Integrating Industry and National Economic Accounts: First Steps and Future Improvements

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Table of Contents

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I. Introduction

As part of its continuing efforts to improve the system of industry accounts, the Bureau of Economic Analysis (BEA) has initiated a series of strategic initiatives with the goal of full integration of the industry accounts, including integration of the annual and benchmark input-output (I-O) accounts with the gross-domestic-product-(GDP)-by-industry accounts, and integration of the industry accounts with the national income and product accounts (NIPAs).[2] Achievement of this goal will require several years of effort by BEA, as well as the continuing participation and cooperation by other statistical agencies, particularly the Bureau of the Census and the Bureau of Labor Statistics (BLS), to further enhance source data. In the interim, a more immediately achievable goal is the partial integration of the industry accounts, including the merging of the GDP-by-industry accounts with the annual I-O accounts. Initial results of this effort will be released in June 2004 as part of BEA's 5-year comprehensive revision.

The integration of the GDP-by-industry accounts with the annual I-O accounts is the most recent in a series of improvements to the industry accounts. These improvements include the following: Resuming the publication of the annual I-O accounts; accelerating the release of the annual I-O accounts to within 3 years after the

[2] In addition, it is BEA's long-run goal to integrate the industry accounts and NIPAs with related regional accounts, namely gross state product (GSP) by industry and regional I-O multiplier estimates. Consistency between the annual I-O accounts and the GDP-by-industry accounts will improve the quality of the GSP accounts, and any increase in timeliness of the GDP-by-industry estimates will be reflected in more speedy delivery of the GSP estimates. Consistent and better measures of value added would also potentially strengthen the links between the GSP accounts and the regional I-O multiplier estimates.

end of the reference year; expanding the GDP-by-industry accounts to include gross output and intermediate inputs for all industries; developing an accelerated set of GDP-by-industry accounts that are available with a lag of 4 months after the end of the reference year; and continuing to work closely with the Bureau of the Census on new initiatives to improve the quality and the timeliness of the source data used to prepare the industry accounts.

With these improvements to the industry accounts in place, as well as with the general improvements made to the quality of industry source data, BEA is ready to integrate the annual I-O accounts and the GDP-by-industry accounts as a first step towards full integration.[3] For purposes of the current paper, this integration is being referred to as "partial integration" and is the first tangible result of the initiative to reach BEA's data users.

This partial integration could have been achieved through a variety of methods. For example, many countries produce integrated annual I-O accounts and GDP-by-industry accounts by assuming that the industry ratios of intermediate inputs to gross output do not change from the most recent set of benchmark I-O accounts. By making this assumption, these ratios are then used to estimate a time series of value added by industry from the annual source data on gross output by industry. BEA has taken a very different approach in developing its integration methodology because of the richness of the source data that are available in the United States. For example, the Bureau of the Census, BLS, and the Internal Revenue Service (IRS) provide data that can be used to estimate value added by industry in various ways. However, the quality of these source

[3] For a discussion on integrating the industry accounts, see Yuskavage.

data varies by data series and by industry. As a result, BEA has developed a method that ranks the available source data by relative quality and estimates a balanced set of annual I-O accounts and GDP-by- industry accounts that incorporate a weighted average of these source data on the basis of this relative quality. In this manner, BEA's integrated annual I-O accounts and GDP-by-industry accounts will provide a more consistent and a more accurate set of estimates.

For full integration of the industry accounts, the measures and levels of value added by industry for the industry accounts will be based on the benchmark I-O accounts. These accounts are prepared for years of the quinquennial economic census and are currently used to establish measures and periodic levels of final expenditures contributing to GDP in the NIPAs. Annual updates of the integrated industry accounts would be based on less comprehensive survey and administrative record data available in nonbenchmark years. For full integration, the measures of value added by industry would be independent of the NIPA measures of gross domestic income (GDI), and would provide a "feedback" loop to the NIPAs that would improve the estimates of the commodity composition of GDP final expenditures.[4] Full integration would also provide a third independent measure of GDP that would be based on the production method recommended by the 1993 System of National Accounts. To achieve this ambitious goal, BEA is working cooperatively with the Census Bureau, BLS, and other statistical

[4] BEA currently uses two approaches to measure GDP: The expenditures approach and the income approach. The expenditures approach measures GDP as the sum of consumption spending, investment spending, government expenditures, and exports minus imports. The income approach measures GDP as the sum of compensation of employees, taxes on production and imports, less subsidies, and gross operating surplus. These approaches allow maximum use of up-to-date, high-quality economic indicators from the Bureau of the Census, the IRS, and the BLS to produce timely, reliable measures of the economy's current performance.

agencies to make the necessary improvements to the quality and coverage of the underlying source data, particularly for information on industry expenses.

This paper has five sections and three appendices. The first section is this introduction. The second section describes in greater detail the partial integration being achieved in the short run. The third section presents BEA's vision for full integration in the long run, including some of the major requirements for achieving this goal as well as the major benefits. The fourth section describes the methodology developed for the partial integration of the annual industry accounts. The last section outlines the future steps required to reach the goal of full integration. The appendices include an expanded description of the probability-based method used to develop a weighted-average estimate of each industry's gross operating surplus; a detailed description of the new balancing procedure developed for automating production of the annual I-O tables; and a statement of the computation method used to estimate chain-type price and quantity indexes in the GDP-by-industry accounts.

Highlights of the partial integration methodology are as follows:

- It allows BEA to incorporate the most timely and highest quality source data available into both the annual I-O accounts and the GDP-by-industry accounts.
- The annual I-O accounts and the GDP-by-industry accounts will be released concurrently for 1998-2002 in June of this year, and for the first time both sets of accounts will present fully consistent measures of gross output, intermediate inputs, and value added by industry.
- The quality of the annual industry accounts will be improved because the accounts will be prepared within a balanced I-O framework; that is, all the

components of the accounts will be in agreement within a balanced row-and-column framework.

- The release of the annual I-O accounts will be accelerated by 2 years in a sequence of two steps that will be completed by the fall of 2004, when they will be released 1 year after the end of the reference year.
- For the first time, the 1998-2002 annual I-O accounts will be presented as a consistent time series; as a consequence, the annual I-O accounts will be more useful for analyses of trends over time.

II. Partial Integration: The First Step

BEA prepares two sets of national industry accounts: The I-O accounts, which consist of the benchmark I-O accounts and the annual I-O accounts, and the GDP-by-industry accounts. Both the I-O accounts and the GDP-by-industry accounts present measures of gross output, intermediate inputs, and value added by industry; however, they are often inconsistent because of the use of different methodologies, classification frameworks, and source data. These inconsistencies are frustrating to data users, who would like to be able to combine the richness of information from each for their own applications. The goal of partial integration is to eliminate these inconsistencies, as well as to improve the accuracy of the combined accounts by drawing on their relative strengths in methodologies and source data. In this section, the traditional I-O and GDP-by-industry methodologies are reviewed and the comparative advantages of each are

examined in the context of an integrated methodology that produces both sets of accounts.

II.1 The Traditional I-O Accounts Methodology

The I-O accounts present a detailed picture of how industries interact to provide inputs to, and use output from, each other to produce the Nation's GDP. The I-O accounts consist of benchmark I-O accounts and annual I-O accounts. The benchmark I-O accounts are prepared every 5 years and are based on data from the quinquennial economic census.[5] The annual I-O accounts update the most recent benchmark I-O accounts. The annual I-O accounts are more timely than the benchmark I-O accounts, but they are generally less detailed because they rely on annual survey data.[6] At present, the I-O accounts are prepared only in current dollars.[7]

Both the benchmark and the annual I-O accounts are prepared within a balanced row-and-column framework that is presented in two tables: A "make" table and a "use" table. The make table shows the commodities that are produced by each industry, and the use table shows the commodities that are used in industry production and that are consumed by final users. In the use table, the columns consist of industries and final uses (chart 1). The column total for an industry is its gross output (consisting of sales or receipts, other operating income, commodity taxes, and inventory change). The rows in the use table consist of commodities and value added. The commodities are the goods and services that are produced by industries or imported and that are consumed either by industries in their production processes or by final users. The commodities consumed by industries in the production process are referred to as intermediate inputs (consisting of

[5] For more information, see Lawson et. al.
[6] For more information, see Planting and Kuhbach.
[7] BEA is beginning research to explore the feasibility of preparing real (inflation-adjusted) I-O accounts.

energy, materials, and purchased services). Value added in the I-O accounts is computed as a residual--that is, as gross output less intermediate inputs by industry. In concept, this residual, which represents the sum of the costs incurred and the incomes earned in production, consists of compensation of employees, gross operating surplus, and taxes on production and imports, less subsidies.[8] GDP equals valued added summed over all industries, and it also equals final uses summed over all commodities.

The I-O accounts have traditionally served two major purposes, both of which have focused on information about the use of commodities and which have supported BEA's NIPAs. First, the accounts have provided the NIPAs with best-level estimates of the commodities that comprise final expenditures for GDP in benchmark years. Second, they provide the NIPAs with information on the split between intermediate inputs and final uses of commodities, which is critical for extrapolating GDP final demand components in nonbenchmark years. Because of their importance in determining the levels of GDP in the NIPAs, the I-O accounts have traditionally focused more on the commodity composition of the economy and less on the measures of value added by industry.

II.2 The Traditional GDP-by-Industry Accounts Methodology

In contrast to the I-O accounts, the GDP-by-industry accounts have traditionally focused on the industry composition of the U.S. economy and the relative performance of

[8] Previously, these costs and incomes were classified as either compensation of employees, property-type income, or indirect business tax and nontax liability. These new classifications are consistent with the aggregations introduced as part of the comprehensive NIPA revision; see Moulton and Seskin for more information. Specifically, all the nontax liabilities except special assessments are removed from indirect business tax and nontax liability, and the remainder of this category is renamed "taxes on production and imports;" the nontax liabilities except special assessments are added to property-type income; subsidies are removed from property-type income, and the remainder of this category is renamed "gross operating surplus;" and subsidies are netted against the value of taxes on production and imports.

these industries as reflected in their measures of value added. The GDP-by-industry accounts are particularly suited for time series analysis of changes in industry shares of GDP and contributions to GDP growth. The GDP-by-industry accounts provide annual estimates of gross output, of intermediate inputs, and of value added by industry and the corresponding price and quantity indexes.[9]

A different estimating approach is used for the GDP-by-industry accounts compared to that used for the I-O accounts. Gross output by industry in the GDP-by-industry accounts is computed by extrapolating best-level estimates from the most recent set of benchmark I-O accounts, using annual survey data. The measures of value added by industry are derived from the industry distributions of the components of gross domestic income (GDI) from the NIPAs. The GDI-based measures of value added by industry represent the sum of the costs incurred and the incomes earned in production and are estimated as the sum of the industry distributions of compensation of employees, gross operating surplus, and taxes on production and imports, less subsidies. These industry distributions incorporate additional annual survey data and source data from annual tax returns and administrative records. In the GDP-by-industry accounts, total intermediate inputs by industry are measured as a residual--that is, total intermediate inputs equal gross output less value added for an industry. Next, real measures of gross output and intermediate inputs by industry are estimated by deflating with detailed price indexes. Finally, price indexes and quantity indexes are derived for each industry's gross output, of intermediate inputs, and of value added.

[9] For more information, see Lum et. al.

II.3 Combining the Two Methodologies

The primary strength of the I-O methodology is the balanced row-and-column framework in which the detailed estimates of gross output and intermediate inputs by industry are prepared; this framework allows for a simultaneous look at both the economy's industries and commodities. The primary strength of the GDP-by-industry accounts methodology is the direct approach to estimating a time series of value added by industry from high quality source income data. The methodology for partial integration incorporates the relative strengths of both. It yields a new and improved set of annual I-O accounts and GDP-by-industry accounts that are prepared within a balanced framework and that incorporate the most timely and highest quality source data available. It also ensures the consistency of the estimates of gross output, of intermediate inputs, and of value added by industry across the two sets of accounts.

The strength of using a balanced I-O framework is demonstrated by again referring to chart 1. A balanced use table ensures that the industry estimates of the I-O accounts (the column totals) are in balance with the commodity estimates of the I-O accounts (the row totals). This framework tracks all of the detailed input and output flows in the economy and guarantees that each commodity that is produced is either consumed by industries as an intermediate input or is consumed by final users. An imbalance in the use table--for example, too little, or too much, supply of a commodity after intermediate inputs by industry and final uses have been accounted for—flags an inconsistency in the data. Therefore, a balanced framework provides a "consistency check" of the use table. No comparable procedure to balance industries and commodities exists for the GDP-by-industry accounts.

The strength of the GDP-by-industry methodology is that the estimates of value added by industry are derived directly from high quality source data, so these measures generally provide better estimates of value added for industries relative to the I-O estimates. Nonetheless, several factors can affect the quality of the GDP-by-industry estimates for specific industries. For example, gross operating surplus, one component of value added by industry, includes several items--such as corporate profits before tax, corporate net interest, and corporate capital consumption allowances--that are based on corporate tax return data from the IRS. Because the consolidated tax return data of an enterprise may account for activities by several establishments classified in different industries, BEA must convert these enterprise- or company-based data to an establishment or plant basis. The conversion can introduce errors because it is based on employment data for establishments that are cross-classified by enterprise, and because it is based on relationships from an economic census year that are likely to change over time. In addition, proprietors' income, another component of gross operating surplus, can introduce errors because the industry distributions of proprietors' income are based on incomplete source data. Industries with large shares of value added from proprietors' income are regarded as having lower quality estimates.[10]

The GDP-by-industry measures of value-added may be of a higher or lower quality than those from the benchmark I-O accounts, depending on the data used. For an industry with high quality data on gross output and intermediate inputs, the measure of

[10] Proprietors' income is defined here to equal the sum of NIPA estimates for proprietors' income without inventory valuation adjustment (IVA) and capital consumption adjustment (CCAdj), proprietors' net interest, proprietors' capital consumption allowance, and proprietors' IVA. The NIPA adjustment to nonfarm proprietors' income without IVA and CCAdj for misreporting on income tax returns is shown in NIPA table 7.14 "Relation of Nonfarm Proprietors' Income in the National Income and Product Accounts to Corresponding Measures as Published by the Internal Revenue Service."

value added from the benchmark I-O accounts may be superior, particularly when the GDP-by-industry measure includes a large enterprise-establishment adjustment or a substantial amount of proprietors' income. Alternatively, for an industry with a small enterprise-establishment adjustment and a negligible amount of proprietors' income, the GDP-by-industry measure may be superior, particularly if the coverage of intermediate inputs in the quinquennial economic census is small for the benchmark I-O measure. For the 1997 benchmark I-O accounts, less than half of all intermediate inputs were covered by the economic census; for many industries, this results in lower quality measures of value added. In contrast, for nonbenchmark years, the GDP-by-industry accounts always provide the preferred measures of value added, because estimates of intermediate inputs in the annual I-O accounts are currently based on very sparse data and are unable to yield high quality measures of value added by industry.[11]

The advantages of a partial integration methodology, however, go beyond incorporating the best methods and source data from each methodology. Because the annual I-O accounts will be estimated concurrently with the GDP-by-industry accounts, they will be released on an accelerated schedule. The 2002 annual I-O table, scheduled for release in June 2004, will be released 18 months rather than 36 months after the end of the reference year. In addition, beginning in the fall of 2004, the annual I-O accounts will adopt the revision schedule of the NIPAs; at that time, the revised tables for 2001 and 2002 and new tables for 2003 will be released. The revised I-O estimates that are consistent with the annually revised NIPA estimates will provide users with yet another

[11] The Bureau of the Census has recently undertaken initiatives to improve the coverage of intermediate inputs by industry in several of its annual surveys. For example, the Annual Survey of Manufactures has expanded its coverage of expenses to include purchased services by industry and the Service Annual Survey has initiated the collection of data on expenses by industry.

level of consistency. Finally, the partial integration methodology will impose a time series consistency on the annual I-O tables, making the tables more useful for analyses of trends over time.

A further advantage of the partial integration methodology is a "feedback loop" to the NIPAs that is demonstrated by examining the relationships among the national accounts (chart 2). Before the integration of the annual I-O accounts and the GDP-by-industry accounts, the benchmark I-O accounts provided the following: A starting point for updating the annual I-O accounts (arrow 1), the best-level estimates of gross output to the GDP-by-industry accounts (arrow 2), and the best-level estimates and commodity splits of GDP to the NIPAs (arrow 3). The NIPAs provided estimates of GDI by industry to the GDP-by-industry accounts (arrow 4) and information on the annual composition of GDP to the annual I-O accounts (arrow 5). The partial integration results in an exchange of information between the annual I-O accounts and the GDP-by-industry accounts (arrow 6), and it also provides a feedback loop to the NIPAs (arrow 7). Because the integrated industry accounts will be prepared within a balanced framework, they will provide annual estimates of the commodity composition of GDP final expenditures that could potentially be used to improve the NIPA measures of GDP.

III. Full Integration: The Long-Run Goal

Integration of the annual I-O accounts and the GDP-by-industry accounts is only the first step, although a very important one, towards BEA's long-run goal to fully integrate all components of its industry accounts, including the benchmark I-O accounts,

and to integrate the industry accounts with the NIPAs. Although full integration is dependent upon continued costly investments by the Federal statistical agencies to improve the coverage and consistency of their economic data, the benefits are significant in providing higher quality information to data users. With more consistent and comprehensive data on industry inputs, the benchmark I-O accounts would provide the best measures of value added by industry for benchmark years. With updated annual information on intermediate inputs by industry, the annual I-O accounts and the GDP-by-industry accounts would provide annual updates of value added by industry that would be independent of the NIPA measures of GDP. With full integration, BEA would have a production-based measure of GDP that would provide new information to the NIPAs through the feedback loop discussed earlier (chart 2). That is to say, it could provide valuable insights into imbalances between BEA's primary measure of GDP based on the final expenditures approach and its "shadow" measure based on income—that is, GDI.

BEA views the underlying framework now being implemented for partial integration as able to accommodate the requirements for full integration. That being said, however, what is presently missing for full integration is the data to populate much of this framework, particularly consistent and comprehensive data on intermediate inputs for industries. For example, less than half of the intermediate input estimates in the 1997 benchmark I-O accounts were based on high quality, consistent data collected by the Bureau of the Census; estimates for the balance were based on fragmented information from trade associations, company annual reports, anecdotal information, and prior benchmark I-O accounts. To be reliable, a production-based estimate of GDP requires an expansion by Census in its coverage of business expenses from less than half to 100

percent. The methods developed by BEA to achieve partial integration in the short run are not an adequate substitute for these improvements to source data in the long run, if the goals of full integration are to be realized. To acquire this information, BEA is working collaboratively with other statistical agencies, particularly the Bureau of the Census to both expand information collected for its annual surveys and for its quinquennial economic census, beginning with that for 2002.

Full integration also implies greater consistency in the data provided by different statistical agencies. For example, the quality of BEA's industry estimates can be affected by inconsistencies in the sampling frames used by the statistical agencies, as well as differences in classification and data collection and tabulation practices. Table A compares estimates of nonagricultural payroll data collected by the Bureau of the Census with wage and salary data collected by BLS for selected industries in 1992. Industries for which comparable information was not available are excluded from the table. The comparison shows that the estimates differ by 10 percent or more for about half of these industries. Although these differences do not directly affect measures of total value added, they can potentially impact the reliability of BEA's estimates of the labor-capital splits of industry value added. BEA envisions that it will be able to further enhance the consistency and quality of its fully integrated accounts because data-sharing initiatives should reveal the sources of these and other similar differences in source data from the various Federal statistical agencies. In the case cited, the consistency between its measures of gross output by industry and compensation of employees by industry, would be improved if payroll by industry data prepared by the Bureau of the Census and the

wages and salaries data prepared by BLS were brought into agreement by the source agencies.

At the earliest, full integration could not be attained until the 2008-2010 timeframe, which is when expanded data from the 2002 Economic Census will be fully incorporated into BEA's economic accounts, beginning with the release of the 2002 benchmark I-O accounts in 2007. If limited data sharing by statistical agencies is also made viable in the interim, BEA will be able to better identify the sources of the differences in data from other agencies such as those identified in the example presented above for BLS and Census data. The major benefit of such data sharing would be to enhance the consistency and quality of BEA's fully-integrated economic accounts.

IV. The Partial Integration Methodology

The methodology, including the source data and the estimating procedures that will be used for the partial integration of the annual I-O accounts and the GDP-by-industry accounts is discussed in this section. The methodology is described in a sequence of five steps: (1) Establishing a level of detail for both industries and commodities; (2) revising the previously published 1997 benchmark I-O accounts that will serve as a reference point for the integrated accounts; (3) developing a 1998-2002 time series for the annual estimates of value added by industry; (4) updating and balancing the annual I-O accounts for 1998-2002, incorporating the revised 1997 benchmark I-O accounts from step 2 and the 1998-2002 estimates of value added by

industry from step 3; and (5) preparing price and quantity indexes for the GDP-by-industry accounts for 1998-2002.

IV.1 Step 1: Level of Industry and Commodity Detail

The first step in integrating the annual I-O accounts and the GDP-by-industry accounts is to establish the level of detail that can be used for both sets of accounts. Table B shows this detail and the corresponding 1997 NAICS industry codes. Table B omits the statistical discrepancy that has traditionally appeared as an industry in the GDP-by-industry accounts. This omission reflects the use of a balanced framework which results in the statistical discrepancy being spread among industries. In addition, table B does not include an industry for the inventory valuation adjustment, which has traditionally been shown in the I-O accounts. In the integrated accounts, the inventory valuation adjustment is treated as a secondary product produced by industries and included in their gross output, as well as a separate commodity going to final demand. The level of detail shown in table B applies to both industries and commodities and serves as the publication level of detail. Most of the estimation procedures, however, are applied at a finer level of industry and commodity detail in order to ensure the best estimates at the publication level.

IV.2 Step 2: Revised 1997 Benchmark I-O Accounts

The second step in the partial integration process is to revise the previously published 1997 benchmark I-O accounts, because it must provide the relationships and levels for integrating the annual I-O accounts and GDP-by-industry accounts. The necessary revisions are from two sources. First, the 1997 benchmark I-O accounts must be modified to incorporate the definitional, methodological, and statistical changes from

the 2003 comprehensive revision of the NIPAs. Incorporating these changes ensures that the integrated accounts for 1998-2002 are consistent with the levels and composition of GDP in the NIPAs. The major NIPA changes and their effects on the 1997 benchmark I-O accounts are summarized in table C.

Second, after the NIPA revisions are incorporated, the level and the composition of value added for each industry must be further modified on the basis of information from both the I-O accounts and the GDP-by-industry accounts.[12] As discussed above, value added by industry in the I-O accounts is computed as the difference between gross output and intermediate inputs by industry, and value added by industry in the GDP-by-industry accounts is computed from the industry distributions of GDI from the NIPAs. In general, these two measures of value added for an industry will differ (see the first two columns of table D).

Chart 3 shows a matrix that demonstrates how the quality of the value added by industry estimates vary across the benchmark I-O accounts and the GDP-by-industry accounts. For example, both the benchmark I-O accounts and the GDP-by-industry accounts provide good measures of value added for the health care industry because of the near-complete coverage of gross output and intermediate inputs by the economic census and the relatively small amount of redistributions of income resulting from enterprise-establishment adjustments. On the other hand, both sets of accounts provide poor measures for the construction industry because of incomplete coverage in the economic census and because of large, lower-quality, enterprise-establishment adjustments. For many industries, the quality of industry value added is mixed. Mining

[12] The GDP-by-industry value added that is based on the NIPA GDI estimates will also incorporate the results from the 2003 comprehensive NIPA revision.

value added, for example, is good in the benchmark I-O accounts because of near-complete industry coverage, yet poor in the GDP-by-industry accounts because of relatively very large enterprise-establishment adjustments. The partial integration methodology draws the best information from both sets of accounts into a single, "combined" estimate of value added for each industry. These combined measures are then incorporated into the 1997 benchmark I-O accounts.[13]

The combined value added for an industry is an average with weights determined by criteria that reflect the relative quality of value added from the two sets of accounts. In general, these criteria are based on the quality of the source data used for each. The criteria for the benchmark I-O accounts include the following:

- The percent of intermediate inputs by industry that are covered by source data from the quinquennial economic census, and
- the percent of an industry's total gross output that is accounted for by the quinquennial economic census.

The criteria for the GDP-by-industry accounts include the following:

- The quality and the size of adjustments used to convert the enterprise-based, profit-type income data to an establishment basis, and
- the percent of an industry's value added that is accounted for by proprietors' income.

For both the benchmark I-O accounts and the GDP-by-industry accounts, these criteria, along with expert analyst judgment, are applied at the industry level shown in

[13] The estimates of "compensation of employees" and "taxes on production and imports, less subsidies" in the revised 1997 benchmark I-O accounts are consistent with those published in the NIPAs. For census-covered industries, the compensation in the previously published 1997 benchmark I-O accounts was based on the 1997 Economic Census. See Lawson, et al., 31.

table B in order to identify point estimates and estimates of variance for each industry's measure of value added.[14] These point estimates and estimates of variance are used to develop a probability distribution of value added for each industry from each set of accounts. Each probability distribution represents a measure of the likelihood that the "true" value added takes on a particular value, given the information available. The distributions are then combined to produce a measure of value added for each industry. Essentially, the combined measure is an average of the two point estimates with the weights being determined by the relative variances--that is, a point estimate with a smaller variance receives a larger weight. Appendix A provides technical details on the procedures used.

Chart 4 gives an example of this process for the educational services industry. The point estimate of value added is $63.4 billion from the revised 1997 benchmark I-O accounts and $61.3 billion from the GDP-by-industry accounts. The related probability distribution for each point estimate is shown in chart 4. Note that the GDP-by-industry distribution is more peaked (smaller variance) than the distribution from the I-O accounts (larger variance). The smaller variance indicates a relatively better GDP-by-industry estimate, which is the result of the small amount of enterprise-establishment adjustments made to the GDI data for this industry. In contrast, the larger variance for the benchmark I-O accounts is the result of the limited coverage of this industry's gross output and intermediate inputs in the quinquennial economic census. As expected, the combined

[14] The estimates are prepared at this level of detail because the industry distributions of GDI are available at this level. These estimates are allocated to more detailed industries when the revised benchmark I-O table is balanced. Source data for 1997 were not available on a 1997 NAICS basis for all of the components of GDI. For selected components, BEA converted data from the 1987 Standard Industrial Classification basis to the 1997 NAICS basis.

estimate of $62.2 billion is closer to the GDP-by-industry estimate than to the I-O estimate. Because more information is used to make this combined estimate, its overall quality is higher than that for either of the individual estimates, as shown by their distributions in chart 4. A complete list of the combined estimates of value added by industry is shown in the third column of table D.

After the two sets of revisions have been made to the 1997 benchmark I-O accounts, it is then balanced. For this balancing, each industry's gross output and new measure of value added are fixed, and its total intermediate inputs is allowed to adjust to the difference. Balancing ensures that the use of commodities equals their supply, the sum of each industry's value added and intermediate inputs equals its gross output, and the sum of final uses equals published GDP. The revised and balanced 1997 benchmark I-O accounts then provide a starting point for preparing the integrated accounts for 1998-2002.

IV.3 Step 3: A Time Series of Value Added for 1998-2002

A time series of value added by industry is prepared by extrapolating the revised 1997 benchmark I-O estimates of value added by industry forward to 1998-2002, using the GDI-based measure of value added from the GDP-by-industry accounts as the extrapolator for each industry. The components of GDI that compose value added by industry and information on the major source data and on the industrial distribution for each component are shown in table E.

As discussed above, the quality of the GDI-based measures of value added depends on a number of factors, including the size of adjustments required to convert enterprise-based, profit-type GDI data to an establishment basis and the size of

proprietors' income. Nonetheless, they are preferred as growth indicators when compared with those from the annual I-O residual methodology because of the scarcity of annual data on intermediate inputs for credible measures of value added.

After extrapolating the revised 1997 benchmark I-O level of value added forward with the GDI-based measure for each industry, the resulting sum of value added across industries will not necessarily sum to GDP in a given year--part of the difference being the statistical discrepancy and the other part being extrapolation errors. This procedure allocates this difference in two steps. In the first step, expert analyst judgment is used to adjust some industries with known measurement problems. In the second step, the remaining difference is distributed across industries in proportion to the industries' value added.

IV.4 Step 4: Updated and Balanced Annual I-O Accounts for 1998-2002

Five tasks must be completed sequentially to update and balance each of the five annual I-O tables for 1998-2002. These tasks include (1) estimating gross output for each industry and commodity; (2) estimating the commodity composition of intermediate inputs for each industry; (3) estimating the domestic supply for each commodity; (4) incorporating estimates of commodities used for personal consumption, for gross private fixed investment, and for government consumption and investment as part of GDP final-demand expenditures; and (5) balancing the use of commodities with available supply and the output of industries with necessary inputs for production.

IV.4.a Industry and Commodity Gross Output

For most industries and commodities, annual source data are available to estimate current-year industry and commodity gross output. The data sources used are shown in

Table F. Manufacturing, trade, and most service industry estimates are based on annual survey data from the Bureau of the Census. Agriculture, insurance, and government enterprise estimates, as well as transportation, utilities, finance, and real estate estimates, are primarily based on data from other government statistical agencies and private sources. For those industries and commodities for which annual source data are not available at the 1997 benchmark I-O level of detail, more aggregated source data are used as extrapolators.

IV.4.b Intermediate Inputs to Industries

Industry inputs are estimated in three steps. First, each industry's current-year output is valued in terms of the previous year's prices, using an industry price index that is calculated--in a Fisher index-number formula--as a weighted average of the price indexes for commodities produced by the industry. For commodities for which a price index is unavailable, an aggregate price index is applied to multiple commodities. The data sources used to prepare these indexes are shown in table F.

Second, each industry's current-year output, valued in the prices for the previous year, is multiplied by the previous year's direct requirements coefficient for the same industry. The initial set of coefficients used are those from the revised 1997 benchmark I-O accounts. The result of this multiplication yields current-year intermediate inputs valued in the prices of the previous year.[15] At this point, the composition of an industry's inputs per dollar of output (valued in the prices of the previous year) is unchanged from that of the previous year. To adjust for changes in relative prices, the results are reflated to current-year prices, using the commodity price indexes.

[15] A direct requirements coefficient represents the amount of a commodity required by an industry to produce a dollar of the industry's output.

Finally, commodity taxes, transportation costs, and trade margins for each intermediate input are estimated. Commodity taxes are added to increase the value of intermediate inputs from basic prices to producers' prices, and transportation costs and trade margins are added to increase the value further to purchasers' prices.[16]

IV.4.c Domestic Supply

The domestic supply is estimated. The domestic supply of each commodity is the total value of goods and services available for consumption as intermediate inputs by industries or for final use as personal consumption, private fixed investment, and government consumption and gross investment. It is calculated as domestic commodity output, plus government sales, and imports less exports and change in private inventories. Imports and exports are based on foreign trade statistics from the Bureau of the Census and on BEA's international transactions accounts. Changes in private inventories are from the NIPAs and the commodity composition of inventories held by industries is based on relationships from the revised 1997 benchmark I-O accounts.

IV.4.d Commodity Composition of Final Uses excluding Imports and Exports and Changes in Private Inventories

The annual estimates of the major expenditure components of final uses for personal consumption, private fixed investment, and government consumption and gross investment are obtained directly from the NIPAs. The initial commodity compositions of these components are estimated using relationships from the revised 1997 benchmark I-O accounts.

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[16] The basic price is the price received by the producer for goods sold; it excludes the taxes collected by the producer from purchasers, as well as transportation costs and trade margins.

IV.4.e Balancing the Use Table

Finally, commodities and industries are brought into balance using a biproportional adjustment procedure. This procedure sequentially adjusts rows and columns to equal the estimated output control totals. The adjustments are made iteratively until the use of each commodity equals its domestic supply, the sum of value added and intermediate inputs for each industry equals its gross output, and final-demand expenditures equal levels in the NIPAs. Appendix B provides a more detailed discussion of the techniques used for this balancing.

The annual I-O accounts are finalized for 1998-2002 after the results have been reviewed and verified. The measures of gross output, intermediate inputs, and value added by industry are then incorporated into the GDP-by-industry accounts.

IV.5 Step 5: Price and Quantity Indexes for the GDP-by-Industry Accounts

Price and quantity indexes for the GDP-by-industry accounts are prepared in two steps. First, price and quantity indexes for gross output and intermediate inputs are prepared for each industry. Second, information on gross output by industry is combined with information on intermediate inputs by industry to derive price and quantity indexes for value added by industry, using the double-deflation procedure.

IV.5.a Indexes for Gross Output and Intermediate Inputs by Industry

Price and quantity indexes for gross output by industry are derived by separately deflating each commodity produced by an industry and included in its gross output. Information on the commodities produced by industries is obtained from annual I-O make tables. Price and quantity indexes for intermediate inputs are estimated by deflating the commodities used by industries from the annual I-O use tables. The

commodity price indexes used for this deflation are listed in table F. When a commodity price index is based on more than one detailed price index, a Fisher index-number formula is used to prepare the composite index. Appendix C "Computing Chain-Type Price and Quantity Indexes in the GDP-by-Industry Accounts" shows the Fisher index-number formulas that are used to prepare the price and quantity indexes for gross output and intermediate inputs by industry.

IV.5.b Indexes for Value Added by Industry

Price and quantity indexes for value added by industry are calculated using the double-deflation method. In the double-deflation method, separate estimates of gross output and intermediate inputs by industry are combined in a Fisher index-number formula in order to generate price and quantity indexes for value added by industry (see Appendix C). This method is preferred for computing price and quantity indexes for value added by industry because it requires the fewest assumptions about the relationships among gross outputs.

V. Future Research

There are several areas of research that must be addressed in order to achieve BEA's long-run goal of full integration of the accounts. The most important of these include:

- Additional evaluation of the coverage, quality, and consistency of data from different sources for the purpose of improving BEA's industry accounts overall and its estimates of value added by industry specifically. This includes working cooperatively with other statistical agencies for the purpose of collecting

additional data as well as expanding data sharing initiatives to address differences across alternative data sources.

- Development of additional procedures to incorporate new data from the 2002 Economic Census and annual surveys of intermediate inputs by industry into BEA's industry accounts on a more accelerated basis, including techniques for evaluating "best-level" estimates as compared to "best-change" estimates.
- Development of new processes and procedures for incorporating information from the production-based approach of measuring GDP into the NIPAs on a timely basis.

Appendix A: Estimating the "Combined" Level of Value Added by Industry

This appendix describes the procedure used to determine the "combined" estimates of value added by industry that are incorporated into the revised 1997 benchmark input-output (I-O) accounts. The procedure allows for the best information from both the I-O accounts and the Gross-Domestic-Product (GDP)-by-industry accounts to be used in determining the combined estimates. This is accomplished by preparing a weighted average of the two independent measures of value-added where the weights reflect the relative quality of the two measures. For each of the 61 industries presented in table B, a weighted average is given by

$$\text{Combined}_{\text{i}} = b_{i,\text{I-O}}(\text{I - O}_{\text{i}}) + b_{i,\text{GDP by Industry}}(\text{GDP by Industry}_{\text{i}}),$$

where (I-O $_{\text{i}}$) is industry i's point estimate of value added from the benchmark I-O accounts and (GDP by Industry $_{\text{i}}$) is industry i's point estimate from the GDP-by-industry accounts. $b_{i,I-O}$ and $b_{i,\text{GDP by Industry}}$ are the weights for the benchmark I-O accounts and the GDP-by-industry accounts, respectively.

In this linear combination, the weights are a simple function of the relative precision of each point estimate. A modeling framework is developed to estimate the precision of each industry's value-added estimator. The precision of each point estimate is summarized using two measures. First, an ordinal quality ranking of industries is developed for both the benchmark I-O accounts and the GDP-by-industry accounts. Second, an approximate 95-percent confidence interval for each point estimate is determined by evaluating the uncertainty in the underlying source data. Implicit in both

the ordinal ranking and the confidence intervals are the quality criteria outlined on page 20 of the main text. A review of these criteria suggests that a significant amount of expert analyst judgment is incorporated into this framework.

Two practical considerations constrained the modeling framework finally selected by BEA for estimating weights. First, the overall objective is to obtain the most accurate weighted average feasible from the information currently available. Second, the model must not be overly sensitive to misspecifications of the 95- percent confidence intervals.

The chosen model requires the following assumptions:

1. Information about each benchmark I-O and GDP-by-industry value-added estimate can be effectively summarized by estimating the mean and standard deviation of a normal distribution. (This assumption implies that the standard deviation accurately summarizes the uncertainty associated with each estimator.)
2. The relative quality of the estimates from the benchmark I-O accounts and the GDP-by-industry accounts can be evaluated based on their point estimate-to-standard deviation ratios.
3. The point estimate-to-standard deviation ratios for all industries can be represented by an ordered vector with elements sampled from a beta distribution.

The steps for estimating each industry's standard deviation are as follows (for illustrative purposes, only the benchmark I-O accounts are discussed but the process is performed on the GDP-by-industry accounts as well):

1. For the benchmark I-O accounts, set candidate values for the two parameters of the beta distribution as a starting point. This distribution is evaluated as a candidate for characterizing the underlying distribution of point estimate-to-standard deviation ratios for all industries in the benchmark I-O accounts.
2. Sample 61 values from the distribution from step 1.
3. Rank order the 61 values from step 2 and assign one to each benchmark industry based on its ordinal ranking.
4. For each industry, use the assigned point estimate-to-standard deviation ratio and the known point estimate to determine the implied standard deviation.
5. Repeat this process many times (on average, about 5000 times), storing the implied standard deviations of the industry estimators from each repetition.
6. Compute the average of the sampled standard deviations for each industry using the results from step 5; use this average to develop a 95-percent confidence interval based on the normal distribution.
7. Compare the upper and lower bounds of the confidence interval estimated in step 6 with the original 95-percent confidence interval estimated for the benchmark I-O accounts.
8. Repeat steps 1 through 7 with all candidate beta parameters. Find the beta parameters that minimize the sum of squared deviations between the 95-percent confidence intervals from the benchmark I-O accounts and those from step 6.
9. After estimating the beta parameters from step 8, follow steps 2 through 6 to estimate the standard deviation for each of the 61 industries in the benchmark I-O accounts.

This procedure approximates the estimator variance for each benchmark I-O and GDP-by-industry value-added estimate. The estimator variance estimates are used to determine the weights for the combined estimates. Estimators with smaller variances are given greater weight, that is to say, the following weights are used to estimate the combined level of value added for each industry:

$$b_{i,\text{I-O}} = \frac{\sigma^2_{i,\text{GDP bt Industry}}}{\sigma^2_{i,\text{GDP bt Industry}} + \sigma^2_{i,\text{I-O}}} \text{ and } b_{i,\text{GDP by Industry}} = \frac{\sigma^2_{i,\text{I-O}}}{\sigma^2_{i,\text{GDP bt Industry}} + \sigma^2_{i,\text{I-O}}}$$

Appendix B: New Updating and Balancing Processes for BEA's Annual I-O Tables

Since 1999, when the Bureau of Economic Analysis (BEA) reinstated its annual input-output (I-O) program beginning with the release of accounts for 1996, BEA has had among its many goals that of releasing annual I-O tables on a schedule synchronized with that for the GDP-by-industry accounts. To achieve this goal implies regularly providing a time series of annual I-O tables with those for the most recent years being updated and revised through the standard advance, preliminary, and finale iterations—a potentially very resource-intensive process.

The five broad tasks required to produce annual I-O tables were identified and discussed in the main body of this report (see section III, step 4, beginning on page 21). In evaluating likely prospects for increased automation, BEA focused on task 5, "balancing the use table," which has tended to be very labor intensive because of BEA's extensive use of hand adjustments for the process. This appendix summarizes the results of BEA's research in this area and describes the changes being incorporated into the current balancing procedures for the 1998-2002 annual I-O accounts.[1]

The appendix is divided into three sections. The first section describes BEA's new balancing procedure. The second section describes the different tests that BEA performed on this procedure before it was adopted. The third section provides summary remarks.

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[1] For further information on this research, see the paper, "Increasing the Timeliness of U.S. Annual I-O Accounts," by M. Planting and J. Guo, in *Economic Systems Research*, No. 2, Vol. 16, 2004. The complete paper can also be obtained from BEA's Web site under "Papers and working papers" (http://www.bea.gov/bea/working_papers.htm).

1. Expanded Automation of Balancing Procedures

BEA has developed a new set of automated procedures for balancing its time series of integrated annual I-O tables for 1998 to 2002. Consistent with the research results, the new balancing procedures:

- Are based on an adjusted RAS (bi-proportional) process;
- balance the I-O table in producers' and purchasers' prices simultaneously;
- incorporate more exogenous data; and
- process the tables at the most detailed level of data feasible.

The new procedures generally begin with an I-O use table that has been updated, following steps one through four described in the main body of this report. The I-O use table matrix is then balanced in both basic prices and purchasers' prices. (The producers' price equals the basis price plus commodity taxes, transportation costs, and margin costs.) This process allocates transportation costs and margin costs to industries and final uses as functions of how the commodities are moved by the economy's transportation system (rail, truck, water, air, pipeline, and gas pipeline) and through its distribution channels (wholesale trade and retail trade). In the use table, these costs are summed for each industry and shown as separate commodity purchases.

The new balancing procedures require fifteen matrices, each of which must be balanced internally, while maintaining the different relationships specified among matrices. The following matrices are prepared: A matrix with commodities valued in basic prices and one in purchasers' prices; one for commodity taxes; one for each of the six transportation modes (rail, truck, water, air, oil pipe, and gas pipe); one for wholesale trade margin; one for retail trade margin; and two matrices for taxes by each type of

margin (see Figure 1). The transportation and wholesale trade matrices are of the same dimensions as those for producers' and purchasers' prices. The retail trade matrix is a single vector with one margin total for all consuming industries and final users. The matrix valued in basic prices is related to that valued in purchasers' prices through the taxes, transportation, and trade matrices. A cell in the purchasers' value matrix equals the corresponding cell in the basic value matrix plus the cells in the taxes, transportation and trade matrices; conversely, a cell in the basic value matrix equals the corresponding cell in the purchasers' value matrix less those in the taxes, transportation and trade matrices.

Control totals are identified for each matrix. The basic price, tax, transportation, and trade matrices are two dimensional and have separate control totals for each row or commodity. The retail trade margin matrices are one dimensional and have single control totals for the margin, sales tax, and other retail tax. The purchasers' price matrix is two dimensional and is the sum of producers' price inputs plus transportation and trade margin costs; it has column control totals for each industry and final use category.

Detailed national income and product accounts (NIPA) estimates, in purchasers' prices, are used as controls for the different types of final uses. These detailed data provide the basis for expanding estimates of personal consumption expenditures from one to 210 categories; gross private fixed investment from one to 33; structures, from one to 26; and government expenditures and investment from six to 136. Elements that remain constant or fixed in all matrices include exports, imports, changes in business inventories, and other negative cells.

Balancing the fifteen matrices is complex and requires several steps and iterations. Beginning first with the rows, adjustment factors are calculated, equaling the row control less the sum of the fixed cells in the row, divided by the sum of the new cells less the fixed cells. These adjustment factors are applied to the row cells that are not fixed in each matrix. The purchasers' price matrix is then calculated as the sum of the twelve other matrices. To balance the columns, adjustment factors are again calculated, this time equaling the column control less the sum of the fixed cells in the column, divided by the sum of the column cells less the fixed cells. These factors are then applied to the column cells that are not fixed in each matrix. The cells in the basic price matrix are then calculated as the difference between the purchasers' price and the sum of the twelve other matrices.

After a set number of iterations, and when the cells are close to being balanced in both basic and purchasers' values, then the taxes, transportation, and trade matrices are forced to also balance to their respective row control totals. The balancing of the taxes, transportation, and trade matrices is delayed until the matrices valued in basic and purchasers' prices are approximately balanced in order to maintain the initial tax rates, transportation cost rates, and trade margin rates as long as possible.

2. Tests on the New Procedures

BEA tested both the new balancing procedures and an alternative, more highly-automated set of procedures, referred to as a "basic model," using an old workfile with 1997 detailed data. Results were then compared to the published 1997 annual I-O use table. Unlike the new procedures which balance multiple matrices, the basis model balances the table in producers' prices only. To evaluate the results from the two

approaches, a set of tests were designed to answer the following questions:

- Does balancing in both producers' and purchasers' prices improve results? Most I-O tables are balanced in producers' prices (basic model). However, balancing in producers' prices ignores the detailed estimates of final use expenditures from the NIPAs, which are valued in purchasers' prices as well as the relationships between transportation and margin costs and the use of goods. It is hypothesized that valuing in purchasers' prices and using detailed data from the NIPAs improve the reliability of the balancing model.
- Does the addition of known estimates of value added for industries improve results? Value added makes up a significant portion of each industry's input structure. It is hypothesized that providing estimates of value added for industries significantly reduces necessary adjustments and improves overall results. (Value added is determined endogenously as a residual for the basic model.)
- Does greater industry and commodity detail improve the results? The more aggregated the table, the more diverse the mix of products grouped together as a single commodity and the more diverse the market. Conversely, the more disaggregated the table, the more specialized commodities are to different markets. It is hypothesized that using more detail at the working level improves the initial distributions of commodities to users and, consequently, also improves the reliability of the balancing model.

To answer these questions, BEA designed twelve tests that could be used to compare results from the new procedures with those from the basic model. Each version of a use table was balanced, using both the new adjustment process and the basic

adjustment process. For the balancing, each was run through 40 iterations. Each final use table was then collapsed to the summary level and compared to the published 1997 annual I-O use table.

The measure used for comparing results is the direct coefficient—that is, the amount of a commodity required by an industry to produce a dollar of output. The fewer the differences in direct coefficients between the balanced tables and the published 1997 annual table, the better the balancing model. Our comparisons were limited to the larger cells of the use table, that is, to direct coefficients with underlying intermediate values of $100 million or greater in producers' prices, and to those cells with absolute value difference (published less the balanced direct coefficient) of greater than 0.01 for direct coefficients.

Table 1 provides the major test results. Overall, large coefficient differences decreased from 11.7 percent for the basic model, balanced at the publication level of data and using value added calculated as a residual, to 5.8 percent for the new model, balanced at the source data level and using independent, fixed value-added estimates. The major conclusions from the tests are as follows:

- Results from the new balancing procedures are better than those from the basic model;
- working with more detail data improves results;
- the addition of known value-added estimates improves results; and
- the new balancing procedures result in only 5.8 percent of the direct coefficients changing by more that 0.01 with a absolute average change of 0.029.

3. Conclusions

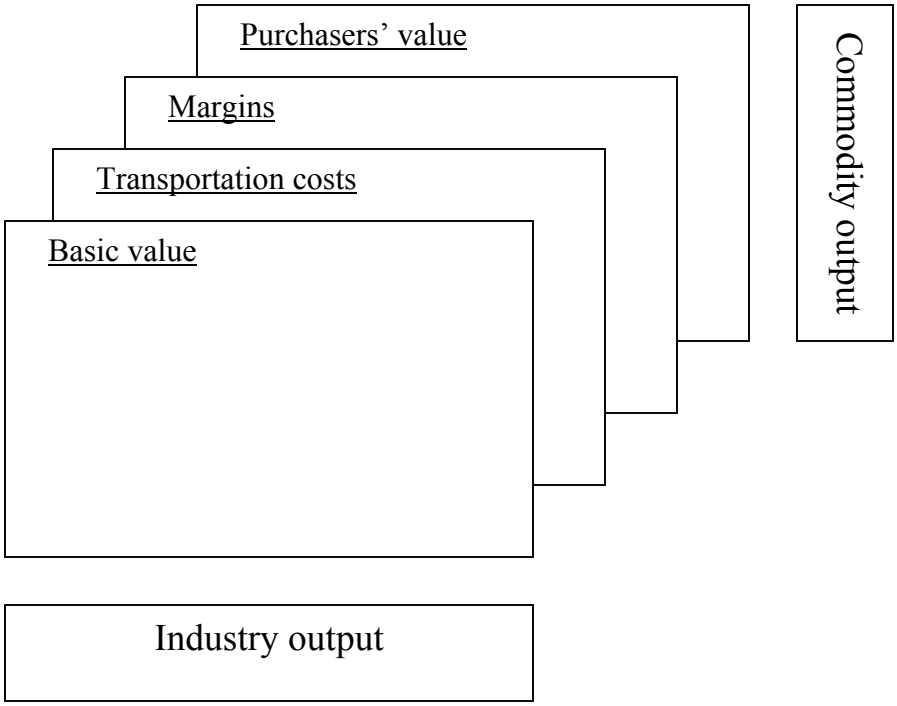
One of BEA's goals has been to develop the capability for producing I-O tables that are more current but are not extremely resource intensive to produce. Research to this end has resulted in BEA's development of new automated procedures for balancing its use tables. From the test results examines, it is concluded that the best results are obtained when balancing in both purchasers' and basic prices. The test results also show that providing fixed estimates of value added and working at the detailed source data level both improve final results. However, although the new procedures produce use tables that are fairly comparable to the published table, the remaining differences are still important. Additional research is needed to evaluate these remaining coefficient differences and their causes.

Table 1. Large Coefficient Differences from the New Balancing Model Compared with those from the Basic Balancing Model [1]

Model	Balancing level	Value added	Percent of cells with large coefficient differences	Mean absolute value of coefficient difference
Basic	Detailed publication level	Residual	11.7	0.027
		Fixed	9.8	0.025
	Source data level	Residual	8.3	0.030
		Fixed	6.5	0.028
New	Detailed publication level	Residual	7.3	0.032
		Fixed	9.6	0.027
	Source data level	Residual	7.3	0.033
		Fixed	5.8	0.029

[1] Large coefficient differences are defined as those greater than 0.01 from the same cell in the published 1997 I-O use table.

Figure 1. Relationship between Basic Value and Purchasers' Value Matrices in the New Balancing Model



Appendix C: Computing Chain-Type Price and Quantity Indexes in the GDP-by-Industry Accounts

The computation of the chain-type Fisher price and quantity indexes for gross output, intermediate inputs, and value added for an industry or an aggregate is summarized below.

1. Chain-type price indexes

In the notation, $LP_{t-1,\,t}$ refers to the Laspeyres price relative for the years t-1 and t, $PP_{t-1,\,t}$ refers to the Paasche price relative, $FP_{t-1,\,t}$ refers to the Fisher price relative, and CP_t refers to the Fisher chain-type price index. The superscript GO refers to gross output, II refers to intermediate inputs, and VA refers to value added; p refers to detailed prices, and q refers to quantities.

Laspeyres price relatives for gross output, intermediate inputs, and value added, respectively, are:

$$LP_{t-1,t}^{GO} = \frac{\sum p_t^{GO}\, q_{t-1}^{GO}}{\sum p_{t-1}^{GO}\, q_{t-1}^{GO}},$$

$$LP_{t-1,t}^{II} = \frac{\sum p_t^{II}\, q_{t-1}^{II}}{\sum p_{t-1}^{II}\, q_{t-1}^{II}}, \text{ and}$$

$$LP_{t-1,t}^{VA} = \frac{(\sum p_t^{GO}\, q_{t-1}^{GO}) - (\sum p_t^{II}\, q_{t-1}^{II})}{(\sum p_{t-1}^{GO}\, q_{t-1}^{GO}) - (\sum p_{t-1}^{II}\, q_{t-1}^{II})}.$$

Paasche price relatives for gross output, intermediate inputs, and value added are:

$$PP_{t-1,t}^{GO} = \frac{\sum p_t^{GO}\, q_t^{GO}}{\sum p_{t-1}^{GO}\, q_t^{GO}},$$

$$PP_{t-1,t}^{II} = \frac{\sum p_t^{II}\, q_t^{II}}{\sum p_{t-1}^{II}\, q_t^{II}}, \text{and}$$

$$PP_{t-1,t}^{VA} = \frac{(\sum p_t^{GO}\, q_t^{GO}) - (\sum p_t^{II}\, q_t^{II})}{(\sum p_{t-1}^{GO}\, q_t^{GO}) - (\sum p_{t-1}^{II}\, q_t^{II})}.$$

Fisher price relatives for gross output, intermediate inputs, and value added are:

$$FP_{t-1,t}^{GO} = \sqrt{LP_{t-1,t}^{GO} \times PP_{t-1,t}^{GO}},$$
$$FP_{t-1,t}^{II} = \sqrt{LP_{t-1,t}^{II} \times PP_{t-1,t}^{II}}, \text{ and}$$
$$FP_{t-1,t}^{VA} = \sqrt{LP_{t-1,t}^{VA} \times PP_{t-1,t}^{VA}}.$$

Fisher chain-type price indexes for gross output, intermediate inputs, and value added for years after the reference year are:

$$CP_t^{GO} = CP_{t-1}^{GO} \times FP_{t-1,t}^{GO},$$
$$CP_t^{II} = CP_{t-1}^{II} \times FP_{t-1,t}^{II}, \text{ and}$$
$$CP_t^{VA} = CP_{t-1}^{VA} \times FP_{t-1,t}^{VA}.$$

In the reference year (2000 for this comprehensive revision),

$$CP_t^{GO} = CP_t^{II} = CP_t^{VA} = 100.$$

2. Chain-type quantity indexes

In the notation, $LQ_{t-1,\,t}$ refers to the Laspeyres quantity relative for the years t-1 and t, $PQ_{t-1,\,t}$ refers to the Paasche quantity relative, $FQ_{t-1,\,t}$ refers to the Fisher quantity relative, and CQ_t refers to the Fisher chain-type quantity index. The superscript GO refers to gross output, II refers to intermediate inputs, and VA refers to value added; p refers to detailed prices, and q refers to quantities.

Laspeyres quantity relatives for gross output, intermediate inputs, and value added, respectively, are:

$$LQ^{GO}_{t-1,t} = \frac{\sum p^{GO}_{t-1}\ q^{GO}_{t}}{\sum p^{GO}_{t-1}\ q^{GO}_{t-1}},$$
$$LQ^{II}_{t-1,t} = \frac{\sum p^{II}_{t-1}\ q^{II}_{t}}{\sum p^{II}_{t-1}\ q^{II}_{t-1}}, \textit{and}$$
$$LQ^{VA}_{t-1,t} = \frac{(\sum p^{GO}_{t-1}\ q^{GO}_{t}) - (\sum p^{II}_{t-1}\ q^{II}_{t})}{(\sum p^{GO}_{t-1}\ q^{GO}_{t-1}) - (\sum p^{II}_{t-1}\ q^{II}_{t-1})}.$$

Paasche quantity relatives for gross output, intermediate inputs, and value added are:

$$PQ^{GO}_{t-1,t} = \frac{\sum p^{GO}_{t}\ q^{GO}_{t}}{\sum p^{GO}_{t}\ q^{GO}_{t-1}},$$
$$PQ^{II}_{t-1,t} = \frac{\sum p^{II}_{t}\ q^{II}_{t}}{\sum p^{II}_{t}\ q^{II}_{t-1}}, \textit{and}$$
$$PQ^{VA}_{t-1,t} = \frac{(\sum p^{GO}_{t}\ q^{GO}_{t}) - (\sum p^{II}_{t}\ q^{II}_{t})}{(\sum p^{GO}_{t}\ q^{GO}_{t-1}) - (\sum p^{II}_{t}\ q^{II}_{t-1})}.$$

Fisher quantity relatives for gross output, intermediate inputs, and value added are:

$$FQ^{GO}_{t-1,t} = \sqrt{LQ^{GO}_{t-1,t} \times PQ^{GO}_{t-1,t}},$$
$$FQ^{II}_{t-1,t} = \sqrt{LQ^{II}_{t-1,t} \times PQ^{II}_{t-1,t}}, \textit{and}$$
$$FQ^{VA}_{t-1,t} = \sqrt{LQ^{VA}_{t-1,t} \times PQ^{VA}_{t-1,t}}.$$

Fisher chain-type quantity indexes for gross output, intermediate inputs, and value added for years after the reference year are:

$$CQ^{GO}_{t} = CQ^{GO}_{t-1} \times FQ^{GO}_{t-1,t},$$
$$CQ^{II}_{t} = CQ^{II}_{t-1} \times FQ^{II}_{t-1,t}, \textit{and}$$
$$CQ^{VA}_{t} = CQ^{VA}_{t-1} \times FQ^{VA}_{t-1,t}.$$

In the reference year (2000 for this comprehensive revision),

$$CQ^{GO}_{t} = CQ^{II}_{t} = CQ^{VA}_{t} = 100.$$

Chart 1. Use Table: Commodities Used by Industries and Final Uses

		Industries																					Final Uses							
		Agriculture, forestry, fishing, and hunting	Mining	Utilities	Construction	Manufacturing	Wholesale trade	Retail trade	Transportation and warehousing	Information	Finance and insurance	Real estate and rental and leasing	Professional, scientific, and technical services	Management of companies and enterprises	Administrative and waste management services	Educational services	Health care and social assistance	Arts, entertainment, and recreation	Accommodation and food services	Other services, except government	Government	Total interme-diate use	Personal consump-tion expendi-tures	Private fixed investment	Change in business inventories	Exports of goods and services	Imports of goods and services	Government consumption expenditures and gross investment	GDP	Total Commodity Output
Commodities	Agriculture, forestry, fishing, and hunting																												
	Mining																												
	Utilities																												
	Construction																												
	Manufactured products																												
	Wholesale trade																												
	Retail trade																												
	Transportation and warehousing																												
	Information																												
	Finance and insurance																												
	Real estate and rental and leasing																												
	Professional, scientific, and technical services																												
	Management of companies and enterprises																												
	Administrative and waste management services																												
	Educational services																												
	Health care and social assistance																												
	Arts, entertainment, and recreation																												
	Accommodation and food services																												
	Other services, except government																												
	Government																												
	Other inputs /1/																												
	Total intermediate inputs																												
Value Added	Compensation of employees																												
	Taxes on production and imports, less subsidies																												
	Gross operating surplus																												
	Total																												
Total Industry Output																													

1. Includes noncomparable imports, scrap, used goods, inventory valuation adjustment, and rest-of-the-world adjustment.

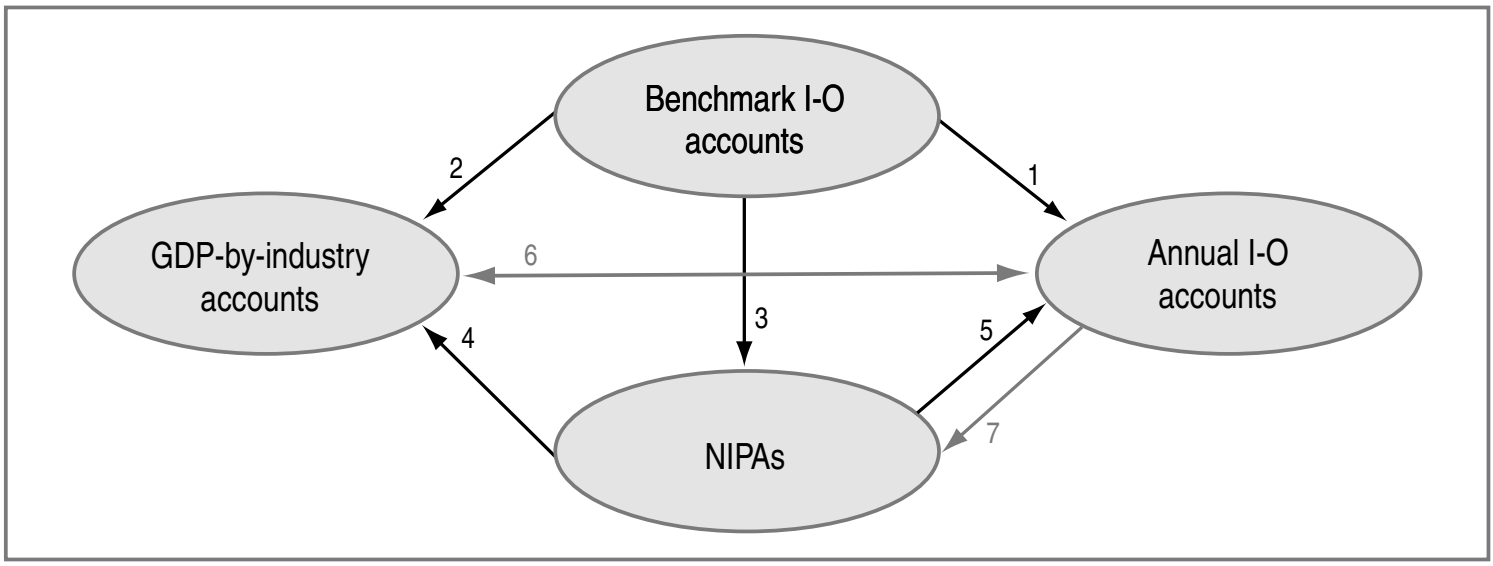
GDP Gross domestic product

U.S. Bureau of Economic Analysis

Total commodity output

Total industry output

Chart 2. Relationships Among National Economic Accounts



GDP Gross domestic product
I-O Input-output
NIPAs National Income and product accounts

U.S. Bureau of Economic Analysis

Chart 3. Merging Information for Setting Value-Added Levels

Benchmark Value Added

GDP-by-Industry Value Added		
	Good Benchmark data/ good GDP-by-industry data e.g., Health care	Good Benchmark data/ poor GDP-by-industry data e.g., Mining
	Poor Benchmark data/ Good GDP-by-industry data e.g., Transportation/ Warehousing	Poor Benchmark data/ poor GDP-by-industry data e.g. Construction

U.S. Bureau of Economic Analysis

Chart 4. Probability Distributions of Value Added for Educational Services

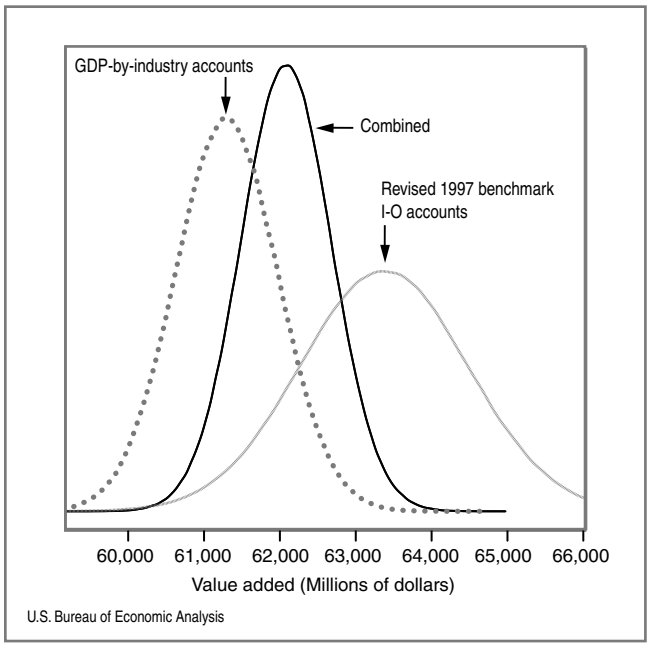


Table A. Comparison of BLS and Census Nonagricultural Payroll Data for Selected Private Industries, 1992 1/
[Millions of dollars unless otherwise noted]

Industry description	BLS	Census	BLS less Census	Absolute percent difference
Total	2,046,864	2,020,570	26,294	1.3
Industries with absolute difference of 10 percent or more				
Membership organizations	15,458	10,188	5,270	34.1
Tobacco products	2,103	2,534	-431	20.5
Miscellaneous repair services	8,263	9,849	-1,586	19.2
Health services	236,388	278,598	-42,210	17.9
Pipelines, except natural gas	975	821	154	15.8
Motor freight transportation and warehousing	35,536	41,070	-5,534	15.6
Leather and leather products	2,320	1,973	347	15.0
Security and commodity brokers and dealers	39,908	34,390	5,518	13.8
Oil and gas extraction	15,539	13,933	1,606	10.3
Insurance agents, brokers, and services	21,327	19,123	2,204	10.3
Nondepository credit institutions	15,007	16,509	-1,502	10.0
Industries with absolute difference of 5 to less than 10 percent				
Real estate	29,634	26,817	2,817	9.5
Textile mill products	14,801	13,531	1,270	8.6
Transportation services	8,959	8,225	734	8.2
Water transportation	5,949	5,481	468	7.9
Industrial machinery and equipment	69,749	64,588	5,161	7.4
Social services	27,508	25,565	1,943	7.1
Retail trade	268,207	249,328	18,879	7.0
Holding and other investment offices	10,313	9,626	687	6.7
Transportation equipment	74,475	69,706	4,769	6.4
Paper and allied products	24,542	23,079	1,463	6.0
Amusement and recreation services	20,816	19,612	1,204	5.8
Motion pictures	9,611	10,160	-549	5.7
Stone, clay, and glass products	15,283	14,441	842	5.5
Wholesale trade	199,687	188,780	10,907	5.5
Industries with absolute difference of less than 5 percent				
Primary metal industries	24,612	23,483	1,129	4.6
Lumber and wood products	15,345	14,669	676	4.4
Petroleum and coal products	7,568	7,246	322	4.2
Local and interurban passenger transportation	5,624	5,394	230	4.1
Rubber and miscellaneous plastics products	24,058	25,028	-970	4.0
Food and kindred products	44,712	43,032	1,680	3.8
Automotive repair, services, and parking	17,207	16,597	610	3.5
Depository institutions	59,464	57,479	1,985	3.3
Fabricated metal products	39,745	40,929	-1,184	3.0
Construction	122,135	118,600	3,535	2.9
Electric, gas, and sanitary services	40,683	39,623	1,060	2.6
Electronic and other electric equipment	52,057	50,812	1,245	2.4
Communications	48,908	47,742	1,166	2.4
Chemicals and allied products	47,911	46,835	1,076	2.2
Insurance carriers	49,457	50,559	-1,102	2.2
Instruments and related products	35,932	36,613	-681	1.9
Apparel and other textile products	16,792	16,506	286	1.7
Legal services	40,480	39,995	485	1.2
Nonmetallic minerals, except fuels	3,291	3,265	26	0.8
Printing and publishing	43,655	43,926	-271	0.6
Business services	115,010	114,446	564	0.5
Furniture and fixtures	10,650	10,678	-28	0.3
Miscellaneous manufacturing industries	9,210	9,189	21	0.2

1/ Several industries are excluded because of differences in coverage or nondisclosure issues. These industries include: Metal mining, coal mining, air transportation, hotels and other lodging places, personal services, educational services, museums, art galleries, and botanical gardens, membership organizations, engineering and accounting services.

Table B. Industries and Commodities in the Integrated Accounts

1997 NAICS industries	1997 NAICS codes
All industries	
Private industries	
Agriculture, forestry, fishing, and hunting	**11**
Farms	111, 112
Forestry, fishing, and related activities	113, 114, 115
Mining	**21**
Oil and gas extraction	211
Mining, except oil and gas	212
Support activities for mining	213
Utilities	**22**
Construction	**23**
Manufacturing	**31, 32, 33**
Durable goods	33, 321, 327
Wood products	321
Nonmetallic mineral products	327
Primary metals	331
Fabricated metal products	332
Machinery	333
Computer and electronic products	334
Electrical equipment, appliances, and components	335
Motor vehicles, bodies and trailers, and parts	3361, 3362, 3363
Other transportation equipment	3364, 3365, 3366, 3369
Furniture and related products	337
Miscellaneous manufacturing	339
Nondurable goods	31, 32 (except 321 and 327)
Food and beverage and tobacco products	311, 312
Textile mills and textile product mills	313, 314
Apparel and leather and allied products	315, 316
Paper products	322
Printing and related support activities	323
Petroleum and coal products	324
Chemical products	325
Plastics and rubber products	326
Wholesale trade	**42**
Retail trade	**44, 45**
Transportation and warehousing	**48, 49**
Air transportation	481
Rail transportation	482
Water transportation	483
Truck transportation	484
Transit and ground passenger transportation	485
Pipeline transportation	486
Other transportation and support activities	487, 488, 492
Warehousing and storage	493
Information	**51**
Publishing industries (includes software)	511
Motion picture and sound recording industries	512
Broadcasting and telecommunications	513
Information and data processing services	514
Finance and insurance	**52**
Federal Reserve banks, credit intermediation, and related activities	521, 522
Securities, commodity contracts, and investments	523
Insurance carriers and related activities	524
Funds, trusts, and other financial vehicles	525
Real estate and rental and leasing	**53**
Real estate	531
Rental and leasing services and lessors of intangible assets	532, 533
Professional, scientific, and technical services	**54**
Legal services	5411
Computer systems design and related services	5415
Miscellaneous professional, scientific, and technical services	5412–5414, 5416–5419
Management of companies and enterprises	**55**
Administrative and waste management services	**56**
Administrative and support services	561
Waste management and remediation services	562
Educational services	**61**
Health care and social assistance	**62**
Ambulatory health care services	621
Hospitals and nursing and residential care facilities	622, 623
Social assistance	624
Arts, entertainment, and recreation	**71**
Performing arts, spectator sports, museums, and related activities	711, 712
Amusements, gambling, and recreation industries	713
Accommodation and food services	**72**
Accommodation	721
Food services and drinking places	722
Other services, except government	**81**
Government	**92**
Federal	**n.a.**
General government	n.a.
Government enterprises	n.a.
State and local	**n.a.**
General government	n.a.
Government enterprises	n.a.

n.a. Not applicable.

Table C. NIPA Changes Incorporated into the 1997 Benchmark Input-Output (I-O) Accounts

NIPA changes [1]	I-O components affected
Recognize the implicit services provided by property and casualty insurance companies and provide a more appropriate treatment of insured losses.	Industry and commodity gross output for insurance carriers and related activities; intermediate inputs and gross operating surplus for all industries; final uses.
Allocate a portion of the implicit services of commercial banks to borrowers.	Industry and commodity gross output for Federal Reserve banks, credit intermediation and related activities; intermediate inputs and gross operating surplus for all industries; final uses.
Redefine change in private farm inventories to include farm materials and supplies.	Intermediate inputs and gross operating surplus for the farms industry; change in private inventories.
Reclassify Indian tribal government activities from the private sector to the state and local government sector.	Gross output, intermediate inputs, and value added for the amusements, gambling, and recreation; accommodation; and state and local government enterprises industries; state and local general government.
Reclassify military grants-in-kind as exports.	Federal general government; exports.
Recognize explicitly the services produced by general government and treat government purchases of goods and services as intermediate inputs.	Gross output and intermediate inputs for the state and local general government and Federal general government industries.
Reclassify business nontax liability as current transfer payments to government and as rent and royalties to government.	Taxes on production and imports, less subsidies and gross operating surplus for all industries; gross output for the rental and leasing services and lessors of intangible assets industry; purchases of the rental and leasing services and lessors of intangible assets commodity by selected industries.

1. For details, see Brent R. Moulton and Eugene P. Seskin, "Preview of the 2003 Comprehensive Revision of the National Income and Product Accounts: Changes in Definitions and Classifications," SURVEY OF CURRENT BUSINESS 83 (June 2003): 20.

NIPA National income and product accounts

Table D. 1997 Industry Value Added Estimates

Industry	Revised benchmark I-O accounts	GDP-by-industry accounts	Combined
Accommodation	75,769	71,018	74,715
Administrative and support services	228,861	197,921	211,393
Air transportation	45,285	55,017	49,465
Ambulatory health care services	267,784	261,920	267,208
Amusements, gambling, and recreation industries	45,180	37,667	41,142
Apparel, leather, and allied product manufacturing	28,918	26,249	27,410
Broadcasting and telecommunications	196,395	212,151	209,135
Chemical manufacturing	149,879	150,776	150,776
Computer and electronic product manufacturing	178,019	144,110	155,121
Computer systems design and related services	69,536	87,477	78,648
Construction	310,029	346,223	337,808
Educational services	63,371	61,295	62,233
Electrical equipment, appliance, and component manufacturing	41,230	79,140	45,584
Fabricated metal product manufacturing	114,396	102,625	108,218
Federal Reserve banks, credit intermediation, and related services	274,457	251,974	259,541
Food services and drinking places	151,890	133,183	141,224
Food, beverage, and tobacco product manufacturing	158,928	130,224	135,540
Forestry, fishing, and related activities	21,110	23,771	22,582
Funds, trusts, and other financial vehicles	9,957	9,882	9,957
Furniture and related product manufacturing	28,181	25,568	27,252
Hospitals and nursing and residential care facilities	205,830	199,526	203,588
Information and data processing services	30,418	18,550	27,179
Insurance carriers and related activities	175,610	217,464	206,153
Legal services	111,052	119,435	114,457
Machinery manufacturing	104,664	88,649	98,140
Mining, except oil and gas	25,869	27,854	26,377
Miscellaneous manufacturing	47,861	47,793	47,861
Miscellaneous professional, scientific and technical services	343,445	308,416	325,061
Motion picture and sound recording industries	25,272	22,899	24,276
Motor vehicle, body, trailer, and parts manufacturing	93,396	117,083	103,340
Nonmetallic mineral product manufacturing	40,720	37,829	40,720
Oil and gas extraction	48,084	59,236	52,828
Other services, except government	206,147	185,476	197,401
Other transportation and support activities	50,523	59,586	55,041
Other transportation equipment manufacturing	55,538	52,444	54,494
Paper manufacturing	51,046	51,354	51,354
Performing arts, spectator sports, museums, and related activities	30,050	34,717	32,892
Petroleum and coal products manufacturing	22,595	67,926	26,663
Pipeline transportation	9,227	8,095	8,759
Plastics and rubber products manufacturing	62,402	49,828	60,748
Primary metal manufacturing	43,799	51,214	48,190
Printing and related support activities	42,725	47,362	44,646
Publishing industries (includes software)	114,475	65,572	87,558
Rail transportation	23,133	22,590	23,061
Real estate	944,801	886,560	907,847
Rental and leasing services and lessors of intangible assets	118,401	74,444	89,752
Retail trade	517,499	588,270	574,076
Securities, commodity contracts, investments	107,598	131,109	119,430
Social assistance	38,834	43,181	40,081
Support activities for mining	11,941	18,439	13,336
Textile and textile product mills	26,012	27,829	26,966
Transit and ground passenger transportation	17,090	12,164	12,964
Truck transportation	87,016	76,343	80,496
Utilities	162,264	180,852	180,046
Warehousing and storage	19,014	20,003	19,550
Waste management and remediation services	22,618	20,339	21,346
Water transportation	7,162	6,273	6,524
Wholesale trade	487,913	531,865	521,239
Wood product manufacturing	26,207	30,666	28,032

Table E. Principal Source Data for Value-Added Extrapolators

Component of gross domestic income	Major source data	Industrial distribution	
		Distribution available in source data	Data or assumption used if distribution by establishment is not available in source data
Compensation of employees, paid			
Wage and salary accruals [1]	BLS tabulations of wages and salaries of employees covered by state UI programs and OPM data on wages and salaries of Federal Government employees.	Establishment.	
Supplements to wages and salaries			
Employer contributions for employee pension and insurance funds	DOL tabulations of IRS data (Form 5500) on pension plans, HHS data from the Medical Expenditure Panel Survey on health insurance, and trade association data for other types.	None. [2]	BLS employer cost index and UI tabulations.
Employer contributions for government social insurance	Federal budget data.	None.	Social Security Administration and BLS tabulations.
Taxes on production and imports, less subsidies			
Taxes on production and imports	Federal budget data and Census Bureau data on state and local governments.	None.	Property taxes are based on BEA capital stock distribution.
Subsidies	Federal budget data and Census Bureau data on state and local governments.	None.	Payments are assigned to the industries being supported.
Gross operating surplus			
Private enterprises			
Net interest and miscellaneous payments, domestic industries			
Corporate	IRS tabulations of data from corporate tax returns (Form 1120 series), FFIEC Call Report data on commercial banks, trade association data on life insurance companies.	Company.	Census Bureau company-establishment employment matrix.
Noncorporate	IRS tabulations of tax return data from sole proprietorships (Form 1040 Schedule C) and partnerships (Form 1065), FRB flow-of-funds-account data on residential mortgages.	Company.	Assumed to be equivalent to an establishment distribution.
Business current transfer payments (net)	IRS tabulations of data from corporate tax returns (Form 1120 series), trade association data for property-casualty insurance net settlements and for other types.	Company.	Industry-specific payments are assigned to those industries; others are based on IRS company industry distribution.
Proprietors' income with IVA and without CCAdj			
Farm	USDA farm income statistics.	Establishment.	
Nonfarm			
Proprietors' income without IVA and CCAdj	IRS tabulations of tax return data from sole proprietorships (Form 1040 Schedule C) and partnerships (Form 1065).	Company.	Assumed to be equivalent to an establishment distribution.
IVA	BLS prices and IRS inventory data.	Establishment.	
Rental income of persons without CCAdj	Census Bureau data on housing units and rents from the American Housing Survey, HMDA data on residential mortgages, and IRS tabulations of data from individual tax returns (Form 1040).	Establishment.	
Corporate profits before tax with IVA and without CCAdj, domestic industries			
Corporate profits before tax without IVA and CCAdj	IRS tabulations of data from corporate tax returns (Form 1120 series) and regulatory agencies and public financial reports data.	Company.	Census Bureau company-establishment employment matrix.
IVA	BLS prices and IRS inventory data.	Establishment.	
Capital consumption allowances			
Corporate	IRS tabulations of data from corporate tax returns (Form 1120 series).	Company.	Census Bureau company-establishment employment matrix.
Noncorporate	IRS tabulations of tax return data from sole proprietorships (Form 1040 Schedule C) and partnerships (Form 1065).	Company.	Assumed to be equivalent to an establishment distribution.
Current surplus of government enterprises	Federal budget data and Census Bureau data on state and local governments.	Establishment.	
Consumption of fixed capital			
Households and institutions [3]	BEA capital stock estimates.	Establishment.	
Government	BEA capital stock estimates.	Type of agency.	

1. Includes wage and salary disbursements to the rest of the world and excludes wages and salaries received from the rest of the world.
2. A company-based industrial distribution for pension plans is available in the source data.
3. Consists of owner-occupied housing and nonprofit institutions primarily serving households.

BEA Bureau of Economic Analysis
BLS Bureau of Labor Statistics
CCAdj Capital consumption adjustment
DOL Department of Labor
FFIEC Federal Financial Institutions Examination Council
FRB Federal Reserve Board of Governors
HCFA Health Care Financing Administration
HHS Department of Health and Human Services
HMDA Home Mortgage Disclosure Act
IRS Internal Revenue Service
IVA Inventory valuation adjustment
OPM Office of Personnel Management
UI Unemployment insurance
USDA U.S. Department of Agriculture

Table F. Principal Sources of Data for Industry and Commodity Output and Prices

Industry and commodity	Source data for extrapolator	Source data for price index
Agriculture, forestry, fishing and hunting		
Farms	USDA cash receipts from marketing and inventory change	USDA prices received by farmers; PPI.
Forestry, fishing, and related activities	For forestry, Census Bureau shipments; for fishing, NOAA value of fish landings; for related activities, NIPA estimates	PPI; NOAA; NIPA deflator.
Mining		
Oil and gas extraction	DOE quantity produced and prices.	For crude petroleum and natural gas, IPD from DOE; for natural gas liquids, PPI.
Mining, except oil and gas	DOE quantity produced and average price for uranium and coal; USGS quantity and price data for all others.	IPD from DOE and USGS.
Support activities for mining	DOE, USGS, and trade sources for quantity produced and prices.	IPD from DOE, USGS and trade sources; for exploration, PPI.
Utilities		
Electric utilities	EIA	PPI.
Natural gas	EIA quantity and price data	PPI.
Water, sewage, and other systems	PCE	CPI.
Construction		
For the Department of Defense (DOD)	DOD expenditures data	DOD prices for military construction; cost indexes from trade sources and government agencies for other construction.
For state and local highways	Census Bureau data from the ASGF	Cost indexes from government agencies.
For private electric and gas utilities	Federal regulatory agencies and trade sources expenditures data	Cost indexes from trade sources and government agencies.
For farms, excluding residential	USDA expenditures data	Trade sources cost index; Census Bureau price deflator for new single-family houses under construction.
For other nonresidential	Census Bureau data on value of construction put in place	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 data on value of construction put in place	Census Bureau price index for new single-family houses under construction; BEA price index for multifamily construction.
Manufacturing	Census Bureau data on shipments and inventory change	PPI; quality adjusted price indexes for computers, photocopying equipment, digital telephone switching equipment, and LAN equipment; BEA price indexes based on DOD prices paid for military equipment.
Wholesale trade	Census Bureau ATS data	Sales price by kind-of-business computed from PPI.
Retail trade	Census Bureau ARTS data	Sales price by kind-of-business computed from CPI.
Transportation and warehousing		
Air transportation	BTS Air Carrier Financial Statistics.	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	Amtrak and trade sources	PPI.
Water transportation	Army Corps of Engineers; trade sources; PCE	For marinas, PCE price index; PPI for freight; for passengers, CPI.
Truck transportation	Census Bureau SAS	PPI.
Transit and ground passenger transportation	PCE; BTS	For taxicabs, intercity buses, and other local transit, PCE price index; for school buses, BLS data on wages and salaries per employee.
Pipeline transportation	Trade sources	PPI.
Other transportation and support activities	PCE	For sightseeing, PCE price index; for other transportation and support activities, PCE price indexes and PPI.
Warehousing and storage	Census Bureau SAS	PPI.
Information		
Publishing industries (includes software)	Census Bureau SAS	BEA price indexes for prepackaged and custom software for software publishers; for all other publishing industries, PPI.
Motion picture and sound recording industries	Census Bureau SAS	PCE price indexes.
Broadcasting and telecommunications	Census Bureau SAS	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	Census Bureau SAS	For information services, PCE price indexes; for data processing services, PPI.

Please see the footnotes at the end of the table.

Table F. Principal Sources of Data for Industry and Commodity Output and Prices—Continued

Industry and commodity	Source data for extrapolator	Source data for price index
Finance and insurance		
Federal Reserve banks, credit intermediation, and related activities	FDIC; FRB; NIPA imputed service charges; NCUA; and other private agencies	PCE price indexes; other government data.
Securities, commodity contracts, and investments	SEC FOCUS Report.	PCE price indexes.
Insurance carriers and related activities	Trade sources for insurance carriers; BEA expected loss estimates for property and casualty insurance; for all other insurance, PCE; for insurance agents, brokers, and services, IRS tabulations of business tax returns	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	NIPA imputed service charges for other financial institutions; EBSA data on pension funds	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 residential dwellings and real estate agents and managers, NIPA housing data; for nonresidential dwellings, IRS tabulations of business tax returns; NIPA rental value of buildings owned by nonprofits	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 rental and leasing services, Census Bureau SAS; for royalties, IRS tabulations of business tax returns	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	Census Bureau SAS	PPI.
Computer systems design and related services	Census Bureau SAS	BEA price indexes for prepackaged and custom software.
Miscellaneous professional, scientific, and technical services	Census Bureau SAS	PPI; BLS wages and salaries per full-time employee.
Management of companies and enterprises	BLS wages and salaries	BLS wages and salaries per full-time employee.
Administrative and waste management services		
Administrative and support services	Census Bureau SAS	BLS wages and salaries per full- time employee; PCE price indexes; PPI.
Waste management and remediation services	Census Bureau SAS	CPI.
Educational services	PCE	PCE price index based on trade sources
Health care and social assistance		
Ambulatory health care services	Census Bureau SAS	PPI; PCE price indexes.
Hospitals and nursing and residential care facilities	Census Bureau SAS	PCE price indexes.
Social assistance	Census Bureau SAS	PCE price indexes.
Arts, entertainment, and recreation		
Performing arts, spectator sports, museums, and related activities	Census Bureau SAS	PCE price indexes.
Amusements, gambling, and recreation industries	Census Bureau SAS	PCE price indexes.
Accommodation and food services		
Accommodation	Census Bureau ARTS	For hotels and motels, PPI; PCE price index.
Food services and drinking places	Census Bureau ARTS	CPI.
Other services, except government	For religious, labor, and political organizations, PCE; for other services, Census Bureau SAS; for private households, BEA compensation of employees	CPI; BLS data on wages and salaries per full-time employee; PCE price indexes.
Government		
Federal		
General government	NIPA estimates	NIPA price indexes.
Government enterprises	USPS receipts; for electric utilities, DOE; other government data	For USPS and electric utilities, PPI; for all others, PCE price index and NIPA price indexes.
State and local		
General government	NIPA estimates	NIPA price indexes.
Government enterprises	For electric utilities, DOE data; for other enterprises, BEA data on revenue by type	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

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