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Will the Real "Real GDP" Please Stand Up?

The Bureau of Economic Analysis (BEA) estimates that in the fourth quarter of 1991, real gross domestic product (GDP) increased at a 0.8 percent annual rate. While it is well known that such estimates are subject to errors of measurement because they are based on sample data, it is less often recognized that there are unresolved *conceptual* problems involved in constructing a measure of the nation's output. Even if we had complete and accurate raw data, the "correct" measure of output still would be ambiguous.

This *Weekly Letter* examines some issues raised by one source of ambiguity, the so-called index number problem. It will describe the new measures of GDP that BEA expects to release later in 1992. While these new measures will not supplant the current series, they will provide an alternative that tackles the index number problem in a different way.

The index number problem

The index number problem arises most often in the context of measures of inflation. A price index number, such as the consumer price index, is an average of the prices of a large number of individual goods and services. When some prices change more than others, the growth rate of such an index depends on the weights attached to individual prices. Changes in the prices of items that are weighted heavily have a bigger effect on the overall index than those of items with low weights. Without some "right" way to choose these weights, such measures are somewhat arbitrary.

Existing measures of real GDP suffer from this same index number problem. GDP is the aggregate of the amounts spent on a vast number of individual goods and services. To adjust for the effects of inflation, spending on each component of GDP is measured at the prices that ruled in a certain base year. As a result, this measure of real GDP is, in principle, an index number, since it is measured as the fixed-weighted sum of its components. The weights depend on relative prices in the base year, which now is 1987. Thus, the measured growth rate of real GDP depends on the relative prices of its components in 1987. Goods and services that had high prices in 1987 contribute more to measured real growth than those that had low prices. This procedure introduces an arbitrary element into measures of real growth.

The results of this arbitrariness appear in various ways. Because it makes sense to measure the growth of real GDP in terms of relative prices in a recent period, the BEA periodically revises the data to a more current base date. Last December, the base date was changed from 1982 to 1987. However, changing the base date may alter the estimated growth rate of real GDP. In both 1987 and 1988, for example, the growth rate of real GDP in 1987 prices is 0.5 percentage point lower than in 1982 prices. Also, using a more recent base date may distort measures of real growth in the distant past. For example, the current measures of real growth during the 1950s, which are constructed in terms of 1987 prices, will underestimate the importance of sectors, such as autos, in which relative prices have declined in the intervening years and will overestimate that of sectors, such as oil, that have experienced large price increases.

Predictable biases

Although its effects on short-run growth are unpredictable, changing the base to a later date usually reduces the estimate of long-run real GDP growth. For example, between 1977 and 1990, real GDP increased at an annual rate of 2.7 percent when measured in 1982 dollars but only 2.5 percent in 1987 dollars (*Survey of Current Business,* December 1991). This effect occurs because sectors of the economy that grow slowly tend to be those that have the largest price increases, and those that grow rapidly generally are those with the smallest price increases. As a result, high-growth sectors have smaller weights in real GDP, and slow-growth sectors have larger weights, if a later base date is chosen. In recent years, for example, the output of computers has increased rapidly, while their prices have fallen

sharply. Owing to the price decline, the measured contribution of this industry to overall growth is smaller when weighted by 1987 prices than by 1982 prices.

The inverse relation observed between changes in sectoral prices and outputs suggests that most relative price changes are due to changes in costs on the *supply* side and that buyers substitute away from goods and services with larger-than-average price increases in favor of items with smaller-than-average gains. If most relative price changes were due to taste changes on the *demand* side, the sectors with the largest increases in prices would be those with the greatest increases in sales. Historically, this has not been the case in the U.S., implying that supply shifts have been more important than demand shifts in changing relative prices.

The economic theory of index numbers

The fact that a change in the base date produces a different measure of real GDP growth implies that this measure has an arbitrary element that cannot be eliminated. Existing measures of the rate of inflation contain the same inherent ambiguity.

Fundamentally, these ambiguities arise because consumers vary their purchases and firms alter their production patterns in response to changes in relative prices, which, in turn, respond to changes in tastes and production possibilities. A branch of microeconomic theory known as the *economic theory of index numbers* (Diewert, 1987; Motley, 1992) suggests that the ambiguity in existing price and output indexes may be avoided by developing index number formulae that explicitly take account of these substitutions between goods and services. Initially, this theory was applied to the problem of defining price and output measures that would measure the "cost" and "standard" of living of a representative consumer. Later it was extended to the definition of other price and quantity indexes.

If we knew a consumer's preferences, we could predict what changes she would need to make in the goods and services she buys in order to maintain the same level of satisfaction in the face of price changes. If, for example, the price of chicken were to rise and that of fish to fall, we could predict how she would rearrange her purchases (more fish and less chicken) so as to maintain the same level of satisfaction. If the new set of purchases cost more than the previous set we would say that the "true" cost of living had risen. This procedure would provide an unambiguous measure of the change in average consumer prices, since it would be based on the cost of a certain level of satisfaction rather than on the cost of an arbitrary bundle of commodities.

With such a price index, the change in the consumer's real income could be measured by the extent to which the increase in her nominal income exceeded the rise in the true cost of living. Measured this way, an increase in real income would indicate a rise in the consumer's satisfaction. Thus, if real GDP were measured by deflating nominal GDP by a true cost of living index, the result would be a measure of output that would represent the level of satisfaction of a typical consumer.

The problem of course, is that consumer preferences are not observable. Without further assumptions, we cannot predict how consumers will respond to changes in relative prices and so cannot construct a true index of the cost of living. However, the assumption that consumers buy the goods and services they prefer implies that observable data on the prices and quantities of commodities do contain information about preferences. The economic theory of index numbers shows that, by making additional assumptions about the nature of consumers' preferences, we can use these price and quantity data to construct an index number that will serve as an indicator of changes in the true cost of living. With such a price index in hand, a measure of real income that indicates the level of satisfaction of a representative consumer may be readily computed by using it to deflate nominal income.

The appeal of this approach is that it is necessary only to specify in algebraic terms the general nature of consumers' preferences and not necessary to have quantitative information about them. Index number formulae derived from this preference-based approach are described as "exact" indexes.

Alternative GDP indexes

One form of exact index number that is easy to compute is the Fisher-ideal index. This index number originally was proposed by the American economist, Irving Fisher, in 1922. The Fisher ideal measure of the increase in output from, say, 1990 to 1991, is the geometric average of the increase computed in terms of 1990 prices and the increase computed in 1991 prices. As long as consumer preferences have the necessary algebraic form, theory indicates that this index will measure the change in consumer satisfaction between these two dates. Similarly, the corresponding Fisher ideal price index will measure the change in the true cost of living; that is, the price of maintaining a constant satisfaction level.

Fisher ideal indexes could provide measures of the growth in the quantity and price of the nation's output between any pair of dates. By computing such measures for each quarter and then compounding these quarterly growth rates, continuous quantity and price series could be constructed. The weights in these indexes would change every quarter.

Later this year, the BEA will begin publishing two new indexes of real GDP and prices using forms of the Fisher-ideal measure. The BEA terms these new measures *time-series generalized Fisher ideal (TGFI) indexes*. As in the original Fisher ideal, the weights used in constructing these alternative indexes will not be fixed. However, they will not change every quarter.

The TGFI index begins by choosing pairs of benchmark years either one or five years apart: 1982/1987 and 1987/1992 will be pairs of benchmark years for one of the new indexes. Real GDP growth from one benchmark year to the next is calculated using the Fisher-ideal procedure. For example, growth from 1982 to 1987 is calculated as the average of growth in 1982 prices and that in 1987 prices. Growth rates in periods between benchmarks are measured as the average of the growth rates calculated using the prices in each of the two benchmark years. For example, real GDP growth from 1984 to 1985 is measured as the average of growth computed in terms of 1982 prices and growth computed in 1987 prices. For periods after the most recent benchmark year, 1987, the calculations will use prices for 1987 and the last complete year, until data for the next benchmark, 1992, are available. Thereafter, growth between 1987 and 1992 will be measured using relative prices in those two years.

Since the benchmark years are relatively close, these new measures of real GDP and the price level will incorporate the current structure of output and relative prices rather than those in a distant base year. Therefore, the new measures should indicate current developments more accurately and may be more valuable to policymakers. Furthermore, after the second benchmark year, BEA will not need to revise the national accounts data to allow for changes in the base year. By contrast, the recent switch in the base date from 1982 to 1987 necessitated changes in the GDP estimates all the way back to 1929.

Conclusion

The measures of real GDP and inflation to which policymakers respond are aggregates of vast numbers of individual prices and quantities. Measuring these macroeconomic variables using fixed-weight indexes adds to the uncertainties facing users of these data, since changes in the base date sometimes alter our perceptions of the economy's long-run real growth and inflation rates or of its short-run cyclical behavior.

These ambiguities result from the particular definitions of output and inflation that are currently in use. If, for example, an increase in total output were defined as a change in the bundle of goods and services produced that raises the satisfaction level of the representative consumer, the ambiguities could, in principle, be resolved. This definition can be made operational by specifying the form of households' preferences and deriving the implied index number formula.

BEA soon will introduce measures of real GDP and inflation based on this approach. The new TGFI measures will avoid some of the ambiguity associated with fixed-weight aggregates and will have a sounder theoretical basis than the current measures. (Of course, since the Fisher ideal formula is derived from a specific assumption about the form of consumers' preferences, an arbitrary element remains.) Furthermore, because the weights used in constructing the indexes will change from one benchmark period to the next, the measures will more closely reflect the current structure of the economy. These improvements will mitigate at least one source of uncertainty facing policymakers.

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