Health Care

By Jeffrey Werling, Sean Keehan, Douglas Nyhus, Stephen Heffler, Ronald Horst, and Douglas Meade

The Bureau of Economic Analysis (BEA) has embarked on a multiyear project to improve the way it measures health care spending. As part of this project, BEA aims to develop a set of statistics—a health care satellite account—that will provide a detailed look at how much Americans spend on medical care. Such an account would allow economists to better assess the returns to treatments of disease, the sources of changes in health care costs, and the effects of health care spending on the economy as a whole. These data will be helpful to researchers, businesses, and policymakers in the effort to better assess returns on medical care spending. Information flowing from this new account also has potential implications for measuring inflation and productivity in the health care sector. BEA will describe this account in a future article in the Survey of Current Business.

BEA has encouraged other statistical agencies and economists to also develop new statistical and analytical approaches, hoping to foster innovation and spark broad-based collaboration that will enhance health care statistics across the board. In this article, economists from the Center for Medicare & Medicaid Services (CMS) and Inforum (the Interindustry Forecasting Project at the University of Maryland) develop supply-side health care data, reconciling widely used statistics from BEA and CMS.

THE CENTERS for Medicare & Medicaid Services (CMS) has estimated that in 2012, the U.S. spent $2.8 trillion on health care related goods and services, accounting for about 17 percent of gross domestic product (GDP) (table 1).[1] This estimate of national health expenditures (NHE) is the well-known topline figure from CMS's detailed national health expenditures accounts (NHEA). It is important to note, however, that NHE reflects the demand side of health care, not the supply side. More specifically, the NHE does not measure the value added and labor required to furnish health care expenditures.

In 1960, when the health sector was just 5 percent of GDP, productive resources could be assembled to produce medical goods and services without disrupting the activities of other sectors. As medical spending has expanded rapidly since then, the direct and indirect health supply has substantially influenced the potential growth and structure of the economy. To date, however, there has been little research concerning the total primary factor requirements of satisfying health care demand.

This article aims to provide a more comprehensive accounting of health care production and provide new analytic capabilities to better understand the supply side of health care. Toward that goal, we must recognize that health care is not just produced in the hospital room or the doctor's office but also by the outside accountant who balances the doctor's books and the utility that supplies the hospital's electricity. In particular, the quantification of health care related labor, as opposed to labor devoted to nonhealth care activities, is an important focus of this report.

Our starting point is the NHEA, the set of detailed historical nominal health expenditures published by CMS.[2] In this article, we translate these expenditures to

1. Martin and others, 2014.

2. Centers for Medicare & Medicaid Services, 2014.

Table 1. National Health Expenditures, 1960–2012

	Billions of U.S. dollars				Annual percent growth	
	1960	1980	1998	2012	1960–2012	1998–2012
Gross domestic product (GDP)	543.3	2,862.5	9,089.1	16,244.6	6.8	4.2
National health expenditures (NHE)	27.4	255.8	1,208.9	2,793.4	9.3	6.2
NHE as percent of GDP	5.0	8.9	13.3	17.2	2.4	1.9
Personal health care	23.4	217.2	1,029.2	2,360.4	8.9	5.9
Hospital care	9.0	100.5	374.9	882.3	8.8	6.1
Physician and clinical	5.6	47.7	258.7	565.0	8.9	5.6
Dental services	2.0	13.4	53.8	110.9	7.7	5.2
Other professional services	0.4	3.5	33.8	76.4	10.1	5.8
Home health care	0.1	2.4	34.2	77.8	13.9	5.9
Nursing home care	0.8	15.3	79.4	151.5	10.1	4.6
Other health services	0.5	8.5	56.1	138.2	11.0	6.4
Prescription drugs	2.7	12.0	88.4	263.3	8.8	7.8
Other nondurables	1.6	9.8	28.6	53.7	6.7	4.5
Durables medical products	0.7	4.1	21.3	41.3	7.7	4.7
Net cost of private insurance	1.0	9.3	49.7	164.3	9.8	8.5
Government administration	0.1	2.8	13.2	33.6	12.4	6.7
Public health activities	0.4	6.4	37.5	75.0	10.2	5.0
Research	0.7	5.4	21.5	48.1	8.2	5.8
Equipment	0.4	6.1	34.2	61.6	9.7	4.2
Structures	1.5	8.6	23.7	50.3	6.8	5.4

corresponding final expenditures for goods and services in the national income and product accounts (NIPAs) and then use standard input-output (I-O) accounting to determine the value-added and labor requirements by industry. More specifically, we use modified versions of the Bureau of Economic Analysis (BEA) industry and I-O accounts to provide health care supply estimates including: (1) the direct and indirect gross output requirements by commodity, (2) the direct and indirect imports by commodity, (3) the value added by industry, and (4) the employment requirements by industry.

The remainder of this article is organized as follows: after a brief description of the existing health spending data, we present our methodology and some of its limitations and then our findings. We conclude by discussing some implications of these results and opportunities for future research.

Health Spending: Demand vs. Supply

Most studies of the health care sector and its implications for the economy as a whole focus exclusively on the demand side. In the NHEA, health spending is broken into 10 personal health care categories (hospital, physician and clinical services, and so forth) as well as categories for the net cost of private health insurance, government administration, research, and investment (table 1). BEA provides a different but similar accounting for health care expenditures within the context of the national income and product accounts. Hartman, Kornfeld, and Catlin (2010) have provided a detailed description of both sets of accounts and their differences, finding similarities in the estimates for the broader categories of spending, such as ambulatory care, hospitals, and insurance.[3]

However, detailed demand side content is not sufficient for a more thorough analysis of health care macroeconomics, particularly analyses that concern supply side issues, such as production patterns and employment. Such additional detail has been requested for several reasons, such as to check the consistency of the demand-side estimates and to better judge how to adjust payment schedules.[4]

In national accounting, the supply side of the economy is focused on determining the primary income, or "value added," for each of the industries within an economy. For example, in the NHE or the demand-side estimates in the NIPAs, spending in the physician sector reflects revenue received, and value added represents physician revenue less any intermediate purchases for supplies, utilities, and services. We can use different definitions of GDP to view this relationship algebraically. The left side of the equation below gives the traditional definition of GDP; NHE expenditures comprise portions of private consumption *(C)*, private investment (*I*), and government expenditures and gross investment (*G*) and are valued at the prices paid by the final purchasers.[5] On the right-hand side, the sum of value added across industries provides an alternative "supply-side" definition of GDP, in which value added includes labor compensation *(W)*; capital income (*P*), which includes profits, rent, interest, and depreciation); and net indirect taxes *(T)*, which includes production and imports taxes minus subsidies paid by each industry:

$$C + 1 + G + (X - M) = GDP = \Sigma_j VA_j = \Sigma_j (W_j + P_j + T_j)$$

Since the circular flow of macroeconomic expenditures (demand) or income (supply) are consistent, these different measures should produce the same result for the U.S. economy as a whole. Industry-level value added (income) data are published in the GDP by industry accounts by BEA.[6] One challenge for applying this relationship to the health sector is that of the 65 unique industries identified in these accounts, only two of them clearly are health care industries: ambulatory health care services and hospitals and nursing and residential care. The combined value added (supply) of these two sectors was 6.6 percent of GDP in 2012, well short of health expenditures' (demand) share of 17.2 percent of GDP.[7]

One reason for this gap is that some important health care activities are subsumed in other industries. Among these are pharmaceutical manufacturing, which is part of the chemicals industry; electro-medical and therapeutic apparatus manufacturing, which is part of the computer and electronic products industry; and medical equipment and supplies manufacturing, which is included in the miscellaneous manufacturing industry. However, even after accounting for these classification issues, a shortfall between health care expenditures and "health care value added" remains for the following three reasons:

- **Indirect expenditures.** Final demand expenditures for health care pay not only the income of health care direct providers (physicians and staff) but also

3. Hartman and others, 2010.
4. Steuerle 2009.

5. More information on each of these terms are available at www.bea.gov/national/index.htm#gdp.
6. At the time of this writing, the GDP by industry data set presents a slightly different concept than corresponding measures reported in the NIPAs. However, the differences are minimal and easily reconciled in the process of developing a consistent interindustry accounting framework. BEA plans to produce completely integrated accounts in connection with the release of the 2007 benchmark input-output table.
7. BEA also provides employment estimates for the 65 value-added industries. The two "mega" health care sectors combined for 9.9 percent of economy-wide employment in 2012.

cover other expenses of the health care sector, including purchases of energy, materials, and services. Production of these intermediate inputs also generates income, or value added, in the industries that supply them. For instance, when a hospital purchases electricity, the proceeds are used to pay workers in the electric utility sector, thus increasing value added, and to purchase raw materials like coal. In turn, a portion of the expenditures for coal is used to pay miners for their labor, thus increasing value added in the coal industry. In this way, the satisfaction of health care demand requires value added across the supply chain, even in those seemingly unrelated industries like coal mining. We can track the required upstream purchases and the associated value added via "interindustry" accounting methods that are reflected in I-O tables. These tables show, for instance, that the purchases of electricity by hospitals in absolute terms, and they can be used to calculate electricity purchases in proportion to total hospital revenue.

- **Trade and transport margins.** The margins garnered by the transport services, wholesalers, and retailers that distribute medical goods and services are not included in the calculation of value added for health care suppliers. In particular, products such as prescription drugs and other medications along with medical supplies and equipment, have these margins built into their costs.
- **Imported products.** Foreign suppliers in part satisfy some demand for domestic health care. For example, about 45 percent of U.S. demand for pharmaceutical products is satisfied through imports. Imports are not only used to supply final demand directly. They also help to supply intermediate purchases, particularly for goods and energy. Ultimately, the economy pays for these imports of foreign value added with exports.

In summary, while much health care demand as measured by NHE is supplied by obvious sectors, such as hospitals and doctors, demand is also satisfied indirectly by every sector of the economy, including agriculture, mining, construction, and even entertainment services. It is desirable to develop a comprehensive measure of supply (income and employment) that can be reconciled with this demand.

Unfortunately, the 65 industry sectors of the BEA data do not have the necessary detail for health care products, industries, and final demand, and the more detailed I-O table is published for only 1 year, making it difficult to follow the evolution of the supply.[8] We thus turn to the Inforum Long-Term Interindustry Forecasting Tool (LIFT) model, a dynamic general equilibrium representation of the U.S. economy that can be used to develop more comprehensive health sector supply-side estimates.

Methodology

Much of the work at Inforum involves LIFT, a dynamic interindustry model of the U.S. economy that also determines macroeconomic quantities consistent with the underlying industry detail.[9] For this article, we use the model's database that contains a full I-O structure populated with time series data; these data are generally consistent with I-O, GDP by industry, and NIPA data from BEA.

The core of these data is a historic time series of 110 x 110 commodity I-O tables with consumption, investment, government, export, and import final demand data from 1998 through 2012. The I-O tables of the LIFT model were developed from the BEA annual I-O tables and the 2002 benchmark I-O table. The LIFT data set contains more detail for health care demand and supply than the BEA annual I-O tables. Such detail is essential for our study because it allows for better accounting for pharmaceuticals, electromedical machinery, and medical equipment and supplies. The LIFT model also features industry output, value added, and employment for the 65 industry classifications in the BEA GDP by industry accounts as well as annual "make" matrices to link commodity output to industry output. The LIFT model thus is well suited for the present study.

Using the NHE, published data from BEA, and the LIFT model, we translate NHE data into value added and employment for the entire health care sector across industries.[10] Our method uses data concordances and matrix algebra to convert health care spending estimates into the value added and employment needed to produce that spending. Since the NHE data is reported by type of service and category, we start by reconciling the NHEA with NIPA categories for health care. We then allocate these final expenditures to the commodity categories of the LIFT model based on "bridge matrices," which track the commodity composition of NIPA-based demand. Using I-O identities in the LIFT model, we then can relate these LIFT commodity categories to BEA's 65 sector classifications and can make use of the LIFT I-O data

8. In fact, benchmark tables are published every 5 years, but industry classifications and other changes often make for difficult comparisons among benchmark tables. We mainly employ the 2002 benchmark tables.

9. Addition information about Inforum, a research center at the University of Maryland, and the LIFT model may be found at www.inforum.umd.edu/services/models/lift.html.

10. Much more detail behind each of these steps is available in the online technical appendix. See www.inforum.umd.edu/services/projects/supplysideofhealthcare.html.

Eight Steps: Translating NHE into Health Care Value Added and Employment

Step 1: estimate national health expenditures by NIPA expenditure categories. The first objective is to allocate the detailed national health expenditures accounts (NHEA) values for personal health care and net private insurance to the corresponding expenditure categories in the national income and product accounts (NIPAs). The goods and services definitions and figures reported in the NHEA are similar to those in the NIPAs, but there are differences. Fortunately, there is a relatively detailed crosswalk from the NHEA to NIPA concepts.[1]

Step 2: estimate NHE by production commodity. Health care spending for NIPA consumption and capital investment (equipment and structures) is distributed across Long-Term Interindustry Forecasting Tool (LIFT) production commodities via bridge (share) tables adapted from Bureau of Economic Analysis (BEA) input-output (I-O) tables. Government administration costs of maintaining Medicare, Medicaid, and other programs are allocated directly to the final demand from the government production sector. Expenditures for public health activities and research are allocated to government sectors, private professional, health, education, and nonprofit sectors.

Step 3: estimate imported NHE by commodity. To distinguish the activities of the domestic supply chain, we separate the final demand that will be satisfied through imports. Direct imports are determined for each commodity by multiplying the LIFT import share of domestic demand for each commodity by the corresponding domestic demand level. The domestic final demand is equivalent to the direct production requirements for each industry.

Step 4: estimate domestic gross output requirements by commodity. To determine the level of domestic production that is consistent with domestic health care final demand by commodity we employ the classic input-output accounting identity

$$q^d = (I - A^d)^{-1} f^d$$

where q^d is a vector of the gross domestic outputs required to produce the vector of domestic final demand f^d, and A^d is an n × n matrix of coefficients representing the domestic sales of each row product used in the production of one unit of the column product. The total gross output requirements include all intermediate costs and the value added generated by the commodity production. The difference between the direct commodity demand and the total commodity requirements is known as the indirect production requirements.

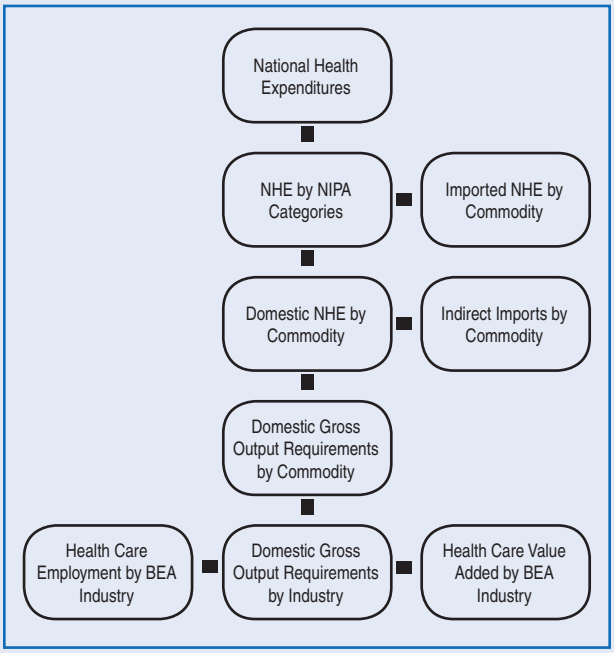
Step 5: estimate indirect imports by commodity. A second "leakage" of demand into imports results from the imported content of indirect production. For example, domestically made medical imaging equipment contains foreign-produced components. These indirect imports are computed by multiplying a matrix of the import shares of intermediate demand by the total domestic output requirements.

Step 6: estimate domestic gross output requirements by industry. Because each industry can make a variety of goods and services, for production analysis, it is more theoretically sound and empirically accurate to use product-to-product tables rather than product-to-industry tables. Value added and employment, however, are characterized and reported by BEA for 65 industries. We employ the Inforum LIFT model "make" matrix to translate production by commodity into gross production by industry. Adapted from the annual BEA input-output tables, this matrix identifies for each industry (row) the quantity of each product (column) produced.

Step 7: health care value added for each industry. Health care value added for each industry is obtained by multiplying the total gross output requirements for each industry by the corresponding historical value added-to-industry output ratios taken from the BEA gross domestic product by industry accounts.

Step 8: health care employment for each industry. To estimate health care employment by industry, we multiply industry total output requirements by the corresponding industry employment-to-output ratios. In addition to the BEA full-time and part-time employment by industry, the LIFT model employment by sector also includes self-employed workers. Because medical services have substantial self-employment, we use the LIFT employment-to-BEA-industry-gross-output ratios.

Translation Steps



1. Hartman and others, 2010.

to determine value added and employment proportions by industry. For a brief explanation of the specific steps, please see the box "Translating NHE into Health Care Value Added and Employment."

Any use of I-O analysis in this fashion is subject to several caveats. First of all, just like any national accounting exercise, the compilation of the BEA I-O accounts involves a myriad of assumptions and imputations to fit data into the accounting framework. The 1997 and 2002 benchmark I-O tables provide very detailed information by commodity and industry. In order to provide insight into the year-by-year evolution of the economy, however, we use the BEA annual I-O tables for 1998 through 2012, which are themselves interpolations of the 1997 and 2002 benchmark I-O tables, which are based on the economic census data. Since changes in market conditions, technology, and productivity could alter interindustry relationships, the farther away we are from the benchmark year, the less reliable the results.[11] There are many important parameters, such as trade and transport margins, that are not observed in the noncensus years and are therefore estimated by BEA in order to compile the annual tables.

As indicated above, we use the LIFT model database in order to provide better detail for final demand expenditures and production of health care goods and services. These details are also estimated using the interpolations of the benchmark and annual tables together with other information (mostly from the NIPAs). While the various columns and rows are constrained to sum to aggregate figures similar to the published I-O, industry, and national accounts, there is no way to test whether individual table entries coincide with actual, but nonobserved, values. Finally, I-O analysis invariably uses various industry ratios (such as value added divided by output or imports divided by domestic demand), which may not necessarily hold in the specific case for which the analysis is applied, as they are documented on a national basis.

Results

Table 1 provides the NHE data by type of service for selected years. Table 2 shows the conversion of the NIPA health data, after reconciling with NHE, to the LIFT commodities (including imports) ranked by how much health spending was used to purchase these commodities in 2012. As an example of how to interpret this data, in 2012, roughly $6.8 billion of the $2.8 trillion in overall health spending was used to purchase computer systems designs and related services. The two largest categories of commodities are hospitals ($826.2 billion, or 30 percent) and the physicians' offices ($597 billion, or 21 percent).

For most health care service sectors, imports are

11. For a detailed description of the major assumptions used to produce BEA's Industry accounts, see Streitweiser 2011.

Table 2. Direct National Health Expenditures Final Demand by LIFT Commodity

	Billions of dollars						Annual percent growth		
	1998			2012			1998–2012		
	Health care direct demand	Direct imports	Domestic direct demand	Health care direct demand	Direct imports	Domestic direct demand	Health care direct demand	Direct imports	Domestic direct demand
Total national health expenditures	1,208.9	24.4	1,184.6	2,793.4	107.4	2,686.0	6.2	11.2	6.0
LIFT commodity									
94 Hospitals	360.3	0.1	360.2	826.2	0.4	825.8	6.1	12.2	6.1
92 Offices of physicians, dentists, other practitioners	285.3	.....	285.3	597.0	.....	597.0	5.4	.....	5.4
95 Nursing and residential care facilities	104.7	.....	104.7	214.3	.....	214.3	5.3	.....	5.3
62 Retail trade	64.1	.....	64.1	182.8	.....	182.8	7.8	.....	7.8
93 Other ambulatory health care services	73.6	.....	73.6	170.6	.....	170.6	6.2	.....	6.2
79 Insurance	49.7	1.2	48.4	164.3	18.4	145.9	8.9	21.4	8.2
27 Pharmaceuticals	63.3	15.4	47.9	151.0	68.6	82.5	6.4	11.3	4.0
61 Wholesale trade	22.4	–0.6	23.0	103.1	–1.9	105.0	11.5	8.1	11.5
91 Home health care services	47.5	.....	47.5	88.1	.....	88.1	4.5	.....	4.5
107 General government industry	28.4	.....	28.4	65.2	.....	65.2	6.1	.....	6.1
13 New construction	21.8	.....	21.8	46.7	.....	46.7	5.6	.....	5.6
85 Professional, scientific and technical services	15.3	0.1	15.2	33.4	0.5	33.0	5.8	11.9	5.7
90 Educational services	12.9	1.7	11.2	32.6	8.0	24.5	6.8	11.8	5.7
58 Medical equipment and supplies, dental labs	15.9	0.0	15.9	31.9	0.1	31.8	5.1	14.3	5.1
106 State and local government enterprises	10.2	.....	10.2	21.2	.....	21.2	5.3	.....	5.3
45 Electromedical, electrotherapeutic apparatus	8.1	2.2	6.0	14.9	5.0	10.0	4.5	6.2	3.7
59 Ophthalmic goods	4.2	1.8	2.4	8.8	3.6	5.2	5.4	5.2	5.6
86 Computer systems design and related services	2.2	0.0	2.2	6.8	0.1	6.7	8.2	9.2	8.2
66 Truck transportation	3.1	0.0	3.1	6.6	0.1	6.5	5.5	14.6	5.4
All other commodities	16.0	2.6	13.4	27.9	4.6	23.3	4.0	4.2	4.0

LIFT Long-Term Interindustry Forecasting Tool

Table 3. Total, Direct, and Indirect Gross Output Requirements for Supplying National Health Expenditures

	Billions of dollars						Annual percent growth		
	1998			2012			1998–2012		
	Direct domestic output	Indirect output	Health care total domestic output	Direct domestic output	Indirect output	Health care total domestic output	Direct domestic output	Indirect output	Health care total domestic output
Gross commodity output	1,184.6	710.8	1,895.4	2,686.0	1,516.8	4,202.8	6.0	5.6	5.9
Multiplier	.....	.....	1.6	.....	.....	1.6	.....	.....	.....
LIFT commodity	.....	.....	.....	.....	.....	.....	.....	.....	.....
94 Hospitals	360.2	0.5	360.7	825.8	1.1	826.9	6.1	6.6	6.1
92 Offices of physicians, dentists, and other practitioners	285.3	0.1	285.4	597.0	0.1	597.1	5.4	5.3	5.4
79 Insurance	48.4	43.8	92.3	145.9	82.7	228.6	8.2	4.6	6.7
95 Nursing and residential care facilities	104.7	0.0	104.7	214.3	0.1	214.4	5.3	5.2	5.3
93 Other ambulatory health care services	73.6	15.8	89.4	170.6	35.5	206.1	6.2	6.0	6.2
62 Retail trade	64.1	5.8	69.9	182.8	5.7	188.5	7.8	–0.1	7.3
85 Professional, scientific and technical services	15.2	67.1	82.3	33.0	151.3	184.3	5.7	6.0	5.9
80 Real estate	23.0	41.0	64.0	105.0	60.7	165.7	11.5	2.8	7.0
61 Wholesale trade	1.9	69.2	71.1	3.7	161.0	164.7	5.0	6.2	6.2
88 Administrative and support services	1.6	50.9	52.5	3.7	130.0	133.7	6.1	6.9	6.9
27 Pharmaceuticals	47.9	29.1	77.0	82.5	34.1	116.6	4.0	1.1	3.0
87 Management of companies and enterprises	0.0	25.3	25.3	0.0	116.5	116.5	.....	11.5	11.5
91 Home health care services	47.5	0.0	47.5	88.1	0.0	88.1	4.5	2.2	4.5
107 General government industry	28.4	0.0	28.4	65.2	0.0	65.2	6.1	.....	6.1
77 Banks, credit cards and finance	0.0	18.7	18.7	0.0	55.2	55.2	.....	8.0	8.0
58 Medical equipment and supplies, dental labs	11.2	14.2	25.5	24.5	24.8	49.3	5.7	4.0	4.8
Other commodities	71.6	329.2	400.8	143.9	657.9	801.8	5.1	5.1	5.1

LIFT Long-Term Interindustry Forecasting Tool

trivial or nonexistent. For pharmaceuticals, however, they are significant. In 2012, out of $151.0 billion of pharmaceutical demand, $68.6 billion was imported. This large and growing share of overseas production has raised concerns about the safety of the drug supply.[12] Nevertheless, total direct health care imports are relatively small, reaching $107.4 billion, or just 3.8 percent of NHE, in 2012.

Table 4. Domestic Health Care Value Added by Industry

	Health care value added by industry				
	1998		2012		1998–2012
	Billions of dollars	Percent of GDP	Billions of dollars	Percent of GDP	Growth rate
Gross domestic product	9,689.1	100.0	16,244.6	100.0	3.8
National health expenditures	1,208.9	12.5	2,793.4	17.2	6.2
Total domestic value added by industry	1,132.8	11.7	2,496.5	15.4	5.8
BEA industry					
Agriculture, forestry and fishing	4.0	0.0	9.8	0.1	6.6
Mining	3.3	0.0	13.3	0.1	10.5
Utilities	12.0	0.1	17.4	0.1	2.7
Construction	15.3	0.2	36.9	0.2	6.5
Manufacturing	100.8	1.0	172.0	1.1	3.9
Durable manufacturing	35.9	0.4	64.0	0.4	4.2
Nondurable manufacturing	64.9	0.7	108.0	0.7	3.7
Wholesale trade	46.8	0.5	112.9	0.7	6.5
Retail trade	49.9	0.5	117.8	0.7	6.3
Transportation	15.7	0.2	30.7	0.2	4.9
Information	25.6	0.3	49.6	0.3	4.8
Finance, insurance, real estate, rental and leasing	133.6	1.4	318.8	2.0	6.4
Insurance carriers and related activities	57.0	0.6	121.5	0.7	5.6
Professional and business services	104.1	1.1	298.0	1.8	7.8
Education, health care and social assistance	496.7	5.1	1,078.3	6.6	5.7
Ambulatory health care services	258.6	2.7	561.4	3.5	5.7
Hospitals and nursing and residential care facilities	229.8	2.4	501.4	3.1	5.7
Arts and recreation	2.0	0.0	5.2	0.0	7.2
Accommodation and food services	8.1	0.1	19.4	0.1	6.5
Other services, except government	12.7	0.1	20.4	0.1	3.4
Government administration and enterprises	102.2	1.1	195.8	1.2	4.8
Federal general government	7.4	0.1	16.9	0.1	6.1
State and local general government	81.5	0.8	159.7	1.0	4.9

Table 3 shows the results of translating LIFT final demand by commodity into direct and indirect gross output requirements for supplying health care. The direct gross output includes all intermediate costs and the value added generated by the commodity production. Indirect output is the materials and services that are purchased for immediate use in the production of health care commodities. An example is the electricity supplied to a hospital that is produced using coal. This whole chain of upstream activities is accumulated in indirect output. The larger health care sectors have minimal indirect output, but indirect outputs are important for other commodities, such as insurance ($82.7 billion in 2012), professional, scientific, and technical services ($151.3 billion), real estate ($161.0 billion), administrative and support services ($130.0 billion), and management of companies and enterprises ($116.5 billion).

Table 4 shows the results of calculating value added for each industry. These value-added estimates represent the wages, capital, and indirect tax income generated, directly and indirectly, by industries as they satisfy the demand for health care; that is, the value-added estimates reflect each industry's contribution to the production of health care in the United States.

As noted, in an open economy, some final demand and intermediate demand "leaks" abroad and is

12. Keuhn 2011.

satisfied by the "import of value added" from other countries. These imports are financed either by exports or by foreign borrowing. As a result, we should expect that the sum of value added will fall short of the sum of final demand. For the United States, aggregating the health care value added across industries results in $2,496.5 billion value added in 2012, or 15.4 percent of GDP. Since NHE totaled $2,793.4 billion in 2012 and accounted for 17.2 percent of GDP, the remaining $296.9 billion and 1.8 percent of GDP primarily represents direct or indirect imported value added.

As expected, the largest sources of value added in health care are the two principle health care sectors. In 2012, the value added of ambulatory health care was $561.4 billion, or 3.5 percent of GDP, and the value added of hospitals, nursing, and residential care was $501.4 billion, or 3.1 percent of GDP. Other notable industries also generated significant value added in the health sector as well. For instance, manufacturing contributed $172.0 billion of value added to health care in 2012, including $71.8 billion for chemical products (pharmaceutical manufacturing). Wholesale trade and retail trade contributed $112.9 billion and $117.8 billion, respectively, of value added associated with health care provision in 2012. Additionally, the insurance industry produced $121.5 billion of health care value added in 2012, and state and local government administration and enterprises (including publicly owned hospitals and other health facilities) produced $159.7 billion of value added for health care.

Table 5 shows the estimates of the number of workers used to produce U.S. health care for all major industries and its largest subindustries. The aggregate number of health care associated jobs was 28 million in 2012, up from 21 million in 1998. Civilian health care employment grew by an annual average of 2.1 percent during the period, compared with 0.3 percent for general employment. The health care share of employment rose from 14.7 percent in 1998 to 18.7 percent in 2012. Ambulatory health care services as well as hospitals, nursing, and residential care facilities accounted for about 14.8 million jobs in 2012, or 9.9 percent of total employment. About 943,000 manufacturing jobs supported health care consumption and investment in 2012, representing almost 8 percent of the 12.3 million jobs in the sector. Retail trade contributed over 2 million jobs (13 percent of the sector), finance, insurance and real estate contributed more than 1.2 million (14.5 percent), and professional services contributed 3.4 million (17 percent). Government employment devoted to health care was 2.5 million in 2012; most of those jobs were devoted to public health activities, particularly state and local hospitals, which employed just over 1.0 million people, according to the Bureau of Labor Statistics (BLS).[13]

Table 5. Health Care Employment by Industry

	Health care employment by industry				
	1998		2012		1998–2012
	Jobs (thousands)	Percent of employment	Jobs (thousands)	Percent of employment	Growth rate
Total U.S. civilian employment	142,372	100.0	149,270	100.0	0.3
Total health care employment	20,969	14.7	27,941	18.7	2.1
BEA industry					
Agriculture, forestry and fishing	93	0.1	101	0.1	0.6
Mining	20	0.0	17	0.0	–1.2
Utilities	45	0.0	35	0.0	–1.7
Construction	321	0.2	464	0.3	2.7
Manufacturing	1,051	0.7	943	0.6	–0.8
Durable manufacturing	479	0.3	437	0.3	–0.7
Nondurable manufacturing	572	0.4	507	0.3	–0.9
Wholesale trade	480	0.3	683	0.5	2.6
Retail trade	1,243	0.9	2,002	1.3	3.5
Transportation	283	0.2	346	0.2	1.5
Information	198	0.1	177	0.1	–0.8
Finance, insurance, real estate, rental and leasing	874	0.6	1,231	0.8	2.5
Insurance carriers and related activities	577	0.4	729	0.5	1.7
Professional and business services	2,127	1.5	3,352	2.2	3.3
Education, health care and social assistance	11,369	8.0	15,082	10.1	2.0
Ambulatory health care services	4,646	3.3	6,723	4.5	2.7
Hospitals and nursing and residential care facilities	6,441	4.5	8,038	5.4	1.6
Arts and recreation	43	0.0	66	0.0	3.1
Accommodation and food services	340	0.2	533	0.4	3.3
Other services, except government	388	0.3	454	0.3	1.1
Government administration and enterprises	2,094	1.5	2,454	1.6	1.1
Federal general government	93	0.1	114	0.1	1.5
State and local general government	1,796	1.3	2,115	1.4	1.2

Discussion

Table 6 provides a summary of the link between the NHE and supply-side accounting using LIFT. Although presented at a high level, a close examination

13. For more information and data tables, see Bureau of Labor Statistics, employment, hours, and earnings database www.bls.gov/ces/home.htm.

Table 6. National Health Expenditures Value Added and Health Care Employment

	Levels (billions of dollars)		Percent change	Share of NHE	
	1998	2012	1998–2012	1998	2012
National health expenditures (NHE)	1,209	2,793	6.2	100.0	100.0
Direct Demand imports	24	107	11.2	2.0	3.8
Direct Demand domestic production	1,185	2,686	6.0	98.0	96.2
Value added	1,133	2,496	5.8	93.7	89.4
Ambulatory care, hospitals, nursing	488	1,063	5.7	40.4	38.0
Other industries	644	1,434	5.9	53.3	51.3
Indirect demand from imports	43	137	8.7	3.5	4.9
Unattributed value added	9	52	.....	0.8	1.9
	Levels (millions of dollars)		Percent change	Share of economy-wide employment	
	1998	2012	1998–2012	1998	2012
Health care employment by industry	21.0	27.9	2.1	14.7	18.7
Ambulatory care, hospitals, nursing	11.1	14.8	2.1	7.8	9.9
Other industries	9.9	13.2	2.1	6.9	8.8

of these figures helps to enhance the understanding of the implications and allows for comparisons with other estimates of health care employment. Total nominal NHE grew by an average compound annual rate of 6.2 percent from 1998 to 2012, reaching 17.2 percent of GDP. Nearly all of this spending was associated with domestic production, though as a share of NHE, it fell slightly over this period because of import penetration. The direct demand from imports increased 11.2 percent per year from 1998 through 2012; as a share of NHE, it increased from 2.0 percent in 1998 to 3.8 percent in 2012. Of the $83 billion increase in direct imports over this period, about $53 billion, or 64 percent, was contributed by pharmaceuticals.

Of the NHE demand directed to domestic direct production of health care services, the vast majority of the value added was generated domestically. Indirect imports were larger than direct imports but were still only 4.9 percent of NHE in 2012. Indeed, this exercise traces 89.4 percent of NHE back to industry-level labor compensation, capital income, and net indirect taxes. Some of this value added was generated via direct production and some through indirect production. What is particularly noteworthy is that the value added in industries measured specifically as health care (ambulatory health care services and hospitals, nursing, and residential care facilities) only accounted for about 38 percent of total NHE, and the value-added share of those industries has fallen since 1998 (by almost 2.0 percentage points). Thus, when thinking about how U.S. health care is produced, it is important to recognize the important contributions of industries such as professional and business services, insurance, wholesale and retail trade, and manufacturing.

We estimate that health care related employment accounted for 18.7 percent of economy-wide employment in 2012, up from 14.7 percent in 1998. Several recent papers have discussed some of the supply components of health care and provided estimates on the historical share of health care employment. Chansky, Garner, and Raichoudhary (2013) used data from the *Current Employment Statistics* survey as a basis for their estimate that health care accounted for 12.6 percent of all nonfarm workers in 2010. They do not, however, attempt to match employment with every part of NHE spending. Turner and Hughes-Cromwick (2013) linked about two-thirds of the NHE to available data on employment, occupation, and compensation from BLS and BEA. They estimated that health care accounted for 10.6 percent of employment in October 2012. Finally, in a recent report on health care macroeconomics and outcome, Moses and others (2013) provide a listing of health care jobs for a mix of industries and occupations and find that health care employed 15.7 percent of the workforce in 2011. The Moses paper is a bit more detailed in the number of jobs that they identify associated with NHE spending; however, it is still incomplete, as the jobs that support the intermediate inputs used by health care providers are not included.

Unlike our estimates that showed that the health share of overall employment was greater than the health spending share of GDP, these other studies report health employment share estimates are significantly below the related health spending share estimates. If one believes that health care services tend to be more labor intensive than average production, these results are counterintuitive. Our estimates are more comprehensive in nature. Through the process explained briefly above and more completely in our technical appendix, we strived to account for every job that contributed to NHE.

Our estimate that health care accounted for a larger share of employment (18.7 percent in 2012) than spending (17.2 percent in 2012) and value added (15.4 percent) is an interesting result. BLS regularly reports on the jobs with the highest annual mean wage, and the vast majority of the jobs in the top 20 on the list are health care related (such as anesthesiologists and surgeons).[14] Therefore, one might expect that fewer jobs support this higher spending. However, these high-paying jobs are relatively small in number; in fact, looking at the industry breakdown of employment supporting health care suggests that most jobs are not highly paid. For example, many of the jobs that indirectly support health care spending, like the retail pharmacy clerk or the delivery truck driver, are on the low end of the pay scale. Also, many jobs in hospitals and doctors' offices are for assistants or technicians, which would have salaries that would be lower than the average U.S. worker.

As a result, our work confirms that the health sector is a labor intensive industry (ambulatory care along with hospitals and nursing facilities directly account for 10 percent of total employment). In fact, by fully tracking the labor needed to support all of the health care demand, we find this intensity is greater than reported elsewhere. Better understanding this relationship is important for addressing policy questions related to meeting future health care demand with the appropriate labor requirements.

Conclusion and Future Research

This work provides a historical reconciliation of the supply and demand sides of the health care industry data. We use I-O techniques to link the final demand

14. See www.bls.gov/oes/current/oes_nat.htm.

values from the NHE to domestic production and imports of commodities, industry value added, and industry employment. In the process, we have identified the resource requirements for furnishing NHE in terms of value added and labor.

We plan to continue to evaluate and improve our methods. Additionally, there are a number of possible applications of this data that would be useful to study. It would be interesting to examine the historical period in greater detail to investigate further the types of jobs and wages for workers who produce health care. For example, it may be possible to provide an employment breakdown by occupation. Also, industry employment data could be combined with health care industry spending estimates and price deflators to generate estimates of health care labor productivity.

We also plan to use our approach, CMS's annual short-run NHE projections, and the LIFT model projections to evaluate the labor needed to support our health spending projection over the next 10 years. Finally, our approach and the LIFT model could be used to evaluate the long-run (75 years) health spending projections and the ramifications on potential U.S. economic growth.

References

Aizcorbe, Ana M., Eli B. Liebman, David M. Cutler, and Allison B. Rosen. 2012. "Household Consumption Expenditures for Medical Care: An Alternate Presentation." SURVEY OF CURRENT BUSINESS (June): 34–48.

Centers for Medicare & Medicaid Services. 2014. *National Health Expenditures Accounts: Methodology Paper, Definitions, Sources, and Methods, 2012;* www.cms.gov.

Chansky, Brian, Corby Garner, and Ronjoy Raichoudhary. 2013. "Measuring Output and Productivity in Private Hospitals." National Bureau of Economic Research (NBER) Working Paper. Washington, DC: Conference on Research in Income and Wealth, Measuring and Modeling Health Care Costs, October 18–19; www.nber.org/criw.

Hartman, Micah B., Robert J. Kornfeld, and Aaron C. Catlin. 2010. "A Reconciliation of Health Care Expenditures in the National Health Expenditures Accounts and in Gross Domestic Product." SURVEY OF CURRENT BUSINESS (September): 42–52.

Keuhn, Bridget M. 2011. "As Production Goes Global, Drug Supply Faces Greater Risks to Safety, Quality." *JAMA, The Journal of the American Medical Association* 306 (August): 811–813.

Martin, Anne B., Micah Hartman, Lekha Whittle, Aaron Catlin, and the National Health Expenditures Accounts Team. "National Health Spending in 2012: Rate of Health Spending Growth Remained Low For The Fourth Consecutive Year." *Health Affairs*, 33:1 (2014): 67–77.

Miller, Ronald E., and Peter D. Blair. 2009. *Input-Output Analysis: Foundations and Extensions.* 2nd edition. New York: Cambridge University Press.

Moses III, Hamilton, David H.M. Matheson, E. Ray Dorsey, Benjamin P. George, David Sadoff, and Satoshi Yoshimura. 2013. "The Anatomy of Health Care in the United States." *JAMA, The Journal of the American Medical Association* 310 (November): 1947–1963.

Steuerle, Gene. 2009. "The New Spending Numbers: What They Tell Us, And What They Don't." *Health Affairs.* (February 24); healthaffairs.org/blog.

Streitweiser, Mary L. 2011. *Measuring the Nation's Economy: An Industry Perspective, A Primer on BEA's Industry Accounts.* Washington, DC: Bureau of Economic Analysis, May; www.bea.gov.

Turner, Ani, and Paul Hughes-Cromwick. 2013. "Connecting U.S. Health Expenditures with the Health Sector Workforce." *Business Economics* 48, 42–57.

Author Information

Jeffrey Werling, Ph.D.
Executive Director, Inforum
University of Maryland, College Park
301–405–4607
werling@econ.umd.edu

Sean Keehan, M.A.
Senior Economist, Office of the Actuary
Centers for Medicare & Medicaid Services
410–786–7158
sean.keehan@cms.hhs.gov

Douglas Nyhus, Ph.D.
Research Associate, Inforum
University of Maryland
301–405–5609
nyhus@econ.umd.edu

Stephen Heffler, M.B.A.
Director, National Health Statistics Group,
Office of the Actuary
Centers for Medicare & Medicaid Services
410–786–1211
stephen.heffler@cms.hhs.gov

Ronald Horst, Ph.D.
Research Associate, Inforum
University of Maryland
301–405–4636
horst@econ.umd.edu

Douglas Meade, Ph.D.
Research Director, Inforum
University of Maryland
301–405–4608
meade@econ.umd.edu