Alternative Measures of Change in Real Output and Prices

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This article and the one that follows it, "Economic Theory and BEA's Alternative Quantity and Price Indexes," present results of BEA's work on alternative measures of production and prices. These measures, which are designed to supplement BEA's featured fixed-weighted measures, were first described in "Alternative Measures of Real GNP" in the April 1989 SURVEY OF CURRENT BUSINESS; in that article, BEA stated that it would develop the alternative measures as part of the next comprehensive revision of the national income and product accounts.

A MAJOR INNOVATION in the recent comprehensive revision of the national income and product accounts (NIPA's) was the development of alternative measures of real gross domestic product (GDP) and of GDP prices. This article describes these measures and provides annual estimates for the period from 1959 to 1990. Later this year, BEA expects to provide quarterly estimates of the alternative measures.

BEA now features real GDP calculated in 1987 prices as its measure of real output.[1] Before the comprehensive revision, the featured measure was real gross national product (GNP) calculated in 1982 prices. However, for reasons set forth in this article, no single measure of real GDP can be considered sufficient for all analytical applications.

BEA first introduced an alternative measure of real output in 1989, when real GNP calculated in 1987 prices was presented as an alternative to real GNP calculated in 1982 prices.[2] This alternative provided a preview of the use of 1987 prices to value real output in the comprehensive revision. BEA also announced that it was conducting research into alternative measures that would not

be based on the fixed price weights of a single year.

In general, a fixed-weighted measure of real output based on the prices of a more recent year increases less than one based on prices of an earlier year. This property, which has often been observed in index number construction, exists because the commodities for which output grows rapidly tend to be those for which prices increase slowly or decrease (and, conversely, the commodities for which output grows slowly tend to be those for which prices increase rapidly). Thus, when real output is recalculated using more recent prices, the commodities with strong output growth receive less weight, lowering the growth rate of the aggregate.[3]

This property has always been recognized as a problem in long-term comparisons of real output. However, until recently, the difference in the effect of using one set of prices rather than another in measuring real GDP in the United States

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3. In considering whether the price of a commodity has increased more or less rapidly than prices of other commodities from one period to another, it is necessary to restate the price weights of the commodities for one of the two periods so that they reflect the same quantities as the weights for the other period. For example, to compare the price of a commodity in 1982 with the price in 1987, output shares in 1982 valued in 1982 and 1987 prices may be compared. It would be incorrect to compare the current-dollar output share in 1982 with the current-dollar output share in 1987 because such comparisons are affected by changes in both prices and quantities.

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1. Depending on the context, real GDP is described in this article in two different but equivalent ways: As the sum of detailed quantities valued in base-year prices, and as the weighted sum of detailed quantity relatives (indexes), where the weights, which are referred to as price weights, are shares of current-dollar output in the base year. Footnote 12 in the appendix to this article, "A Note on Alternative Measures of Real GDP" provides several equivalent algebraic formulations for real GDP.

2. See Allan H. Young, "Alternative Measures of Real GNP," SURVEY OF CURRENT BUSINESS 69 (April 1989): 27–34.

had generally been considered small enough to be safely ignored. The simplicity of an output measure in which the prices of a single year were used to value real GDP for all years was considered to outweigh any advantage provided either by presenting alternative measures based on prices of other years or by using more complex approaches to weighting.

Two situations have contributed to a change in this view. First, beginning in the 1970's, changes in the prices and quantities of the energy and food components of GDP have been large enough in certain periods to make the measurement of the change in real GDP sensitive to the choice of price weights. However, to some extent these price and quantity movements reversed direction in later periods, moderating the effects on measured long-term growth.

Second, since the introduction of BEA's price index for computers in the 1985 comprehensive revision, changes in the prices and quantities of computers have been large enough to make the measurement of the change in real GDP quite sensitive to the choice of price weights. For example, over the period 1982 to 1987, business expenditures on computers and peripheral equipment in 1987 prices increased over 300 percent, while computer prices declined 60 percent. Consequently, computers receive a lower valuation when real GDP is calculated in 1987 prices than when calculated in 1982 prices; for this reason, they contribute about 1.5 percentage points less to the growth from 1982 to 1987 in real GDP in 1987 prices than in 1982 prices.

In addition, if improved measures of prices of high-tech goods other than computers (and of high-tech services) are developed in the future, they may show larger declines or smaller increases in prices than the price indexes now used in the deflation of these commodities. If so, the effect of the selection of price weights on the calculation of real GDP may become greater still.

Real GDP Measures

In this article, BEA's featured measure of real GDP is shown as a fixed-weighted quantity index in which the weights are 1987 prices. This index multiplied by the 1987 value of current-dollar GDP is equal to real GDP in constant 1987 dollars—the form of real GDP customarily presented in the NIPA charts and tables. The two series are identical in terms of percent changes. Showing the featured measure in index form facilitates comparisons with the two alternative measures of real GDP introduced in this article.

Unlike the fixed-weighted measure, the two alternative measures of real GDP introduced in this article are not based on the price weights of a single base year: In one, the weights change each year; in the other, the weights change each benchmark year—that is, at about 5-year intervals. The first index is referred to as the *chain-type annual-weighted quantity index*; the second, as the *benchmark-years-weighted quantity index*.[4] (The alternative quantity indexes are presented in table 2 at the end of this article.)

These alternative indexes use the Fisher Ideal index formula to provide a measure of change between two periods.[5] A Fisher Ideal quantity index is a geometric mean of a Laspeyres and a Paasche quantity index. The Laspeyres quantity index uses the prices of the first of the two periods being compared to weight quantities. The Paasche quantity index uses the prices of the second period. Given that the Fisher Ideal index is a geometric mean, the change in the Fisher Ideal index falls between the changes in the Paasche and Laspeyres indexes.[6]

BEA expects to introduce a third alternative in 1993: A fixed-weighted quantity index with 1992 prices as weights. If, in the comprehensive revision of the mid-1990's, BEA continues to feature real GDP calculated in the prices of a given year, the price weights are likely to be those for 1992.

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4. The concept of the benchmark-years-weighted quantity index was developed by Jack Triplett, Chief Economist at BEA. He has referred to such an index as the "Time-series Generalized Fisher Ideal Index." See Jack E. Triplett, "Superlative and Quasi-Superlative Indexes of Price and Output for Investment Goods: Office, Computer, and Accounting Machinery," BEA Discussion Paper No. 40 (presented at a National Bureau of Economic Research Summer Workshop, Boston, MA, July 1988). Copies may be obtained from the author.

5. The Fisher Ideal index was one of many index formulas examined by Irving Fisher in *The Making of Index Numbers*, New York: Houghton Mifflin Company, 1922.

6. The Fisher Ideal quantity index formula is $Q^f = \sqrt{Q^l \times Q^p}$, where Q^l is the Laspeyres quantity index and Q^p the Paasche quantity index. For the first period, $Q_1^l = Q_1^p = \sum p_1 q_1 / \sum p_1 q_1 = 1.0$, and $Q_1^f = 1.0$, where the p's and q's represent prices and quantities. For the second period,

$$Q_2^l = \frac{\sum p_1 q_2}{\sum p_1 q_1},$$

$$Q_2^p = \frac{\sum p_2 q_2}{\sum p_2 q_1}, \text{ and}$$

$$Q_2^f = \sqrt{\frac{\sum p_1 q_2}{\sum p_1 q_1} \times \frac{\sum p_2 q_2}{\sum p_2 q_1}}.$$

The growth rate from period 1 to period 2 is $100(Q_2^f / Q_1^f - 1.0) = 100(Q_2^f - 1.0)$.

Gross Product by Industry: A Preview

When BEA revises the gross product by industry estimates to make them consistent with the comprehensive revision of the NIPA's, estimates of real gross product by industry will be calculated using fixed 1987 price weights. Updating the fixed weights from 1982 to 1987 will have the largest impact on manufacturing—specifically, on the nonelectrical machinery industry, in which computers and peripheral equipment are produced. BEA will also prepare alternative estimates of real gross product by industry using benchmark-years weights. (BEA does not plan to calculate chain-type annual-weighted indexes—the other alternative measure presented in the article—for real gross product by industry, because less product detail is available annually than for benchmark years.)

Because of the substantial change in the relative price structure—traceable largely to the declining prices of computers and peripheral equipment—the use of fixed 1987 price weights for the gross product by industry series will not adequately portray the course of manufacturing in the late 1970's or early 1980's. Likewise, use of fixed 1977 or fixed 1982 price weights will not adequately portray manufacturing in the late 1980's. The benchmark-years-weighted index, which allows for change in the relative price structure, will present a more accurate picture.

Exhibit 1 shows the differences in growth rates for manufacturing that result from the use of prices of either 1977, 1982, or 1987 as fixed weights in calculating an index of real manufacturing gross product. The exhibit also shows the growth rates that result from the use of benchmark-year prices as weights. The index based on 1982 price weights essentially corresponds to the 1982 dollar series released in April 1991, before the comprehensive revision of the NIPA's (it incorporates small revisions that have little effect on the growth rates). The other three indexes are calculated from the same price and quantity information as used for the 1982 dollar series. When the gross product by industry indexes are revised, the growth rates may differ from those in the exhibit; however, the pattern of differences in growth rates will remain about the same.

The lack of additivity of the benchmark-years-weighted quantity index may present a problem to some users of the gross product by industry series. Within the framework of the benchmark-years-weighted quantity indexes, it may not be possible to calculate, in an exact sense, a time series for manufacturing as a share of total output. However, by comparing the growth rates of manufacturing with those of total GDP, it will be possible to determine whether manufacturing gross product increased more or less rapidly than total GDP.

Exhibit 1.—Fixed-Weighted and Benchmark-Years-Weighted Indexes of Real Gross Product in Manufacturing: Average Annual Rate of Change Over Selected Periods

	Fixed-weighted indexes			Benchmark-years-weighted index
	1977 weights	1982 weights	1987 weights	
1977-87	4.7	2.6	1.6	2.6
1977-82	0.8	−0.7	−1.3	0.1
1982-87	8.8	6.0	4.5	5.2

NOTE.—With fixed-weighted indexes, real gross product is obtained by the double deflation method as the difference between real gross output and real intermediate inputs. For the benchmark-years-weighted quantity index, the following relationship was used to obtain the gross product index: $(I_{GPO})^{\theta_2} = I_{GO}/(I_{II})^{\theta_1}$, where I_{GPO} is the derived benchmark-years-weighted index of gross product, I_{GO} is a benchmark-years-weighted quantity index of gross output, I_{II} is a benchmark-years-weighted quantity index of intermediate input, and θ_1 and θ_2 are the average current-dollar shares of gross output accounted for by intermediate inputs and value added. Use of this relationship provides a close approximation to a benchmark-years-weighted quantity index.

Chain-type annual-weighted quantity index.—For this alternative, a Fisher Ideal quantity index is used to calculate the change from year $t-1$ to year t. Thus, the annual change is provided by the geometric mean of the year t values of two fixed-weighted quantity indexes, one of which uses prices of year $t-1$ as weights and the other, prices of year t as weights. Annual changes computed in this manner are "chained" (multiplied) together to form a time series.

Benchmark-years-weighted quantity index.—For this alternative, the Fisher Ideal index formula is adapted to use weights from two adjacent benchmark years, which are customarily 5 years apart. For each pair of adjacent benchmark years and the interval between them, two fixed-weighted quantity indexes are computed: One with the prices of the first benchmark year as weights, and the other with the prices of the second benchmark year as weights. The geometric mean of these indexes is the benchmark-years-weighted quantity index. Cumulation of the annual changes

in the benchmark-years-weighted index is equal to the Fisher Ideal change calculated directly from one benchmark to the next. Benchmark years are used as weighting periods because, for components of GDP that incorporate information from the quinquennial economic censuses, the benchmark-year price and quantity estimates are considered to be more accurate than those for other years.

For 1982–87, the benchmark-years-weighted quantity index is the geometric mean of the fixed-weighted quantity index that uses 1987 prices as weights and the fixed-weighted quantity index that uses 1982 prices as weights. (Except for statistical and definitional revisions, this latter index corresponds to the fixed-weighted GDP measure used before the comprehensive revision in 1991.) For years beyond the most recent benchmark year, the benchmark-years-weighted quantity index is calculated as the geometric mean of the fixed-weighted quantity index that uses prices of the most recent benchmark year and the fixed-weighted quantity index that uses prices of the

most recent year. Thus, at present, for years beyond 1987, the index is calculated with 1987 and 1990 prices. Following the annual NIPA revision, the index will be recalculated using 1987 and 1991 prices. When prices for the next benchmark year, 1992, become available, the index will be recalculated using prices of the two benchmark years.

Considerations in selecting an appropriate index

A difference between two measures of real GDP is not evidence that one is wrong. A measure of real GDP is not composed of actual transactions that can, at least in principle, be added up from information obtained from transactors to obtain a single, correct total. A measure of real GDP is a construct in which transactions are valued by the compiler in terms of prices chosen, at least in part, arbitrarily. The worth of such a measure lies in whether or not it proves useful in analysis. Viewed in this way, there can be more than one useful measure.

The fixed-weighted quantity index has the advantage of simplicity. This simplicity is the result of three characteristics. First, the index formula itself is simple. Second, when the fixed-weight formula is applied to a fixed base year, it is possible to compare any two, or in fact any number of, periods on a consistent basis. Third, the index may be stated in terms of real dollars (by using only the numerator of the formula), making it possible to "add up" the components of real output and to compute "real dollar shares" of GDP for each component.

The disadvantage of a fixed-weighted quantity index lies in the fact that the relative price structure in the economy changes over time. For most purposes, a fixed-weighted quantity index can only be considered appropriate for comparisons in which both of the years being compared have relative price structures that are approximately the same as that of the base year. Thus, real GDP in 1987 prices may only be appropriate for assessing the performance of the economy in the years around 1987, when the relative price structure resembled that in 1987.

Whether the fixed-weighted index remains adequate for assessing the U.S. economy in the mid-1990's will depend on the extent to which the relative price structure changes. The two alternatives introduced in this article, as well as the rebased fixed-weighted measure to be introduced in 1993, will provide a basis for monitoring such changes; in the mid-1990's, each of them will re-flect more recent price weights than the featured measure.

The two alternatives are designed to allow for change over time in the relative price structure of GDP. The annual chain-type index measures the performance of the economy from one year to the next in terms of the price structures of the 2 years involved in the comparison. The benchmark-years index measures the performance of the economy between benchmark years in a similar fashion. The alternatives have the advantage that they portray as accurately as possible, that is, as accurately as any other indexes that could be calculated, the year-to-year or benchmark-to-benchmark changes in the economy over the entire period covered by the indexes. The disadvantage of these alternatives is that, because of the use of geometric means, they lack the additive property of the fixed-weighted index. Real GDP cannot be obtained by "adding up" its components; consequently, the contribution of each component to a given change in real GDP is not readily apparent.

One of the most interesting uses of the alternatives will be in business cycle analysis. One would expect that more useful analytical relationships will emerge from using the alternatives for such analyses; for example, one may find a closer correspondence between declines in the alternative measures of real GDP and declines in employment.

In selecting an index, it is useful to keep in mind that the estimates of the change in real GDP are subject to several types of error. Particularly for current quarter-to-quarter changes, the net effect of such errors may be as large as, or larger than, differences arising from the use of one or another of the index formulas.

Index numbers in practice.—Other major indexes prepared by U.S. statistical agencies, such as the Bureau of Labor Statistics consumer price index and the Federal Reserve Board industrial production index, do not maintain the same fixed-weighted structure over all years. For example, in the consumer price index, the composition of the market basket is changed periodically. Although the index number formulas are not the same, the approaches to weighting taken in these other indexes tend to resemble that in the benchmark-years-weighted index.

In measuring real GDP, few countries follow the U.S. practice of using the Laspeyres index formula with the same fixed-weighted structure over all years. Among the countries surveyed for this article, Japan is the only one that essen-

tially follows the U.S. practice. Australia, Canada, Germany, and the United Kingdom update price weights at about 5-year intervals. Real GDP is calculated for the 5-year interval using the Laspeyres index formula. The series is then extended back by linking on the data for previous years that incorporate earlier price weights. The Netherlands and Norway calculate an annual chain index of real GDP using annual price weights and the Laspeyres index formula; Canada provides such a measure as an alternative. France prepares two measures: In one, the price weights are updated at 10-year intervals; the other is an annual chain index.

Thus, with the exception of Japan, the surveyed countries use a chain-type procedure with the Laspeyres index formula, updating weights at 5- or 10-year intervals or annually. A characteristic of such procedures, as mentioned earlier, is that additivity is not maintained over all periods—that is, the components do not add to the total as in the U.S. measure. In order to provide additive results, some countries that link at 5- or 10-year intervals adjust either the total or the components for the earlier periods; other countries include an adjusting entry so that the components add to the total. Some of the countries do not provide additive results.

Why does BEA feature the fixed-weighted index?

The choice between the fixed-weighted measure and the alternative measures may be viewed as a choice between simplicity and accuracy as one moves away from the base period, with the extent of the gain in accuracy depending on the degree of change in the relative price structure as one moves away from the base year. Given this choice, one may ask why BEA continues to feature the fixed-weighted index. Several practical considerations entered into the decision.

First, users of the NIPA's have a substantial investment in the fixed-weighted measure in terms of knowledge and experience. Although users may come to prefer another measure, it seems best for any such change to be evolutionary.

Second, the differences between the featured and alternative measures may not be large enough to affect many types of analysis. Consistent use of one measure may very well lead to the same analytical results as consistent use of another measure. If experience shows that the differences are generally insignificant, the simplicity of the fixed-weighted index would constitute a strong argument for its retention as the featured measure. It seems best for both users and BEA to

gain such experience before considering whether another measure should be featured.

Third, BEA cannot currently prepare the alternative measures on the same schedule as the fixed-weighted measures. The computations underlying the alternatives, which are described later in the article, are substantial. Initially, BEA will calculate the alternative measures for the preliminary and final GDP estimates of the current quarter and present them in the SURVEY OF CURRENT BUSINESS; eventually, BEA probably will be able to prepare them for the advance GDP estimates and also to prepare them on a schedule that permits their inclusion in the news releases.

As the previous paragraphs suggest, experience with the alternatives may lead to a decision to feature a different measure of real GDP in the next comprehensive revision. That measure could be one of the alternatives presented in this article or a different measure. BEA expects to do further research on the selection of weights for measuring real GDP. Both the use of quarterly price weights in the chain-type index and the use of business cycle peak years in place of benchmark years as weights will be explored.

Comparison of real GDP measures

For 1959–87, the alternative indexes of real GDP show somewhat more rapid growth than the fixed-weighted index (chart 1 and table A). Both alternatives increase at an average annual rate of 3.4 percent, compared with 3.1 percent in the fixed-weighted index. For intervals between benchmark years, the largest differences occur in 1963–67, when the chain-type annual-weighted index increases an average 0.4 percentage point per year more than the fixed-weighted index, and the benchmark-years-weighted index increases 0.5 percentage point per year more. The smallest differences occur in 1982–87, when both alterna-

Table A.—Fixed-Weighted and Alternative Measures of Real GDP: Average Annual Rate of Change Over Selected Periods

[Percent]

	Fixed-weighted index, 1987 weights	Chain-type annual-weighted index	Bench-mark-years-weighted index	Col. 2 − col. 1	Col. 3 − col. 1	Col. 3 − col. 2
1959–87	3.1	3.4	3.4	0.3	0.3	0
1959–63	3.5	3.8	3.8	.3	.3	0
1963–67	4.9	5.3	5.4	.4	.5	.1
1967–72	3.0	3.3	3.3	.3	.3	0
1972–77	2.6	2.9	2.9	.3	.3	0
1977–82	1.3	1.6	1.7	.3	.4	.1
1982–87	3.8	4.0	4.0	.2	.2	0
1987–90	2.5	2.5	2.4	0	−.1	−.1

tives increase 0.2 percentage point per year more than the fixed-weighted index.

On an annual basis, the differences between the changes in the fixed-weighted GDP index and the alternatives range up to 1.0 percentage point (see table 1 at the end of the article). The largest differences between the fixed-weighted index and the chain-type annual-weighted index occur in 1962 (0.9 percentage point), 1965 (0.9), 1973 (0.7), 1981 (0.7), and 1984 (0.8). The largest differences between the fixed-weighted index and the benchmark-years-weighted index occur in 1962

(0.9), 1965 (0.8), 1966 (0.7), 1977 (0.7), and 1981 (0.9).

For 1987–90, the benchmark-years-weighted index increases slightly less than the fixed-weighted index. The benchmark-years-weighted index increases at an average annual rate of 2.4 percent; both the fixed-weighted and the chain-type annual-weighted indexes increase 2.5 percent. On an annual basis, the differences are no larger than 0.1 percentage point.

For the major components of real GDP, the alternative indexes in general also show more rapid

Table B.—Fixed-Weighted and Alternative Measures of Real GDP and Its Major Components: Average Annual Rates of Change Over Selected Periods

[Percent]

	1959–87	1982–87	1987–90	1987–88	1988–89	1989–90		1959–87	1982–87	1987–90	1987–88	1988–89	1989–90
Gross domestic product:							Merchandise:						
Fixed 1987 weights	3.1	3.8	2.5	3.9	2.5	1.0	Fixed 1987 weights	5.5	3.4	12.7	19.3	11.8	7.4
Chain-type annual weights	3.4	4.0	2.5	3.9	2.6	1.0	Chain-type annual weights	5.9	3.9	12.4	19.0	11.7	6.9
Benchmark-years weights	3.4	4.0	2.4	3.8	2.5	1.0	Benchmark-years weights	6.1	4.2	12.5	19.0	11.8	7.1
Personal consumption							Services:						
expenditures:							Fixed 1987 weights	7.0	6.1	8.6	7.5	9.8	8.6
Fixed 1987 weights	3.5	4.0	2.2	3.6	1.9	−1.6	Chain-type annual weights	6.9	6.0	8.7	7.6	9.8	8.6
Chain-type annual weights	3.6	4.1	2.2	3.6	1.9	−1.9	Benchmark-years weights	7.1	6.1	8.7	7.6	9.8	8.6
Benchmark-years weights	3.6	4.2	2.2	3.5	1.9	−1.8	Imports:						
Durable goods:							Fixed 1987 weights	6.1	10.8	3.2	3.7	3.7	2.2
Fixed 1987 weights	4.6	9.0	2.8	6.2	2.8	−.4	Chain-type annual weights	5.9	10.4	2.9	3.5	3.3	2.0
Chain-type annual weights	5.3	9.2	2.7	6.2	2.7	−.6	Benchmark-years weights	6.1	10.9	3.0	3.6	3.4	2.1
Benchmark-years weights	5.3	9.3	2.7	6.1	2.8	−.5	Merchandise:						
Nondurable goods:							Fixed 1987 weights	7.1	11.3	3.4	4.0	4.4	1.8
Fixed 1987 weights	2.4	3.0	1.3	2.4	1.4	.1	Chain-type annual weights	6.6	10.9	3.1	3.8	4.0	1.6
Chain-type annual weights	2.6	3.0	1.3	2.4	1.3	.1	Benchmark-years weights	6.8	11.4	3.2	4.0	4.1	1.6
Benchmark-years weights	2.6	3.0	1.2	2.3	1.3	.1	Services:						
Services:							Fixed 1987 weights	3.5	8.6	2.2	2.2	.2	4.2
Fixed 1987 weights	4.0	3.6	2.7	3.7	2.0	2.3	Chain-type annual weights	4.0	8.5	2.1	2.1	.1	4.0
Chain-type annual weights	4.0	3.7	2.7	3.7	2.0	2.3	Benchmark-years weights	4.1	8.6	2.1	2.1	.2	4.1
Benchmark-years weights	4.0	3.7	2.7	3.7	2.0	2.3							
Gross private domestic							**Government purchases:**						
investment:							Fixed 1987 weights	2.2	4.0	1.8	.6	1.5	3.2
Fixed 1987 weights	3.4	6.7	−.2	3.2	2.0	−5.7	Chain-type annual weights	2.3	4.2	1.8	.6	1.7	3.2
Chain-type annual weights	4.1	6.9	−.2	3.0	2.5	−5.9	Benchmark-years weights	2.3	4.2	1.7	.5	1.5	3.2
Benchmark-years weights	4.3	7.0	−.3	3.1	2.1	−5.8	Federal:						
							Fixed 1987 weights	1.3	4.7	−.4	−2.0	−.6	1.6
Fixed investment:							Chain-type annual weights	1.5	5.0	−.3	−2.1	−.3	1.5
Fixed 1987 weights	3.4	5.3	1.0	4.2	.4	−1.6	Benchmark-years weights	1.5	4.9	−.4	−2.2	−.6	1.5
Chain-type annual weights	4.0	5.4	.8	4.2	.3	−1.9	National defense:						
Benchmark-years weights	4.4	5.6	.8	4.1	.3	−1.8	Fixed 1987 weights	....	5.7	−1.2	−1.7	−2.2	.2
Nonresidential:							Chain-type annual weights	....	6.0	−1.3	−1.8	−2.3	.1
Fixed 1987 weights	4.0	2.8	3.3	6.6	2.2	1.2	Benchmark-years weights	....	6.0	−1.4	−1.9	−2.3	.1
Chain-type annual weights	4.8	3.0	3.1	6.6	2.0	.8	Nondefense:						
Benchmark-years weights	5.2	3.3	3.1	6.5	2.0	1.0	Fixed 1987 weights	....	1.9	2.4	−2.8	4.6	5.5
Structures:							Chain-type annual weights	....	1.9	2.8	−3.2	6.1	5.7
Fixed 1987 weights	3.0	−1.1	1.3	1.6	2.0	.3	Benchmark-years weights	....	1.7	2.5	−3.0	5.0	5.6
Chain-type annual							State and local:						
weights	3.0	−1.6	1.2	1.6	1.8	.2	Fixed 1987 weights	3.1	3.5	3.4	2.6	3.1	4.4
Benchmark-years weights	3.0	−1.7	1.2	1.6	1.9	.2	Chain-type annual weights	3.2	3.6	3.4	2.6	3.1	4.4
Producers' durable							Benchmark-years weights	3.2	3.6	3.4	2.6	3.1	4.4
equipment:													
Fixed 1987 weights	4.7	5.3	4.3	9.3	2.3	1.6	**Addenda:**						
Chain-type annual							Final sales of gross domestic						
weights	5.9	6.0	4.1	9.3	2.1	1.1	product:						
Benchmark-years weights	6.5	6.5	4.1	9.2	2.0	1.3	Fixed 1987 weights	3.1	3.6	2.5	4.1	2.2	1.7
Residential:							Chain-type annual weights	3.4	3.8	2.5	4.1	2.3	1.6
Fixed 1987 weights	2.3	12.7	−4.6	−1.1	−3.8	−8.7	Benchmark-years weights	3.4	3.8	2.5	4.0	2.2	1.6
Chain-type annual weights	2.4	12.6	−4.6	−1.2	−3.8	−8.8	Gross domestic purchases:						
Benchmark-years weights	2.4	12.7	−4.6	−1.1	−3.8	−8.7	Fixed 1987 weights	3.1	3.8	1.8	3.0	1.9	.5
							Chain-type annual weights	3.4	4.0	1.8	2.9	1.9	.5
Change in business inventories	....	....	....	....	....	....	Benchmark-years weights	3.4	4.0	1.7	2.9	1.8	.5
Net exports of goods and							Gross national product:						
services	....	....	....	....	....	....	Fixed 1987 weights	3.1	3.7	2.5	4.0	2.4	1.1
							Chain-type annual weights	3.4	3.8	2.5	4.0	2.5	1.1
Exports:							Benchmark-years weights	3.4	3.8	2.5	3.9	2.4	1.1
Fixed 1987 weights	5.9	4.2	11.6	15.9	11.3	7.7							
Chain-type annual weights	6.1	4.5	11.3	15.7	11.2	7.3							
Benchmark-years weights	6.3	4.7	11.4	15.6	11.2	7.5							

growth before 1987 than their fixed-weighted counterparts (table B). For personal consumption expenditures and for government purchases, the alternative indexes increase an average 0.1 percentage point per year more than the fixed-weighted index. For exports, the differential for the chain-type annual-weighted index is 0.2 percentage point per year and for the benchmark-years-weighted index, 0.4 percentage point. For imports, the differential for the chain-type annual-weighted index is −0.2 percentage point per year.

The differentials for fixed investment (as well as for gross private domestic investment) are much larger than those for the other major components: 0.6 percentage point per year for the chain-type annual-weighted index, and 1.0 percentage point per year for the benchmark-years-weighted index. Thus, the alternative measures, particularly the benchmark-years-weighted index, show a higher rate of gross capital formation relative to output than do the fixed-weighted indexes. In terms of the fixed-weighted indexes, fixed investment increases at an average annual rate of 3.4 percent from 1959 to 1987, while GDP increases at a rate of 3.1 percent. In terms of the benchmark-years-weighted indexes, fixed investment increases at an annual rate of 4.4 percent, while GDP increases at a rate of 3.4 percent.

An analysis of the sources of the differences between the fixed-weighted indexes and the alternatives requires further work. It is clear, however, that changes in the prices and quantities of computers and peripheral equipment are the major source of the differences for total GDP, fixed investment, and exports. In addition to changes in the prices and quantities of computers, the differentials for imports reflect changes in the prices and quantities of imported petroleum. Imported petroleum behaved atypically during 1959–87 in that both quantities and relative prices increased; this behavior worked to offset the contribution of computers and peripheral equipment.

GDP Price Measures

The featured measure of GDP prices is the fixed-weighted GDP price index with 1987 quantity weights.[7] The fixed-weighted GDP price index, like the fixed-weighted measure of real GDP, has the property that, when weights of a more recent year are substituted and the index recalculated, the index increases less than when the weights for an earlier year are used. For the reasons discussed earlier, this property exists because the commodities with strong (weak) price increases receive less

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7. As part of the 1991 comprehensive revision, the fixed-weighted gross domestic purchases price index with 1987 quantity weights replaced the fixed-weighted GNP price index with 1982 quantity weights as the featured measure of price change in the U.S. economy. This section focuses on measures of GDP prices in order to provide a parallel discussion with the section on real GDP. The fixed-weighted and alternative price indexes for gross domestic purchases are shown as addenda to the tables in this article.

CHART 1

Real Gross Domestic Product: Average Annual Rate of Change in Fixed-Weighted and Alternative Measures Over Selected Periods

Percent

Fixed 1987 weights
Chain-type annual weights
Benchmark-year weights

1959-63 1963-67 1967-72 1972-77 1977-82 1982-87 1987-90

U.S. Department of Commerce, Bureau of Economic Analysis
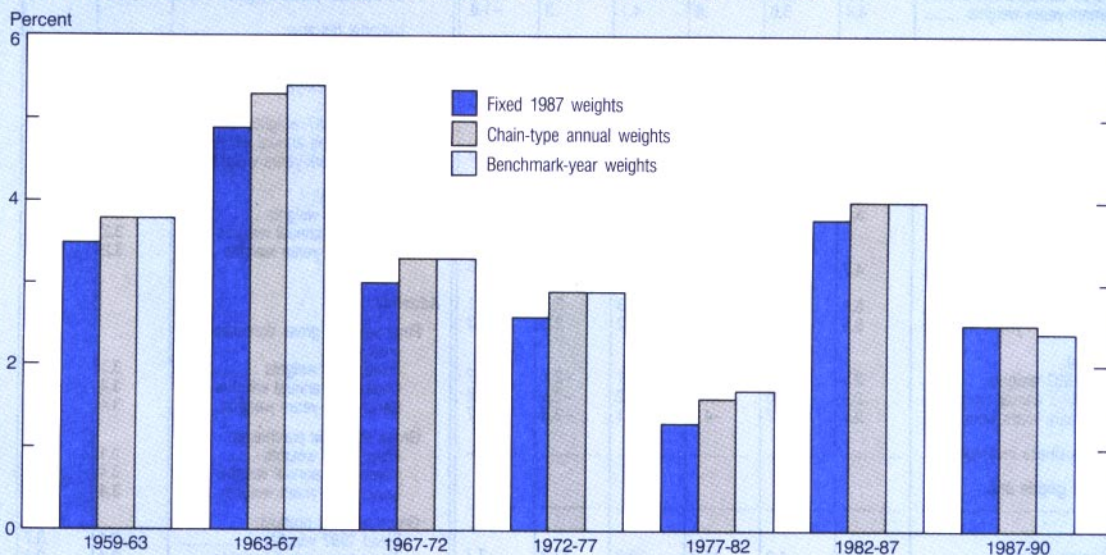
(more) weight, thus lowering the increase in the aggregate measure.

Two alternative measures of GDP prices are introduced in this article. They involve the use of the Fisher Ideal index formula and are analogues to the two alternative quantity measures discussed earlier; that is, the p's and q's are simply reversed in the index formulas. One alternative is referred to as the *chain-type annual-weighted price index*; the other, as the *benchmark-years-weighted price index.* (The alternative price indexes are presented in table 3 at the end of this article.)

One property of price and quantity indexes calculated with the Fisher Ideal index formula is that they fully account for the current-dollar change; that is, the product of the price change and the quantity change equals the current-dollar change. The featured Laspeyres fixed-weighted-price index and Laspeyres fixed-weighted quantity index do not have this property. This full accounting of the current-dollar change applies to annual changes in the chain-type annual-weighted index and to changes between adjacent benchmarks in the benchmark-years-weighted index.[8]

The fixed-weighted price indexes for several components of GDP—producers' durable equipment (PDE), exports, and imports—and for total GDP and the investment aggregates will not be shown in the NIPA tables for years before 1982, because the use of the relative quantity structure in 1987 to measure price change for those years is inappropriate. Before 1982, the combination of the high level and very rapid decline of the price index for computers and the large 1987 quantity weight for computers results in either very small

overall price increases or price declines for these components and for total GDP.[9] The affected entries are bold-italicized in the tables in this article; these bold-italicized entries should not be used as measures of price change.

Comparison of GDP price measures

The differences between the fixed-weighted GDP price index and the two alternative price indexes average 0.2 percentage point per year or less for 1982–87 and for 1987–90, the two periods shown in table C for which use of the fixed-weighted price index is appropriate. For 1982–87, the fixed-weighted GDP price index increases at an average annual rate of 3.3 percent, while the chain-type annual-weighted index increases at a 3.4-percent rate and the benchmark-years-weighted index, at a 3.5-percent rate. For 1987–90, the fixed-weighted and benchmark-years-weighted indexes increase at a 4.2-percent rate, compared with a 4.1-percent rate for the chain-type annual-weighted index. On an annual basis, the differences are no larger than 0.3 percentage point during 1982–87 and 0.1 percentage point during 1987–90 (see table 1 at the end of the article).

For 1959–87, the alternative price indexes grow more rapidly than the fixed-weighted indexes for personal consumption expenditures (PCE) and government purchases (table D). For PCE, the chain-type annual-weighted index increases at an average annual rate of 4.7 percent, the benchmark-years-weighted index at a 4.6-percent rate, and the fixed-weighted index at a 4.3-percent rate. For government purchases, the chain-

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8. Using the notation in footnote 6, the Fisher Ideal price index is $P^f = \sqrt{P^l \times P^p}$, where P^l is the Laspeyres price index and P^p the Paasche price index. For the first period, $P_1^l = P_1^p = \sum p_1 q_1 / \sum p_1 q_1 = 1.0$, and $P_1^f = 1.0$. For the second period,

$$P_2^l = \frac{\sum p_2 q_1}{\sum p_1 q_1},$$

$$P_2^p = \frac{\sum p_2 q_2}{\sum p_1 q_2}, \text{ and}$$

$$P_2^f = \sqrt{\frac{\sum p_2 q_1}{\sum p_1 q_1} \times \frac{\sum p_2 q_2}{\sum p_1 q_2}}.$$

The current-dollar change from period 1 to period 2 expressed as a ratio is $\sum p_2 q_2 / \sum p_1 q_1$ and is equal to the product of the Fisher Ideal price and quantity indexes:

$$\frac{\sum p_2 q_2}{\sum p_1 q_1} = \sqrt{\frac{\sum p_2 q_1}{\sum p_1 q_1} \times \frac{\sum p_2 q_2}{\sum p_1 q_2}} \times \sqrt{\frac{\sum p_1 q_2}{\sum p_1 q_1} \times \frac{\sum p_2 q_2}{\sum p_2 q_1}}.$$

9. The fixed-weighted GNP price index published prior to the comprehensive revision of 1991 was not affected to the same extent, because the computer price index for PDE was carried back only to 1969 and was held at a constant level in earlier years. In the 1991 comprehensive revision, the computer price index for PDE was extended back to 1959. In addition, the relative quantity of computers increased greatly from 1982 to 1987.

Table C.—Fixed-Weighted and Alternative Measures of GDP Prices: Average Annual Rate of Change Over Selected Periods

[Percent]

	Fixed-weighted index, 1987 weights	Chain-type annual-weighted index	Bench-mark-years-weighted index	Col. 2 – col. 1	Col. 3 – col. 1	Col. 3 – col. 2
1959–87	**−5.3**	4.7	4.6	....	....	−.1
1959–63	**−22.3**	1.3	1.3	....	....	0
1963–67	**−22.8**	2.3	2.3	....	....	0
1967–72	**−2.0**	4.7	4.7	....	....	0
1972–77	**3.5**	7.2	7.2	....	....	0
1977–82	**5.8**	8.1	7.9	....	....	−.2
1982–87	3.3	3.4	3.5	.1	.2	.1
1987–90	4.2	4.1	4.2	−.1	0	.1

NOTE.—Bold-italicized entries should not be used as measures of price change. See the text for an explanation.

type index increases at a 5.6-percent rate, the benchmark-years index at a 5.7-percent rate, and the fixed-weighted index at a 5.1-percent rate.

Because use of the fixed-weighted price index for GDP for periods before 1982 is not appropriate, it is of interest to compare the alternative GDP price indexes with the fixed-weighted GNP price index calculated with 1982 quantity weights that was published before the comprehensive revision. As shown in the following tabulation, the previously published fixed-weighted GNP price index increases more slowly than the benchmark-years-weighted GDP price in-

dex over each benchmark interval from 1959 to 1977. Most of the difference is due to the different approaches to weighting and not to revised source data.

	Fixed 1982 weights, GNP prices	Benchmark-years weights, GDP prices	Difference
1959–63	1.0	1.3	−0.3
1963–67	1.9	2.3	−.4
1967–72	3.6	4.7	−1.1
1972–77	6.2	7.2	−1.0
1977–82	7.9	7.9	0

Table D.—Fixed-Weighted and Alternative Measures of GDP Prices and Its Major Components: Average Annual Rates of Change Over Selected Periods

[Percent]

	1959–87	1982–87	1987–90	1987–88	1988–89	1989–90		1959–87	1982–87	1987–90	1987–88	1988–89	1989–90
Gross domestic product:							**Imports:**						
Fixed 1987 weights	−5.3	3.3	4.2	3.9	4.4	4.4	Fixed 1987 weights	1.4	−.2	4.2	5.4	3.1	4.3
Chain-type annual weights ..	4.7	3.4	4.1	3.9	4.3	4.2	Chain-type annual weights	5.6	.4	4.1	5.2	3.1	4.2
Benchmark-years weights	4.6	3.5	4.2	3.9	4.3	4.3	Benchmark-years weights	5.4	−.1	4.1	5.1	3.0	4.2
Personal consumption expenditures:							Merchandise:						
Fixed 1987 weights	4.3	3.8	4.8	4.3	4.8	2.3	Fixed 1987 weights	1.0	−.9	3.8	5.1	3.1	3.1
Chain-type annual weights	4.7	3.9	4.7	4.2	4.8	2.1	Chain-type annual weights	5.6	−.2	3.7	5.0	3.1	3.1
Benchmark-years weights	4.6	3.9	4.7	4.2	4.8	2.2	Benchmark-years weights	5.4	−.7	3.6	4.8	3.0	3.1
Durable goods:							Services:						
Fixed 1987 weights	2.2	1.6	2.2	2.0	2.5	2.1	Fixed 1987 weights	4.7	3.0	6.2	6.3	3.0	9.3
Chain-type annual weights	2.9	1.9	2.1	2.0	2.4	1.9	Chain-type annual weights	5.4	3.2	6.1	6.2	3.0	9.3
Benchmark-years weights	2.9	1.9	2.1	1.9	2.4	2.0	Benchmark-years weights	5.3	3.0	6.1	6.1	3.0	9.3
Nondurable goods:													
Fixed 1987 weights	4.2	2.4	5.1	3.8	5.5	6.2	**Government purchases:**						
Chain-type annual weights	4.4	2.4	5.1	3.8	5.4	6.0	Fixed 1987 weights	5.1	3.3	4.0	3.7	4.1	4.2
Benchmark-years weights	4.4	2.4	5.1	3.8	5.4	6.1	Chain-type annual weights	5.6	3.4	3.9	3.6	4.0	4.0
Services:							Benchmark-years weights	5.7	3.4	3.9	3.7	4.1	4.1
Fixed 1987 weights	5.2	5.2	5.2	5.1	5.0	5.4							
Chain-type annual weights	5.3	5.4	5.1	5.1	5.0	5.3	Federal:						
Benchmark-years weights	5.3	5.3	5.1	5.1	5.0	5.3	Fixed 1987 weights	4.6	2.5	3.9	2.8	4.3	4.5
Fixed investment:							Chain-type annual weights	5.5	2.5	3.7	2.7	4.0	4.3
Fixed 1987 weights	−11.1	.9	2.8	3.3	3.0	2.3	Benchmark-years weights	5.5	2.6	3.8	2.8	4.1	4.4
Chain-type annual weights	4.3	1.4	2.7	3.2	2.8	2.1							
Benchmark-years weights	3.9	1.2	2.7	3.1	2.8	2.2	National defense:						
							Fixed 1987 weights	....	2.2	3.9	3.1	4.1	4.6
Nonresidential:							Chain-type annual weights ..	....	2.4	3.8	3.0	3.9	4.4
Fixed 1987 weights	−12.3	−.1	2.6	2.8	2.7	2.2	Benchmark-years weights	....	2.4	3.8	3.0	3.9	4.4
Chain-type annual weights	3.9	.7	2.5	2.8	2.6	2.0	Nondefense:						
Benchmark-years weights	3.4	.4	2.4	2.7	2.6	2.1	Fixed 1987 weights	....	3.4	3.7	2.0	4.8	4.3
							Chain-type annual weights ..	....	3.1	3.4	1.7	4.6	4.0
Structures:							Benchmark-years weights	....	3.2	3.8	2.5	4.8	4.1
Fixed 1987 weights	5.2	1.5	3.8	4.6	4.2	2.6							
Chain-type annual weights ..	5.2	.7	3.8	4.6	4.2	2.7	State and local						
Benchmark-years weights	5.2	.9	3.8	4.5	4.2	2.7	Fixed 1987 weights	5.7	4.0	4.1	4.3	4.0	3.9
Producers' durable equipment:							Chain-type annual weights	5.8	4.1	4.1	4.3	4.0	3.9
Fixed 1987 weights	−13.6	−.8	2.0	1.9	1.9	2.0	Benchmark-years weights	5.8	4.1	4.1	4.3	4.0	3.9
Chain-type annual weights ..	3.1	.7	1.8	1.9	1.8	1.7							
Benchmark-years weights	2.4	.3	1.7	1.7	1.7	1.8	**Addenda:**						
Residential:													
Fixed 1987 weights	5.1	3.2	3.4	4.3	3.4	2.4	Final sales of gross domestic product:						
Chain-type annual weights	5.2	3.3	3.4	4.2	3.5	2.4	Fixed 1987 weights	−5.3	3.3	4.2	4.0	4.4	4.4
Benchmark-years weights	5.2	3.2	3.4	4.2	3.4	2.4	Chain-type annual weights	4.7	3.5	4.1	4.0	4.3	4.2
							Benchmark-years weights	4.7	3.5	4.2	4.0	4.3	4.3
Exports:													
Fixed 1987 weights	.1	−.1	3.2	5.7	2.3	1.6	Gross domestic purchases:						
Chain-type annual weights	4.4	.7	3.1	5.5	2.3	1.6	Fixed 1987 weights	−5.3	3.3	4.3	3.9	4.4	4.6
Benchmark-years weights	4.2	.4	3.0	5.3	2.2	1.6	Chain-type annual weights	4.7	3.4	4.2	3.9	4.3	4.4
							Benchmark-years weights	4.6	3.5	4.3	3.9	4.4	4.5
Merchandise:													
Fixed 1987 weights	−.8	−1.3	2.9	6.5	2.1	.2	Gross national product:						
Chain-type annual weights	4.2	−.2	2.9	6.2	2.1	.3	Fixed 1987 weights	−5.3	3.3	4.2	3.9	4.4	4.4
Benchmark-years weights	4.0	−.5	2.7	6.0	2.0	.3	Chain-type annual weights	4.7	3.4	4.1	3.9	4.3	4.1
Services:							Benchmark-years weights	4.6	3.5	4.2	3.9	4.3	4.2
Fixed 1987 weights	4.6	3.2	3.8	3.6	3.6	5.0							
Chain-type annual weights	5.0	3.3	3.8	3.6	2.7	5.0							
Benchmark-years weights	4.8	3.2	3.8	3.6	2.7	5.0							

NOTE.—Bold-italicized entries should not be used as measures of price change. See the text for an explanation.

How the Alternative Measures Are Calculated

With one exception, the alternative measures of real GDP and of GDP prices are calculated using the same level of detail as used in calculating real GDP in 1987 prices.[10] As shown in table E, the number of components increases from 765 in 1959 to 2,678 in 1987. Most of this increase came in producers' durable equipment and change in nonfarm business inventories. For 1990, the number of components falls to 1,088, mainly reflecting drops in these same two components. The drops occur because of a lag in the availability of detailed product and industry data for manufacturing; in the next annual NIPA revision, the number of components used for 1990 will increase to the level used for 1987.

For most of the detailed components, a current-dollar estimate and an associated price index are available to compute a quantity measure. For those components for which the quantity measure is obtained by extrapolation, a price measure is computed from the current- and constant-dollar estimates. Most of the detailed price indexes used in the calculations are components of the major price indexes com-

10. The exception is Federal Government purchases by the Departments of Defense and Veterans Affairs, for which BEA develops very detailed constant-dollar estimates from price and quantity information provided by these agencies. This information, which is available beginning in 1972, is aggregated to about 200 components for use in calculating the fixed-weighted price index and alternative measures.

Table E.—Number of Detailed Components Used in Calculating Alternative Measures of Real GDP and GDP Prices, Selected Years

	1959	1972	1977	1987	1990 [1]
Gross domestic product	765	992	2,260	2,678	1,088
Personal consumption expenditures	197	197	200	203	203
Durable goods	32	32	34	34	34
Nondurable goods	63	63	63	63	63
Services	102	102	103	106	106
Gross private domestic investment	346	348	1,603	1,831	241
Fixed investment	201	221	455	683	105
Nonresidential	201	203	437	665	87
Structures	18	20	20	20	20
Producers' durable equipment	183	183	417	645	67
Residential	18	18	18	18	18
Change in business inventories	127	127	1,148	1,148	136
Net exports of goods and services	51	83	91	278	278
Exports	25	42	48	135	135
Merchandise	5	11	11	98	98
Services	20	31	37	37	37
Imports	26	41	43	143	143
Merchandise	5	13	13	113	113
Services	21	28	30	30	30
Government purchases	171	364	366	366	366
Federal	68	261	261	261	261
National defense	....	191	191	191	191
Nondefense	....	70	70	70	70
State and local	103	103	105	105	105

1. See the text for an explanation of the drop in component detail for 1990.
NOTE.—The level of detail shown in this table is also used in calculating the fixed-weighted GDP price index.

piled by the Bureau of Labor Statistics—that is, the consumer price index, the producer price index, and the international price indexes. Exceptions include the price indexes for computers and for national defense purchases, which are prepared by BEA; the construction price indexes, prepared by the Census Bureau and BEA; and agricultural commodity prices, prepared by the Department of Agriculture.[11] The prices for government employee compensation are computed from current- and constant-dollar estimates, where the latter are prepared by extrapolating base-year compensation for detailed categories by indexes of employment or hours worked.

BEA plans to make available the detailed current-dollar and price-index components used to prepare the alternative measures of real GDP and of GDP prices. Information on the availability of this database will appear in a subsequent issue of the SURVEY.

Appendix: A Note on Alternative Measures of Real GDP

The effect of different approaches to weighting on the measurement of real GDP can perhaps best be illustrated using a hypothetical two-commodity economy. Exhibit 1 shows prices, quantities, and current-dollar values—that is, price times quantity—for two commodities (A and B) in years 1 to 6. An important characteristic of the example is that the price of A grows more than the price of B while the quantity of A grows less than the quantity of B.

Fixed weighting.—Using the entries in exhibit 1, fixed-weighted measures of real GDP are obtained

11. A summary of the price information used in preparing the constant-dollar estimates is provided in table 7 in "The U.S. National Income and Product Accounts: Revised Estimates," SURVEY 70 (July 1990): 30–33. See also the individual methodology papers listed on the inside back cover of this issue.

Exhibit 1.—Hypothetical Two-Commodity Economy

	Year						Ratio: Year 6 to year 1
	1	2	3	4	5	6	
Price (dollars):							
A	5	6	8	9	11	12	2.40
B	4	4	5	5	6	6	1.50
Quantity (units):							
A	6	7	7	8	8	7	1.17
B	5	7	8	10	11	11	2.20
Value (dollars):							
A	30	42	56	72	88	84	2.80
B	20	28	40	50	66	66	3.30
Total	50	70	96	122	154	150	3.00

by multiplying quantities in each year by prices in a designated base period. Thus, with year 1 as the base period, real GDP in year 1 is $(5 \times 6)+(4 \times 5)=$ 50; in year 2, $(5 \times 7)+(4 \times 7)=$ 63; and so on. Likewise, with year 2 as the base period, real GDP in year 1 is $(6 \times 6)+(4 \times 5)=$ 56; in year 2, $(6 \times 7)+(4 \times 7)=$ 70; and so on. Similarly, real GDP can be calculated using the other years as the base period.[12]

Thus, in principle there are as many measures of fixed-weighted real GDP as there are years that could be used as the base period. Exhibit 2 shows a matrix of real GDP measures calculated from exhibit 1, using each of the 6 years as the base period. The first six rows in the exhibit show real GDP in dollars; the next six rows show real GDP as indexes with the base period set equal to 100.0; the last six rows show period-to-period growth rates in the measures.[13]

In the exhibits, years 1, 3, and 5 are designated as benchmark years. Thus, the index of real GDP based on prices in year 5, the most recent benchmark year, corresponds to the fixed-weighted measure that is featured in practice.

In this example, selecting a later year as the base period produces a lower growth rate than selecting an earlier year because of the characteristic mentioned earlier—that the price of commodity A grows more than the price of commodity B, while the quantity of A grows less than the quantity of B. Therefore, commod-

ity A receives more weight (and commodity B less) when a later year is the base period. *It is true generally* that a later base period produces lower growth in real GDP because fast-growing quantities tend to be associated with relatively slow-growing prices and slow-growing quantities with relatively fast-growing prices.

Over long timespans, such inverse relationships in the growth of prices and quantities tend to be the rule. One explanation for such relationships is that as changes in technology or in market structure lower some relative prices and raise others, buyers respond by demanding relatively more of the low-priced goods and relatively less of the high-priced ones and that these responses outweigh any contrary effects arising from changes in taste or in income levels.

Chain-type annual weighting.—In this alternative, the Fisher Ideal index formula is used to calculate the annual change in real GDP. The Fisher Ideal index is the geometric mean of a Laspeyres and a Paasche index. In terms of the example, the year 2 value of the fixed-weighted measure based on prices in year 1 is a Laspeyres quantity index, while the year 2 value of the fixed-weighted measure based on prices in year 2 is a Paasche quantity index. The year 2 values of these indexes (in terms of percent changes) may be taken from the bottom panel of exhibit 2. The geometric mean of these two indexes is the Fisher Ideal index for year 2; that is, the Fisher Ideal

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12. Because quantity data are not available for most components of real GDP, real GDP is obtained by deflating current-dollar values by price indexes that express the price of each period relative to that of the base period. This procedure yields results identical to those obtained directly from prices and quantities. For example, using prices and quantities directly with year 1 as the base year, commodity A in real terms in year 2 is $(5 \times 7)=$ 35. The identical result is obtained by deflating the current-dollar value of 42 for commodity A in year 2 by the price index with year 1 as the base year for commodity A in year 2. The price index is $(6 \div 5)=$ 1.20. Thus, commodity A in real terms is $(42 \div 1.20)=$ 35.

Algebraically, these two procedures can be shown to be identical as follows: Using prices and quantities directly, real GDP is $\sum p_o q_t$, where p_o is the price in the base period and q_t is the quantity in year t. Deflating current-dollar values, the fixed-weighted measure of real GDP is $\sum \left(p_t q_t / (p_t / p_o) \right) = \sum p_o q_t$. Real GDP may also be expressed as a weighted sum of quantity relatives (indexes) scaled by the base-year value of GDP; that is,

$$\sum \frac{q_t}{q_o}(W_t) \times \sum p_o q_o = \sum p_o q_t, \text{ where}$$

$$W_t = \frac{p_o q_o}{\sum p_o q_o}$$

is the share of current-dollar output in the base year accounted for by the commodity, and $\sum p_o q_o$ is the base-year value of GDP.

13. As shown in footnote 12, the fixed-weighted measure of real GDP in year t is $\sum p_o q_t$, where p_o is the price in base year o, and q_t is the quantity in year t. The growth rate in this measure from year $t-1$ to year t is

$$100 \left(\frac{\sum q_t p_o}{\sum q_{t-1} p_o} - 1.0 \right).$$

Exhibit 2.—Fixed-Weighted Measures of Real GDP

	Year						Ratio: Year 6 to year 1
	1	2	3	4	5	6	
	Real GDP in dollars, based on prices in year:						
1	50	63	67	80	84	79	1.580
2	56	70	74	88	92	86	1.536
3	73	91	96	114	119	111	1.521
4	79	98	10	122	127	118	1.494
5	96	119	125	148	154	143	1.490
6	102	126	132	156	162	150	1.471
	Indexes of real GDP, based on prices in year:						
1	100.0	126.0	134.0	160.0	168.0	158.0	1.580
2	80.0	100.0	105.7	125.7	131.4	122.9	1.536
3	76.0	94.8	100.0	118.8	124.0	115.6	1.521
4	64.8	80.3	84.4	100.0	104.1	96.7	1.494
5	62.3	77.3	81.2	96.1	100.0	92.9	1.490
6	68.0	84.0	88.0	104.0	108.0	100.0	1.471
	Percent change in real GDP, based on prices in year:						
1		26.0	6.3	19.4	5.0	−6.0	
2		25.0	5.7	18.9	4.5	−6.5	
3		24.7	5.5	18.8	4.4	−6.7	
4		24.1	5.1	18.4	4.1	−7.1	
5		24.0	5.0	18.4	4.1	−7.1	
6		23.5	4.8	18.2	3.8	−7.4	

index is $\sqrt{1.260 \times 1.250} = 1.255$, and the growth rate from year 1 to year 2 is 25.5 percent. Similarly, the Fisher Ideal index for year 3 is $\sqrt{1.057 \times 1.055} = 1.056$, and the growth rate is 5.6 percent. Thus, the growth rates in the chain-type annual-weighted index are computed from pairs of year-to-year changes (expressed as ratios) in the fixed-weighted quantity indexes moving diagonally down and across the bottom panel of exhibit 2. These growth rates are entered in the top panel of exhibit 3 and are chained together to provide the chain-type annual-weighted index (with year 5=100) in the bottom panel.[14]

Benchmark-years weighting.—In this alternative, the geometric means of the two fixed-weighted quantity indexes based on prices in adjacent benchmark years are used to calculate the annual change in real GDP. In the example, years 1 and 3 form the first pair of adjacent benchmark years, and the fixed-weighted quantity indexes used to calculate the growth rates in real GDP from year 1 to year 3 are based on prices in years 1 and 3. The growth rate from year 1 to year 2 is given by the geometric mean of the year 2 values of the two fixed-weighted indexes. These values (in terms of percent changes) may be taken from the bottom panel of exhibit 2. For year 2, the index value is $\sqrt{1.260 \times 1.247} = 1.253$, and the growth rate is 25.3 percent. Similarly, the geometric mean for year 3 is $\sqrt{1.063 \times 1.055} = 1.059$, and the growth rate is 5.9 percent. The cumulated change from year 1 to year 3 of 32.7 percent is identical to the growth rate calculated with the Fisher Ideal index directly from year 1 to year 3—that is, $\sqrt{1.340 \times 1.315} = 1.327$ (where $134.0 \div 100.0 = 1.340$, and $100.0 \div 76.0 = 1.315$).[15]

Beyond the most recent benchmark year, only one set of benchmark weights is available, but the index formula requires two. Therefore, the most recently available year is used as if it were the next benchmark year. In the exhibit, this procedure provides the same annual change for year 6 as in the chain-type annual-weighted index. Once data for year 7 become available, the annual change for year 6 in the benchmark-years-weighted index would be recalculated.

The growth rates for the benchmark-years-weighted index are entered in the top panel of exhibit 3 and chained together to provide an index in the bottom panel. For comparison, exhibit 3 also shows the fixed-weighted quantity index based on prices in year 5, the most recent benchmark year.

Tables 1 through 3 follow.

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14. The chain-type annual-weighted measure of real GDP growth from year $t-1$ to year t is

$$100 \left(\sqrt{\frac{\sum q_t p_{t-1}}{\sum q_{t-1} p_{t-1}} \times \frac{\sum q_t p_t}{\sum q_{t-1} p_t}} - 1.0 \right).$$

---

15. The benchmark-years-weighted measure of real GDP growth from year $t-1$ to year t is

$$100 \left(\sqrt{\frac{\sum q_t p_a}{\sum q_{t-1} p_a} \times \frac{\sum q_t p_b}{\sum q_{t-1} p_b}} - 1.0 \right), \text{ where}$$

a and b are benchmark years and $t = a+1, a+2, \ldots, b$. The cumulation of the benchmark-years-weighted index values for the years between a and b is equal to the Fisher Ideal index value calculated directly from year a to year b:

$$\sqrt{\frac{\sum q_{a+1} p_a}{\sum q_a p_a} \times \frac{\sum q_{a+1} p_b}{\sum q_a p_b}} \times \sqrt{\frac{\sum q_{a+2} p_a}{\sum q_{a+1} p_a} \times \frac{\sum q_{a+2} p_b}{\sum q_{a+1} p_b}} \times \cdots$$

$$\times \sqrt{\frac{\sum q_b p_a}{\sum q_{b-1} p_a} \times \frac{\sum q_b p_b}{\sum q_{b-1} p_b}} = \sqrt{\frac{\sum q_b p_a}{\sum q_a p_a} \times \frac{\sum q_b p_b}{\sum q_a p_b}}.$$

Exhibit 3.—Alternative Measures of Real GDP Compared With Fixed-Weighted Measures Based on Prices in Year 5

	Year						Ratio: Year 6 to year 1
	1	2	3	4	5	6	
Percent change in real GDP, based on:							
Chain-type annual weights	....	25.5	5.6	18.6	4.1	−7.3	....
Benchmark-years weights [1]	....	25	5.9	18.6	4.3	−7.3	....
Fixed weights, year 5 prices	....	24.0	5.0	18.4	4.1	−7.1	....
Indexes of real GDP (year 5 = 100), based on:							
Chain-type annual weights	61.1	76.7	81.0	96.1	100.0	92.7	1.517
Benchmark-years weights [1]	60.9	76.3	80.8	95.9	100.0	92.7	1.522
Fixed weights, year 5 prices	62.3	77.3	81.2	96.1	100.0	92.9	1.490

1. Years 1, 3, and 5 are benchmark years.

Table 1.—Fixed-Weighted and Alternative Quantity and Price Indexes for Gross Domestic Product, Percent Change from Preceding Period

[Percent]

Index and year	GDP			Final sales of domestic product			Gross domestic purchases			GNP		
	Fixed-weighted index	Chain-type annual-weighted index	Benchmark-years-weighted index	Fixed-weighted index	Chain-type annual-weighted index	Benchmark-years-weighted index	Fixed-weighted index	Chain-type annual-weighted index	Benchmark-years-weighted index	Fixed-weighted index	Chain-type annual-weighted index	Benchmark-years-weighted index
Quantity indexes												
1960	2.2	2.3	2.3	2.5	2.6	2.5	1.4	1.5	1.5	2.2	2.4	2.4
1961	2.7	2.4	2.4	2.7	2.5	2.5	2.6	2.3	2.3	2.7	2.4	2.4
1962	5.2	6.1	6.1	4.8	5.5	5.5	5.4	6.4	6.4	5.2	6.1	6.2
1963	4.1	4.3	4.4	4.1	4.4	4.5	3.9	4.1	4.2	4.1	4.3	4.4
1964	5.6	6.0	5.9	5.7	6.1	6.1	5.3	5.6	5.5	5.7	6.0	6.0
1965	5.5	6.4	6.3	5.2	5.7	5.7	5.9	6.8	6.7	5.5	6.4	6.3
1966	5.9	6.5	6.6	5.5	6.0	6.1	6.4	6.9	6.9	5.8	6.4	6.4
1967	2.6	2.5	2.7	3.0	3.0	3.2	2.8	2.8	2.9	2.6	2.5	2.7
1968	4.2	4.6	4.5	4.4	4.9	4.8	4.6	5.0	4.9	4.2	4.6	4.5
1969	2.7	3.1	3.0	2.7	3.1	3.0	2.8	3.1	3.1	2.7	3.0	3.0
1970	0	0	0	.7	.8	.7	−.2	−.3	−.3	0	0	0
1971	2.9	3.4	3.4	2.3	2.8	2.8	3.2	3.6	3.7	2.9	3.4	3.5
1972	5.1	5.5	5.7	5.1	5.4	5.6	5.4	5.6	5.9	5.1	5.5	5.7
1973	5.2	5.9	5.7	4.7	5.3	5.1	4.4	4.9	4.9	5.4	6.1	5.9
1974	−.6	−.6	−.6	−.4	−.3	−.2	−1.5	−1.5	−1.5	−.5	−.5	−.4
1975	−.8	−.7	−.9	.6	.7	.6	−1.6	−1.6	−1.7	−1.1	−.9	−1.1
1976	4.9	5.3	5.5	3.7	3.9	4.1	5.9	6.4	6.4	5.1	5.5	5.7
1977	4.5	4.9	5.2	4.3	4.5	4.8	5.1	5.7	5.7	4.6	5.0	5.3
1978	4.8	5.3	5.2	4.8	5.2	5.2	4.8	5.2	5.1	4.8	5.2	5.1
1979	2.5	2.8	2.8	3.2	3.5	3.6	2.0	2.1	2.2	2.8	3.1	3.1
1980	−.5	−.2	0	0	.6	.8	−1.6	−1.9	−1.6	−.6	−.2	0
1981	1.8	2.5	2.7	.9	1.3	1.6	2.0	2.6	2.9	1.6	2.3	2.5
1982	−2.2	−2.3	−1.9	−1.1	−1.0	−.6	−1.4	−1.6	−1.2	−2.3	−2.4	−2.0
1983	3.9	3.8	3.9	3.3	3.4	3.4	5.2	5.2	5.2	3.8	3.7	3.8
1984	6.2	7.0	6.7	4.6	4.9	4.9	7.8	8.5	8.3	6.0	6.8	6.5
1985	3.2	3.2	3.3	4.3	4.5	4.5	3.6	3.6	3.6	2.9	3.0	3.0
1986	2.9	2.9	2.9	3.2	3.3	3.2	3.0	3.1	3.1	2.8	2.7	2.7
1987	3.1	3.1	3.2	2.7	2.7	2.9	2.7	2.8	2.9	3.0	3.0	3.1
1988	3.9	3.9	3.8	4.1	4.1	4.0	3.0	2.9	2.9	4.0	4.0	3.9
1989	2.5	2.6	2.5	2.2	2.3	2.2	1.9	1.9	1.8	2.4	2.5	2.4
1990	1.0	1.0	1.0	1.7	1.6	1.6	.5	.5	.5	1.1	1.1	1.1
Price indexes												
1960	....	1.5	1.4	....	1.5	1.5	....	1.5	1.4	....	1.5	1.4
1961	....	1.2	1.1	....	1.2	1.1	....	1.1	1.0	....	1.2	1.1
1962	....	1.3	1.3	....	1.4	1.3	....	1.3	1.2	....	1.3	1.3
1963	....	1.2	1.2	....	1.2	1.2	....	1.2	1.3	....	1.2	1.2
1964	....	1.4	1.3	....	1.4	1.3	....	1.5	1.4	....	1.4	1.3
1965	....	1.9	1.9	....	1.9	1.9	....	1.8	1.8	....	1.9	1.9
1966	....	2.8	2.9	....	2.9	2.9	....	2.8	2.8	....	2.8	2.9
1967	....	3.2	3.2	....	3.2	3.3	....	3.0	3.0	....	3.2	3.2
1968	....	4.4	4.3	....	4.4	4.3	....	4.4	4.2	....	4.4	4.3
1969	....	4.7	4.7	....	4.7	4.7	....	4.6	4.6	....	4.7	4.7
1970	....	5.3	5.3	....	5.4	5.3	....	5.4	5.4	....	5.3	5.3
1971	....	5.0	5.0	....	5.1	5.1	....	5.2	5.1	....	5.0	5.0
1972	....	4.3	4.5	....	4.3	4.4	....	4.5	4.7	....	4.3	4.5
1973	....	5.6	5.5	....	5.6	5.5	....	5.8	5.8	....	5.6	5.5
1974	....	8.8	8.6	....	8.8	8.6	....	10.0	10.1	....	8.8	8.6
1975	....	9.4	9.4	....	9.4	9.4	....	9.3	9.2	....	9.5	9.4
1976	....	5.8	5.9	....	5.9	5.9	....	5.8	5.8	....	5.9	5.9
1977	....	6.4	6.5	....	6.5	6.6	....	6.8	7.0	....	6.4	6.5
1978	....	7.5	6.6	....	7.5	6.7	....	7.5	6.7	....	7.5	6.6
1979	....	8.4	8.4	....	8.5	8.3	....	8.9	8.8	....	8.4	8.4
1980	....	9.0	9.2	....	9.1	9.1	....	10.5	10.6	....	9.0	9.2
1981	....	9.2	9.1	....	9.2	9.1	....	9.0	8.9	....	9.2	9.1
1982	....	6.3	6.4	....	6.4	6.5	....	5.8	5.7	....	6.3	6.4
1983	3.8	4.1	4.1	3.8	4.2	4.1	3.3	3.7	3.6	3.8	4.1	4.1
1984	3.3	3.6	3.6	3.3	3.6	3.6	3.0	3.4	3.4	3.3	3.6	3.6
1985	3.5	3.6	3.6	3.5	3.6	3.6	3.3	3.4	3.5	3.5	3.6	3.6
1986	2.7	2.7	2.9	2.7	2.8	2.9	2.7	2.8	2.9	2.7	2.7	2.9
1987	3.1	3.1	3.2	3.0	3.1	3.2	3.4	3.5	3.5	3.1	3.1	3.2
1988	3.9	3.9	3.9	3.9	4.0	4.0	3.9	3.9	3.9	3.9	3.9	3.9
1989	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.4	4.3	4.3	4.3
1990	4.3	4.2	4.3	4.3	4.2	4.3	4.5	4.4	4.5	4.3	4.1	4.2

GDP=Gross domestic product; GNP=Gross national product

Table 2.—Fixed-Weighted and Alternative Quantity Indexes for Gross Domestic Product

[Index numbers, 1987=100]

Year	GDP	Personal consumption expenditures				Gross private domestic investment				Exports	Imports	Government purchases			Final sales of domestic product	Gross domestic pur-chases	Gross national product
		Total	Durable goods	Non-durable goods	Services	Total	Fixed investment					Total	Federal	State and local			
							Total	Non-residential	Residential								
Fixed-weighted index																	
1959	42.5	38.6	28.3	51.3	33.3	39.6	39.1	33.2	52.2	20.3	18.9	53.9	69.0	42.2	42.4	41.7	42.7
1960	43.4	39.7	28.6	52.1	34.7	38.8	39.1	34.8	48.6	24.3	18.9	54.1	67.3	43.9	43.5	42.2	43.6
1961	44.6	40.6	27.1	53.2	36.1	38.6	39.0	34.6	48.9	24.7	18.8	56.9	70.2	46.6	44.7	43.3	44.8
1962	46.9	42.4	29.8	54.7	37.9	42.9	42.3	37.2	53.5	26.1	20.8	59.5	74.6	47.7	46.8	45.7	47.2
1963	48.8	44.0	32.3	55.7	39.6	45.8	45.3	38.6	59.9	28.0	21.2	60.8	74.2	50.5	48.7	47.4	49.1
1964	51.6	46.4	34.8	58.2	42.0	49.6	49.3	43.0	63.1	31.7	22.3	62.3	73.2	53.8	51.5	49.9	51.9
1965	54.4	49.0	38.7	61.0	44.2	55.1	53.6	50.3	61.0	32.4	24.5	64.3	73.3	57.4	54.2	52.9	54.8
1966	57.6	51.6	41.1	64.0	46.4	58.5	55.5	55.6	55.3	34.5	28.3	70.6	83.0	61.0	57.1	56.2	57.9
1967	59.1	53.2	41.4	65.2	48.6	55.9	54.1	54.4	53.4	35.7	30.3	75.8	91.2	63.8	58.9	57.8	59.5
1968	61.6	55.9	45.7	67.9	51.1	58.7	57.6	56.3	60.5	38.5	35.0	77.9	91.7	67.2	61.4	60.5	62.0
1969	63.3	58.0	47.3	69.5	53.6	61.6	60.4	59.5	62.2	40.6	37.3	77.4	88.4	68.8	63.1	62.2	63.6
1970	63.3	59.4	45.5	70.9	55.7	57.4	58.6	58.7	58.5	44.3	38.7	75.5	81.8	70.7	63.5	62.1	63.6
1971	65.1	61.4	49.9	71.8	57.8	63.5	62.9	57.6	74.6	44.5	41.0	74.0	75.6	72.8	65.0	64.1	65.5
1972	68.4	64.8	55.8	74.8	60.9	71.0	70.5	62.6	87.9	47.7	45.4	74.1	73.9	74.2	68.3	67.6	68.8
1973	72.0	67.7	61.1	76.9	63.6	79.0	76.6	71.8	87.3	57.8	48.2	73.1	68.9	76.3	71.6	70.5	72.6
1974	71.5	67.3	56.3	75.1	65.2	72.5	70.8	71.6	69.1	64.4	47.0	74.4	68.2	79.1	71.3	69.4	72.2
1975	71.0	68.7	56.2	75.9	67.4	58.4	62.5	63.6	59.8	64.0	41.4	75.3	68.2	80.7	71.7	68.3	71.5
1976	74.5	72.3	63.5	79.3	70.2	69.5	68.5	66.0	73.9	66.9	49.3	74.8	67.1	80.8	74.3	72.3	75.1
1977	77.8	75.2	69.3	81.1	73.1	80.1	78.3	73.2	89.6	67.8	54.2	75.3	68.3	80.8	77.5	76.0	78.5
1978	81.6	78.4	72.5	83.6	76.6	88.7	86.8	82.9	95.2	74.2	59.2	76.8	69.8	82.2	81.2	79.7	82.3
1979	83.6	80.2	71.6	85.3	79.2	89.4	90.8	90.2	92.1	80.6	60.0	78.2	70.6	84.1	83.8	81.3	84.6
1980	83.2	80.2	65.1	85.1	80.9	79.3	83.4	88.0	73.2	88.0	57.2	79.9	74.0	84.4	83.8	80.0	84.1
1981	84.7	81.2	65.5	85.8	82.1	84.2	83.9	91.4	67.3	89.6	60.0	80.9	76.9	84.0	84.6	81.6	85.5
1982	82.8	82.0	65.0	86.3	83.6	72.1	77.2	87.2	55.1	81.5	60.0	82.1	79.5	84.1	83.7	80.5	83.5
1983	86.0	85.8	73.7	89.0	86.8	80.0	82.3	84.5	77.4	78.5	67.5	84.4	83.3	85.2	86.5	84.6	86.7
1984	91.4	90.0	83.8	92.4	90.0	101.1	95.4	98.5	88.5	84.0	84.3	87.0	86.0	87.8	90.4	91.2	91.9
1985	94.3	93.9	91.7	94.8	93.9	99.5	100.1	104.8	89.7	84.9	89.7	92.3	92.3	92.3	94.3	94.5	94.5
1986	97.0	97.3	99.6	98.0	96.3	98.1	100.5	100.5	100.4	90.5	95.6	97.0	96.9	97.1	97.4	97.4	97.1
1987	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1988	103.9	103.6	106.2	102.4	103.7	103.2	104.2	106.6	98.9	115.8	103.7	100.6	98.0	102.6	104.1	103.0	104.0
1989	106.5	105.6	109.2	103.8	105.8	105.3	104.6	109.0	95.1	128.9	107.5	102.1	97.4	105.8	106.4	104.9	106.5
1990	107.6	106.9	108.7	103.9	108.3	99.4	102.9	110.2	86.8	138.9	109.8	105.4	99.0	110.4	108.2	105.4	107.7
Chain-type annual-weighted index																	
1959	39.2	37.3	23.6	49.4	33.0	32.7	33.4	27.0	51.5	18.9	20.1	52.2	65.8	41.0	39.4	39.0	39.4
1960	40.1	38.3	24.1	50.2	34.5	32.5	33.6	28.5	47.8	22.8	20.3	51.7	62.7	42.6	40.4	39.6	40.3
1961	41.0	39.2	23.2	51.3	35.9	32.1	33.5	28.3	47.9	23.2	20.2	54.4	65.5	45.3	41.4	40.5	41.3
1962	43.5	41.1	25.9	53.0	37.7	36.3	36.5	30.7	52.5	24.4	22.5	57.6	71.3	46.5	43.6	43.1	43.8
1963	45.4	42.8	28.4	54.1	39.4	38.7	39.2	32.3	58.7	26.3	23.1	58.9	70.6	49.3	45.6	44.9	45.7
1964	48.1	45.3	31.0	56.7	41.8	42.0	42.9	36.1	62.2	29.8	24.3	60.2	69.4	52.7	48.3	47.4	48.4
1965	51.2	48.1	35.0	59.5	44.0	47.8	47.3	42.3	60.3	30.4	26.9	62.1	69.4	56.2	51.1	50.6	51.5
1966	54.5	50.8	37.9	62.5	46.3	51.8	49.8	47.5	54.9	32.4	30.8	68.2	78.4	59.9	54.2	54.1	54.8
1967	55.9	52.3	38.5	63.6	48.5	49.6	48.8	46.7	53.2	33.1	33.0	73.6	87.1	62.8	55.8	55.6	56.2
1968	58.5	55.3	42.8	66.3	51.0	52.1	52.2	48.7	60.5	35.5	37.9	75.8	87.7	66.2	58.6	58.3	58.8
1969	60.3	57.3	44.3	68.0	53.5	55.2	55.3	52.2	62.3	37.4	40.0	75.3	84.4	67.9	60.4	60.1	60.6
1970	60.3	58.6	42.9	69.5	55.6	51.3	53.9	51.7	58.5	41.5	41.7	73.2	77.3	69.7	60.8	59.9	60.6
1971	62.3	60.7	47.1	70.7	57.7	57.0	58.0	51.7	74.6	41.8	43.9	71.8	71.6	72.0	62.5	62.1	62.7
1972	65.7	64.3	53.1	73.7	60.8	63.9	65.0	56.3	87.9	45.1	48.8	71.8	69.5	73.5	65.9	65.6	66.1
1973	69.6	67.5	58.6	76.0	63.5	71.6	70.9	64.5	87.3	54.6	51.0	71.2	65.7	75.7	69.4	68.8	70.1
1974	69.1	67.0	54.7	74.6	65.0	65.9	66.2	64.9	69.3	59.7	49.7	72.6	65.6	78.4	69.2	67.8	69.8
1975	68.7	68.4	54.7	75.6	67.3	53.8	58.8	58.1	60.3	59.3	44.2	73.4	65.5	79.8	69.7	66.8	69.2
1976	72.4	72.2	61.7	79.2	70.1	64.6	64.6	60.9	74.4	62.6	52.7	73.0	64.5	80.1	72.4	71.0	73.0
1977	75.9	75.4	67.5	81.3	73.1	75.3	74.2	68.1	90.2	64.0	58.3	73.7	65.9	80.1	75.7	75.1	76.6
1978	79.9	78.5	70.8	83.9	76.6	84.2	83.0	78.2	95.8	71.0	63.8	75.3	67.5	81.7	79.7	78.9	80.6
1979	82.2	80.3	70.2	85.6	79.1	85.6	87.6	85.9	92.3	77.7	64.9	76.9	68.6	83.7	82.5	80.6	83.1
1980	82.0	79.9	64.2	85.1	80.7	76.5	81.8	85.6	73.1	86.2	60.6	78.7	72.3	84.0	83.0	79.1	82.9
1981	84.1	80.8	64.7	85.7	81.9	83.5	83.4	90.2	67.3	87.5	62.1	80.2	75.9	83.6	84.0	81.2	84.9
1982	82.2	81.6	64.4	86.2	83.4	71.6	77.1	86.1	55.2	80.3	60.9	81.4	78.5	83.8	83.2	79.8	82.8
1983	85.3	85.6	73.3	88.9	86.7	78.2	82.0	84.1	77.4	77.8	68.1	83.9	82.5	85.0	86.0	83.9	85.9
1984	91.3	89.8	83.5	92.3	89.9	101.8	95.6	98.7	88.5	83.8	84.2	86.4	84.9	87.7	90.2	91.1	91.8
1985	94.2	93.8	91.4	94.7	93.8	99.8	100.2	104.8	89.7	84.8	88.7	91.9	91.6	92.2	94.3	94.4	94.5
1986	97.0	97.2	99.5	98.0	96.2	98.0	100.3	100.3	100.4	90.4	95.3	96.9	96.7	97.1	97.3	97.3	97.1
1987	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1988	103.9	103.6	106.2	102.4	103.7	103.0	104.2	106.6	98.8	115.7	103.5	100.6	97.9	102.6	104.1	102.9	104.0
1989	106.6	105.5	109.1	103.7	105.8	105.7	104.4	108.7	95.1	128.6	106.9	102.2	97.6	105.8	106.4	104.9	106.6
1990	107.6	106.8	108.4	103.9	108.2	99.4	102.4	109.6	86.7	138.1	109.1	105.5	99.1	110.4	108.1	105.4	107.7

Table 2.—Fixed-Weighted and Alternative Quantity Indexes for Gross Domestic Product—Continued

[Index numbers, 1987=100]

Year	GDP	Personal consumption expenditures				Gross private domestic investment				Exports	Imports	Government purchases			Final sales of domestic product	Gross domestic pur-chases	Gross national product
		Total	Durable goods	Non-durable goods	Services	Total	Fixed investment					Total	Federal	State and local			
							Total	Non-residential	Residen-tial								
						Benchmark-years-weighted index											
1959	38.8	37.2	23.5	49.3	33.0	30.6	30.2	24.0	51.1	18.0	19.2	52.5	66.6	41.0	38.8	38.7	39.0
1960	39.7	38.2	24.0	50.1	34.5	30.3	30.4	25.3	47.4	21.7	19.4	52.0	63.6	42.6	39.8	39.2	39.9
1961	40.7	39.1	23.1	51.2	35.9	30.0	30.2	25.1	47.6	22.1	19.3	54.7	66.3	45.3	40.8	40.1	40.9
1962	43.2	41.0	25.8	52.9	37.7	34.0	33.0	27.3	52.1	23.2	21.4	58.0	72.0	46.4	43.0	42.7	43.4
1963	45.1	42.7	28.3	54.0	39.4	36.3	35.5	28.9	58.3	25.0	22.1	59.2	71.4	49.2	44.9	44.5	45.4
1964	47.7	45.2	30.9	56.6	41.8	39.4	38.9	32.2	61.7	28.3	23.2	60.5	70.2	52.6	47.7	46.9	48.1
1965	50.7	48.0	34.8	59.4	44.0	44.7	42.8	37.8	59.8	28.9	25.6	62.4	70.1	56.2	50.4	50.1	51.1
1966	54.1	50.7	37.7	62.4	46.2	48.6	45.3	42.5	54.5	30.9	29.4	68.5	79.1	59.8	53.4	53.5	54.4
1967	55.5	52.2	38.3	63.5	48.5	46.8	44.8	42.4	52.8	31.6	31.5	74.0	87.9	62.7	55.1	55.1	55.8
1968	58.0	55.1	42.5	66.2	51.0	49.1	47.8	44.2	59.9	33.9	36.2	76.2	88.6	66.1	57.8	57.8	58.4
1969	59.8	57.1	44.1	67.9	53.4	52.1	50.6	47.3	61.7	35.7	38.3	75.7	85.5	67.8	59.5	59.6	60.1
1970	59.8	58.4	42.7	69.4	55.6	48.5	49.4	46.9	58.0	39.5	40.0	73.5	78.4	69.6	59.9	59.4	60.1
1971	61.8	60.6	46.9	70.6	57.6	54.0	53.3	47.0	73.9	39.8	42.1	72.0	72.3	71.8	61.6	61.5	62.2
1972	65.3	64.2	52.9	73.6	60.7	61.0	60.1	51.7	87.2	43.0	46.7	72.0	70.2	73.3	65.1	65.1	65.7
1973	69.0	67.3	58.3	75.9	63.4	68.4	65.6	59.3	86.6	51.8	49.6	71.2	65.9	75.5	68.4	68.3	69.6
1974	68.6	66.8	54.3	74.4	64.9	63.1	61.4	59.7	68.7	57.7	48.4	72.6	65.8	78.2	68.3	67.3	69.3
1975	68.0	68.2	54.3	75.5	67.1	50.9	54.5	53.5	59.7	57.7	42.8	73.5	65.7	79.8	68.7	66.1	68.5
1976	71.8	72.0	61.3	79.0	70.0	61.4	60.1	56.3	73.8	60.9	50.9	73.2	64.8	80.0	71.6	70.4	72.4
1977	75.5	75.2	67.1	81.1	72.9	71.6	69.2	63.3	89.5	62.7	55.9	73.9	66.3	80.0	75.0	74.4	76.2
1978	79.4	78.3	70.3	83.7	76.4	79.6	77.5	72.7	95.0	69.2	60.4	75.5	68.0	81.6	78.9	78.2	80.1
1979	81.7	80.0	69.8	85.4	79.0	81.2	82.0	80.1	91.7	75.8	61.4	77.0	69.0	83.5	81.7	79.9	82.7
1980	81.7	79.8	63.9	84.9	80.6	73.6	77.6	80.7	72.8	84.2	57.8	78.9	72.7	83.9	82.4	78.6	82.6
1981	83.9	80.7	64.3	85.7	81.7	81.1	80.5	86.7	67.1	86.1	60.1	80.2	76.0	83.6	83.7	80.8	84.7
1982	82.3	81.6	64.2	86.1	83.2	71.4	76.1	85.0	55.0	79.4	59.6	81.6	78.9	83.8	83.1	79.8	83.0
1983	85.5	85.4	73.0	88.9	86.5	78.7	81.1	82.7	77.3	76.8	66.8	84.0	82.8	85.0	85.9	84.0	86.1
1984	91.2	89.7	83.1	92.3	89.7	100.7	94.6	97.2	88.4	82.7	83.1	86.7	85.5	87.6	90.1	91.0	91.7
1985	94.2	93.6	90.9	94.7	93.7	99.1	99.3	103.4	89.6	84.0	87.8	92.1	92.0	92.1	94.2	94.3	94.4
1986	96.9	97.2	99.2	98.0	96.2	97.5	99.5	99.3	100.3	89.8	94.6	96.9	96.7	97.1	97.2	97.2	97.0
1987	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1988	103.8	103.5	106.1	102.3	103.7	103.1	104.1	106.5	98.9	115.6	103.6	100.5	97.8	102.6	104.0	102.9	103.9
1989	106.4	105.5	109.0	103.7	105.8	105.2	104.4	108.7	95.1	128.6	107.1	102.1	97.3	105.8	106.3	104.8	106.4
1990	107.5	106.8	108.4	103.8	108.2	99.1	102.5	109.7	86.8	138.3	109.3	105.3	98.7	110.4	108.0	105.3	107.6

GDP=Gross domestic product

Table 3.—Fixed-Weighted and Alternative Price Indexes for Gross Domestic Product

[Index numbers, 1987=100]

Year	GDP	Personal consumption expenditures				Fixed investment			Exports	Imports	Government purchases			Final sales of domestic product	Gross domestic pur-chases	Gross national product
		Total	Durable goods	Non-durable goods	Services	Total	Non-residential	Residen-tial			Total	Federal	State and local			
Fixed-weighted index																
1959	....	30.5	54.1	31.4	24.1	....	....	25.0	....	....	23.9	27.2	21.4	....	....	....
1960	....	30.9	53.9	31.8	24.7	....	....	25.1	....	....	24.4	27.6	22.0	....	....	....
1961	....	31.2	53.6	32.0	25.1	....	....	25.1	....	....	24.9	27.9	22.5	....	....	....
1962	....	31.4	53.2	32.1	25.5	....	....	25.0	....	....	25.7	28.8	23.3	....	....	....
1963	....	31.6	53.0	32.5	25.9	....	....	24.7	....	....	26.2	29.5	23.7	....	....	....
1964	....	32.0	53.0	32.8	26.3	....	....	24.9	....	....	26.8	30.2	24.2	....	....	....
1965	....	32.3	52.2	33.3	26.8	....	....	25.5	....	....	27.5	31.1	24.7	....	....	....
1966	....	32.9	51.4	34.3	27.5	....	....	26.4	....	....	28.6	32.0	25.9	....	....	....
1967	....	33.8	52.0	35.1	28.5	....	....	27.2	....	....	29.9	33.1	27.3	....	....	....
1968	....	35.1	53.2	36.5	29.7	....	....	28.6	....	....	31.5	34.9	28.8	....	....	....
1969	....	36.4	54.3	38.1	30.8	....	....	30.7	....	....	33.3	36.7	30.7	....	....	....
1970	....	38.0	55.2	39.9	32.5	....	....	31.7	....	....	36.0	39.6	33.0	....	....	....
1971	....	39.6	56.8	41.1	34.4	....	....	33.5	....	....	38.5	42.4	35.3	....	....	....
1972	....	40.9	57.2	42.4	36.0	....	....	35.6	....	....	41.1	46.0	37.3	....	....	....
1973	....	42.8	57.9	45.3	37.5	....	....	38.7	....	....	43.7	48.4	40.1	....	....	....
1974	....	46.8	61.1	51.3	40.4	....	....	42.8	....	....	46.9	50.2	44.3	....	....	....
1975	....	50.6	66.2	55.3	43.8	....	....	46.6	....	....	51.4	54.6	48.9	....	....	....
1976	....	53.4	69.3	57.5	46.9	....	....	49.7	....	....	54.4	57.3	52.2	....	....	....
1977	....	56.7	71.9	60.8	50.5	....	....	54.7	....	....	57.6	60.4	55.7	....	....	....
1978	....	60.7	75.5	64.7	54.6	....	....	61.4	....	....	61.7	64.1	59.9	....	....	....
1979	....	65.9	80.1	71.3	59.0	....	....	68.2	....	....	66.8	68.9	65.1	....	....	....
1980	....	72.6	84.8	79.6	65.3	....	....	75.3	....	....	73.3	75.2	71.9	....	....	....
1981	....	78.9	89.5	86.0	71.9	....	....	81.3	....	....	79.6	82.3	77.6	....	....	....
1982	84.8	83.2	92.4	88.8	77.4	95.8	100.6	85.3	100.1	101.5	85.0	88.5	82.3	84.9	85.5	84.9
1983	88.1	86.7	93.7	91.1	82.4	95.0	98.5	87.3	99.5	98.0	88.5	92.2	85.5	88.2	88.3	88.2
1984	91.1	89.9	94.9	93.7	86.4	94.8	97.0	89.8	99.8	97.0	92.2	95.6	89.6	91.2	91.1	91.1
1985	94.3	93.3	96.0	96.2	90.9	95.8	97.5	92.1	98.2	94.6	95.4	97.9	93.5	94.4	94.1	94.4
1986	97.0	96.1	97.1	96.2	95.8	97.9	98.9	95.8	97.3	93.8	97.6	99.0	96.5	97.0	96.6	97.0
1987	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1988	103.9	104.3	102.0	103.8	105.1	103.2	102.7	104.3	105.7	105.4	103.7	102.8	104.3	104.0	103.9	103.9
1989	108.4	109.3	104.6	109.5	110.4	106.2	105.5	107.8	108.1	108.6	107.9	107.2	108.5	108.5	108.5	108.4
1990	113.1	115.0	106.8	116.2	116.3	108.7	107.9	110.4	109.8	113.3	112.4	112.1	112.7	113.2	113.4	113.1
Chain-type annual-weighted index																
1959	27.8	28.0	44.9	29.7	23.4	30.9	34.6	24.2	30.0	21.9	21.5	22.6	20.5	27.6	27.1	27.8
1960	28.2	28.4	44.7	30.2	24.0	31.1	34.7	24.4	30.4	22.2	21.9	22.9	21.0	28.0	27.5	28.2
1961	28.5	28.7	44.8	30.3	24.5	31.0	34.5	24.4	30.9	22.2	22.3	23.2	21.5	28.3	27.8	28.5
1962	28.9	29.1	45.0	30.6	24.9	31.0	34.5	24.5	30.8	21.9	23.0	23.8	22.3	28.7	28.2	28.9
1963	29.3	29.4	45.1	30.9	25.3	31.0	34.6	24.3	30.8	22.3	23.6	24.4	22.8	29.0	28.5	29.2
1964	29.7	29.8	45.4	31.3	25.7	31.2	34.8	24.5	31.0	22.8	24.2	25.2	23.3	29.5	29.0	29.7
1965	30.2	30.3	44.9	31.9	26.3	31.7	35.2	25.2	32.0	23.2	24.9	26.0	23.9	30.0	29.5	30.2
1966	31.1	31.1	44.7	33.0	27.0	32.4	35.7	26.1	33.0	23.7	25.9	26.9	25.1	30.9	30.3	31.1
1967	32.1	31.9	45.4	33.7	27.9	33.3	36.6	27.0	34.3	23.9	27.0	27.7	26.5	31.9	31.2	32.1
1968	33.5	33.1	46.9	35.0	29.1	34.7	38.0	28.4	35.0	24.3	28.6	29.4	28.1	33.3	32.6	33.5
1969	35.1	34.5	48.2	36.7	30.3	36.4	39.6	30.4	36.2	24.9	30.4	30.9	30.0	34.9	34.1	35.1
1970	36.9	36.1	49.3	38.5	31.9	38.0	41.4	31.4	37.7	26.4	33.0	33.6	32.5	36.7	36.0	36.9
1971	38.8	37.8	51.1	39.6	33.9	39.9	43.4	33.2	39.0	28.0	35.4	36.3	34.8	38.6	37.8	38.8
1972	40.5	39.1	51.7	41.0	35.4	41.7	45.0	35.2	40.3	30.1	38.2	39.9	36.9	40.2	39.5	40.5
1973	42.7	41.2	52.4	44.2	37.0	44.0	46.7	38.3	46.2	35.3	41.1	42.9	39.7	42.5	41.8	42.7
1974	46.5	45.4	55.7	50.5	39.8	48.4	51.3	42.3	57.2	50.5	45.1	46.6	43.9	46.2	46.0	46.5
1975	50.9	49.1	60.8	54.4	43.1	54.5	58.5	46.2	63.1	54.7	49.7	51.3	48.4	50.6	50.3	50.9
1976	53.8	51.8	64.2	56.5	46.3	57.7	61.8	49.2	65.4	56.5	53.0	54.7	51.7	53.6	53.2	53.8
1977	57.3	55.3	67.0	59.7	50.0	62.2	65.9	54.3	68.2	61.7	56.7	58.3	55.3	57.0	56.8	57.3
1978	61.5	59.3	70.8	63.8	54.0	67.6	70.5	61.0	72.1	65.6	60.8	62.5	59.5	61.3	61.1	61.5
1979	66.7	64.6	75.5	70.8	58.4	73.8	76.3	67.8	80.9	76.8	66.2	67.9	64.8	66.5	66.5	66.7
1980	72.7	71.7	82.0	79.4	64.5	80.7	83.1	74.8	89.0	95.7	73.1	75.2	71.5	72.6	73.5	72.8
1981	79.4	78.1	87.5	85.9	71.1	88.3	91.3	80.8	95.1	100.9	79.4	82.4	77.1	79.2	80.1	79.4
1982	84.4	82.6	91.0	88.7	76.9	93.2	96.5	85.1	96.7	98.2	84.7	88.2	82.0	84.3	84.8	84.5
1983	87.9	86.4	93.0	91.0	82.1	93.1	95.6	87.2	97.7	95.1	88.2	91.9	85.4	87.9	87.9	88.0
1984	91.1	89.8	94.3	93.6	86.3	93.7	95.5	89.7	99.2	94.9	92.0	95.1	89.6	91.0	90.9	91.2
1985	94.4	93.2	95.6	96.1	90.8	95.2	96.6	92.0	97.8	92.9	95.3	97.7	93.5	94.3	94.0	94.4
1986	97.0	96.0	97.0	96.1	95.8	97.7	98.6	95.8	97.1	93.5	97.5	98.8	96.5	97.0	96.6	97.0
1987	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1988	103.9	104.2	102.0	103.8	105.1	103.2	102.8	104.2	105.5	105.2	103.6	102.7	104.3	104.0	103.9	103.9
1989	108.3	109.2	104.4	109.4	110.3	106.2	105.4	107.8	107.9	108.4	107.8	106.9	108.5	108.4	108.4	108.3
1990	112.8	114.8	106.4	116.0	116.2	108.4	107.6	110.4	109.6	113.0	112.2	111.4	112.7	113.0	113.2	112.8

Table 3.—Fixed-Weighted and Alternative Price Indexes for Gross Domestic Product—Continued

[Index numbers, 1987=100]

Year	GDP	Personal consumption expenditures				Fixed investment			Exports	Imports	Government purchases			Final sales of domestic product	Gross domestic pur-chases	Gross national product
		Total	Durable goods	Non-durable goods	Services	Total	Non-residential	Residen-tial			Total	Federal	State and local			
						Benchmark-years-weighted index										
1959	28.0	28.0	45.0	29.8	23.5	34.2	38.8	24.4	31.4	23.1	21.4	22.3	20.5	28.0	27.4	28.0
1960	28.4	28.5	44.8	30.2	24.0	34.4	38.9	24.6	31.8	23.3	21.8	22.7	21.0	28.4	27.8	28.4
1961	28.8	28.8	44.9	30.4	24.5	34.2	38.7	24.6	32.3	23.3	22.2	23.0	21.5	28.7	28.1	28.7
1962	29.1	29.1	45.1	30.6	24.9	34.2	38.6	24.7	32.3	23.0	22.9	23.6	22.3	29.1	28.4	29.1
1963	29.5	29.5	45.3	31.0	25.3	34.1	38.7	24.5	32.2	23.4	23.4	24.2	22.8	29.5	28.8	29.5
1964	29.9	29.9	45.5	31.4	25.7	34.1	38.6	24.7	32.4	23.9	24.1	25.0	23.3	29.9	29.2	29.9
1965	30.4	30.3	45.1	32.0	26.3	34.6	38.8	25.4	33.5	24.3	24.8	25.7	23.9	30.4	29.7	30.4
1966	31.3	31.1	44.9	33.0	27.0	35.2	39.3	26.3	34.5	24.9	25.8	26.6	25.1	31.3	30.6	31.3
1967	32.3	32.0	45.7	33.8	27.9	36.3	40.4	27.2	36.0	25.0	26.9	27.4	26.6	32.3	31.5	32.3
1968	33.7	33.2	47.1	35.1	29.1	37.6	41.5	28.6	36.7	25.4	28.5	29.1	28.1	33.7	32.8	33.7
1969	35.2	34.6	48.4	36.7	30.3	39.4	43.1	30.6	37.9	26.1	30.3	30.7	30.1	35.3	34.3	35.2
1970	37.1	36.2	49.5	38.5	31.9	41.0	45.1	31.6	39.6	27.6	32.9	33.4	32.6	37.1	36.2	37.1
1971	39.0	37.8	51.3	39.7	33.9	43.1	47.2	33.4	40.9	29.3	35.3	36.0	34.9	39.0	38.1	39.0
1972	40.7	39.2	51.9	41.0	35.4	45.1	49.0	35.5	42.3	31.4	38.1	39.6	37.0	40.8	39.8	40.7
1973	43.0	41.3	52.7	44.2	37.0	47.4	50.6	38.6	47.8	36.8	41.0	42.5	39.8	43.0	42.2	43.0
1974	46.7	45.4	56.0	50.5	39.9	52.0	55.4	42.6	58.7	52.5	45.0	46.3	44.0	46.7	46.4	46.7
1975	51.1	49.2	61.2	54.4	43.2	58.3	62.8	46.6	64.6	57.0	49.7	51.2	48.5	51.0	50.7	51.1
1976	54.1	51.9	64.6	56.4	46.3	61.7	66.4	49.6	66.7	58.8	52.9	54.3	51.7	54.0	53.6	54.1
1977	57.6	55.4	67.5	59.8	50.1	66.6	70.8	54.7	69.6	64.3	56.5	58.0	55.4	57.6	57.4	57.6
1978	61.4	59.4	71.2	63.9	54.1	69.7	72.7	61.4	73.0	68.3	60.7	62.1	59.5	61.4	61.2	61.4
1979	66.6	64.8	75.9	70.9	58.5	75.5	78.0	68.2	81.6	79.3	65.9	67.4	64.7	66.6	66.6	66.6
1980	72.7	71.8	82.2	79.5	64.7	82.0	84.5	75.2	89.6	98.2	72.9	74.8	71.5	72.6	73.6	72.7
1981	79.3	78.3	87.7	86.0	71.3	89.6	92.7	81.2	95.9	103.8	79.2	82.0	77.1	79.2	80.2	79.3
1982	84.3	82.7	91.2	88.7	77.1	94.3	97.8	85.2	97.8	100.4	84.5	87.8	82.0	84.4	84.8	84.3
1983	87.7	86.4	92.9	91.0	82.1	93.9	96.4	87.3	98.1	97.1	88.0	91.5	85.3	87.8	87.8	87.8
1984	90.9	89.7	94.2	93.6	86.3	94.2	95.9	89.9	99.2	96.6	91.8	94.9	89.5	90.9	90.8	90.9
1985	94.2	93.2	95.4	96.1	90.8	95.7	97.0	92.2	97.8	94.5	95.1	97.4	93.4	94.2	93.9	94.2
1986	96.9	96.0	96.8	96.1	95.7	98.0	98.8	95.8	96.9	93.2	97.3	98.5	96.4	96.9	96.6	96.9
1987	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1988	103.9	104.2	101.9	103.8	105.1	103.1	102.7	104.2	105.3	105.1	103.7	102.8	104.3	104.0	103.9	103.9
1989	108.4	109.2	104.4	109.4	110.3	106.0	105.3	107.8	107.7	108.2	107.9	107.1	108.5	108.4	108.5	108.4
1990	113.0	114.9	106.5	116.0	116.2	108.3	107.5	110.4	109.3	112.7	112.3	111.8	112.7	113.1	113.3	113.0

GDP=Gross domestic product