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Chapter Title: Recent and Planned Improvements in the Measurement and Deflation of Services Outputs and Inputs in BEA's Gross Product Originating Estimates

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1 Recent and Planned Improvements in the Measurement and Deflation of Services Outputs and Inputs in BEA's Gross Product Originating Estimates

Michael F. Mohr

The GNP-by-industry estimates, alternatively known as the gross product originating (GPO) estimates, are a widely used and closely monitored series prepared by the Bureau of Economic Analysis (BEA) as an integral part of the national income and product accounts (NIPAs). Compared to output measures (such as sales, value of shipments, or gross output), GPO measures have two main attributes: (1) they measure the GNP originating from the component industries of the U.S. economy and (2) the sum of industry GPO provides an unduplicated measure of the total output produced by the economy.¹ During the 1970s and especially during the 1980s, the GPO estimates have become the object of regular and intense interest by policymakers and economists investigating hotly debated, high profile, and closely associated economic issues of national importance. These issues include

- *Productivity growth.* Why has the rate of productivity growth of the aggregate U.S. private business and nonfarm economies declined since the mid-1960s and especially since 1973? Why has the productivity growth of the services sector of the economy not rebounded since 1979 as robustly as has manufacturing? And is the post-1979 productivity improvement in manufacturing real or just an artifact of the GPO measures?

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1. Although GPO is a value-added measure, that term is not used here because of possible confusion with census value added. GPO differs from census value added largely because GPO excludes, but census value added includes, services inputs. Students of productivity growth should also note that GPO and gross output are distinctly different measures. Even over expansion intervals, the mean growth rates of industry GPO and gross output are quite different for nearly all industries shown in table 1.1 of the text.

- *Structural change.* Is the manufacturing share of the U.S. private domestic product declining? Is the United States becoming a service economy? And are the effects of structural change a net good or bad for the U.S. economy?
- *Competitiveness.* Are U.S. industries strong and healthy enough to compete in a world economy? Is foreign competition destroying the industrial and technical base of the United States?

As a consequence of their critical importance in the foregoing areas, the industry GNP estimates in recent years have been the subject of several studies investigating the possibility that flaws in the source data and estimating methods underlying the industry estimates are producing profoundly incorrect answers to the questions raised in the above issue areas.

BEA acknowledged the potential significance of several of these criticisms in the July 1988 *Survey of Current Business* (SCB), when it announced its intention to reexamine the methodology underlying the industry GNP estimates and, where existing source data permitted, to undertake improvements to the estimates (Bureau of Economic Analysis 1988). The fruits of phase 1 of the GPO improvement program effort are now emerging; improved estimates for 1977–88, published in the January 1991 SCB, mark the first publication of GPO estimates since July 1988 (Bureau of Economic Analysis 1991).

This paper focuses on the improved measures of services outputs, inputs, and GPO generated by phase 1 of the GPO improvement program; it also discusses future improvements planned for phases 2 and 3. Section 1.1 defines the services-producing industries included in the GPO estimates, and it demonstrates the growing role of services in the GPO estimates and in the U.S. economy from both output and input perspectives. Section 1.1 summarizes the recent literature criticizing the services measures underlying or produced from the GPO estimates. Section 1.3 outlines not only the methodology BEA uses to generate the current estimates of GNP for services-producing industries but also the measurement problems attendant to those procedures. Section 1.4 develops the major improvements in the constant-dollar measures of services outputs, inputs, and GPO that have been embodied in the recently published phase 1 estimates for 1977–88. Section 1.5 summarizes the overall GPO improvement program, and it outlines important planned future changes in methodology that will be instituted during phases 2 and 3 to further improve the services measures in the GPO accounts. Section 1.6 closes the paper with a discussion of critical source data deficiencies that can be addressed only through expanded data collection by other agencies.

1.1 Services in the GPO Estimates and the Economy

1.1.1 Services-Producing Industries

The industry detail currently contained in the GPO estimates is shown in table 1.1, which also gives the 1972 standard industrial classification (SIC)

definition of each GPO industry. Annual current- and constant-dollar GPO estimates, at the level of detail shown in table 1.1, have traditionally been published in tables 6.1 and 6.2, respectively, of the July SCB. Included in the existing GPO estimates are 60 private industries, which provide approximately two-digit SIC private-sector detail. Of these 60 private industries, 28 are commodity producing and 32 are services producing. Following convention, the services-producing or service sector of the private economy is defined here to include the detailed industries classified by SIC under transportation; communications; electric, gas, and sanitary services; trade; finance, insurance, and real estate (FIRE); and services in table 1.1. And, the commodity-producing sector is defined to include all the component industries classified by SIC under agriculture, forestry, and fisheries; mining, construction, and manufacturing in table 1.1.²

1.1.2 The Share of Gross National Product in Services-Producing Industries

Table 1.1 also demonstrates the dramatic growth that has taken place in the share of total real GNP accounted for by services-producing industries. Between 1960 and 1988, the share of total real GNP originating in services-producing industries increased 10.5 percentage points—from 46.2 percent to 56.7 percent. Led by the rapid growth in the telephone and telegraph, wholesale trade, real estate, business services, and health services, most of the relative growth of services-producing industries occurred between 1969 and 1979. By 1988 these five industries accounted for more than 27.6 of the 56.7 percentage point share of GNP traceable to services-producing industries, compared with 19.2 of 46.2 percentage points in 1960.

1.1.3 The Services Share of Intermediate Inputs Consumed

Another measure of the importance of services in the economy and in the GPO estimates is the value of services inputs consumed relative to the value of all intermediate inputs consumed by U.S. industries. Based on estimates for 1977 and 1985 derived from the recent methodology improvements, this input perspective on the importance of services is demonstrated in tables 1.2 and 1.3. For example, table 1.3 demonstrates a fact that may surprise many: real services inputs are not only a rapidly growing but also a very large share of the real inputs consumed by every major industrial sector of the private nonfarm economy. Indeed, services constitute well over half of the real cost of intermediates in seven out of ten nonfarm industry divisions in both 1977 and 1985. In addition, services relative share of such costs has also grown rapidly in seven of these industries between 1977 and 1985. Table 1.2 demonstrates that this relative growth has been particularly pronounced in the con-

2. This commonly used definition of commodity-producing industries incorporates industries such as agricultural services, mining services, and maintenance and repair construction, which might be more appropriately defined as services producing.

Table 1.1 GNP by Industry as a Percentage of Constant-Dollar GNP for Select Years

Industry or Sector	1972 SIC	1960	1969	1979	1988	Difference, 1988 - 1990
GNP		100.0	100.0	100.0	100.0	—
Domestic industries (GDP)		99.3	99.3	98.3	99.3	—
Private industries		86.1	85.8	87.0	89.7	3.6
Commodity-producing industries		39.9	37.7	34.4	33.3	-6.9
Agriculture, forestry, & fisheries		4.1	2.7	2.4	2.3	-1.8
Farms	01-02	3.7	2.4	2.0	1.8	-1.9
Agricultural services, forestry, & fisheries	07-09	0.4	0.3	0.4	0.5	0.1
Mining		5.7	5.3	4.5	3.2	2.5
Metal	10	0.2	0.1	0.1	0.1	-0.1
Coal	11-12	0.5	0.4	0.4	0.5	—
Oil & gas extraction	13	4.8	4.6	3.8	2.5	-2.3
Nonmetallic minerals, except fuels	14	0.2	0.2	0.2	0.2	—
Construction	15-17	9.8	7.6	5.2	4.4	-5.4
Manufacturing		20.3	22.1	22.3	23.0	2.7
Durable goods		12.2	13.8	13.6	14.5	2.3
Lumber & wood products	24	0.5	0.6	0.7	0.6	0.1
Furniture & fixtures	25	0.3	0.3	0.3	0.3	—
Stone, clay & glass products	32	0.8	0.8	0.7	0.6	-0.2
Primary metal industries	33	2.3	2.1	1.7	0.9	-1.4
Fabricated metal products	34	1.7	2.0	1.8	1.6	-0.1
Machinery, except electrical	35	2.0	2.4	2.7	4.2	2.2
Electric & electronic equipment	36	1.0	1.5	1.9	2.2	1.2
Motor vehicles & equipment	371	1.1	1.5	1.5	1.3	-0.2
Other transportation equipment	372-79	1.5	1.6	1.1	1.5	—
Instruments & related products	38	0.4	0.6	0.7	0.8	0.4
Miscellaneous manufacturing industries	39	0.4	0.4	0.4	0.4	—
Nondurable goods		8.2	8.4	8.7	8.6	0.4
Food & kindred products	20	2.0	1.8	1.9	1.7	-0.3
Tobacco manufactures	21	0.4	0.3	0.3	0.1	-0.3
Textile mill products	22	0.4	0.5	0.5	0.4	—
Apparel & other textile product	23	0.7	0.6	0.4	0.6	-0.1
Paper & allied products	26	0.8	0.9	0.9	0.9	0.1
Printing & publishing	27	1.3	1.3	1.2	1.1	-0.2
Chemicals & allied products	28	1.1	1.4	1.7	1.8	0.7
Petroleum & coal products	29	1.0	0.9	0.8	1.1	0.1
Rubber & miscellaneous plastic products	30	0.4	0.6	0.6	0.7	0.3
Leather & leather products	31	0.2	0.2	0.1	0.1	0.1
Transportation & public utilities:						
Transportation		4.4	4.3	3.9	3.7	-0.7

Table 1.1 (continued)

Industry or Sector	1972 SIC	1960	1969	1979	1988	Difference, 1988 - 1990
Railroad transportation	40	1.4	1.2	0.7	0.7	-0.7
Local & interurban passenger transit	41	0.7	0.3	0.2	0.2	-0.5
Trucking & warehousing	42	1.3	1.5	1.7	1.6	0.3
Water transportation	44	0.3	0.2	0.3	0.1	-0.2
Transportation by air	45	0.3	0.6	0.6	0.8	0.5
Pipelines, except natural gas	46	0.1	0.1	0.2	0.1	0.0
Transportation services	47	0.2	0.2	0.2	0.3	0.1
Communication		1.2	1.5	2.3	2.7	1.5
Telephone & telegraph	481, 482, 489	1.0	1.4	2.0	2.4	1.4
Radio & television broad- casting	483	0.2	0.2	0.3	0.2	0.1
Electric, gas, & sanitary services	49	2.1	2.4	3.0	3.3	1.2
Wholesale trade	50-51	5.5	6.1	6.2	7.4	1.9
Retail trade	52-59	9.2	8.8	9.1	9.9	0.7
Finance, insurance, & real estate		12.4	13.0	14.4	14.5	2.1
Banking	60	1.5	1.5	1.7	1.6	0.2
Credit agencies other than banks	61	0.1	0.1	0.2	0.2	0.1
Security & commodity brokers, & services	62	0.3	0.4	0.3	0.8	0.5
Insurance carriers	63	0.9	0.8	1.1	1.0	0.1
Insurance agents & brokers, & services	64	0.6	0.6	0.5	0.5	-0.1
Real estate	65-66	8.8	9.4	10.5	10.1	1.3
Holding & other investment companies	67	0.1	0.1	0.2	0.3	0.2
Services		11.4	11.9	13.7	15.3	3.9
Hotels & other lodging places	70	0.7	0.7	0.8	0.7	0.0
Personal services	72	1.1	1.0	0.7	0.7	-0.4
Business services	73	1.4	1.9	2.5	3.7	2.3
Auto repair, services & garages	75	0.5	0.6	0.8	0.7	0.2
Miscellaneous repair services	76	0.3	0.2	0.3	0.3	0.0
Motion pictures	78	0.2	0.2	0.2	0.2	0.0
Amusement & recreation services	79	0.5	0.4	0.4	0.5	0.1
Health services	80	2.5	3.0	4.0	4.0	1.5
Legal services	81	0.9	0.9	0.9	1.0	0.1
Educational services	82	0.5	0.6	0.6	0.6	0.0
Social services & member- ship organizations	83, 86	0.9	0.9	0.9	0.9	0.0
Miscellaneous professional services	84, 89	0.9	1.0	1.4	1.7	0.8
Private households	88	0.9	0.5	0.2	0.2	-0.7

(continued)

Table 1.1 (continued)

Industry or Sector	1972 SIC	1960	1969	1979	1988	Difference, 1988 - 1990
Government & government enterprises		14.4	14.0	11.8	10.5	-3.9
Federal		7.4	6.6	4.3	3.7	-3.7
Government	91-97	6.5	5.8	3.5	3.1	-3.4
Government enterprises	01-89	0.8	0.8	0.7	0.6	-0.2
State and local		7.1	7.4	7.5	6.7	-0.4
Government	91-96	6.5	6.9	7.0	6.2	-0.3
Government enterprises	01-89	0.6	0.5	0.5	0.5	-0.1
Statistical discrepancy*		-0.5	-0.4	0.0	-0.2	0.3
Residual [†]		-0.7	-0.1	-0.5	-0.7	0.0
Rest of the world [‡]		0.7	0.7	1.7	0.7	0.0

Note: Percentages for 1960 and 1969 are based on data published in *National Income and Product Accounts of the United States, 1929-82: Statistical Tables* and are not fully consistent with the 1979 and 1988 percentages, which are based on the revised estimates published in the January 1991 *Survey of Current Business*.

*Current-dollar statistical discrepancy equals GNP measured as the sum of expenditures less charges against GNP—i.e., GNP measured as the sum of costs incurred and profits earned in production. Constant-dollar statistical discrepancy is equal to current-dollar statistical discrepancy divided by the implicit deflator for gross domestic business product.

[†]Equals GNP in constant dollars measured as the sum of expenditures less the statistical discrepancy in constant dollars and GNP in constant dollars measured as the sum of gross product by industry.

[‡]Production abroad that is attributable to factors of production supplied by U.S. residents less the production in the United States attributable to factors of production supplied by foreign residents. Production is measured by the net inflow of labor and property incomes.

Table 1.2 Services Share of Constant-Dollar Intermediate Inputs of Nonfarm Industries, 1977 and 1985 (%)

Industry*	1977	1985	Difference, 1985 - 1977
Mining	53.1	56.1	3.0
Construction	33.5	38.7	5.3
Manufacturing	21.4	24.3	2.9
Transportation	53.5	58.4	4.9
Communications	58.3	57.8	-0.5
Electric, gas, & sanitary services	41.5	41.8	0.4
Wholesale trade [†]	76.1	78.1	2.0
Retail trade [†]	60.8	66.5	5.7
Finance, insurance, & real estate	94.1	91.9	-2.2
Services	61.0	64.8	3.8

*Column includes only those industries shown in table 1.5 that are double deflated under phase I of GPO improvement program.

[†]Intermediate input excludes cost of purchases for resale.

Table 1.3 Industrial Composition of Constant-Dollar Intermediate Inputs Consumed by Manufacturing Industries, 1977 and 1985 (%)

Input Type	1977	1985	Difference, 1985 - 1977
All inputs	100.0	100.0	—
Commodity inputs	77.2	74.0	-3.2
Agriculture, forestry, & fisheries	5.9	6.5	0.6
Mining	14.2	10.5	-3.7
Construction	1.1	0.5	-0.6
Durables manufacturing	30.7	30.0	-0.7
Nondurables manufacturing	25.3	26.5	1.2
Services inputs	21.4	24.3	2.9
Transportation	3.7	3.7	0.0
Railroad	1.0	0.8	-0.2
Local & interurban passenger	0.2	0.1	-0.1
Trucking & warehousing	1.6	1.6	0.0
Water	0.3	0.2	-0.1
Air	0.4	0.6	0.2
Pipelines, except natural gas	0.3	0.4	0.1
Services	0.0	0.0	0.0
Communication	0.4	0.5	0.1
Telephone & telegraph	0.4	0.5	0.1
Radio & television broadcasting	0.0	0.0	0.0
Electric, gas, & sanitary services	3.6	3.8	0.2
Wholesale trade	5.5	6.2	0.7
Retail trade	0.9	0.9	0.0
Finance, insurance, & real estate	1.8	2.3	0.5
Banking	0.6	0.8	0.2
Credit agencies other than banks	0.0	0.1	0.1
Security & commodity brokers, services	0.1	0.1	0.0
Insurance carriers	0.3	0.1	-0.2
Insurance agents & brokers, services	0.0	0.0	0.0
Real estate	0.9	1.3	0.4
Services	5.3	6.9	1.6
Hotels & other lodging places	0.3	0.3	0.0
Personal	0.1	0.1	0.0
Business	3.2	4.2	1.0
Auto repair, services, & garages	0.4	0.7	0.3
Miscellaneous repair	0.4	0.5	0.1
Motion pictures	0.0	0.0	0.0
Amusement & recreation	0.0	0.0	0.0
Health	0.0	0.0	0.0
Legal	0.2	0.3	0.1
Educational	0.1	0.1	0.0
Social services, membership organizations	0.1	0.1	0.0
Miscellaneous professional	0.6	0.7	0.1
Other*	1.4	1.7	0.3

*Scrap and imports of commodities not produced in the United States.

struction, transportation, and retail trade industries; in each of these, services share of intermediate input cost grew by 5.0 percentage points or more.

Although manufacturing shows the lowest relative share—21.4 percent in 1977 and 24.3 percent in 1985—this industry nevertheless accounts for the largest value of real expenditures on service inputs. Table 1.3 decomposes the real cost of intermediate inputs consumed by manufacturers; it shows that the share of intermediate input cost accounted for by commodity-producing industries declined by 3.2 percentage points between 1977 and 1985 and that the share from services-producing industries rose by 2.9 percentage points. It also shows that more than half (1.7 out of 2.9 percentage points) of the relative growth in manufacturing's consumption of service inputs occurred in services purchased from wholesale trade and from the business services group.³ By 1985, these two groups of services constituted 10.4 percent of the total real cost of intermediate inputs consumed by manufacturers, compared to 8.7 percent in 1977.

Taken together, the data in tables 1.2 and 1.3 are suggestive of the critical contribution of services to important changes taking place in industry production processes and in interindustry relationships. Industries are lowering their cost of production and increasing their international competitiveness by procuring more of the activities—accounting, advertising, legal help, computer software, and temporary help, and so on—that they used to perform in-house from service firms that specialize in such activities.

1.2 Recent Criticisms of BEA Services Measures

The recent literature on productivity, structural change, and competitiveness contains several studies that suggest deficiencies in the measures of services outputs and inputs produced from the GPO estimates through July 1988. These studies include contributions by Mohr and Christy (1986), Mishel (1988, 1989), and Baily and Gordon (1988), and Kelly and Wyckoff (1989). Mohr and Christy (M-C) observed that, although detailed industry GNP measures are the ideal output series for analyzing structural change, the GNP estimates for several service-sector industries are likely to have significant errors. The M-C study attributes these potential errors to deficiencies in the underlying methodology—particularly, the use of employment and earnings data to extrapolate GPO benchmarks in several service-sector industries does not allow for productivity change in those industries.

Several of the industries singled out by M-C were scrutinized in the Baily

3. The business services group is consistent with the definition in BEA's input-output (I-O) tables. It consists of services included in SIC 73, business services, as well as services defined in SICs 76, 81, and 89. The SIC composition of I-O industries is shown in Bureau of Economic Analysis (1984).

and Gordon (B-G) study for evidence of large measurement errors that may help to explain the yet-unexplained slowdown in nonmanufacturing U.S. productivity growth since 1973. The B-G study examines both the current-dollar data and the price deflators used to construct the GPO estimates in FIRE, retail trade, and transportation industries. In each case, B-G finds evidence of “large potential errors” in the measurement of real GPO, most of which result from the failure to measure properly real output growth and to account for quality change. Their analysis suggests that improved GPO estimates could be achieved by one or more of the following: (1) use of either new or better physical output quantity indexes to extrapolate base-year output estimates in transportation, finance, and insurance; and (2) the development of hedonic price indexes to deflate the output of the insurance, real estate, and air-transportation industries.⁴

Mishel examined in detail the methodology underlying the entire spectrum of prerevision GPO estimates and highlighted several major measurement problems. These problems included the omission of import prices from the input price deflators, the use of outdated and, in some cases, inappropriate relationships to distribute company-based profits and depreciation allowances to establishment-based industries in measuring current-dollar industry GNP, and errors in the measurement of the prices and value of service inputs. He conjectured that the combination of these problems in the old GPO series helped to mask a significant erosion in manufacturing’s share of GNP and in its productivity growth since 1979 and thereby caused a complementary understatement of output and productivity growth in the service sector.

Finally, Kelly and Wyckoff (K-W) noted that reliable estimates of GNP by industry are important for assessing interindustry rates of productivity growth and innovation; for understanding complex interindustry relationships, and for monitoring important changes in these relationships.⁵ They observed, however, that, although the input-output (I-O) tables provide the basic tool for achieving such estimates, the lack of up-to-date information on services used as inputs is a major impediment to improving the quality of the industry GNP estimates. Specifically, K-W examined the methodology underlying BEA’s annual I-O tables, which are used in the revised GPO estimates to compute the distribution of intermediate inputs consumed by U.S. industries. The K-W study concluded that, because they are too sparse in services detail and are based on out-of-date input distributions from the 1977 benchmark I-O table, the annual I-O tables (and GPO estimates) do not adequately capture the rapidly growing importance of services inputs relative to goods inputs.

4. Nevertheless, B-G conclude that the net result of all their recommended measurement improvements would be but a small improvement in aggregate nonfarm productivity growth.

5. Although industry GNP is still widely used in labor productivity studies, the clear preference in the contemporary productivity literature is for total factor productivity studies employing industry gross output measures.

1.3 Estimation of Current-Dollar GPO: Past and Present Practice

In principle, equivalent measures of current-dollar (CU\$) industry GNP can be calculated from either of two methods:

$$\begin{aligned} \text{Method (1)} \quad \text{CU\$ GNP} &= \text{CU\$ gross output} \\ &\quad - \text{CU\$ intermediate inputs,} \end{aligned}$$

or

$$\begin{aligned} \text{Method (2)} \quad \text{CU\$ GNP} &= \text{Sum of CU\$ payments to labor and capital} \\ &\quad + \text{CU\$ nonfactor charges.} \end{aligned}$$

The value of intermediate inputs shown in method (1) includes the cost of materials and services either purchased from other domestic industries or imported. The payments to labor in method (2) include not only wages and salaries but also supplements; payments to capital include profits, rent, and net interest; and nonfactor charges include depreciation, business transfer payments, indirect business taxes, and subsidies.

Method 1 corresponds to the procedure that would be used to generate industry value added from a consistent set of production accounts or I-O tables; this is the procedure prescribed in the United Nations system of national accounts (SNA) literature.⁶ Presently, this method is not used by BEA because sufficiently detailed and SIC consistent annual production accounts are not yet available, as a result of source data limitations. As noted below, however, BEA intends to develop such accounts during phases 2 and 3 of the GPO improvement program.

Consequently, method 2 is the procedure used both historically and presently by BEA to generate current-dollar GNP for all industries except farms and nonfarm housing services. Under this method, the components of industry GNP correspond exactly to the components of the income side of the NIPAs or charges against GNP (CAGNP).⁷ As such, the sum of industry GNP is identical to CAGNP, and, like CAGNP, total industry GNP plus statistical discrepancy is equal to GNP, which is measured from the expenditures side of the accounts. However, the source data actually used to allocate the components of CAGNP are in some cases poorly suited to obtaining consistent and precise SIC establishment-industry GNP estimates.

Table 1.4 summarizes both the components and the major source data that are presently used to construct the current-dollar GPO estimates. In deriving industry GNP, BEA presently seeks to distribute each component of aggregate CAGNP on an establishment basis, using industries defined according to the 1972 SIC. As previously noted, the methodology used to effect these distributions has several problems. Included among them are the following.

6. See United Nations (1968).

7. See, e.g., *Survey of Current Business*, July 1988, 36.

- (1) No one establishment-based data source covers either all the private industries included in the GPO or all the 14 factor and nonfactor components of the current-dollar GNP for a single industry;
- (2) The before-tax corporate profits, capital consumption allowance, nonfarm proprietor's income, net interest, and pensions (in other labor income) components of CAGNP are derived from company-based rather than establishment-based industry data; and
- (3) establishment-industry distributions of the components of industry current-dollar GNP can be inconsistent (e.g., wages and salaries are based primarily on classifications assigned by The Bureau of Labor Statistics [BLS]; profits are based on classifications assigned by the Census Bureau; and nonfarm proprietor's income are based on classifications assigned by IRS).⁸

The accuracy of BEA's estimated establishment-industry distributions for corporate profits before tax and for capital consumption allowance (depreciation) is the most questionable of all the CAGNP components.⁹ Here, the primary source data are tabulations of corporate tax-return information. The IRS classifies a corporation into an SIC industry according to the industry that accounts for the largest percentage of its sales. Many companies, however, either are highly diversified or draw a high percentage of their profits from an industry that lies outside their principal industry. Depreciation and profits for IRS industries covered in the economic censuses are reallocated by use of a 1972 employment matrix that provides the Census Bureau's establishment-industry distribution for employment for corporations classified by IRS into specific SIC industries.¹⁰ Use of the employment matrix for this purpose has

8. Evidence of the difference between BLS and census establishment classifications is found in Office of Management and Budget (1990).

9. For the corporate net interest component of CAGNP, BEA makes no attempt to redistribute the IRS value, because no adequate basis exists for converting from a company-industry to an establishment-industry distribution. For the noncorporate CAGNP components, BEA assumes that the IRS data are already distributed on an establishment-industry basis, because noncorporate firms generally operate in only one business.

10. Algebraically, the employment-matrix model can be described as follows:

$$(1) \quad C_i = A_{i2} X_i$$

where

$C_i = (n \times 1)$ vector whose elements c_{it} represent company-based industry i profits or depreciation from tax-return data for year t ; $A_{i2} = (n \times n)$ matrix whose elements a_{ij} represent the number of employees of company-based industry i who worked in establishment-based industry j during 1972; $X_i = (n \times 1)$ unknown vector whose elements x_{ij} represent either the profits or depreciation per employee in establishment-industry j .

Model (1) is solved simultaneously by matrix inversion to yield:

$$(2) \quad X_i = A_{i2}^{-1} C_i$$

The solution vector X_i thus represents the profit/depreciation rates per employee that must exist in census establishment-based industries in order to redistribute current-year company-based industry profits/depreciation in a manner that is consistent with the corresponding 1972 distribution of

Table 1.4 Major Sources for Current-Dollar GPO by Industry

Component of Charges against GNP	Major Source Data	Industrial Distribution	
		Distribution Available in Source Data	Data or Assumption Used if Establishment-Industry Distribution Is Not Available in Source Data
Compensation of Employees:			
Wages and salaries	BLS tabulations of wages and salaries of employees covered by state unemployment insurance and Office of Personnel Management data on wages of federal government employees	Establishment	
Employer contributions for social insurance	Federal budget data	None	Social Security Administration and BLS tabulations
Other labor income	Trade association data and IRS tabulations of business tax returns	None	Census Bureau and IRS tabulations
Proprietors' income with IVA:			
Farm	Department of Agriculture net income	Establishment	
Nonfarm:			
Proprietors' income	IRS tabulations of business tax returns	Company	Assumed to be equivalent to an establishment-industry distribution
IVA	BLS prices and Census Bureau inventory data	Establishment	
Rental income of persons	Census Bureau American housing survey, BLS consumer expenditures survey, & IRS tabulations of business & individual tax returns	Establishment	

Corporate profits with IVA:			
Corporate profits before taxes	IRS tabulations of business tax returns	Company	Census Bureau & Department of Energy data, relating establishment-industry & company-industry data
IVA	BLS prices & Census Bureau inventory data	Establishment	
Net interest:			
Corporate	IRS tabulations for business tax returns	Company	None
Noncorporate	*	Company	Assumed to be equivalent to an establishment-industry distribution
Business transfer payments	*	None	Industry-specific payments are estimated using IRS, FBI, ABA, & BAA data
Indirect business tax & nontax liability	Federal budget data & Census Bureau data on state & local governments	None	Industry-specific payments of nonproperty taxes are estimated using Treasury, Census Bureau, IRS, & state data; property taxes are based on BEA capital stock distributions
Subsidies	*	Establishment	
Current surplus of government enterprises	*		
Capital consumption allowances:			
Corporate	IRS tabulations of business tax returns	Company	Same as corporate profits before tax
Noncorporate	*	Company	Assumed to be equivalent to an establishment-industry basis

Note: BLS = Bureau of Labor Statistics; IRS = Internal Revenue Service; FBI = Federal Bureau of Investigation; ABA = American Bankers Association; BAA = *Best's Aggregates and Averages*; IVA = Inventory valuation adjustment.

*Same source as preceding line.

several major weaknesses; these affect the accuracy of the current-dollar GNP estimates for both services- and commodity-producing industries.

The first weakness reflects the fact that the use of the employment matrix forces all the reallocations to take place between census-covered companies and establishments. As such, there is no employment matrix reallocation of profits or depreciation for agriculture, forestry, and fisheries; transportation; communication; electric, gas, and sanitary services; FIRE; and service industries numbered in the SIC 80s, except for legal services. Thus, the only services-producing industries covered by the employment matrix are those numbered in the SIC 70s and SIC 81.

The second weakness is that, at best, an updated employment matrix is only available every fifth year prior to 1972, and it has not been updated since 1972.¹¹ Application of the matrix for years since 1972 assumes no change in company-industry structure as a result of mergers, divestitures, or acquisitions that cross industry lines. There has been a considerable number of such transactions since 1972, and they often have the effect of changing the company classification as well as the underlying establishment distribution. Use of a prior year's employment matrix under such conditions can result in incorrect reallocations.

The third weakness of the employment matrix is that it often misallocates profits and depreciation associated with assets leased through subsidiaries whose establishment-industry classification is different from that for the parent company. For example, many large manufacturers run leasing operations through their finance subsidiaries. These subsidiaries are frequently consolidated with the parent's tax return, which is classified in manufacturing. Because the employment matrix excludes financial activities, the profits and depreciation on these leased assets are allocated to manufacturing rather than to credit agencies.

Despite these weaknesses, BEA has historically used the employment matrix for several reasons. First, in most industries, diversification is not a problem. Second, profits are typically a small part of industry GNP; therefore even large errors in profit distribution cause relatively small errors in industry GNP estimates. Third, there are offsetting errors in the allocations of profits and depreciation derived from the employment matrix. Fourth, BEA had hoped to improve its estimates of industry profits and depreciation by using Federal Trade Commission line-of-business data or Securities and Exchange Commission business-segment data, but neither alternative materialized as a viable substitute. Finally, BEA has planned to improve the employment

employment. Finally, given the solution vector X_i , estimates of establishment-industry profits/depreciation in the current year obtained as

$$(3) \quad C_j = \sum_i a_{ij} x_j \quad (j = 1, \dots, 17).$$

11. Beginning with 1958 and ending with 1972, new employment matrices were developed for every quinquennial census year—1958, 1963, 1967, and 1972.

matrix by updating it annually and expanding it to cover all industries, but the Census Bureau has so far been unable to fund this program.

Thus, for the lack of a better alternative at this juncture, the employment matrix method 2 continues to underlie the current-dollar industry GNP estimates derived from phase 1 of the GPO improvement program. However, it is anticipated that its use will terminate with the development during phase 3 of direct estimates of industry intermediate input consumption of sufficient quality to permit current-dollar industry GNP to be estimated by method 1.

1.4 Estimation of Constant-Dollar GNP for Services Producing Industries: Past Practices and Recent Improvements

1.4.1 Methods of Estimation

Historically, constant-dollar industry GNP estimates were estimated using three different variants of the double-deflation procedure and two non-double-deflation techniques: extrapolation and direct deflation. A description of these five estimating techniques follows.

Double Deflation

Method 1. The constant-dollar (CO\$) analogue to method 1 for computing CU\$ GNP; CO\$ GNP is computed as

$$\text{CO\$ GNP} = \text{CO\$ gross output} - \text{CO\$ intermediate input.}$$

This variant is used only for industries where there exist direct and consistent gross output and intermediate input data that provide complete coverage of the industry.

Method 2. The constant-dollar analogue to method 2 for computing current-dollar GNP; constant-dollar GNP is computed in two steps as

$$(1) \quad \text{CO\$ intermediate input} = \frac{(\text{CU\$ gross output} - \text{CU\$ GNP})}{\text{intermediate input deflator}};$$

$$(2) \quad \text{CO\$ GNP} = \text{CO\$ gross output} - \text{CO\$ intermediate input.}$$

This variant is used only when there exists complete and consistent industry gross output and GNP data.

Method 3. Indirect double deflation procedure; an industry GNP deflator is derived by using method 1 double deflation on industry gross output and intermediate input data that are consistent, but not compatible, with method 2 current-dollar GNP because they cover only part of the industry. This derived deflator is then used to deflate the current-dollar industry GNP derived from method 2.¹²

12. For example, method 3 was formerly used to obtain the real GNP of the electric, gas, and sanitary services industry because the previous measure of gross output and purchased input covered only the electric and gas components of the industry. Using method 1 current- and constant-

Nondouble Deflation

Extrapolation. Constant-collar industry GNP is derived by extrapolating the base-year value of industry GNP by an indicator series, either CO\$ gross output, the number of employees, or hours worked.

Direct deflation. Constant-dollar industry GNP is derived by directly deflating current-dollar GNP; the index used for deflation is either gross output prices or earnings.

1.4.2 Past Practice

The preferred procedure for obtaining industry constant-dollar GNP is the double-deflation procedure because it measures GNP in the same way it is defined and because, given the appropriate data, double deflation allows for changes over time in the relationship between gross output and intermediate inputs.¹³ In the international and the United Nations SNA literature, double deflation is defined as the method 1 variant presented above.¹⁴ Although many users of the GNP estimates assumed that method 1 double deflation has been historically employed for all private industries, table 1.5 shows that only two industries were and continue to be so estimated—farms and the nonfarm housing services component of real estate.

Beyond these two industries, double deflation in one of the two other variants above had been used to obtain real GNP only for construction, manufacturing industries (except petroleum and coal products), electric, gas, and sanitary services, and railroad transportation. Real GNP for manufacturing industries (except petroleum) was derived by method 2; the real GNP estimates for the three remaining industries were derived by using method 3.

In brief, table 1.5 shows that, under past practices, real GNP for only three of 33 services-producing industries (including the housing services component of real estate) was derived by some form of double deflation. For the 30 remaining services-producing industries, real GNP for 18 industries was estimated by the extrapolation method; the direct-deflation method was used for 12 industries. Table 1.5 also indicates that the extrapolator used in 9 of the 18 extrapolated industries was based either on employment or on hours, and that the deflator used in 5 of the 12 directly deflated industries was based in whole or in part on earnings data.

Put differently, before the phase 1 revision, the real GNP of services-producing industries representing 15.4 percent of private GNP and 23.5 percent of service-sector GNP in 1987 was based on a methodology that assumed away all or part of productivity change; the real GNP for services-producing

dollar GNP estimates, these data were used to derive an implicit GNP deflator for electric and gas utilities, which was then used to deflate BEA's CAGNP-based estimate of current-dollar GNP for the entire electric, gas, and sanitary services industry.

13. See, however, n. 26.

14. See, e.g., United Nations (1979) and Lal (1990).

Table 1.5 Previously Published and Phase 1 Methods for Estimating Constant-Dollar GPO for Services-Producing Industries

Industry	Method	
	Previously Published	Phase 1
Transportation:		
Railroad	Double deflation (M3) [†]	Double deflation [‡]
Local & interurban passenger transit	Extrapolation (0) [§]	Double deflation
Trucking & warehousing	Direct deflation (P)	Double deflation
Water	Extrapolation (0)	Double deflation
Air	Extrapolation (0)	Double deflation
Pipelines, except natural gas	Extrapolation (0)	Double deflation
Services	Extrapolation (L)	*
Communication:		
Telephone & telegraph	Direct deflation (P,W)	Double deflation
Radio & television broadcasting	Direct deflation (W)	Double deflation
Electric, gas, & sanitary services	Double deflation (M3)	Double deflation
Wholesale trade	Direct deflation (P)	Double deflation
Retail trade	Extrapolation (0)	Double deflation
Finance, insurance, & real estate:		
Banking	Extrapolation (L)	*
Credit agencies other than banks	Extrapolation (L)	*
Security & commodity brokers, & services	Extrapolation (L)	Double deflation
Insurance carriers	Extrapolation (0)	Double deflation
Insurance agents & brokers, & services	Extrapolation (0)	Double deflation
Real estate [#]		
Nonfarm housing services	Double deflation (M1)	*
Other real estate	Direct deflation (P)	*
Holding & other investment companies	Extrapolation (L)	*
Services:		
Hotels & other lodging places	Extrapolation (0)	Double deflation
Personal	Direct deflation (P)	Double deflation
Business	Extrapolation (L)	*
Auto repair, services, & garages	Direct deflation (P)	Double deflation
Miscellaneous repair	Extrapolation (L)	Double deflation
Motion pictures	Direct deflation (P,W)	*
Amusement & recreation	Direct deflation (P)	Double deflation
Health	Extrapolation (0)	Double deflation
Legal	Extrapolation (0)	Double deflation
Educational	Extrapolation (L)	Double deflation
Social services & membership organizations	Direct deflation (W)	*
Miscellaneous professional	Direct deflation (W)	*
Private households	Direct deflation (W)	*

*Same method as used for previously published estimates.

†In the previously published estimates, two variants—M1 or M3—of double deflation were used to estimate GNP for services-producing industries; the variant used for a given industry is indicated by showing M1 or M3 in parentheses. For a description of the double-deflation variants see the text, section 1.4.

‡In the phase 1 estimates, (M2) double deflation is used for all industries except the nonfarm housing services component of real estate, which continues to be derived by (M1) double deflation.

(continued)

Table 1.5 (continued)

§Industries using labor input extrapolation are indicated by (L); industries using gross output extrapolation are indicated by (O).

¶Industries using direct deflation by earnings are indicated by (W); industries using direct deflation by gross output prices are indicated by (P); industries using direct deflation by both earnings and gross output prices are indicated by (P,W).

*The real estate industry is listed in two parts because the estimates for the two parts are prepared using different methods.

industries representing 35.3 percent of private GNP and 54.1 percent of service sector GNP was based on a methodology that assumed fixed proportions either between real values of GNP, gross output, and intermediate input or between the prices of these respective measures; and the real GNP for services-producing industries representing 12.7 percent of private GNP and 18.5 percent of service sector GNP was based on indirect, or method 3, double deflation.

1.4.3 Recent Improvements

The source of the limitations in the previous real GNP series can be traced largely to the lack of available source data, although for some industries newly available sources were not introduced into the estimating method.¹⁵ The real GNP estimates derived from phase 1 of the GPO improvement program incorporate comprehensive improvements in methodology and source data. The phase 1 improvements can be subsumed into the three following categories: (1) double deflation; (2) gross output; and (3) intermediate input prices.

Double Deflation

Double deflation is the core of the improvements incorporated into the GPO estimates during phase 1 of the improvement program. The extension of this procedure resulted in significantly improved measures not only of real gross output and GNP of services-producing industries but also of the services inputs consumed. Under past practice, the real GNP estimates for only two services-producing industries—railroads and electric, gas, and sanitary services—were obtained using some variant of the double-deflation procedure. Moreover, as noted above, nearly 80 percent of the real GNP from services-producing industries was based on a methodology that either assumed no change in labor productivity or assumed that no substitution occurred between value-added inputs (labor and capital) and intermediate inputs. And, the remaining 20 percent was derived by an indirect double-deflation procedure based on incomplete data. In contrast, under phase 1 the real GNP estimates for most services-producing industries—representing about 80 percent of the GNP produced by the service sector—are now derived by double deflation.

15. Source data problems in the early constant-dollar GPO estimates are discussed in Marimont (1969).

Out of the 33 services-producing industries shown in table 1.5, the GNP estimates for all but 10 industries and the nonfarm housing services component of the real estate industry are now obtained by uniformly employing method 2 double deflation—the same procedure is presently used for all commodity-producing industries, except farms. The real GNP for nonfarm housing services continues to be derived by method 1 double deflation. Four of the ten non-double-deflated industries are in FIRE: these four include banking, credit agencies other than banks, holding and other investment companies, and real estate (except nonfarm housing services). The remaining six omitted industries are transportation services, business services, motion pictures, social services and membership organizations, miscellaneous professional organizations, and private households.¹⁶

Gross Output

This expansion in the double deflation of service-producing industries was made possible by the development of gross output estimates for each double-deflated services-producing industry. These estimates were constructed by developing underlying 1977 and 1982 benchmark and annual extrapolator real gross output estimates at various levels of I-O industry and product detail. Table 1.6 describes this detail as well as the methods and source data used to construct the current- and constant-dollar values.

Three items of particular interest are highlighted in table 1.6: (1) the high degree of product detail used to obtain the current and constant-dollar gross output for most industries; (2) the extensive use of output quantity indexes to derive the real gross output estimates for all transportation industries, gas and electric utilities, and security brokers and services; and (3) the use of a quality-adjusted cost index to obtain the real gross output of radio and television broadcasting.¹⁷

To deflate service outputs, approximately 100 true output deflators were either constructed from quantity extrapolation or selected from components of the consumer price index (CPI), the producer price index (PPI), and implicit price deflators prepared as part of the expenditure estimates of GNP. In all, approximately 120 current- and constant-dollar component series were developed and used to construct the gross output estimates for the 23 services-

16. Double deflation is not appropriate for private households because GNP for this industry is defined as employee compensation.

17. The cost index used to deflate the current-dollar gross output of radio and television broadcasting is an estimate of the cost to advertisers to reach 1,000 of viewing or listening audience, as opposed to the cost per unit of air time. The former better represents the extent that two media are providing more effective access by advertisers to targeted markets. It should be noted, however, that advertising revenues are not a direct measure of the gross output of programs produced by the radio and television industries, nor is the deflator discussed above a direct measure of the quality of programming from a consumer's point of view. It should also be noted that the advertising-revenues approach has the effect of making the entire output of the industry an intermediate, as compared to a consumer, good.

Table 1.6 Principal Source Data and Estimating Methods Used in Preparing Phase I Estimates of Gross Output for Double-Deflated Industries

Industry	Current Dollars	Constant Dollars
	Extrapolator or Interpolator of Benchmark Values†	Price Index for Deflation or Quantity Extrapolator of Base-Year Value
Transportation:		
Railroad	Total operating revenues for class I freight & AM-TRAK passenger revenues (1977, 1982)	Composite index of IPD for class I freight, from revenue ton miles from AAR, and of IPD for AMTRAK, from passenger miles from NRPC
Local & interurban passenger transit:		
Taxicabs	PCE (1977)	CPI for taxi fares
Intercity buses	Operating revenues from ABA (1977, 1982)	Passenger miles from ABA
School buses	Wages & salaries from BLS (1977, 1982)	Employment from BLS
Local transit	Operating revenues of private local transit systems from APTA (1977)	Passenger trips from APTA
Trucking & warehousing	For 1977–83, operating revenues for class I motor carriers of property from ICC; for 1984–88, Census Bureau annual survey (1977, 1982)	Ton miles from DOT
Water	Receipts from IRS tabulation of corporate tax returns (1982)	Composite index of ton miles for deep-sea foreign transportation from BEA, ton miles for other water transportation from DOD, & tons for marine cargo handling from DOD
Air:		
Domestic & international passenger	Operating revenues of scheduled air carriers from DOT and the Federal Express from DOT and public sources (1977, 1982)	Separate revenue passenger miles for domestic and for international travel from DOT
Domestic & international mail, freight & express	*	Separate ton miles for domestic and for international mail; separate ton miles for domestic and international freight and express.

Other	*	Composite index of IPDs for passenger, freight, and mail.
Pipelines, except natural gas	Oil pipeline operating revenues from OGJ (1977, 1982)	Ton miles from AOP
Communications:		
Radio & television broadcasting	Advertising expenditures from M-E (1977, 1982)	Composite deflator based on cost per 1,000 of audience from M-E
Telephone & telegraph	Revenues from FCC (1977, 1982)	Composite deflator based on PPIs for local telephone service, toll telephone services, and directory advertising
Electric, gas, & sanitary services:		
Electric utilities	Private class A and B revenues (adjusted for imports and cost of resales), from DOE and BEA; REA cooperatives revenues (adjusted for cost of resales), from USDA (1977, 1982)	Kilowatt hours for investor owned and cooperatives from EEI
Gas utilities	Revenues of gas pipelines (adjusted for imports) & of gas utilities (adjusted for state & local government utilities) from BEA & AGA (1977, 1982)	For gas pipelines, BTUs of gas for resale from AGA; for gas utilities, BTUs of gas utility sales to final customers from AGA
Sanitary services	Receipts from IRS tabulations of business tax returns (1977, 1982)	CPI for water & sewage maintenance
Wholesale trade		
Merchant wholesalers gross margins‡	Gross margin rate times sales: For 1977-82, margin rate from Census Bureau quinquennial censuses & sales from Census Bureau annual survey; for 1983-88, both from annual survey (1977, 1982)	1982 gross margin rate-weighted sales deflated by kind-of-business deflators derived from PPIs
Manufacturers' sales branches & sales offices (MSB&O) gross margins‡	Estimated operating expense rate times estimated MSB&O sales: estimated operating expense (excluding expense for equipment rental by wholesalers of commercial machines & equipment) derived by extrapolating MSB&O operating expenses from Census Bureau quinquennial cen-	1982 operating expense rate-weighted sales deflated by manufacturing shipments deflators (at 3-digit trade level) derived from PPIs

(continued)

Table 1.6 (continued)

Industry	Current Dollars	Constant Dollars
	Extrapolator or Interpolator of Benchmark Values†	Price Index for Deflation or Quantity Extrapolator of Base-Year Value
Agents & brokers (A&B) gross margin‡	<p>suses with estimated sales. Estimated sales derived by extrapolating MSB&O sales from Census Bureau quinquennial censuses with 4-digit manufacturing shipments from Census Bureau annual surveys, allocated to 3-digit MSB&Os using distribution by class of customer data from 1977 Census of Manufacturers (1977, 1982)</p> <p>Estimated earnings rate times estimated A&B sales: estimated earnings derived by extrapolating A&B earnings (commissions plus margins) from Census Bureau 1982 quinquennial census with estimated gross margin for merchant wholesalers. Estimated sales derived by extrapolating 3-digit A&B sales from 1982 quinquennial census by corresponding 3-digit sales of merchant wholesalers from Census Bureau surveys (1977, 1982)</p>	1982 gross earning rate-weighted sales deflated by kind-of-business deflators derived from PPI
Computer & office equipment rentals	Log linear interpolation between 1977, 1982, & 1987 computer & office equipment rentals earned by wholesalers of commercial machines and equipment from Census Bureau quinquennial censuses, & forward extrapolation at 1982–87 rate§	IPD based on ratio of historical to constant-dollar gross stock of office computer & accounting equipment
Excise taxes	Excise taxes paid by wholesalers of petroleum, of alcoholic beverages, & of tobacco & tobacco products (SICs 517, 518, & 519) from BEA (1977, 1982).	1982 excise tax rate times deflated sales for SICs 517, 518, and 519; sales deflated by kind-of-business deflators derived from PPI

Sales taxes	Aggregate sales tax rate times aggregate sales (including excise taxes) of merchant wholesalers. For 1977–84, tax rates & sales from Census Bureau surveys; for 1985–88 sales from Census Bureau survey & tax rate from Census Bureau 1987 quinquennial census (1977, 1982)	1982 aggregate sales tax rate times sum of deflated sales and excise taxes paid by merchant wholesalers; sales deflated by kind-of-business deflators derived from PPIs
Import duties	Import duties from BEA	IPD for all merchandise imports from BEA
Retail trade		
Eating and drinking places	Sum of sales of eating & drinking places from Census Bureau annual survey & of sales taxes on food & on drink from BEA (1977, 1982)	For sales of eating and drinking places, IPD composed of CPIs for meals and drinks away from home. For sales tax on meals, 1982 sales tax rate (on sales with sales taxes) for eating places times deflated sales of meals. For sales tax on drinks, 1982 sales tax rate (on sales with sales tax) for drinking places & deflated sales of drink.
Other retail:		
Gross margin‡	Gross margin rate times sales at ¾-digit kind-of-business detail, both from Census Bureau survey (1977, 1982)	1982 gross margin rate (on sales with sales taxes) weighted sales deflated by kind-of-business deflators derived from CPIs
Sales tax	Sum of ¾-digit kind-of-business sales taxes from BEA (1977, 1982)	1982 sales tax rate (on sales with sales taxes) times sales deflated by kind-of-business deflators derived from CPIs
Finance, insurance, & real estate:		
Security & commodity brokers & services:		
Security brokers & services:		
Commissions	Securities commissions from SEC (1977, 1982)	Numbers of public securities orders from SEC & BEA
Mutual funds	Revenue from sale of investment company securities from SEC (1977, 1982)	IPD for securities commissions
Underwriting/selling new securities	Profits (loss) from underwriting/selling from SEC (1977, 1982)	New securities registrations for each sale from SEC
Trading & investment gains, excluding interest, & other revenues, excluding repro interest	Gain (loss) on trading & investment accounts from SEC less BEA estimate of interest earnings on trading accounts plus other revenues less interest	IPD for GNP

(continued)

Table 1.6 (continued)

Industry	Current Dollars	Constant Dollars
	Extrapolator or Interpolator of Benchmark Values†	Price Index for Deflation or Quantity Extrapolator of Base-Year Value
Revenue of self-regulatory organization	earned on margin account from SEC & less BEA estimate of interest from repos Revenues earned by exchanges from SEC (1977, 1982)	*
Commodity brokers	Residual estimate (1977, 1982)	IPD composed of IPDs for commissions, underwriting/selling & GNP
Insurance carriers	Sum of life insurance company net premiums for health insurance from ACLI, PCE expense of handling life insurance, & nonlife insurance company net premiums (adjusted for losses) for auto, accident, and health, property, & workers' compensation from A. M. Best Company (1977, 1982)	IPD composed of BEA implicit deflators for health, life, & workers' compensation, & CPIs for auto & property insurance
Insurance brokers & agents	Receipts from IRS tabulations of business tax returns (1977, 1982)	Composite deflator computed as sum of insurance carrier deflators weighted by commissions from A. M. Best Company.
Real estate—nonfarm housing services	PCE for owner & tenant-occupied nonfarm dwellings (1977, 1982)	IPD for PCE
Services:		
Hotels, rooming houses, camps, & others	Receipts from Census Bureau quinquennial census & annual survey (1977, 1982)	Laventhol & Horwath room-rate index
Personal:		
Laundry, cleaning & garment services	*	CPI for laundry & dry cleaning
Shoe repair shops, shoe-shine parlors	*	CPI for other apparel services

Photographic studies (portrait) & miscellaneous personal services	*	IPD composed of CPIs for other entertainment services, personal financial & legal services, CPI for beauty & barber shops, & BEA earnings & expense index for clubs & fraternal organizations
Beauty shops	*	CPI for beauty parlor services for females
Barber shops	*	CPI for haircuts & other barbershop services
Funeral service & crematories	*	CPI for funeral expenses
Automotive repair, services, & garages:		
Automotive rental & leasing without drivers	*	CPI for other auto-related fees
Automobile parking, repair services, & other auto services	*	CPI for auto maintenance & repair
Miscellaneous repair:		
Electrical repair shops	*	CPI for appliance & furniture repair
Watch, clock, & jewelry repair	*	CPI for other apparel services
Reupholstery & furniture repair	*	CPI for furniture repair
Miscellaneous repair shops	*	Average annual earnings from BLS
Amusement & recreation, except motion pictures:		
Dance halls, studios, & schools and amusements & recreation services, n.e.c.	*	CPI for other entertainment services
Theatrical producers, bands, orchestras, & entertainers	*	CPI for admissions
Bowling alleys & billiard & pool establishments	*	CPI for participant sports
Commercial sports	*	IPD composed of CPI for other entertainment services & BEA implicit deflator for pari-mutuel net receipts
Health services:		
Offices of physicians, osteopathic physicians, dentists, & other health practitioners	*	IPD composed of CPIs for physicians, dentists, & other professional medical services

(continued)

Table 1.6 (continued)

Industry	Current Dollars	Constant Dollars
	Extrapolator or Interpolator of Benchmark Values [†]	Price Index for Deflation or Quantity Extrapolator of Base-Year Value
Nursing & personal care facilities	*	HCFA index of input prices
Hospitals	Sum of nonprofit hospital expenses & profit hospital revenues, both from AHA (1977, 1982)	BEA composite deflator composed of HCFA index of input prices & CPI for hospital room
Medical & dental laboratories	Receipts from Census Bureau quinquennial census & annual survey (1977, 1982)	CPI for other professional services, medical services
Outpatient care facilities	*	CPI for professional medical services
Health & allied services, n.e.c.	*	CPI for other professional medical services
Legal	*	CPI for legal service fees
Education:		
Private education & libraries	Sum of PCE for private lower & higher education, private commercial & vocational schools, & private libraries (1977, 1982)	IPD composed of BEA deflators for private lower education, private higher education, private commercial & vocational schools, & private libraries
Private education housing & meals	Sum of PCE for elementary, secondary & higher education housing & meals (1977, 1982)	IPD composed of PCE deflators for elementary & secondary education housing & for higher education housing

Notes: A&B = agents and brokers; AAR = Association of American Railroads; ABA = American Bus Association; ACLI = American Council of Life Insurance; AGA = American Gas Association; AOP = Association of Oil Pipelines; APTA = American Public Transit Association; BEA = Bureau of Economic Analysis; BLS = Bureau of Labor Statistics; CPI = Consumer Price Index (BLS); DOD = Department of Defense; DOE = Department of Energy; DOT = U.S. Department of Transportation; EEI = Edison Electric Institute; FCC = Federal Communications Commission; HCFA = Health Care Finance Administration; ICC = Interstate Commerce Commission; IPD = implicit price deflator; IRS = Internal Revenue Service; M-E = McCann-Erickson; NRPC = National Railroad Passenger Corporation; O&G = Oil and Gas Journal; PCE = personal consumption expenditure; PPI = Producer Price Index; REA = Rural Electrification Administration; SEC = Securities and Exchange Commission; and USDA = U.S. Department of Agriculture.

*Same source as preceding line.

[†]The year(s) in parentheses represents the benchmark input-output (I-O) table to which gross output is directly benchmarked.

[‡]Gross margin, which is used to measure the gross output of most of the wholesale and retail trade industry, equals sales minus cost of goods sold.

[§]The 1987 quinquennial census, in addition to the 1977 and 1982 quinquennial censuses, was used to benchmark the operating expense, equipment and rental revenues, and sales of MSB&O.

producing industries (including nonfarm housing services) that are double deflated under phase 1.

Intermediate Input Prices

The estimation of composite deflators for intermediate inputs consumed by industries was significantly improved over past practice in three areas: (1) intermediate input weights; (2) imported inputs; and (3) services inputs.

Intermediate Input Weights. The weighting scheme used to construct the new composite deflators differs from that used previously in three important dimensions: First, it incorporates a 1972 SIC-based version of the benchmark I-O table for 1977; this eliminates an inconsistency in past practice that arises because I-O industries are defined differently than SIC industries.¹⁸ Second, it employs unique annual SIC-based weights for every year between 1977 and 1985 (1978–81 weights are derived by interpolation) rather than 1977 I-O weights reflatd to 1982 prices. Third, it includes separate weights for domestic and imported inputs rather than assume that all inputs are domestically produced. These new annual weights were constructed by intensive use of both 1977 benchmark I-O work files and unpublished annual I-O work files for 1981–85, with the 1985 weights also used for 1986–89.¹⁹

Imported inputs. Improved measures of industry constant-dollar intermediate inputs were developed by decomposing the value of each I-O defined product consumed by an industry into imported and domestically produced components, by deflating each component with corresponding import and domestic prices, and by computing composite Paache input price indexes for each industry. In general terms, the procedure involves using the 1977 benchmark I-O work files to allocate each imported product class between final demand and intermediate consumption and to allocate the latter across consuming industries in proportion to product-class inputs purchased by each industry. These 1977 proportions are then used to allocate annual estimates of imports by product class, taken from the annual I-O tables; in all, more than 1,400 distinct imports are identified and priced.

The phase 1 input pricing model incorporates approximately 645 distinct import prices taken from the BLS international price program, from the Bureau of the Mines for mineral products, and from the Commerce Department's

18. The SIC-based output and input industry definitions used in the GPO differ from I-O based definitions for several reasons including: (1) In some cases, I-O splits an industry out of a larger GPO industry, but in other cases, I-O combines industries across detailed GPO industries; (2) I-O redefines out the secondary products produced by an industry to the industry where it is primary; and (3) I-O treats new and maintenance and repair force-account construction performed by non-construction industries as part of the construction industry. A discussion of I-O conventions is found in Bureau of Economic Analysis (1984).

19. See Bureau of Economic Analysis (1984, 1990) for information on the benchmark and annual I-O tables.

national energy accounts (updated by BEA) for energy products.²⁰ BLS compiles three different classifications of price indexes for imports—standard international trade classification (SITC), SIC, and end-use category. The import price chosen for each I-O product class is determined as follows; If the product class matches, an SITC price is used; if no match is obtained on the SITC, then an appropriate SIC-based price index is used; and, as a last resort, end-use price indexes are used. Because BLS price indexes do not exist for many product classes prior to 1982, either (1) higher-level import prices or (2) matching domestic prices were used to extrapolate the available BLS prices back to 1977. However, less than 26 percent of the 1977 value of imported inputs was so deflated by these two methods in 1977; by 1982 less than 1 percent of the 1977 value of imports was so deflated.

Services inputs. An important by-product of the phase 1 effort to develop detailed gross output deflators for services-producing industries is a significant improvement in the deflation of purchased services of all industries. Under past practice, only 30 broad categories of service inputs were identified, and the real input estimates for all of these categories were obtained by deflating with implicit two-digit GPO or earnings deflators. In contrast, the phase 1 estimates of services inputs consumed by 50 double-deflated industries are obtained by using unique annual purchases weights for every year between 1977 and 1985 (with the 1985 weights also used for 1986–89). Moreover, these improved input weights provide detail for more than 300 types of services deflated using more than 100 distinct output-based services deflators; only nine GPO or earnings deflators are used in the new methodology. Table 1.7 shows the services input detail and the prices used to deflate each services input under phase 1.

1.4.4 Effect of the Phase 1 Improvements

Table 1.8 illustrates the effect of the recent improvements in terms of their effect on the percentages of GNP accounted for and on the rates of growth experienced by service-sector industries. Specifically, the table compares the unrevised industry GNP shares for 1979 and 1987 with those generated under phase 1 of the GPO improvement program; it also compares previous and revised industry growth rates for the 1979–87 period. Shown also are 1988 industry shares and 1979–88 industry growth rates; these measures are available only in terms of the new methodology of phase 1.

It is apparent from table 1.8 that the new methodology does not fundamentally rewrite economic history. Industries with the largest share of constant-dollar GNP and the fastest growth in real GNP before revision are also the largest and fastest growing after revision. Nevertheless, several notable effects

20. The national energy accounts are maintained by the Commerce Department's Office of Business Analysis.

Table 1.7 Principal Sources of Phase 1 Service Input Prices for Double-Deflated Industries

Service Input	Source of Price Index
Agricultural services	IPD for agricultural service gross output
Railroad transportation:	
Dining car receipts, business travel	CPI for food away from home
Other passenger train services	CPI for intercity train fares
Rail freight	IPD for freight gross output
Other railroad services	IPD for freight gross output
Local and interurban passenger transit:	
Services from local private transit systems	IPD for local transit system gross output
Taxicabs	CPI for taxi fares
Other	IPD for intercity bus gross output
Trucking and warehousing	IPD for trucking and warehousing gross output
Water transportation	IPD for water transportation gross output
Transportation by air:	
Domestic passenger	IPD for domestic passenger gross output
International passenger	IPD for international passenger gross output
Mail	IPD for domestic and international mail gross output
Freight and express	IPD for overseas freight and express gross output
Other air services	IPD for transportation by air
Pipelines, except natural gas	IPD for pipelines, except natural gas gross output
Transportation services:	
Private car line services	IPD for boxcar rental
Other	IPD for transportation services GPO
Communication services:	
Telephone services	IPD for telephone gross output
Telegraph services	PPI for telephone toll service
Television services	IPD for radio & television gross output
Other communication services	IPD for telephone & telegraph gross output
Electric, gas, & sanitary services:	
Electric utilities	PPI for electric power
Gas pipeline	IPD for gas pipeline gross output
Gas utilities	IPD for gas utility gross output
Water, sanitation, & other	CPI for water & sewage maintenance
Wholesale trade:	
Merchant wholesaler & agents & brokers	IPD for merchant wholesalers & agents and brokers' gross output
Manufacturers' sales offices & branches	IPD for manufacturers' sales offices & branches gross output
Rental of gasoline tanks & pumps	IPD for machinery, equipment, & supplies wholesale trade gross output
Retail trade:	
Eating & drinking	IPD for eating and drinking gross output
Other	IPD for other retail trade gross output

(continued)

Table 1.7 (continued)

Service Input	Source of Price Index
Banking:	
Imputed service charges	IPD for financial services furnished without payment by commercial banks
Other	CPI for personal financial services
Credit agencies:	
Savings & loan imputed service charges	IPD for financial services furnished without payment by savings & loan associations
Other	CPI for personal financial services
Security and commodity brokers & services:	
Securities underwriting	IPD for underwriting gross output
Securities trading	IPD for securities commissions gross output
Services allied with exchange of securities	IPD for security & commodity brokers, & services gross output
Other services	IPD for GNP
Insurance carriers:	
Automobile insurance	CPI for automobile insurance
Nonlife insurance services, except automobile	IPD for insurance carrier gross output
Other insurance services	CPI for property and household insurance
Mortgage & loan insurance	IPD for new nonfarm residential buildings and IPD for GNP
Insurance agents & brokers, & services	IPD for insurance agents & brokers, & services
Real estate services:	
Nonfarm business rental & property management	Rental rate per square foot from BOMA
Farm rental	IPD for rental value of farm housing PCE
Rent paid by nonprofits	IPD for capital consumption allowance of nonprofit organizations
Royalties for oil & gas mining	IPD for oil & gas extraction gross output
Royalties, except oil & gas mining	IPD for PCE
Commissions paid to real estate dealers	IPD for new nonresidential building construction
Condominium association fees & assessments by cooperatives	CPI for home maintenance & repair services
Other	IPD for real estate GPO
Hotel & lodging places	Laventhol and Horwath room-rate index
Personal services:	
Funeral & burial expenses	CPI for funeral expenses
Other	CPI for laundry & dry cleaning
Business services:	
Local, national network, & spot TV advertising	McCann-Erickson cost index for network & spot TV advertisements
Radio advertising	McCann-Erickson cost index for radio advertisements
Magazine & supplements advertising	McCann-Erickson cost index for magazine advertisements
Newspaper advertising, national, classified & local	McCann-Erickson cost index for newspaper advertisements
Direct mail advertising	McCann-Erickson cost index for direct mail
Other advertising	McCann-Erickson composite cost index

Table 1.7 (continued)

Service Input	Source of Price Index
Maintenance, cleaning, disinfecting, & exterminating	CPI for home maintenance & repair services
Photofinishing	IPD for film development PCE
Other business services	IPD for business services gross output
Automotive repair, services, & garages:	
Repairs, tire retreading, parking, & washing	CPI for automobile maintenance & repair
Other	CPI for other auto-related fees
Miscellaneous repair services:	
Radio, TV, refrigeration, & air conditioning, & electrical & electronic repairs	CPI for appliance & furniture repairs
Other	Average annual earnings for miscellaneous repair shops & related services from BLS
Motion picture services:	
Production & allied services	Average annual earnings for motion picture production & allied services from BLS
Distribution & allied services	Average annual earnings for motion picture distribution & allied services from BLS
Amusement & recreation services:	
Sports, recreation, & amusements	IPD for sports & recreation camps
Other commercial recreation & amusements	IPD based on PCEs for sightseeing, commercial participant amusement n.e.c., sports & recreation camps, & commercial amusement (n.e.c.)
Theatrical, dance, symphony, & spectator sports productions	CPI for admissions
Health services:	
Physicians services	CPI for physicians
Other	CPI for other medical professionals
Legal services	CPI for legal services
Education services:	
Vocational schools, except high schools	IPD for commercial & vocational schools PCE
Higher education & related services	IPD for private higher education PCE
Social services	Average annual earnings for job training & vocational rehabilitation services from BLS
Membership organizations:	
Membership organization expenses	BEA earnings & expense index
Business associations	Average annual earnings for business associations from BLS
Professional organizations	Average annual earnings for professional membership organizations from BLS
Miscellaneous professional services:	
Noncommercial museums & art galleries	IPD for miscellaneous professional services GPO
Accounting, auditing, & bookkeeping services	CPI for personal financial & legal services fees
Other	IPD for miscellaneous professional services gross output

(continued)

Table 1.7 (continued)

Service Input	Source of Price Index
Government enterprises:	
Postal services:	
Unallocated services	PPI for U.S. postal service, all types
1st-class mail	PPI for 1st-class mail
2d-class mail	PPI for 2d-class mail
3d-class mail, bulk rate	PPI for 3d-class bulk mail
3d-class mail, nonprofit bulk rate	PPI for 3d-class nonprofit bulk mail
4th-class mail	PPI for 4th-class mail
Penalty fees	PPI for special services and fees
Money orders	PPI for special services
Pension benefit guaranty insurance	BEA earnings & expense index for life insurance
Share insurance for member credit unions	No price change assumed
Insurance protection for commercial bank deposits	Product of index of FDIC ratio of deposit insurance fund to insured deposits & fixed-weighted GNP deflator
Share & deposit insurance	IPD for GNP, fixed weighted
Services to members of Federal Home Loan Banks	IPD for financial services furnished without payment by savings & loan associations
Imported services:	
Rail freight transportation	PPI for railroad freight
Water transportation (n.e.c.)	IPD for imports of passenger water transportation services
Gas utilities	Unit prices for imported natural gas from DOE
Tire retreading	PPI for tires & inner tubes

Notes: For this table, services consist of the primary outputs of (1) private businesses in the agricultural services, transportation and public utilities, trade, finance, insurance, and real estate, and services industries as defined by the 1972 standard industrial classification, and (2) similar services provided by government enterprises. Prices for imported services are shown separately at the end of the table if they differ from prices used for corresponding domestic services. Sources of price indexes for gross output IPDs, except for business services and for miscellaneous professional services, are shown in table 1.6. The IPDs for the gross output for these two industries were estimated from the IPDs for GPO for these industries and from information on inputs from the I-O tables. Abbreviations: BEA = Bureau of Economic Analysis; BLS = Bureau of Labor Statistics; BOMA = Building Owners and Managers Association; CPI = consumer price index; DOE = Department of Energy; GPO = gross product originating; IPD = implicit price deflator; PCE = personal consumption expenditures; and PPI = producer price index.

of the new methodology can be found in table 1.8. Examples are highlighted below.

Industry Shares of Real GNP

The service sector's 1979 share of constant-dollar GNP has been revised down by 0.6 percentage points—from 53.1 to 52.5 percent; the commodity sector's share has been revised upward by an offsetting amount—from 33.7 to 34.4 percent. The upward revision in the share from commodity-producing industries is traceable to mining, whose share increased from 4.1 to 4.5 per-

cent of real GNP and to durables manufacturing, whose share increased from 13.3 to 13.6 percent. The downward revision in the share from services-producing industries is traceable to the transportation sector, where the shares from railroads and transportation by air were both revised down by 0.2 percentage points, and to wholesale trade, whose 1979 share was revised down by 0.6 percentage points. Partially offsetting the combined -1.0 percentage point revision from these three industries is an 0.4 percentage point upward revision in the 1979 share of real GNP attributable to electric, gas, and sanitary services.

Turning to 1987, we find that the share of real GNP from services-producing industries is virtually unchanged from the previous estimated—56.8 versus 56.7 percent, but the share from commodity-producing industries is revised up by 0.7 percentage points—from 31.9 to 32.6 percent. Both of these upward adjustments are balanced by a 0.8 percentage point downward revision in the residual—from 0.1 to -0.7 percent.²¹ The upward revision in the commodity-producing share in 1987 is traceable to the agriculture, forestry, and fisheries and mining industries, each of whose 1987 shares were increased by 0.2 percentage points, and to nondurables manufacturers, whose share was increased by 0.4 percentage points. Although there is little difference between the previous and phase 1 estimates of the service sector's share of real 1987 GNP, significant revisions did occur in two of the sector's detailed industries: the share attributable to electric, gas, and sanitary services was revised up by 0.4 percentage points; the share attributable to health services was revised down by 0.5 percentage points.

Finally, comparing the newly estimated 1988 shares of real GNP with the revised share estimates for the 1979 business cycle peak, we find that commodity-producing industries lost 1.4 percentage points between 1979 and 1988; services-producing industries gained 4.2 percentage points. These compare with minus 1.8 and plus 4.3 percentage points, respectively, between 1979 and 1987.

Industry GNP Annual Average Rates of Change

Turning to average rates of change, table 1.8 shows many large differences between the previous and phase 1 industry GNP estimates for the 1979–87 period. All the particularly large revisions occurred in services-producing industries. For example, the changes recorded by railroad, local and interurban passenger, trucking and warehousing, and air transportation; wholesale trade, security and commodity brokers; and hotel and other lodging phases were all revised up by between 1.2 and 7.7 percentage points. Meanwhile, very large downward revisions were made to the changes recorded by water and pipeline transportation; radio and TV broadcasting; insurance carriers and insurance agents and brokers; auto repair services and garages; and health and legal

21. The residual component of the GPO estimates is the difference between aggregate GNP in constant dollars, measured as the sum of expenditures less the statistical discrepancy in constant dollars, and aggregate GNP in constant dollars measured as the sum of GPO by industry.

Table 1.8

Previous and Phase 1 Average Annual Rates of Change and Shares of Constant-Dollar GNP for Selected Years (%)

	Share of GNP							Average Annual Rates of Change of GNP				
	1979			1987			1988*	1979-87			1979-88,*	
	Previous	Phase 1	Revision	Previous	Phase 1	Revision		Previous	Phase 1	Revision		Phase 1
GNP	100.0	100.0	0.0	100.0	100.0	0.0	100.0	2.4	2.4	0.0	2.6	
Commodity-producing industries	33.7	34.4	0.7	31.9	32.6	0.7	33.0	1.7	1.7	0.0	2.1	
Agriculture, forestry, & fisheries	2.4	2.4	0.0	2.5	2.7	0.2	2.3	3.0	3.9	0.9	2.3	
Mining	4.1	4.5	0.4	3.1	3.3	0.2	3.2	-1.3	-1.5	-0.2	-1.2	
Construction	5.4	5.2	-0.2	4.6	4.6	0.0	4.4	0.2	0.6	0.4	0.6	
Durables manufacturing	13.3	13.6	0.3	13.7	13.4	-0.3	14.5	2.72	2.2	-0.5	3.4	
Nondurables manufacturing	8.6	8.7	0.1	8.2	8.6	0.4	8.6	1.8	2.2	0.4	2.4	
Services-producing industries	53.1	52.5	-0.6	56.7	56.8	0.1	56.7	3.2	3.4	0.2	3.5	
Transportation	4.3	3.9	-0.4	3.5	3.8	0.3	3.7	-0.2	2.1	2.3	2.1	
Railroad	0.9	0.7	-0.2	0.4	0.7	0.3	0.7	-6.0	1.7	7.7	2.0	
Local & interurban passenger transit	0.2	0.2	0.0	0.2	0.2	0.0	0.2	-1.9	-0.6	1.3	-0.7	
Trucking & warehousing	1.8	1.7	-0.1	1.6	1.7	0.1	1.6	0.8	2.1	1.3	1.9	
Water	0.3	0.3	0.0	0.2	0.1	-0.1	0.1	-0.6	-9.9	-9.3	-8.8	
Air	0.8	0.6	-0.2	0.7	0.8	0.1	0.8	1.7	6.2	4.5	5.4	
Pipelines, except natural gas	0.2	0.2	0.0	0.1	0.1	0.0	0.1	-0.5	-2.2	-1.7	-0.2	
Services	0.2	0.2	0.0	0.3	0.3	0.0	0.3	5.7	5.7	0.0	5.8	
Communication	2.3	2.3	0.0	2.8	2.7	-0.1	2.7	5.1	4.8	-0.3	4.6	
Telephone & telegraph	2.0	2.0	0.0	2.5	2.5	0.0	2.4	5.2	5.1	-0.1	4.9	
Radio & television broadcasting	0.2	0.3	0.1	0.3	0.2	-0.1	0.2	4.1	1.7	-2.4	2.0	
Electric, gas, & sanitary services	2.6	3.0	0.4	2.8	3.2	0.4	3.3	3.0	3.1	0.1	3.9	
Wholesale trade	6.8	6.2	-0.6	7.6	7.5	-0.1	7.4	3.7	4.9	1.2	4.7	
Retail trade	9.2	9.1	-0.1	9.6	9.6	0.0	9.9	2.8	3.0	0.2	3.5	
Finance, insurance, & real estate	14.4	14.4	0.0	14.5	14.7	0.2	14.5	2.5	2.6	0.1	2.7	
Banking	1.7	1.7	0.0	1.6	1.6	0.0	1.6	1.9	1.9	0.0	1.6	

Credit agencies other than banks	0.2	0.2	0.0	0.2	0.2	0.0	0.2	6.3	6.3	0.0	5.7
Security & commodity brokers, & services	0.3	0.3	0.0	0.6	0.8	0.2	0.8	10.8	14.5	3.7	14.3
Insurance carriers	0.9	1.1	0.2	1.0	1.0	0.0	1.0	3.3	1.2	-2.1	1.7
Insurance agents & brokers, & services	0.6	0.5	-0.1	0.6	0.5	-0.1	0.5	3.7	2.5	-1.2	2.3
Real estate	10.6	10.5	-0.1	10.3	10.3	0.0	10.1	2.0	2.1	0.1	2.2
Holding & other investment companies	0.2	0.2	0.0	0.3	0.3	0.0	0.3	7.3	7.3	0.0	7.1
Services	13.5	13.7	0.2	15.9	15.3	-0.6	15.3	4.5	3.9	-0.6	3.9
Hotels & other lodging places	0.7	0.8	0.1	0.6	0.7	0.1	0.7	0.6	1.9	1.3	2.4
Personal	0.7	0.7	0.0	0.7	0.7	0.0	0.7	2.5	2.2	-0.3	2.3
Business	2.5	2.5	0.0	3.6	3.6	0.0	3.7	7.4	7.4	0.0	7.2
Auto repair, services, & garages	0.8	0.8	0.0	0.9	0.7	-0.2	0.7	3.5	1.7	-1.8	1.7
Miscellaneous repair	0.3	0.3	0.0	0.3	0.3	0.0	0.3	1.7	2.2	0.5	2.9
Motion pictures	0.2	0.2	0.0	0.2	0.2	0.0	0.2	2.8	3.6	0.8	3.6
Amusement & recreation	0.4	0.4	0.0	0.5	0.5	0.0	0.5	5.1	5.7	0.6	5.9
Health	3.9	4.0	0.1	4.6	4.1	-0.5	4.0	4.6	2.8	-1.8	2.6
Legal	0.9	0.9	0.0	1.0	1.0	0.0	1.0	3.6	2.6	-1.0	3.1
Educational	0.6	0.6	0.0	0.6	0.6	0.0	0.6	3.1	2.6	-0.5	2.7
Social services & membership organizations	0.9	0.9	0.0	0.9	0.9	0.0	0.9	2.5	2.5	0.0	2.9
Miscellaneous professional	1.4	1.4	0.0	1.7	1.7	0.0	1.7	5.0	4.9	-0.1	4.7
Private households	0.2	0.2	0.0	0.2	0.2	0.0	0.2	1.5	1.5	0.0	1.3
Government & government enterprises	11.8	11.8	0.0	10.8	10.8	0.0	10.5	1.3	1.2	-0.1	1.3
Statistical discrepancy	0.0	0.0	0.0	-0.2	-0.1	0.1	-0.2	—	—	—	—
Residual	-0.3	-0.5	-0.2	0.1	-0.7	-0.8	-0.7	—	—	—	—
Rest of the world	1.7	1.7	0.0	0.7	0.7	0.0	0.7	-9.3	-8.8	0.5	-7.3

*1988 industry GNP was not estimated until phase 1 of the GPO improvement program.

services. The 1979–87 average annual rate of change in each of these industries was reduced by between 1.0 and 9.3 percentage points.

As shown in table 1.8, the upward revisions made to the 1979–87 real growth rates of railroads, air transportation, and security and commodity brokers are particularly large. Below, we outline the sources of the revision in each industry in order to further illustrate the influence of the improved estimating procedures. In the case of railroads, the previous estimates of constant-dollar GNP were obtained by indirect, or method 3, double deflation. As such, a significant part of the revision in growth rates is due to the switch from method 3 to method 2 double deflation, but most of the revision is due to improvements made in the constant-dollar gross output estimates. The previous gross output estimates were obtained by using a composite implicit deflator based on the PPI for railroad freight and the CPI for intercity train fares. By contrast, the revised real gross output estimates are obtained by using a composite implicit deflator based solely on the physical gross output of freight and passengers transported, as described in table 1.6.

In the case of air transportation, the previous estimates of constant-dollar GNP were obtained by extrapolation with constant-dollar gross output estimates for the industry. Thus, the revision in the real GNP growth rate reflects both the switch from output extrapolation to method 2 double deflation and revision of the constant-dollar gross output estimates. The latter revision stems largely from the incorporation of benchmarks from the 1977 and 1982 benchmark I-O tables and of a quantity extrapolator for the output of domestic passengers transported (see table 1.6) in place of the CPI and personal consumption expenditure (PCE) deflators for airline passenger fares used in the previous estimates.

Finally, in the case of securities and commodity brokers, the previous estimates of constant-dollar GNP were obtained by extrapolation with labor input and thereby assumed no productivity growth. The large upward revision in this industry's real GNP growth reflects the switch from labor input extrapolation to method 2 double deflation. To implement double deflation in this industry, original estimates of the components of its real gross output were constructed. Of particular significance, the real output of the security brokerage activity is now estimated by extrapolating 1982 securities commissions with a quantity index representing the number of public orders received by registered exchanges and over-the-counter markets. And, the real output of securities underwriting/investment banking activities is now estimated by extrapolating 1982 fees for such activities with an index of the quantity of new issues brought to market by underwriters (see table 1.6).

In summary, the new GPO estimates, derived from the aforementioned methodology improvements, indicate not only that the share of the U.S. economy accounted for by services-producing industries during 1979–87 was more than a half a percentage point smaller than previously estimated but also

that the increase in that share between 1979 and 1987 was a half point larger than previously estimated. However, in contrast to much publicized speculation, the relative growth in the service sector has not come at the expense of manufacturing.²² On the contrary, reflecting the large increases in productivity that occurred after 1982 and the rapid growth in manufactured exports that occurred after 1986, the new GPO estimates indicate that manufacturing, especially durables, increased its relative share by 1.2 percentage points between 1979 and 1988. Finally, the revised GPO estimates for transportation industries (except water), wholesale trade, security and commodity brokers, and hotels and lodging places suggest, *ceteris paribus*, that these services-producing industries experienced substantially more productivity growth during 1979–87 than previously estimated.

1.5 GPO Improvement Program

The GPO improvement program is a long-run and ongoing effort to improve comprehensively and systematically both the industry current- and constant-dollar GNP estimates by preparing consistent time series of production accounts, which will provide detailed and complete coverage of the outputs produced and the inputs consumed by each industry. The result of achieving this core objective will be a substantial reduction in most of the remaining methodology limitations and will provide GNP estimates that are better suited for measuring industry growth and productivity.

The program is anticipated to be completed in three phases. Phase 1 has been completed and has produced extensive, but incomplete, improvements covering the period from 1977 to 1989.²³ Phase 2, scheduled for completion during September 1992 as part of the forthcoming comprehensive NIPA revision, will provide estimates that reflect most of the planned methodology and date improvements for the 1977-forward period. Finally, phase 3 will extend the improvement program back to 1958 and is expected to be completed during 1993, depending on available resources. In what follows, major improvements planned for phases 2 and 3 of the improvement program are discussed in detail.

1.5.1 Selected Improvements

Six specific categories of improvements are to be implemented during phases 2 and 3. Included are the following: (1) improved current-dollar GNP

22. See, e.g., Mishel (1988, 1989) and Kelly and Wyckoff (1989). Each has been prominent in speculating not only that there has been a secular decline in manufacturing's share of GNP since 1979 but also that this decline would be manifested in the new GPO estimates.

23. Phase 1 of the GPO improvement program was completed when revised 1987 and 1988 estimates and initial 1989 estimates were published in the *Survey of Current Business*, April 1991.

estimation; (2) expanded use of double deflation; (3) improved measurement of gross output; (4) improved measurement of intermediate inputs; (5) expanded industry detail; and (6) use of superlative indexes.

Current-Dollar GNP Estimation

Under phase 1, current-dollar industry GNP continued to be developed by the method 2 technique discussed in section 1.3; during phase 3, current-dollar GNP estimates for most, if not all private industries, will be increasingly derived by the method 1 technique; that is, as the difference between current-dollar gross output and current-dollar intermediate input. The latter method will ensure that industry gross output, GPO, and intermediate input measures are internally consistent and it will make BEA's estimating methodology for the GPO consistent with United Nations SNA accounting procedures.

Double Deflation

With completion of phase 1, double deflation is now used to derive the real GNP for 50 industries and the nonfarm household services component of real estate; these industries represent 87 percent of the 1987 real GNP originating in the private sector. In conjunction with the adoption of method 1 for current-dollar GNP estimation, the objective during phases 2 and 3 of the improvement program is to obtain the real GNP estimates for the component industries of the entire service sector (except private households) through method 1 double deflation, including the nine industries above private households in table 1.6.²⁴ Of these nine, particular effort will be directed toward business services, banks and other credit agencies, and real estate, except nonfarm business services.

Gross Output

Preliminary current- and constant-dollar gross output estimates for 1977–89 were developed during phase 1 for the component SIC industries listed in table 1.7. In order to achieve the expanded double deflation objective, current- and constant-dollar gross output and intermediate inputs measures will be developed for the remaining non-double-deflated services-producing industries. The final estimates for 1977-forward will be constructed during phase 2; those for 1958–76 will be constructed during phase 3. The methodology for producing these estimates is designed to generate nominal and real gross output measures that (1) are defined on a consistent SIC industry definition; (2) provide comprehensive coverage of every industry's output; and (3) identify the major product composition of each industry's gross output. This last change permits more accurate deflation than is possible in existing real gross output measures.

24. See n. 16.

With respect to the current-dollar estimates, the new methodology involves the use of a consistent definition of gross output across industries, the development of five-year benchmarks consistent with benchmark I-O tables, and the development of annual extrapolator series that are both consistent over time and consistent with the benchmark data sources. Construction of industry and product benchmarks and extrapolators have been and will continue to be based not only on intensive use of benchmark and annual I-O account work files but also on considerable research to choose the “best” annual extrapolator for each industry and product. With the possible exception of some finance industries, the phases 2 and 3 final benchmark estimates for industry nominal gross output (GO) will be based on the following formula:

$$\begin{aligned} \text{GO} &= \text{receipts (including BEA coverage adjustment)} - \text{cost of resales} \\ &+ \text{inventory change} + \text{commodity taxes} \\ &+ \text{new force-account construction.} \end{aligned}$$

With respect to the constant-dollar gross output estimates, the improvements to be implemented during phases 2 and 3 involve both improving the manufacturing methodology and introducing a similar one for services-producing industries. Under the phase 1 methodology, the product composition and deflation of total shipments from each four-digit manufacturing industry is determined at the five-digit product-class level. Inventory change is currently estimated and deflated at the two-digit industrial level so that real gross output can be determined only at the two-digit industry level. For phases 2 and 3, however, current- and constant-dollar inventory change will be available at the four-digit manufacturing level, and benchmarked current-dollar gross output estimates will be generated and deflated at four-digit level.

The effort to replicate the manufacturing procedure in services-producing industries, which began during phase 1, will be extended during phases 2 and 3 in several steps. First, benchmark I-O work files will be used to identify and measure more of the products produced by each industry. Second, more and better source data will be incorporated in order to develop improved current-dollar extrapolators at this more detailed product level. Third, more detailed industry product deflators or quantity index extrapolators will be incorporated. Together these improvements are expected to produce better real gross output and implicit price deflator estimates for services-producing industries.

Intermediate Inputs

Critical to achieving the improvements outlined above and below is the implementation and completion of a comprehensive project designed to produce improved estimates of the current- and constant-dollar services and other intermediate inputs consumed. Under phase 1, estimates of the current-dollar intermediate input consumed by each industry continued to be derived by the residual method—current-dollar gross output less current-dollar value added—and the constant-dollar estimates continued to be derived by employ-

ing industry-specific composite intermediate input deflators. During phase 3, current-collar and constant-collar estimates of the detailed services and other intermediate inputs consumed by each industry will be constructed from I-O tables. In turn, these improved input estimates will permit method 1 estimation of both current- and constant-dollar industry GNP.

The methodology used to construct the improved input estimates will go beyond that employed in phase 1 in several ways: (1) it will incorporate SIC-based benchmarks developed from the 1958, 1963, 1967, 1972, 1977, and 1982 benchmark I-O tables, and from the latest annual I-O table; (2) it will partition the intermediate transactions matrix of each benchmark into three submatrices—energy, other materials, and services; (3) intrabenchmark interpolation will be conducted either on the basis of input cost share coefficients within each of the three submatrices or by incorporating previously unused industry data to move the cell values within a submatrix between benchmarks; (4) the final current-dollar cell estimates in each submatrix will be obtained by using a biproportional balancing algorithm and a comprehensive collection of row and column controls; and (5) the constant-dollar input estimates will incorporate both improved estimates of the imported and domestic composition of inputs and more detailed deflators for services inputs.

Industry Detail

The private-sector industry detail in the phase 1 GNP estimates is confined to 60, essentially two-digit industries. It is anticipated that the improvements in methodology discussed above will make it possible in phase 3 to significantly increase the number of industries in the GPO estimates. Although the industry count that ultimately will appear is uncertain at this time, an expansion to three-digit detail from the present two-digit detail appears possible for the mining; manufacturing; electric, gas, and sanitary services; and services industries. This expansion in industry detail will permit a much more refined study of productivity, structural change, and competitiveness issues than that possible from the presently published GPO series.

Superlative Indexes

A major criticism of BEA's existing aggregate real GNP estimates is that they are calculated by using a fixed base-year weighing formula. As a result, the aggregate real GNP estimates may not properly reflect price-induced substitution along given utility and production functions and thereby tend to overstate aggregate prices increases and understate aggregate real output increases. In addition, periodic shifting of the base year tends to reduce growth rates because the new index often overweighs goods whose prices have risen most rapidly between base years and whose real sales have, therefore, grown least rapidly. For these reasons, several observers have suggested computing aggregate annual real GNP and its growth by the use of chain superlative

index number formulas.²⁵ The BEA is planning to publish estimates of the growth in aggregate real GNP obtained by alternative index number formulas as part of the forthcoming comprehensive GNP revision (Young 1989).

The above noted criticisms also apply to industry level real GNP estimates. The foregoing improvements in the measurement of gross output and intermediate input will result in an increase in the quality and quantity of the data necessary to develop estimates of the change in industry-level measures of aggregate gross output and intermediate inputs based on superlative index numbers. In turn, these estimates can be used to prepare implicit superlative index number estimates of the change in industry-level GNP.²⁶

1.6 Concluding Remarks

The BEA anticipates that the fully implemented GPO improvement program will significantly improve the services measures in the GPO estimates, eliminate most of the criticisms of the previous industry GNP estimates, and improve the credibility of productivity, structural change, and competitiveness analyses based on the industry GNP estimates. There are, however, limits to the degree to which either the historical or future estimates can be improved. In the first instance, going back in time runs directly into the source data constraints that in large part shaped the previous methodology with all its apparent potential for measurement error. The introduction of a new methodology and more intense mining and exploitation of existing data can produce significant improvements but they cannot completely mitigate measurement error traceable to limitations in the available source data.

Since the early 1980s, advances in the Census Bureau's annual coverage of service industries have made possible significant improvement in the estima-

25. Superlative index numbers are traced to Diewert (1976). A summary of the contemporary literature on aggregation theory and the production theory foundations of alternative superlative index formulas is found in Mohr (1988), chap. 2 and appendix. Triplett (1989) provides a comparison of the growth in producers durable equipment calculated from the conventional base-year-price weighted quantity indexes and from alternative superlative index number specifications.

26. Two possible formulas for calculating the growth of industry real GNP from the growth in its gross output and purchased inputs come to mind:

$$(1) \quad \text{CO\$ GNP} = \text{CO\$ GO} - \text{CO\$ purchased input}$$

or

$$(2) \quad \log \text{CO\$ GNP} = \log \text{CO\$ GO} - \log \text{CO\$ purchased input.}$$

The first formula, which is the standard double-deflation calculation of methods 1 and 2 in the text, is justified only if an industry's production technology is additively separable between its value-added inputs and its intermediate inputs; i.e., intermediate and value-added inputs of all forms are either perfect substitutes or complements—partial elasticities of substitution are either infinite or zero. The second formula, however, is justified under the somewhat less restrictive condition of log linear (multiplicative) separability; i.e., intermediate inputs and value added inputs of all forms are exact substitutes—partial elasticities of substitution are finite and equal. See, e.g., Denny and May (1977).

tion of current-dollar gross output for many service industries. Nevertheless, there remains a substantial agenda of long-standing limitations that can only be overcome through expanded source data collection by BLS and the Census Bureau. Included in this agenda are the following:

1. Expand economic censuses to all services-producing industries, particularly those in FIRE;
2. Provide at least census-year coverage of not only the detailed types of materials but also of the detailed types of services inputs consumed by U.S. industries.
3. Expand the coverage of Census annual surveys to all industries and collect data on both materials and services inputs.
4. Collect annual quantity data by type of product or service provided by service sector industries. These data will provide improved estimates of real gross output and will provide weights for the development of quality-adjusted prices.
5. Expand the business services portion of the BLS PPI program.
6. Develop (by BLS) output and input price deflators that reflect both changes in the character and improvements in the quality of services produced.
7. Collect (by the Census Bureau) annual data on imported goods sold and purchased by establishments in wholesale and retail trade.

This agenda has few new items. Over the years, BEA has supported Census Bureau and BLS data-collection initiatives in the aforementioned areas. In addition, several independent committees have prepared reports that recommended granting BEA, BLS, and Census Bureau increased budgetary authority to address these pressing problems. The earlier reports included the 1977 report of the advisory committee on gross national product data improvements and the 1981 report of the National Science Foundation panel to review productivity statistics. Unfortunately, the necessary resources have just begun to materialize and the problems still remain many years after several calls to action.

In recent years, however, criticism of the industry GNP data has significantly raised not only the level of visibility of these problems but also the consequences of failing to adequately address them. For example, the April 1987 report of the working group on the quality of economic statistics to the Economic Policy Council noted:

Because of difficulties of measuring quality in services, construction, and various high-technology products, current-dollar output in these industries may have been "over-deflated" and real growth underestimated.

. . . The solution is not entirely in BEA's hands—BEA depends upon data produced by other government agencies and private organizations and cannot always readily bring about improvements in the quality of these data.

More recently, on January 25, 1990, Michael Boskin, chairman of the Council of Economic Advisers, issued a coordinated call to action on these problems when he released the recommendations of President Bush's working group on improving economic statistics—"Improving the Quality of Economic Statistics."²⁷ Most recently, these recommendations formed the basis for a comprehensive initiative for improving economic statistics in the president's fiscal year 1992 budget. This initiative, the fiscal year 1992 Economic Statistics Initiative, includes programs that address the agenda of needs in services measures outlined earlier in this section.²⁸ As a result of these developments, prospects for effective action to deal with important source data deficiencies in services and other areas of the GPO estimates appear much brighter.

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27. A summary of the working group's report appears in the *Survey of Current Business*, February 1990, 2.

28. See Office of Management and Budget (1991); for further information see Council of Economic Advisers (1991).

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Comment Martin Neil Baily

There is a common perception that the slow growth of productivity in the U.S. economy since 1973 is attributable in some substantial degree to the mismeasurement of real output, particularly service-sector output. This proposition was fairly easy to refute with respect to the 1973–79 period. The growth slowdown was pretty much across the board, so that almost all the major sectors of the economy had experienced slower growth, and in fact the most serious declines in productivity occurred in the goods producing industries of construction and mining.

The situation changed in the 1980s, however, a change that seems to be continuing into the 1990s. Fueled by huge increases in the quality of computers, productivity growth has recovered dramatically in the manufacturing sector. And the collapse of productivity in construction and mining has ameliorated. Meanwhile, the growth slowdown in service industries has intensified. The growth rate of labor productivity in services in the 1950s and 1960s was quite good, but it has become steadily weaker since then. The extent to which

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the U.S. economy resumes more normal rates of productivity growth in the remainder of this century largely depends on the extent to which the (broadly defined) service sector is able to achieve improvements in productivity.

Of course one possibility is that improvements in service-sector productivity are really taking place but we are not seeing them because of errors in the data. This was a question that Robert J. Gordon and I addressed in our 1988 paper (see full citation in Michael F. Mohr's paper). And the story we came up with is a paradoxical one. There is a lot of evidence of egregious errors in the data, and many of these errors suggest that productivity growth in the service sector is being understated. On the other hand, it is very difficult to make the case that measurement errors account for a major part of the slowdown, either in service-sector productivity growth or in aggregate growth. The explanation for this paradox is that first, in many cases the measurement errors predated the slowdown in growth. And second, many of the errors are in industries that are partly or wholly intermediate goods suppliers, which means that improvements in the measurement of output in these industries does not change the estimates of aggregate real output.

In a way, however, it is a relief to get the slowdown issue out of the way, because that takes the pressure off the statistical agencies. We can now get down to the serious business of tackling the many measurement errors that do exist in the data for the service sector. Probably the slowdown cannot be explained as a measurement problem, but the interest in this issue has prompted a major effort at data improvement. And irrespective of explaining the slowdown, it is very important to know how prices, real output, and productivity are doing in the service industries, the part of the economy that accounts for over half of GNP.

Michael F. Mohr is the head of the branch at the Bureau of Economic Analysis (BEA) that prepares the data on gross product originating by industry and in his paper he describes the major effort that is underway to improve the quality of those data. It is an impressive effort, particularly so because the budget crisis keeps all of the statistical agencies squeezed for funds.

In the past, value added in many parts of the service sector has not been computed using data for outputs and inputs and their appropriate deflators. In some cases the deflator for labor compensation has been used to deflate current dollar GPO, which has the effect of making real GPO growth in the affected industry depend largely on the growth in employment. The improvement program that Mohr describes will develop "industry current- and constant-dollar GNP estimates by preparing consistent time series of production accounts, which will provide detailed and complete coverage of the outputs produced and the inputs consumed by each industry" (see sec. 1.5). This program of improvement has been partially completed already and the remainder will be completed by 1993.

In the next rounds of improvement, the BEA will also be exploring the use of superlative index numbers, a change that could make a big difference,

given the large relative price changes that take place in the economy. We can look forward to the results of this effort, including the BEA's proposal to compute some *divisia* value-added numbers to compare with the standard figures for value added. The concept of value added as the arithmetic difference between gross output and purchased inputs is not one with much validity in production theory.

In table 1.8 some of the fruits of the first phase of the program are shown, and one important issue brought out in the table is the share of output produced in services. Some people have argued that data errors have led to an exaggeration of the share of GNP produced in the manufacturing sector with a corresponding understatement of the service-sector share. This idea is not supported by the revised data presented in the table. There was a rearrangement of manufacturing, giving a bigger share to nondurables and a smaller share to durables, but the total manufacturing share has not changed much at all. The data do show a rise in the service share, but this has come at the expense of the government sector. The revisions have resulted in a shift away from the share of services that are publicly provided.

In looking at the growth rates of real output in the main service sector categories, Gordon and I can perhaps be forgiven a bit of "I told you so." As we predicted, the improvements in the data have not led to a big change in the estimate of overall growth—the slowdown has not been explained away. And the biggest changes in estimated growth have occurred in the transportation sector, where we suggested that growth was being understated.

Despite the fact that the program of improvement that Mohr has described is an impressive one, there remain some serious problems to be tackled, most of which are out of Mohr's hands and will surely need new funding to solve. In particular, the price indexes for banking and financial services, for medical services, for insurance and for the rental component of the real estate sector are very weak indeed. The increase in the quality of health services is not being captured by the current deflators and this problem also gets carried over to the insurance industry, to the extent that this industry is providing health insurance. Improvements in the quality of houses and office buildings are not well captured, despite the use of hedonics for the construction industry, so that real rental costs are probably being exaggerated and the real output of the real estate sector is then understated. The deflators for banking and financial services are also still weak. And while it is hard right now to argue that bank productivity has really been great over the last ten years, one can still be concerned that the contributions that innovations in this sector will be making to future productivity will be missed.

Another problem is more directly in Mohr's province. His paper shows that the improvements that are being made in the industry data are making heavy use of input-output tables. But the reference table that is being used is the 1977 table. This same table is even being used to carve up imports. BEA is making annual adjustments to the coefficients in this table, but it is still a

pretty old reference table to be using, given all the structural changes that have been taking place in the economy. We will have much more confidence in the revised industry numbers when more complete data finally emerge.

A similar problem arises with the employment matrix—actually the problem is even worse. Adequate data are not currently available by which to allocate capital income by industry for firms that span several industries. In practice, Mohr has to use an industry employment matrix and even this is somewhat out-of-date. As he notes, capital income is not such a large fraction that this is going to throw off real output estimates by much. But there are situations where it is important to know the profit rate by industry. For example, Charles Schultze and I found that there was an apparent inconsistency between the manufacturing profit rate and the predictions of the neoclassical growth model. This may simply reflect allocational errors in capital income. Phase 3 of the improvement program will allow BEA to replace the figures that are generated by the employment matrix and hopefully this will improve the estimates of profit rates by industry.

This is an enormously helpful paper that will hearten those of us who consume the data that Mohr's office puts out. There has been an erosion of the statistical base in some areas, so it is good to see a place where things are improving. There remains much to be done, but we are grateful that so much is being done.