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# FRBSF WEEKLY LETTER

Number 95-24, July 7, 1995

## New Measures of Output and Inflation

Making good economic policy depends on having good economic data, especially accurate measures of the economy's output and rate of inflation. But devising accurate measures of output and inflation for the large and complex U.S. economy involves overcoming a number of statistical problems. Some of these problems lead to an upward bias in the current measures of output and inflation—the so-called “constant-dollar” Gross Domestic Product (GDP) and the fixed-weight GDP price index. In recent years, the Bureau of Economic Analysis (BEA) has worked at reducing this bias, and later this year it will introduce new measures of output and prices, which are the result of this work. This *Weekly Letter* describes the new measures and explains how they will remedy some of the shortcomings of the present measures.

### Biases in the existing measures

GDP measures, in dollars, the value of all the goods and services produced in the U.S. economy—from breakfast cereal to doctors' examinations, from evening gowns to ice-skating lessons. In computing the sum total of these disparate products, each is valued at the price paid by its final purchaser. The purchase price is a natural measure of each product's importance in the total, because it reflects the item's usefulness to the purchaser at the margin—in other words, the fact that a buyer is willing to pay more for another ice-skating lesson than for an extra box of cereal is evidence that it provides more satisfaction. If the average level of prices rises, however, changes in the dollar value of GDP include the effects of this inflation as well as of changes in output. “Constant-dollar” GDP addresses this problem by valuing each product at its price in some base period rather than at the price actually paid; currently the base period is 1987.

However, this method of measuring “real” GDP gives rise to what is called “substitution bias.” Substitution bias arises because the prices of some products rise more slowly than those of other products. Since buyers will substitute lower-priced goods for higher-priced goods, output tends to grow faster in the parts of the

economy that experience smaller price increases. Because their *relative* prices are higher in the base year than in the current year, the faster-growing components of the economy get larger weights in constant-dollar GDP, which tends to pull the overall measure upward. For example, the prices of information-processing equipment have declined by 20 percent since 1987 as their output has roughly doubled. Expressing the value of these items in 1987 prices rather than current prices gives too much weight to this rapidly growing sector of the economy in the years since 1987, so that measured GDP growth is overstated. Conversely, in the years before 1987, the constant-dollar GDP measure tends to understate total growth, because industries with rapidly rising output and declining or slowly rising prices are given weights that are too small.

A similar bias is found in the fixed-weight GDP price index. This index measures inflation for all domestic products in the same way that the consumer price index measures inflation for goods and services bought by households. In this index, the price of each item is weighted by the amount produced in the base year. This means that prices in the parts of the economy in which output is growing rapidly are given relatively smaller weights. Because these prices tend to increase less than average, the overall price index is pulled upward. For example, because information-processing prices receive too small a weight in the 1987-weighted price index, the effect of the declines in these prices in holding down the overall index is underestimated; this causes measured inflation to be biased upward.

### Reducing substitution bias

Periodically, the BEA revises its data and adopts a new base period that is closer to the present. While this practice reduces the substitution bias in *recent* years, it worsens the bias in earlier years, because they are now further away from the base year.

This year, however, the BEA plans to replace the present “fixed-weight” measures of both real GDP and the price level with so-called *Fisher*

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ideal indexes that are designed to reduce or eliminate substitution bias. In a Fisher ideal index, growth from one period to another is measured by computing growth using first-period weights and again using second-period weights and taking the average of these two measures. For example, GDP growth from 1987 to 1993 is measured as the average of growth measured in 1987 prices and that measured in 1993 prices.

The Fisher ideal index has several attractive theoretical properties (Motley, 1992 and Triplett, 1992). With appropriate assumptions about consumers' preferences and firms' production constraints, this index number takes account of the substitutions that households and firms make in response to changes in relative prices and so eliminates substitution bias. A Fisher ideal index for consumer prices, for example, would measure how much nominal income a representative consumer must receive in any year to obtain the same level of satisfaction as she obtained in the base period. This means that a constant level of real income (measured as nominal income deflated by the price index) would correspond to a constant level of consumer satisfaction. This is a more satisfying definition of real income than one that corresponds to an ability to purchase a fixed bundle of consumer goods.

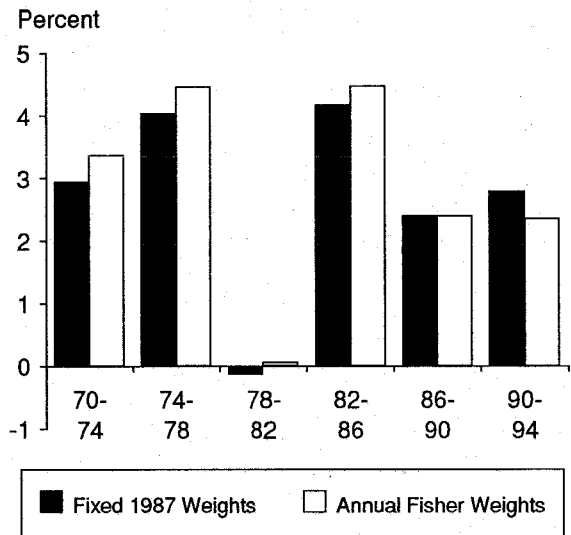
In the case of a single commodity, the amount of output sold multiplied by the market price is equal to the nominal value of sales. Fisher ideal measures of real GDP and the price level have the corresponding property that their product is equal to nominal GDP. In other words, if nominal GDP is divided by a Fisher ideal index of prices, the result is a Fisher ideal measure of real GDP, and conversely. This means that changes in nominal GDP may be divided readily into "price" and "quantity" effects.

The BEA plans to measure both quantities and prices using a chain-index version of the Fisher ideal index, in which the weights will change each year. In this index, real GDP growth from, say, 1992 to 1993 will be computed by taking the average of growth computed using 1992 prices and growth computed using 1993 prices. As a result, the features of the Fisher ideal index will be present in every year. In the most recent year, of course, this will not be possible, since data for the succeeding year will not be available.

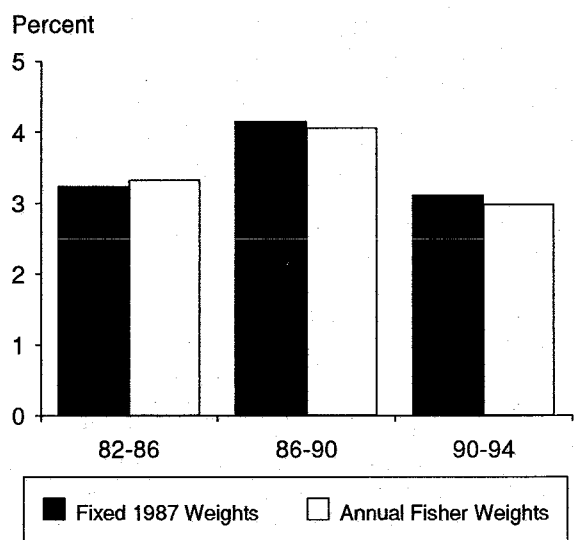
The BEA has constructed experimental chain-weighted Fisher ideal price and quantity indexes

of GDP and its principal components since 1991, but has not emphasized them. Figure 1 shows the growth in real GDP since 1970 as measured by the current fixed-weight method and by the Fisher chain index. When measured by the Fisher index, average annual real GDP growth is 0.4 percentage point lower during the 1990s and is 0.3 percentage point higher during the 1970s. Similarly, Figure 2 shows inflation since 1982 as measured by the two alternative methods. Using the Fisher index yields annual inflation measures that are 0.1 percentage point lower during the

**Figure 1**  
Growth of GDP Quantity Indexes:  
Base Year vs. Fisher Weights



**Figure 2**  
Growth of GDP Price Indexes:  
Base Year vs. Fisher Weights



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1990s and 0.1 percentage point higher during the early 1980s. These figures illustrate the substitution biases in the fixed-weight measures.

### Problems

At present, the BEA has not decided whether the data will be presented in the form of index numbers or in dollar values. In the experimental Fisher measures, BEA has presented only index numbers of real GDP and its components, with values set (arbitrarily) to 100 in 1987. Data on real GDP in terms of *dollars* may be constructed by dividing the index number by 100 and multiplying by the 1987 value of nominal GDP. It would not be strictly correct to describe the units of the resulting real GDP data as being "1987 dollars," since the new concept would not represent "what GDP would be if all prices had remained at their 1987 levels," as does the present constant-dollar concept. Indeed, it is unclear how the units of the new measures should be described.

A related drawback of using Fisher chain indexes to compute "dollar" values of real GDP and its components (consumption, investment, and so on) is that these components do not sum precisely to total GDP. In the existing constant-dollar measure of GDP, each component is separately deflated using its own measure of prices, and real GDP is then defined as the sum of these components. This ensures that the additive property of nominal GDP also applies to real GDP. In the Fisher ideal chain measures, real GDP and each of its components are deflated independently, with the result that the additive property is lost, even when the data are presented in dollars.

When presented in the form of index numbers, of course, no summing of GDP components into larger aggregates is possible. This means that one cannot answer such questions as "How much of GDP growth is due to the rise in consumption or investment?" If the data were transformed into

dollars, such questions could be addressed, but it would be necessary to include a set of "adding-up adjustments" into the accounts to assure that each aggregate is consistent with its components.

Economists making forecasts often proceed by projecting the components of spending and then summing them to obtain a projection of total GDP. The fact that measured real GDP is not precisely equal to the sum of its components will complicate this process. However, this problem may be less severe in practice than it appears in principle. Because substitutions between commodities take place slowly, the adding-up adjustments also should change slowly and so be relatively easy to forecast, at least over short periods of time.

The BEA will publish articles later this summer describing the new data. The BEA appears committed to making the changes and to resolving the outstanding issues. Users of these data will find that the measures of economic performance that they have come to know and love will be replaced by a series of new concepts. Although these will be unfamiliar at first, they will provide more precise measures of how the overall economy is behaving.


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