

**Constant-Price Measures in the U.S. National Accounts:
The Experience of the Bureau of Economic Analysis**

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An important task in national accounting involves restating the current value of a set of economic transactions in the prices of a different time period. This practice allows for more meaningful comparisons of the structure, workings, and performance of an economy over time. Although the *System of National Accounts 1993* (SNA) provides a set of international guidelines for the creation of such “constant-price” measures, the experiences associated with the application of these guidelines often differ across countries.^{1, 2} This paper discusses the experiences of the U.S. Bureau of Economic Analysis (BEA) in developing constant-price measures for its national economic accounts.

A discussion of BEA’s experiences with constant-price measurement is useful for at least three reasons. First, as BEA relies on price data collected by many agencies within the decentralized U.S. statistical system, a discussion of its experiences illustrates how a wide variety of source data can be used to produce a set of constant-price national accounts. Second, a discussion of BEA’s experiences provides an opportunity to highlight some recent methodological improvements, including the adoption of chain-type price and volume measures. Third, it provides an opportunity to highlight some of the more problematic issues associated with constant-price measurement.

¹ See Commission of the European Communities, International Monetary Fund, Organization for Economic Co-operation and Development, United Nations, and the World Bank, *System of National Accounts 1993* (Brussels/Luxembourg, New York, Paris, and Washington, DC, 1993).

² For an additional set of guidelines that are provided to countries in the European Union, see Commission of the European Communities, *Handbook on Price and Volume Measures in National Accounts*. (Luxembourg: Office for Official Publications of the European Communities, 2001).

This paper consists of four sections. The first section introduces several concepts related to developing constant-price measures. The second section provides an overview of the methodology used to create the constant-price measures in BEA's national accounts. The remaining two sections discuss recent improvements and continuing issues associated with these measures.

1. Basic concepts

The development of constant-price measures essentially involves decomposing current transaction values into their price and volume components and replacing the current prices with those from another year. For a single homogenous good or service, the value of transactions is simply equal to the price per unit of the product times the number of units. However, in national accounting, the transactions associated with many heterogeneous goods and services are often grouped together into a set of aggregate measures that attempts to characterize the economy in a meaningful and comprehensive manner.

In order to develop constant-price transactions for a homogenous good or service, one of three methods can be used. In the *deflation method*, a quantity index is obtained by dividing the current-dollar index for the transaction by an appropriate price index; the result is then multiplied by 100. In the *quantity extrapolation method*, a quantity index is obtained by using a quantity indicator to extrapolate the reference-year value of 100. In the *direct valuation method*, a quantity index is obtained by multiplying reference-period prices by actual quantity data; the result is then expressed as an index with the reference year set equal to 100.

The deflation method is preferred by the SNA so as long as independent, reliable, and comprehensive source data are available to effectively apply this method. One reason for this preference is that prices usually exhibit less variation than quantities, and as a result, the sampling errors associated with price indexes tend to be smaller than those associated with volume (*i.e.*, aggregate product) indexes. Another reason for this preference is that there is usually no guarantee that the goods and services counted in one year – under the quantity extrapolation and direct valuation methods – have not changed in quality between years. Changes in quality can inappropriately become attributed to changes in price when one of these two methods is used. Price indexes typically avoid this problem by comparing the prices of a fixed basket of goods and services that remain constant between two periods. This problem can sometimes be avoided with the use of the quantity extrapolation or direct valuation methods so long as highly detailed data are available.

Although there are a number of index-number formulas that are commonly used to create aggregate constant-price measures, the SNA prefers the use of “chained” Fisher indexes whenever possible. A Fisher index is a geometric mean of a Laspeyres index (that uses weights of the first period in a two-period example) and a Paasche index (that uses weights of the second period). Such an index is chained when measures of long-term movements are obtained by cumulating (*i.e.*, multiplying) short-term movements.

Chained Fisher indexes are preferred, in part, because they mitigate particular forms of bias that are common in fixed-weighted indexes. A particular concern is substitution bias, which reflects the fact that the commodities for which output grows rapidly tend to be those for which prices increase less than average or decline. As a

result, when constant-price measures are recalculated using more recent-period price weights, the commodities with strong output growth generally receive less weight, and growth in the aggregate measure is reduced. Substitution bias in fixed-price indexes tends to cause an understatement in growth for periods before the base period and an overstatement of growth for periods after the base period.

Chained Fisher indexes have other advantages over fixed-weighted indexes. First, chained Fisher indexes mitigate distortions of growth in components and in industries that are often present with fixed-weighted indexes. Second, these indexes mitigate anomalies that arise from using recent-period weights to measure periods in the past when a far different set of prices prevailed.³

2. Constant-price measurement in BEA's accounts

Two separate approaches are used by BEA to produce constant-price measures for the value of final goods and services produced by the U.S. economy. In the *expenditures approach* that is used in the National Income and Product Accounts (NIPAs), constant-price measures are separately created for each of the detailed components of final demand. These measures are then aggregated to create constant-price measures for GDP (*i.e.*, gross value added) and its major components. In the *double-deflation approach* that is used in the related Annual Industry Accounts, constant-price measures are created separately for gross output and for intermediate inputs for each industry in the economy.

³ For a more thorough discussion of the more desirable properties of the Fisher index, see SNA § 16.23-30.

The measures for gross output and intermediate inputs are then combined to produce constant-price measures for value added by industry.⁴

With both of these approaches, BEA tries to use the most appropriate source data and methods. It also tries to create the most detailed set of constant-price measures possible before aggregating to the higher-level series published in its accounts.

2.1 National Income and Product Accounts

Although BEA supports the goal of international harmonization and continues to adopt SNA guidelines to the greatest extent possible, the presentation of production and the generation of income in the NIPAs still differs from that recommended by the SNA. This is because BEA maintains several aggregate measures to meet the specific needs of its users. For instance, the SNA recommends that gross output, intermediate consumption, and gross value added for each sector and for the total domestic economy be presented in a production account. The NIPAs do not provide information on gross output or intermediate consumption for non-government sectors.⁵ The NIPAs do, however, present GDP as the sum of final expenditures (a calculation that the SNA presents only in the input-output tables.) As a result, the expenditures approach forms the basis of the constant-price measures in the NIPAs.

⁴ A discussion of BEA's Preliminary Annual Industry Accounts is left out of this paper in the interests of brevity. For more information on BEA's Preliminary Annual Industry Accounts, see Erich H. Strassner and Thomas F Howells III, "Annual Industry Accounts: Advance Estimates for 2004," *Survey of Current Business* 85(May 2005): 7-19. For more information on BEA's Revised Annual Industry Accounts that are discussed in this paper, see Brian C. Moyer, Mark A. Planting, Mahnaz Fahim-Nader, and Sherlene K.S. Lum, "Preview of the Comprehensive Revision of the Annual Industry Accounts," *Survey of Current Business* 84 (March 2004): 38-51.

⁵ The NIPAs also provide measures of gross output and intermediate consumption for a few additional types of economic units. In particular, supplemental tables include a complete production account for farm and housing output, along with separate measures of motor vehicle gross output. These measures are supplemental in the sense that they do not correspond with the sectors that is used to organize the main set of NIPA accounts.

In order to understand how available data are used to create the constant-price measures in the NIPAs, it is useful to discuss each major final demand category separately. These categories are personal consumption expenditures (*i.e.*, final consumption expenditures of households and nonprofit institutions serving households), fixed private investment and change in private inventories (*i.e.*, gross capital formation for non-government entities), government consumption expenditures and gross investment (*i.e.*, final consumption and gross capital formation for government), and net exports of goods and services (*i.e.*, exports less imports).

2.1.1 Personal consumption expenditures

The constant-price measures for most transactions in personal consumption expenditures (PCE) involves deflating current transaction values with detailed data provided by the U.S. Bureau of Labor Statistics (BLS) Consumer Price Index (CPI) program (table 1). However, since the primary purpose of the CPI program is to provide an aggregate price index to adjust income and expenditure streams for changes in the cost of living, and not to provide a direct price index for PCE, these data need to be supplemented with data from other sources.

There are three types of transactions in PCE that are not consistent with those included in the CPI data. First, PCE includes more than just the out-of-pocket costs that are included in the CPI data. For example, medical costs in PCE include the payments made by third parties on behalf of a household, whereas the CPI data only include the out-of-pocket expenses of households. Second, PCE includes the value of non-market transactions that are not included in the CPI data. These include the values associated

with imputed transactions, such as those associated with owner-occupied housing, and the values associated with the expenditures of nonprofit institutions serving households. Third, PCE includes expenditures that are associated with the generation of income, such as brokerage fees; these are excluded from the CPI data as this measure is only intended to cover the general cost of living and not expenditures associated with the generation of income.

For the areas where the transactions covered in PCE differ from those covered in the CPI program, detailed data provided by the BLS Producer Price Index (PPI) program are often used for deflation. Examples include the goods and services provided by public and private “for-profit” hospitals, physicians, proprietary and government nursing homes, home health care, medical laboratories, employment agencies, and some financial intermediaries. Although the PPI data are based on the prices received by producers rather than the prices paid by consumers, the use of detailed PPI data is believed to produce a better set of constant-price measures because they more comprehensively cover the transactions included in PCE.⁶

There are a few categories of goods and services in PCE where data other than those from BLS are used to create constant-price measures. For instance, BEA maintains its own index, based on the foreign CPI data, for deflating expenditures abroad by U.S. residents less personal remittances in kind to nonresidents. BEA also maintains its own composite index of input prices, based on a variety of different source data, that are used to deflate the value of goods and services provided by nonprofit institutions serving

⁶ The use of PPI data does not create many measurement problems in this context as long as taxes on production, taxes on imports, and distribution costs are usually small or constant over time. Arguably, these conditions hold for the U.S. economy and the benefits of using these data outweigh the costs in these instances.

households. Although the deflation of inputs to create constant-price measures is common for non-market goods and services, using this method is problematic because it assumes that there are no productivity changes associated with the production of non-market goods and services over time. Quantity extrapolation can be used to circumvent this issue, but as previously stated, very detailed data are often needed to produce a reliable set of constant-price measures using this methodology.

Although the primary method used to estimate constant-price measures in PCE is deflation, both the quantity extrapolation and the direct valuation methods are used for some goods and services. For instance, quantity extrapolation is used in the construction of constant-price measures for the rental value of farm dwellings, and direct valuation is used to create constant-price measures for automobile dealerships. (The data from the CPI program are based on auction prices with no dealership markups.)

2.1.2 Fixed investment and change in private inventories

Two general types of data are used to prepare constant-price measures for fixed investment in the NIPAs. First, most constant-price measures for nonresidential equipment and change in private inventories are prepared by deflating current-values with detailed data provided by the PPI program. As with the use of PPI data for some categories of PCE, this method is not perfect because the PPI data are based on prices received by producers rather than prices paid by purchasers. Second, the majority of the constant-price measures for structures are developed from a wide variety of trade-source data that are used by BEA to create cost indexes to deflate current-value estimates. Although BEA believes that this is the best procedure, given currently available data, this

procedure is less than optimal, as it implicitly assumes zero productivity growth associated with the production of structures.

There are few special cases in the preparation of constant-price measures that are worth noting because they relate to a common issue that arises when the quality of available goods and services change rapidly over time. Price indexes that effectively ignore the introduction of new goods and service because observations for a particular product cannot be matched over time can produce biased results. This bias can often be mitigated by making quality adjustments or using a “hedonic” price index. Hedonic indexes are based on the notion of replacing “missing” price data for new products in previous periods with inferred price data that are based on the values associated with their detailed characteristics.

BEA makes both quality adjustments and uses a hedonic price index in the creation of its constant-price measures for fixed investment. For example, BEA makes adjustments to the price indexes for some categories of nonresidential equipment and software. These include prepackaged, own-account, and custom software, along photocopying and telephone switching equipment. BEA also uses the U.S. Census Bureau hedonic price index for single-family homes under construction to prepare its constant-price measures of investment in residential structures.⁷

The constant-price measures of the change in inventories are complicated by the fact that these estimates can be either positive or negative. BEA prepares constant-price estimates of the change in inventories by differencing the constant-price measures of the

⁷ BEA supplements the U.S. Census Bureau price index for single-family homes because investment in residential structures includes other items such as multi-family homes, manufactured home improvements, and brokers’ commissions.

beginning-of-period and the end-of-period inventory stocks. PPI data are usually used to deflate the current-valued measures.

2.1.3 Government consumption expenditures and gross investment

The constant-price measures for government consumption expenditures and gross investment are complicated for at least two reasons. First, specific information associated with the breakdown of government purchases and prices paid by government is generally not available. Second, the scope of transactions included in this expenditure category is much broader than that of the other expenditure categories. Not only does this expenditure category include government expenditures that are associated with the provision of government goods and services, such as compensation of employees, but it also includes government investment purchases.

Despite these complications, there are a few general statements that can be made about the creation of constant-price measures for government expenditures by focusing separately on compensation of employees, purchases of goods and services, and investment.

The constant-price measures for the compensation of employees involves using separate quantity extrapolations for military and for nonmilitary compensation. For military compensation, full-time equivalent employment by rank and length of service is used to create an extrapolator series; for nonmilitary compensation, full-time equivalent employment by civilian pay grade is used to create the extrapolator series. The use of data on military rank and civilian pay grade improves BEA's measures by accounting for differences in the quality of government employees.

The constant-price measures for purchases of goods and services also involves the separate treatment of military and nonmilitary purchases. Detailed data from the PPI program are used to deflate some nonmilitary purchases of goods and services; however, the PPI data are not used to deflate most categories of military spending because more detailed and appropriate price information for these purchases is available from the U.S. Department of Defense. Also, some transactions, such as purchases of electricity, natural gas, and agricultural commodities, employ the direct valuation method using alternative data sources.

The constant-price measures for the components of government investment generally rely on the same data used for the components of private fixed investment. For instance, BEA cost indexes are used to deflate government spending on most structures. PPI data are used to deflate the current-market value associated with the purchase of different types of equipment. Quality adjustments are made for a few types of investment purchases, such as photocopying equipment, telephone switching equipment, and own-account software.

2.1.4 Net exports

Constant-price measures for net exports rely heavily on the use of detailed data provided by the BLS International Price Indexes (IPI) program. There are a few areas where these IPI data are supplemented. For instance, quantity extrapolation is used for exports of financial services provided without payment; volume measures of bank service charges are subtracted from the BLS index of total bank output to form the quantity measure used for extrapolation.

2.2 Annual Industry Accounts

The Annual Industry Accounts present constant-price estimates for gross output, intermediate inputs, and gross value added by industry. Constant-price measures of gross output are developed by deflating the values of the commodities that comprise an industry's gross output. Constant-price measures of intermediate consumption are derived by deflating the values of the commodities that comprise an industry's intermediate inputs. The double-deflation method is then used to construct constant-price measures of gross value added by industry.

The data used to deflate each of these commodities is collected from a wide variety of sources (table 2). A substantial portion of the price indexes used to deflate the current-value commodity measures are from the detailed data provided in the PPI program. The PPI data are the most appropriate deflators for developing constant-price gross output, as these deflators are based on prices paid to producers for goods and services. However, the PPI data often need to be used to deflate the value paid for intermediate inputs because separate price indexes for these types of purchases generally do not exist.

Although the PPI data provide a wealth of information that is used for deflation in the Annual Industry Accounts, these data must be supplemented with data from other sources, such as the CPI data. Although BLS continues to expand the coverage of commodities included in the PPI program, there are still a number of industries where commodity coverage is incomplete. This is especially true for many commodities in the service and construction industries. These gaps in coverage are occasionally filled through the use of CPI data, as is the case for the waste management and food

preparation industries. However, these gaps are more often filled using a deflator or cost index that is initially created for use in the NIPAs. In particular, deflators used to prepare constant-price PCE measures are commonly used to fill in the missing details. As a result, a number of the issues associated with the constant-price measures in the NIPAs are also present in the Annual Industry Accounts.

3. Recent improvements

There have been a number of recent developments in the U.S. statistical system that have improved the quality of the constant-price measures presented in BEA's economic accounts. The first of these developments is the introduction of chained Fisher indexes to calculate BEA's constant price measures. The second development is the increased use of hedonic and other types of quality-adjustment procedures in the U.S. statistical system. The third development is the expansion of the commodities covered in the BLS PPI program.

3.1 Chained Fisher indexes

BEA switched from using traditional fixed-weighted Laspeyres indexes to using chained Fisher indexes in its national accounts in 1996. Even though the use of such indexes is more computationally burdensome, a comparison of the old and new constant-price measures indicated that a substantial amount of substitution bias was eliminated with the new measures. For instance, it was found that the fixed-weighted constant-price measures, based on 1987 prices, understated GDP growth during seven U.S. economic

expansions over the 1949-1990 period by an average of 0.4 percentage point and overstated growth over the 1991-1995 period by 0.5 percentage point.

A comparison of the fixed-weighted indexes with the chained Fisher indexes also indicated that the new measures eliminated distortions of growth in industries and anomalies that arose from using recent-period weights to measure periods in the past when far different prices prevailed. For instance, it was found that the constant-price measures based on the new indexes indicated that manufacturing industries grew at an annual average rate of 2.7 percent over the 1977-1987 period. Measured through the use of fixed 1987 weights, the growth rate would have been 1.7 percent. Additionally, the constant-price measures based on the new indexes indicated that GDP dropped 13 percent during the 1944-1947 period. Measured through the use of fixed weights, the drop would have been 25 percent due, in part, to the use of 1987 prices for defense equipment rather than the lower postwar prices for defense equipment.⁸

There is, however, a major difficulty with chained Fisher indexes. Constant-price measures based on chained Fisher indexes are not additive-in-level. That is, the sum of related components that are valued in the same prices over all time periods do not add up precisely to their totals. To address this difficulty, BEA has introduced additive-in-level “contributions” estimates that identify a component’s contribution to aggregate price and volume changes.

⁸ For a more thorough discussion of the advantage of using chained Fisher indexes in the context of the NIPAs, see J. Steven Landefeld and Robert P. Parker, “BEA’s Chained Indexes, and Measures of Long-Term Growth,” *Survey of Current Business* 84 (March 2004): 38-51.

3.2 Quality-adjusted prices

The use of hedonic methods to create price indexes by the U.S. statistical agencies has increased dramatically in recent years. In fact, it was estimated that in 2001 about 18 percent of the final expenditures in GDP were deflated using price indexes that were based on hedonic methods.⁹

Even though the Census Bureau had been producing its hedonic index for single family homes since 1968, the use of additional hedonic indexes in BEA's accounts did not occur until 1985 when BEA's work with the IBM Corporation led to the introduction of hedonic price indexes for computer equipment and peripherals into the NIPAs. Although skeptics have occasionally questioned the rapid price declines (*e.g.*, an average price decline of around 17.5 percent a year over the 1959-2000 period), scholarly studies have found similar rates of price decline that both support BEA's indexes and demonstrate the importance of the use of hedonic price measures for such goods. Subsequently, the BLS has adopted quality-adjustment techniques for preparing its computer and peripherals price indexes. BEA now uses these quality-adjusted BLS indexes to prepare its national accounts.

With the assistance of the Census Bureau, BEA introduced its own hedonic price index for multifamily residential structures in 1993. In the late 1990's, BEA also introduced its own hedonic price indexes for telephone switching equipment. Other

⁹ See Brent R. Moulton, "The Expanding Role of Hedonic Methods in the Official Statistics of the United States" (paper presented at the BEA Advisory Committee, Washington, DC, November 30, 2001). The reference listed in this footnote also contains a more thorough discussion of the use of hedonic methods in the U.S. statistical system than the discussion included in this paper and is available at BEA's Web site <www.bea.gov>.

examples of quality-adjusted indexes created and used by BEA include prepackaged, own-account, and custom software, and photocopying equipment.

Beyond producing quality-adjusted prices for computers, BLS has also contributed to the improvement of BEA's constant-price measures through its recent adoption of hedonic price indexes for many other goods and services. Although BLS began producing hedonic indexes to account for the quality of rental units and homes in 1987, a large number of hedonic price indexes have been introduced into the CPI since 1998 and have improved the NIPAs. Examples include computers, televisions, audio equipment, camcorders, college textbooks, clothes washers and dryers, DVD players, microwave ovens, refrigerators, and videocassette players. A more limited set of hedonic price indexes have been introduced into the PPI program.

3.3 Expansion of the Producer Price Index Program

Traditionally, the PPI program only covered the output of domestic goods in the agriculture, forestry, fisheries, mining, scrap, and manufacturing industries. However, in recent years, the PPI program has been expanded to cover domestic services in the transportation, retail trade, insurance, real estate, health, legal, and professional service industries. The Annual Industry Accounts have directly benefited from this expansion. The NIPAs have also benefited, as the newer PPI data have been adopted for transactions such as the personal expenditures associated with brokers' commissions and physician services.

4. Continuing issues

Although many recent developments have improved the constant-price measures presented in BEA's economic accounts, there are many more improvements that are likely to be made in the foreseeable future. The first involves BLS' plans to continue the increase in the coverage of commodities included in the PPI program. The second involves BEA's plans to research the use of quality adjustment to develop constant-price measures for government-provided education and health services. The third involves future research on hedonic price measurement.

The areas for which BLS is expecting to expand commodity coverage include the utilities, finance, business services, and construction sectors. This expansion is likely to lead to direct improvements in the Annual Industry Accounts as more appropriate data at a more detailed product detail will be available for deflation. This expansion is also likely to improve the constant-price measures in the NIPAs. For instance, newly available PPI data for the construction industry could improve BEA's constant-price measures of nonresidential fixed investment in structures by replacing the estimates based on cost indexes. In addition, improvements are likely to be made to the constant-price measures associated with financial services in PCE.

In light of the conclusions presented in the Atkinson Report for the U.K. Office of National Statistics, BEA is giving careful consideration to the use of quality adjustments in the development of constant-price measures that rely on the quantity extrapolation method.¹⁰ BEA is specifically conducting research to possibly improve its current-price estimates for government-provided education and health services.¹¹

¹⁰ See U.K. Office of National Statistics, *Atkinson Review: Final Report* (Houndmills, Basingstoke, Hampshire, and New York: Palgrave MacMillan, 2005.)

BEA is also conducting research related to hedonic price measurement that could improve its constant-price measures. For example, it is conducting research on the possible use of scanner data to improve its constant-price measures of prepackaged software; it is also conducting research on the use of insurance claims data to improve its constant-price measures of medical care services.¹²

¹¹ For preliminary research results associated with the constant-price measurement of educational services see Barbara Fraumeni, Marshall B. Reinsdorf, and Brook B. Robinson, "Price and Real Output Measures for the Education Function of Government: Exploratory Estimates for Primary and Secondary Education." (Paper presented at the CRIW Conference on Price Index Concepts and Measurement, Vancouver, Canada, June 28-29, 2004.) This paper is available at <www.ipeer.ca/CRIW.htm>.

¹² BEA also has plans to investigate the possible use of scanner data to improve its current-valued estimates for some personal consumption expenditure (PCE) categories. This research could indirectly lead to improvements for current-price PCE measures by implicitly improving the weighting used to construct constant-price measures for this aggregate.

Table 1. Methodology Used in Preparing Estimates of Constant-Price Gross Domestic Product

Component	Deflation, using price based on		Using quantity for extrapolation or direct valuation	
	CPI or PPI	Other index		
Personal consumption expenditures				
Durable and nondurable goods				
Most durable and nondurable goods except those listed below	CPI PPI, for military clothing		Direct valuation. For used autos and used light trucks, in two parts: (1) Margin, unit sales from trade sources with dealers' margins from Census Bureau and trade sources; (2) net transactions, net change in unit stock of autos held by consumers by year of original sale, valued by depreciated original value in base-year dollars.	
New autos	CPI			
Net purchases of used autos and used light trucks	.....	.....
New trucks	CPI			
Gasoline and oil	CPI			
Food furnished to employees (including military)	CPI			
Expenditures abroad by U.S. residents less personal remittances in kind to nonresidents	.....	Foreign CPIs ¹	
Services				
Nonfarm dwellings: Space rent for owner-occupied dwellings and rent for tenant-occupied dwellings	CPI			Quantity extrapolation. Real dollar net stock of farm housing from BEA capital stock estimates.
Rental value of farm dwellings	.....	.....
Motor vehicle repair, rental, and other services; other repair services; other purchased intercity transportation; legal and funeral services; barber-shops, beauty parlors, and health clubs; nursing homes; laundries; employment agency fees; accounting and tax return preparation services; recreation (except cable TV, parimutuel net receipts, lotteries, and computer online services); hotels and motels; commercial business, trade, and correspondence schools; educational services not elsewhere classified; research organizations and foundations	CPI PPI, for proprietary and government nursing homes and employment agency fees	Composite index of input prices from the Centers for Medicare and Medicaid Services for private nonprofit nursing homes; for clubs and fraternal organizations, and for nonprofit research and foundation expenses, BEA composite indexes of input prices.		

See the footnotes at the end of the table.

Table 1. Methodology Used in Preparing Estimates of Constant-Price Gross Domestic Product –Continued

Component	Deflation, using price based on		Using quantity for extrapolation or direct valuation
	CPI or PPI	Other index	
Physicians, dentists, and other professional medical services	CPI PPI, for physicians, home health care, and medical laboratories		
Private nursery schools, elementary and secondary schools, day care, welfare activities, political organizations, foundations, and trade unions, and professional associations	.....	BEA composite indexes of input prices.	
Financial services furnished without payment by banks, other depository institutions, and investment companies ²	PPI, for investment companies' securities commissions	BEA composite index of input prices, for investment companies' "total deductions."	Quantity extrapolation. Banks, BLS index of total output (less BEA real bank service charges) times consumer share based on shares of deposits and loans; for other depository institutions, paid employee hours of relevant financial institutions; for investment companies' "implicit charges," BEA orders derived from volume data from trade sources.
Brokerage charges and investment counseling, bank service charges, intercity transportation except "other", and private higher education	CPI PPI, for securities commissions	BEA index based on revenue per passenger mile from DOT and trade source for air transportation; for private higher education, BEA composite index of input prices.	Quantity extrapolation. For mutual fund sales charges, value of new sales deflated by CPI.
Domestic service	CPI		
Public education and hospitals, water and other sanitary services, and lotteries	CPI PPI, for public hospitals		
Insurance, private hospitals, religious activities, cable TV, electricity, natural gas, telephone, and local transport	CPI PPI, for private for-profit hospitals	BEA composite indexes of input prices, for life insurance and religious activities; for private nonprofit hospitals, composite index of input prices from the Centers for Medicare and Medicaid Services.	Quantity extrapolation. For auto insurance, premiums deflated by CPI; for medical care and hospitalization insurance, benefits deflated by PPI; for workers' compensation, premiums deflated by PPI.
Foreign travel by U.S. residents less expenditures in the United States by nonresidents	CPI, for expenditures in the United States	BEA composite index of foreign CPIs, ¹ for foreign travel; for airfares in foreign travel, BLS import price data.	

See the footnotes at the end of the table.

**Table 1. Methodology Used in Preparing Estimates of Constant-Price
Gross Domestic Product –Continued**

Component	Deflation, using price based on		Using quantity for extrapolation or direct valuation
	CPI or PPI	Other index	
Other services: Motor vehicle leasing; parimutuel net receipts; other housing except hotels and motels; tolls; other household operation except repairs and insurance; travel and entertainment card fees; stenographic and reproduction services; money orders and classified advertising; and computer online services	CPI	.....	Quantity extrapolation. For parimutuel net receipts, gross winnings deflated by CPI.

Fixed investment

Nonresidential structures

Commercial and healthcare	.....	BEA index based on costs per square foot from trade source for commercial structures; for healthcare, BEA index based on cost index from trade source and on Census Bureau price deflator for single-family houses under construction.	
Manufacturing	.....	BEA index based on costs per square foot from trade source.	
Power and communication	PPI, for power excluding electric	Cost indexes from trade sources and government agencies, for power; for communication, cost index from trade source.	
Mining exploration, shafts, and wells	PPI, for casing, oil and gas well drilling, and oil and gas field services	BEA index based on cost index from trade source and on Census Bureau price deflator for single-family houses under construction, for mines.	Quantity extrapolation. For drilling, footage by geographic area from trade source.
Other structures	PPI, for brokers' commissions	BEA index based on costs per square foot from trade source, for educational and vocational structures; for railroads, BEA price index; for other components, BEA index based on cost index from trade source and on Census Bureau price deflator for single-family houses under construction.	

Nonresidential equipment and software

Equipment except those listed below	PPI, for most domestic components and for imported transportation equipment	BLS import price indexes, for imported components, except transportation equipment.	
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See the footnotes at the end of the table.

**Table 1. Methodology Used in Preparing Estimates of Constant-Price
Gross Domestic Product –Continued**

Component	Deflation, using price based on		Using quantity for extrapolation or direct valuation
	CPI or PPI	Other index	
New autos, new light trucks, and net purchases of used autos and used light trucks	CPI, for new autos; PPI for new light trucks	Direct valuation. For used autos and used light trucks, see the entry "Net purchases of used autos and used light trucks" under personal consumption expenditures.
Telephone and telegraph installation	.....	BEA cost index
Telephone switching equipment	.....	BEA price index
Photocopying equipment	.....	BEA price index
Software	.....	BEA cost index, BLS employment cost index, and PPI, for own-account and custom software.
Residential investment			
Permanent-site new single-family housing units	Census Bureau price deflator for single-family houses under construction.	
Permanent-site new multifamily housing units	.....	BEA price index
Manufactured homes	PPI	BEA composite index of input prices, for major replacements; for additions and alterations, BEA index based on Census Bureau price deflator for single-family houses under construction and BEA index for major replacements.	
Improvements	.....	
Brokers' commissions	PPI		
Equipment	CPI		
Change in private inventories			
Nonfarm			
Purchased goods of all industries	PPI	Composite price from the Energy Information Administration, for crude petroleum; BLS import price indexes, for imported goods purchased by trade industries.	Direct valuation. Quantities and prices of stocks of coal, petroleum, and natural gas for utilities from Energy Information Administration.
Work-in-process and finished goods, manufacturing	PPI	BEA indexes of unit labor cost.	
Farm	USDA average market prices	

See the footnotes at the end of the table.

**Table 1. Methodology Used in Preparing Estimates of Constant-Price
Gross Domestic Product –Continued**

Component	Deflation, using price based on		Using quantity for extrapolation or direct valuation
	CPI or PPI	Other index	
Government consumption expenditures and gross investment			
Federal government			
National defense except consumption of general government fixed capital	PPI, for selected goods and services, CPI and PPI, for utilities and communications	BEA indexes based on DOD prices paid, for some goods and services and for most military structures; for some services, BLS employment cost indexes; for nonmilitary structures, cost indexes from trade sources and government agencies; for own-account software, BEA index derived from nondefense compensation; for custom software, BEA index derived from nondefense compensation price index and PPI.	Quantity extrapolation. For military compensation, full-time equivalent employment by rank and length of service; for civilian compensation, full-time equivalent employment by grade, adjusted for change from base year in hours worked. Direct valuation. For some goods and services and a few military structures, quantities and prices from DOD reports; for electricity and natural gas, quantities from DOE.
National defense consumption of general government fixed capital	.....	.....	Direct valuation. Perpetual-inventory calculations based on gross investment.
Nondefense except consumption of general government fixed capital	PPI, for most goods and selected services CPI, for rent, utilities, and communications	Cost indexes from trade sources and government agencies, for structures; for some services, BLS employment cost indexes; for own-account software, BEA index derived from nondefense compensation; for custom software, BEA index derived from nondefense compensation price index and PPI.	Quantity extrapolation. For compensation, full-time equivalent employment by grade, adjusted for change from base year in hours worked; for financial services furnished without payment, ² BLS index of total bank output (less BEA real bank service charges). Direct valuation. For net purchases of agricultural commodities by the Commodity Credit Corporation, quantities by crop from agency reports and USDA prices; for selected petroleum transactions, DOE quantities and prices.
Nondefense consumption of general government fixed capital	.....	.....	Direct valuation. Perpetual-inventory calculations based on gross investment.

See the footnotes at the end of the table.

**Table 1. Methodology Used in Preparing Estimates of Constant-Price
Gross Domestic Product –Continued**

Component	Deflation, using price based on		Using quantity for extrapolation or direct valuation
	CPI or PPI	Other index	
State and local government			
Consumption expenditures and gross investment except those listed below	CPI for services PPI for electricity, hospitals, most professional services, and goods	BEA indexes based on Federal nondefense prices paid, for transportation, books, and postal services; for elementary and secondary education, welfare, and libraries, BEA composite indexes of input prices; for maintenance and repair services, BEA composite price index for state and local construction.	
Compensation of general government employees	.....	.....	Quantity extrapolation. For employees in education, full-time equivalent employment by education and experience, adjusted for change from base year in hours worked; for other employees, full-time equivalent employment, adjusted for change from base year in hours worked.
Consumption of general government fixed capital	.....	.....	Direct valuation. Perpetual-inventory calculations based on gross investment.
Structures	.....	Cost indexes from trade sources and government agencies.	
Software	.....	See the entry for software under nonresidential equipment and software.	
Brokerage charges and financial services furnished without payment	.....	.....	Quantity extrapolation. See the entries for brokerage charges and for financial services under personal consumption expenditures.
Net exports of goods and services			
Exports and imports of goods	PPI for gold; semi-conductor exports, selected transportation equipment; selected agricultural foods, feeds, and beverages; and selected imports of refined petroleum	BLS export and import price indexes; for electric energy exports and imports, and for petroleum imports, unit-value indexes based on Census Bureau values and quantities.	

See the footnotes at the end of the table.

**Table 1. Methodology Used in Preparing Estimates of Constant-Price
Gross Domestic Product –Continued**

Component	Deflation, using price based on		Using quantity for extrapolation or direct valuation
	CPI or PPI	Other index	
Exports and imports of services	CPI for travel receipts, medical receipts, and nonresident students' expenditures PPI, for selected other transportation	Selected deflators, for military transfers and defense expenditures: see "National defense except consumption of general government fixed capital" below. BLS export and import price indexes, for passenger fares; BEA composite index of foreign CPIs, ¹ for travel payments, for miscellaneous services, and U.S. students' expenditures abroad; BLS export and import price indexes, for selected other transportation; and for royalties and fees, and other private services, BEA price indexes, CPI, PPI, and implicit price deflator for final sales to domestic purchasers.	Quantity extrapolation. For exports of financial services furnished without payment, ² BLS index of total bank output (less BEA real bank service charges).

BLS Bureau of Labor Statistics
CPI Consumer price index
DOD Department of Defense
DOE Department of Energy
DOT Department of Transportation
PPI Producer price index
USDA U.S. Department of Agriculture

¹. The foreign CPIs have been adjusted for differences in exchange rates.

². Also referred to as "services furnished without payment by financial intermediaries, except life insurance carriers."

**Table 2. Source Data Used in Preparing Estimates of Constant-Price
Gross Value Added by Industry**

Industry and commodity	Source data for price index
Agriculture, forestry, fishing and hunting	
Farms.....	USDA prices received by farmers; PPI.
Forestry, fishing, and related activities.....	PPI; NOAA; NIPA deflator.
Mining	
Oil and gas extraction... ..	For crude petroleum and natural gas, IPD from DOE; for natural gas liquids, PPI.
Mining, except oil and gas.....	IPD from DOE and USGS.
Support activities for mining.....	IPD from DOE, USGS and trade sources; for exploration, PPI.
Utilities	
Electric utilities.....	PPI.
Natural gas.....	PPI.
Water, sewage, and other systems.....	CPI.
Construction	
For the Department of Defense (DOD)	DOD prices for military construction; cost indexes from trade sources and government agencies for other construction.
For state and local highways.....	Cost indexes from government agencies.
For private electric and gas utilities.....	Cost indexes from trade sources and government agencies.
For farms, excluding residential.....	Trade sources cost index; Census Bureau price deflator for new single-family houses under construction.
For other nonresidential.....	Trade sources and government agency cost indexes; Census Bureau price index for new single-family houses under construction; BEA quality-adjusted price indexes for factories, office buildings, warehouses, and schools.
For other residential.....	Census Bureau price index for new single-family houses under construction; BEA price index for multifamily construction.

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**Table 2. Source Data Used in Preparing Estimates of Constant-Price
Gross Value Added by Industry –Continued**

Industry and commodity	Source data for price index
Wholesale trade	Sales price by kind-of-business computed from PPI.
Retail trade	Sales price by kind-of-business computed from CPI.
Transportation and warehousing	
Air transportation.....	IPD for total passenger-related revenues and passenger miles from DOT; IPD for total freight-, mail-, and express-related revenues and ton miles from DOT; wages and salaries per employee from BLS.
Rail transportation.....	PPI.
Water transportation.....	PPI for freight; for passengers, CPI.
Truck transportation.....	PPI.
Transit and ground passenger transportation...	For taxicabs, intercity buses, and other local transit, PCE price index; for school buses, BLS data on wages and salaries per employee.
Pipeline transportation.....	PPI.
Other transportation and support activities.....	For sightseeing, PCE price index; for other transportation and support activities, PCE price indexes and PPI.
Warehousing and Storage.....	PPI.
Information	
Publishing industries (includes software).....	BEA price indexes for prepackaged and custom software for software publishers; for all other publishing industries, PPI.
Motion picture and sound recording industries.....	PCE price indexes.
Broadcasting and telecommunications.....	For cable networks, programming, and telecommunications, PPI; for radio and television broadcasting, network receipts, and all other telecommunications, composite price index of PPIs.
Information and data processing services.....	For information services, PCE price indexes; for data processing services, PPI.
Finance and insurance	
Federal Reserve banks, credit intermediation, and related activities.....	PCE price indexes; other government data.
Securities, commodity contracts, investments.....	PCE price indexes.

Continued on next page.

**Table 2. Source Data Used in Preparing Estimates of Constant-Price
Gross Value Added by Industry –Continued**

Industry and commodity	Source data for price index
Insurance carriers and related activities.....	For health and life insurance, PCE price indexes; for property and casualty insurance, PPI; for agents, brokers, and services, composite price index based on trade sources data and PCE price indexes.
Funds, trusts, and other financial vehicles.....	IPD from NIPA imputed service charges; composite price index based on PCE price indexes; PPI data; BLS data on wages and salaries per full-time employee.
Real estate and rental and leasing	
Real estate.....	For nonfarm residential dwellings, NIPA price index; for nonresidential dwellings, PPI; for real estate managers and agents, PPI and trade sources; IPD for nonprofit and farm residential dwellings.
Rental and leasing services and lessors of intangible assets.....	For automotive equipment rental, PPI; for other rental services, PCE price indexes; for royalties, PCE price index and IPD from DOE and PPI.
Professional, scientific, and technical services	
Legal services	PPI.
Computer systems design and related services.....	BEA price indexes for prepackaged and custom software.
Miscellaneous professional, scientific and technical services.....	PPI; BLS wages and salaries per full-time employee.
Management of companies and enterprises.....	BLS wages and salaries per full-time employee.
Administrative and waste management services	
Administrative and support services.....	BLS wages and salaries per full-time employee; PCE price indexes; PPI.
Waste management and remediation services.....	CPI.
Educational services.....	PCE price index based on trade sources.

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**Table 2. Source Data Used in Preparing Estimates of Constant-Price
Gross Value Added by Industry –Continued**

Industry and commodity	Source data for price index
Health care and social assistance	
Ambulatory health care services.....	PPI; PCE price indexes.
Hospitals and nursing and residential care facilities.....	PCE price indexes.
Social assistance.....	PCE price indexes.
Arts, entertainment, and recreation	
Performing arts, spectator sports, museums, and related activities.....	PCE price indexes.
Amusements, gambling, and recreation industries.....	PCE price indexes.
Accommodation and food services	
Accommodation.....	For hotels and motels, PPI; PCE price index.
Food services and drinking places.....	CPI.
Other services except government.....	CPI; BLS data on wages and salaries per full-time employee; PCE price indexes.
Government	
Federal	
General government.....	NIPA price indexes.
Government enterprises.....	For USPS and electric utilities, PPI; for all others, PCE price index and NIPA price indexes.

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**Table 2. Source Data Used in Preparing Estimates of Constant-Price
Gross Value Added by Industry –Continued**

Industry and commodity	Source data for price index
State and local	
General government	NIPA price indexes.
Government enterprises...	PPI.

ARTS Annual Retail Trade Survey, Census Bureau
 ASGF Annual Survey of Government Finances, Census Bureau
 ATS Annual Trade Survey, Census Bureau
 BEA Bureau of Economic Analysis
 BLS Bureau of Labor Statistics
 BTS Bureau of Transportation Statistics
 CPI Consumer Price Index, BLS
 DOC Department of Commerce
 DOD Department of Defense
 DOE Department of Energy
 DOT Department of Transportation
 EBSA Employee Benefits Security Administration
 EIA Energy Information Administration
 FDIC Federal Deposit Insurance Corporation
 FOCUS Financial and Operational Combined Uniform Single Report, SEC
 FRB Federal Reserve Board of Governors
 IPD Implicit price deflator
 IRS Internal Revenue Service
 NCUA National Credit Union Association
 NIPA National income and product accounts, BEA
 NOAA National Oceanic and Atmospheric Administration
 PCE Personal consumption expenditures, BEA
 PPI Producer Price Index, BLS
 SAS Service Annual Survey
 SEC Securities and Exchange Commission
 USDA U.S. Department of Agriculture
 USGS U.S. Geological Survey, Office of Minerals
 USPS U.S. Postal Service