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# Do Price Indexes Tell Us About Inflation? A Review of the Issues

**B**ECAUSE its effects are so pervasive, virtually everyone is concerned about inflation. While understanding the concept of inflation seems to be easy enough, finding a meaningful *measure* of it is much more difficult than it might appear. For us as consumers and citizens, to understand how inflation is defined and the extent to which the commonly used price indexes actually measure it is clearly important.

This article describes the broad issues involved in defining inflation, then examines how useful the commonly used U.S. price indexes are in interpreting and understanding it.

## INFLATION: DEFINITIONS AND CONCEPTS

Because there is substantial controversy about precisely what inflation is, a variety of definitions of inflation have cropped up over the years.<sup>1</sup> Definitions of inflation generally fall into two classifications: descriptive ones, which focus on the symptoms of inflation, and causal ones, which focus on the reasons for inflation. A typical descriptive definition of inflation is a

“continuous rise in the general level of prices.” A typical causal definition is “too much money chasing too few goods.” While other variations of these definitions could be cited, these two provide a point of departure for our analysis.

The “continuous” part of the descriptive definition refers to the sustained nature of the increases as opposed to temporary short-term movements in prices (for example, the effects of a drought), or one-time jumps in the price level (for example, resulting from an increase in an excise tax). In recent years, short-term price movements have reflected primarily price volatility in the markets for energy and food. The “general” part of the descriptive definition refers to the average behavior of prices as opposed to movements in the prices of individual commodities or services. As Alchian and Klein (1973) indicate, a general measure of inflation should be based on the prices of *all present and future* consumption services.<sup>2</sup> Their theoretical measure of inflation is defined as the change in the nominal cost of achieving a given level of well-being over time, or what could be termed loosely as changes in the cost of living.<sup>3</sup>

<sup>1</sup>For a general discussion of inflation, particularly its effects, see the section on “Inflation: Impact and Measurement” in Alchian (1977).

<sup>2</sup>Alchian and Klein (1973).

<sup>3</sup>To avoid confusion with the consumer price index, which is sometimes referred to as a measure of the cost of living, Alchian and Klein refer to their measure as “the cost of life.”

The causal definition of inflation—too much money chasing too few goods—is a carryover from the writings of nineteenth-century economists who defined inflation as a continuous decline in the purchasing power of money.<sup>4</sup> Money is accorded a causal role because it serves as the medium of exchange. Friedman refines the causal definition by stating that “inflation is always and everywhere a monetary phenomenon . . . and can be produced only by a more rapid increase in the quantity of money than in output.”<sup>5</sup>

This discussion suggests that the important aspects of inflation, properly defined and measured, are its broad and continuous nature and its monetary underpinnings. A key question that follows from combining the descriptive and causal aspects of inflation is to what extent the U.S. price indexes reflect these aspects.

### *Measuring the Cost of Living*

Since inflation refers to changes in the general level of prices, it is useful to examine the measurement of the cost of living. A theoretical measure of the cost of living, like the one proposed by Alchian and Klein, is based on a long-term goal of maximizing economic well-being. Individuals (or society) decide how to maximize their well-being in terms of both current and future consumption; this means that the prices of both current and future consumption of goods and services must enter into the cost of achieving a level of economic well-being. (For a numerical example, see the shaded insert on the following page.) As Alchian and Klein point out, however, because separate futures markets exist for only a small number of commodities, price quotations for future consumption goods and services are generally not available. Fortunately, asset prices, which are the prices for the *sources* of future consumption services, provide a good proxy and are readily available.

Our theoretical measure of the cost of living should include all asset prices that yield present and future consumption services. Thus, such a measure would include the prices of both new and used cars, new and used appliances and furniture and asset prices that yield a monetary (pecuniary) return, like financial assets (stocks, bonds, savings accounts) and land.

The asset prices to be considered for this measure would not necessarily be limited to assets actually held by individuals because the asset combination that would yield the desired consumption pattern might differ from the assets that are actually held. The objective underlying the construction of this measure is to determine the money cost of achieving the individuals' maximum level of well-being.

Table 1 provides a list of the major components of household net worth for selected years since World War II. Although net worth has changed little relative to personal consumption since 1952, its composition has changed substantially. Tangible assets, in particular, land, now constitute a larger portion of net worth than in 1952. Households are now net debtors with respect to credit market instruments; they were net creditors in 1952. Also, holdings of equity in noncorporate business are now much less important relative to total net worth than they were in 1952. To measure the theoretical cost of living, however, we must examine changes in the prices of these diverse components of net worth.

Table 2 summarizes U.S. trends in prices of current consumption goods and services, along with those for selected assets for selected periods from 1952-88.<sup>6</sup> For the full period, prices of both common stock and land have increased more than consumer prices. For the shorter periods, which range from six to 13 years in length, a theoretical measure of price change including asset prices would imply substantially different effects on the cost of maintaining an individual's well-being than implied by considering only prices of current consumption. The extent of these effects, of course, would depend on the individual's preferences for current vs. future consumption.

A theoretical measure of the cost of living, as defined by Alchian and Klein, provides a basis for measuring inflation primarily as viewed by individuals. Changes in that measured cost of living correspond to the “general” part of the descriptive definition of inflation. The theoretical measure also provides a standard for comparison in evaluating the price indexes that are

<sup>4</sup>Bronfenbrenner (1968) and Allen (1975).

<sup>5</sup>Friedman (1966), p. 25.

<sup>6</sup>The periods shown correspond for the most part with changes in the rate of increase of consumer prices. It will

be shown later that they also correspond to marked and sustained changes in the growth of money relative to output.

## A Numerical Example of Theoretical (Alchian-Klein) Cost-of-Living Index

Suppose that an individual is achieving a certain level of well-being by allocating his income of \$1,000 as follows:

Initial situation:

	Price	Quantity	Price x quantity
Present consumption	\$ 4	159.6	\$ 638
Future consumption	20	18.1	362
		Total	\$1,000

Present consumption includes units purchased of food, clothing, shelter, etc., and future consumption includes allocations to common stocks, bonds, etc. Suppose that the prices of both present and future consumption change, but income is unchanged at \$1,000. The individual responds, maximizing his well-being by shifting his allocation as follows:

Changed situation:

	Price	Quantity	Price x quantity
Present consumption	\$ 5	126.4	\$ 632
Future consumption	30	12.3	368
		Total	\$1,000

With the prices of present and future consumption goods both rising, although by dif-

ferent amounts, the individual has to adjust his allocation. Exactly how much the quantity purchased of each good changes depends on the preference of the individual.

The price of present consumption goods and services has risen by 25 percent and future consumption goods and services by 50 percent, and clearly the individual's well-being has declined. How much have average prices increased? The theoretical price index asks what the money cost was of achieving the level of well-being that was achieved initially. Given the changed relative price structure (\$5/\$30 instead of \$4/\$20), assume that the individual could achieve his previous well-being with present consumption of goods and services of 171.5 units and future consumption of goods and services of 16.3 units. The money cost in the second period is

$$\$5(171.5) + \$30(16.3) = \$1,347.$$

The index of the money cost of achieving a level of well-being has increased by 35 percent  $((1347/1000) - 1) \times 100$ . If the individual's wealthholdings actually increased from one situation to the next, then that increase could be compared with the change in the money cost of achieving a level of well-being.

used in the United States. Left unexamined, however, is the "continuous" part of the definition. Presumably, an individual is concerned with changes in the cost of living regardless where they came from or whether they are continuous.<sup>7</sup> Policymakers, on the other hand, though concerned with movements in the general level of prices, have to differentiate between movements of prices that are continuing and those that are temporary (or short term). To gain an understanding of the continuous aspect of inflation, it is helpful to turn to the causal definition of inflation—"too much money chasing too few goods."

### Monetary Inflation

Policymakers are concerned about inflation because one of their goals is to control it. This means they must use measures of price movements in such a way that the inflationary effects of their actions are readily identifiable. This might mean that the price measure most relevant to them differs from that most relevant to individuals.

Singled out for emphasis here is the causal definition of inflation that stresses the role of

<sup>7</sup>This is not to say that individuals are oblivious to the source of price change. Rather than complicate the analysis by introducing expectations, the analysis focuses

on measuring the change in the money cost of maintaining individuals' well-being, that is, measuring what happened to prices rather than what is expected to happen.

**Table 1**  
**Distribution of Household Net Worth (dollar amounts in billions)<sup>1</sup>**

	1988		1972		1952	
	Amount	Percent of total	Amount	Percent of total	Amount	Percent of total
Net worth	\$15,446.6	100.0%	\$3,853.3	100.0%	\$1,102.2	100.0%
Tangible assets	6,538.4	42.3	1,411.8	36.6	373.7	33.9
Reproducible assets	5,203.9	33.7	1,217.7	31.6	337.1	30.6
Residential structures	3,067.3	19.9	704.2	18.3	187.3	17.0
Nonprofit plant & equipment	290.4	1.9	88.8	2.3	15.8	1.4
Consumer durables	1,846.2	12.0	424.7	11.0	134.0	12.2
Land	1,334.5	8.6	194.1	5.0	36.6	3.3
Total net financial assets	8,908.2	57.7	2,441.5	63.4	728.5	66.1
Deposits & credit market instruments	1,251.8	8.1	367.7	9.5	156.2	14.2
Checkable deposits & currency	515.7	3.3	142.4	3.7	62.3	5.7
Other time & savings deposits & MMF shares	2,525.3	16.3	563.7	14.6	79.8	7.2
Credit market instruments	-1,789.2	-11.6	-338.4	-8.8	14.1	1.3
Corporate equities plus net security credit	2,217.8	14.4	905.9	23.5	168.6	15.3
Life insurance & pension fund reserves	2,866.0	18.6	469.2	12.2	92.1	8.4
Equity in noncorporate business	2,373.8	15.4	667.4	17.3	301.6	27.4
Miscellaneous assets	198.8	1.3	31.3	0.8	10.0	0.9
Memo:						
Personal consumption expenditures (flow during the year)	\$3,227.5	20.9%	\$757.6	19.7%	\$219.1	19.9%

<sup>1</sup> Year-end outstandings

SOURCES: Federal Reserve Flow of Funds and U.S. Department of Commerce

**Table 2**  
**Rates of Change for Prices of Current Consumption and Selected Assets**

	Full period 1952-88	Average rate of change Subperiods			
		1982-88	1972-82	1965-72	1952-65
Consumer prices, all items	4.2%	3.5%	8.7%	4.1%	1.3%
Common stock prices	6.8	13.8	1.3	3.5	9.9
Land prices	8.3	4.8	14.5	6.2	6.4
Home prices					
New	N.A.	8.7	10.8	4.9	N.A.
Existing	N.A.	5.8	10.6	N.A.	N.A.

monetary forces.<sup>8</sup> As Friedman's research indicates, the continuous aspect of inflation is attributable primarily to growth in the quantity of money relative to output. His preferred measure of money, based on extensive research, is M2, and his measure of output is "trend real GNP." The use of trend real GNP permits the influence of other slow-changing factors to come into play. Such factors include changes in the quantity and quality of the labor force (or population), capital formation and technological changes.

From this causal view of inflation, policymakers would be interested in a price measure that reflects movements, probably with a lag, in the money-output measure.<sup>9</sup> The previous discussion of the descriptive definition of inflation suggests that policymakers might prefer a measure of price change that excludes the influences of temporary factors.

### USING THE U.S. PRICE INDEXES TO MEASURE INFLATION

The U.S. price measurement system consists primarily of three sets of price indexes: the consumer price indexes, the producer price indexes and the deflators implicit in the GNP accounts.<sup>10</sup> (For a basic review of index numbers, see the shaded insert at right.) Each month, announcements about the latest readings of these indexes are made. The consumer and producer price indexes are prepared monthly; the implicit deflators are prepared only quarterly, although revisions are announced monthly. This section summarizes the origins of each index, as well as their coverage, uses and limitations, and concludes with an evaluation of the cost of living in light of the theoretical (Alchian-Klein) definition. The following section examines the indexes in the context of Friedman's causal definition of inflation.

#### *The Consumer Price Index*

The consumer price index (CPI), perhaps the best-known price index available for the United

States, is a measure of price change for a fixed market basket of goods and services purchased by urban consumers.<sup>11</sup> The CPI is familiar to almost everyone because:

- (1) it measures prices that consumers can relate to easily in their everyday purchases;
- (2) it is available each month, announced with a short lag and receives substantial coverage by the media;
- (3) it provides considerable detail on components of the index and geographical differences in prices; and
- (4) its long historical record provides perspective on similar price movements in the past.

**History**—The consumer price index was developed during World War I in an attempt to arrive at a fair wage scale for workers in shipbuilding yards. Initially, expenditure data were gathered for wage-earner families in 92 cities while price data were gathered for retail stores in 32 cities; in 1919, "cost-of-living" indexes were published semiannually for these 32 cities. A national index was published in 1921 with data compiled back to 1913. Quarterly indexes were published in 1935 and monthly indexes were initiated in 1940.

The first expenditure survey covered the years 1917-19, followed by surveys for 1934-36, 1947-49, 1950, 1960-61, 1972-73 and 1982-84. The purpose of these surveys is to update the weights assigned to particular items in the consumer's budget.<sup>12</sup> Table 3 shows how the weights have changed over the years, reflecting the changing patterns of consumer spending.

The CPI, with its updated expenditure surveys, is a "shifting-weight" index. This means that each time a new survey is conducted, the weights used to compute the index are changed; the past data, however, are not revised. Thus, the CPI data reflect changing weights and different measurement procedures over time. This

<sup>8</sup>For a general discussion of alternative theories of inflation, see Frisch (1983).

<sup>9</sup>This reasoning is somewhat circular. The point to be emphasized here is that prices have to be monitored continuously by policymakers to determine the appropriateness of their policy indicator.

<sup>10</sup>For an alternative discussion of U.S. price indexes, see Webb and Willems (1989).

<sup>11</sup>Since 1978, there have been two CPIs—CPI-U and CPI-W. CPI-U is for all urban consumers, covering about 80 per-

cent of the population. CPI-W is for urban wage earners and clerical earners which covers about 45 percent of the population. Unless denoted otherwise, the CPI-U measure is the one used in this article.

<sup>12</sup>The Labor Department also changes the reference base period from time to time, that is, the base year that is called 100. The choice of the base year, which, incidentally, need not be the same as the year of the expenditure survey, is of no particular significance other than to provide the user of the index with a point of reference.

## Index Numbers: Some Basics

An index number is a measure of something of interest relative to a specific standard for comparison. The simple price index, for example, could be a comparison of the price of a particular commodity with its price in a base year or, at a given time, a comparison with its price in a particular geographical area. Major U.S. price indexes combine many prices in such a way that the index number measures the weighted average price change over time.<sup>1</sup>

### An Example

The problems inherent in the construction and application of an index number can be enumerated with a simple example. Suppose we are interested in constructing an index of prices received by U.S. farmers for their major crops in 1986 compared with 1982. The basic data are:

	Prices (dollars/bushel)		Quantities (millions of bushels)	
	1982	1986	1982	1986
Wheat	\$3.55	\$2.34	2765	2087
Oats	1.49	1.16	593	385
Soybeans	5.69	4.65	2190	2007
Corn	2.68	1.49	8235	8253

One method would be to add the four prices for 1986, divide by 4 and compare this with a simple average for 1982. This procedure would ignore the relative importance of the different commodities in the production mix. A more reasonable method would be to allow for this relative importance.

One way to measure relative importance is to consider quantities, for example, the bushels of each commodity relative to total bushels. The weighted average of price relatives would be as follows:

	Price relative ( $P_{1986}/P_{1982}$ )	Relative importance*
Wheat	0.66	0.20
Oats	0.78	0.04
Soybeans	0.82	0.16
Corn	0.56	0.60

\* Proportion of total bushels in 1982

The price relative is simply the 1986 price divided by the 1982 price. In other words,

prices of commodities in 1982 serve as a base year, where  $P_{1982} = 1.00$ . To get the weighted index, multiply each price relative by its relative importance and sum to obtain 0.63. The result is an index (with 1982 = 1.00) of major crop prices in 1986 relative to 1982 using 1982 production as weights.

### Fixed-Weight Formulas

Most price indexes use fixed-weight formulas. The two most common are:

$$I_{01}^L = \frac{\sum p_1 q_0}{\sum p_0 q_0} \text{ and } I_{01}^P = \frac{\sum p_1 q_1}{\sum p_0 q_1}$$

The first formula uses the quantities,  $q$ , in period 0 as weights; the price index in period 1 relative to period 0 is labeled  $I_{01}^L$ , where "L" denotes a Laspeyres-type index. It compares a hypothetical expenditures (or sales) total ( $\sum p_1 q_0$ ) with actual expenditures ( $\sum p_0 q_0$ ) in the base period. The second formula is the same except that the quantities in period 1 are used as weights; this is called a Paasche-type index. For this index, actual expenditures in period 1 are compared with a hypothetical total in period 0. The objective is the same for both: to isolate the change in prices when expenditures or sales change from one period to the next. Holding the quantities fixed means that an identical basket of goods and services is being priced in successive periods. Alternatively, the "standard of living," or consumer welfare, is being held constant between the two periods.

### Substitution Bias

Price indexes are constructed mainly because all prices do not move proportionately. Because of disproportionate change, the fixed-weight indexes are subject to substitution bias. This bias occurs because an identical market basket is being used to weight the importance of prices. When substitution among goods is possible, however, consumers will buy more of those goods whose prices rise most slowly, or fall in relative terms, and less of those goods whose prices rise most rapidly. In other words, given the new prices, there is a different market basket that would leave the consumer's level of well-being constant, or, as explained in the principles of

economics, "on the same indifference curve." If such an index were constructed, it would measure the change in the "true cost of living." The Laspeyres index tends to assign too much weight to those goods whose prices rise most rapidly, while the Paasche index assigns too little weight to those goods. Thus, these indexes, when computed for consumers, are measures of average change in prices for goods and services purchased for family living and technically not cost-of-living indexes because they do not hold the standard of living constant.

Although the direction of bias in the fixed-weight indexes is generally known, its magnitude is not. Triplett surveys some empirical work on the bias in cost-of-living indexes and reports that "the empirical results indicate merely that the bias is small enough that it can probably be neglected as a matter of practical importance, whether the index is to be used for escalation of income payments, or as a macroeconomic policy indicator."<sup>2</sup>

### ***Annual Rates of Change: Converting a Price Index to an Inflation Measure***

Following the movements of a price index (or any economic time series) is facilitated by

calculating annual rates of change. In this way, all movements of the index, regardless of the time interval, are converted to a standardized period of one year.

For monthly data, the formula for a compounded annual rate of change is:

$$CAR_{0,t} = \left\{ \left( \frac{I_t}{I_0} \right)^{12/t} - 1 \right\} \times 100,$$

where  $CAR_{0,t}$  is the compounded annual rate of change of the index (I) from month 0 to month t. It is the percent change that would occur if the change from 0 to t were maintained for 12 months.

For quarterly data, the formula is:

$$CAR_{0,t} = \left\{ \left( \frac{I_t}{I_0} \right)^{4/t} - 1 \right\} \times 100,$$

where t is the number of quarters in the interval.

For annual data, the formula is:

$$CAR_{0,t} = \left\{ \left( \frac{I_t}{I_0} \right)^{1/t} - 1 \right\} \times 100,$$

where t is the number of years in the interval.

<sup>1</sup>For an overview of the early literature on price measurement and index number theory in general, see Diewert (1988).

<sup>2</sup>Triplett (1975), p. 28.

procedure is followed primarily to avoid legal problems that might arise because of contracts that use the CPI as a basis for wage or price escalation.

**Coverage**—The CPI is derived from a sample of prices of essentially everything that consumers purchase for day-to-day living. Among these are prices of food, clothing, shelter, transportation, medical care, entertainment and personal care. Sales, excise and real estate taxes are also included, but income and Social Security taxes are not. The weights and composition of the index are currently based on the Survey of Consumer Expenditures for 1982-84. Table 4 summarizes the coverage and weights for CPI-U in 1988.

**Uses and limitations**—The CPI is commonly used as a measure of the cost of living and, relatedly, as an index to deflate income payments or other contracts involving monetary payment. As pointed out in the shaded insert on index numbers, the CPI is only approximate and might not be appropriate for a particular consumer whose expenditure pattern differs from the typical urban consumer. It is commonly used, however, because it is readily available and understandable.

The CPI is also used to deflate time series of nominal data so that they can be interpreted in real terms. Nominal data series mean little without accompanying information on price changes. Dividing the nominal data by a price

Table 3

### Percent Distribution of CPI Market Basket for Wage Earners and Clerical Workers (selected years)

Major group	1935-39	1952	1963	1972-73	1988
Food and beverages	35.4%	32.2%	25.2%	20.4%	19.6%
Housing	33.7	33.6	34.9	39.8	39.8
Apparel	11.0	9.4	10.6	7.0	6.4
Transportation	8.1	11.3	14.0	19.8	19.1
Medical care	4.1	4.8	5.7	4.2	5.1
Entertainment	2.8	4.3	3.9	4.3	4.1
Other goods and services	4.9	4.8	5.7	4.5	5.9

Table 4

### Consumer Price Indexes by Commodity and Service Group

	1988 index* (1982 = 100)	Relative importance (December 1988)
All items	118.3 (122.6)	100.0%
Commodities	111.5 (114.9)	45.3
Food and beverages	118.2 (121.5)	17.7
Commodities less food and beverages	107.3 (110.7)	27.6
Nondurables less food and beverages	105.2 (107.0)	15.9
Apparel commodities	113.7 (115.7)	5.8
Other	103.2 (104.9)	10.2
Durables	110.4 (116.1)	11.6
Services	125.7 (130.9)	54.7
Rent or shelter	N.A. (132.0)	27.2
Household services less rent	N.A. (115.3)	9.3
Transportation services	128.0 (133.2)	6.7
Medical care services	138.3 (149.4)	4.8
Other services	132.6 (141.8)	6.7

\* Figures in parentheses are 1988 index converted to 1982 = 100.

index, which equals 1.0 in the base period, yields a deflated series in base-year prices. For example, personal income divided by a consumer price index provides a measure of real personal income. If this measure rises over time, it is usually interpreted as a rise in the standard of living. Other economic series that are commonly deflated with the CPI are retail sales, measures of earnings and consumption components of the gross national product.

The two most commonly heard criticisms leveled against the CPI are that (1) it is a fixed-weight index and (2) it does not capture quality changes of consumer goods accurately.<sup>13</sup> The fixed-weight criticism focuses on the substitution bias that is inherent in its construction. Those goods whose prices increase the most are purchased in smaller quantities, and those that rise the least are purchased in larger quantities. (See the shaded insert on page 14 for a

<sup>13</sup>For a survey of the validity and accuracy of price indexes, see Triplett (1975).



numerical example of the cost-of-living index.)<sup>14</sup> It is unclear, however, given the U.S. price experience, that this bias is serious enough to distort the index for the purposes of most users.

The second criticism about quality measurement is relevant because, in the face of rapidly changing technology and tastes, the methods of adjustment will always be subject to criticism. While the CPI's construction does adjust for quality change, some analysts have found the adjustment too large for some goods.<sup>15</sup>

**Evaluation**—The CPI covers the prices of current consumption goods and services only; these goods constitute only a portion of an individual's wealth. Thus, implicit in the CPI's construction is that economic well-being depends primarily on current, not future, consumption. If an individual's well-being depends on his holdings of wealth, however, asset prices should be included, because they serve as a proxy for the prices of future consumption goods and services.

The prices of some newly produced assets, like household furnishings, other consumer durables and new cars, are included in the CPI. But uses of consumer savings, like purchases of stocks, bonds and real estate, are not included. In fact, Alchian and Klein argue that the CPI was more accurate as a price index before 1983 when the price of new housing was included.<sup>16</sup> Since 1983, a rental equivalence measure of shelter costs has been used. This measure is an estimate of the cost of renting housing equal to those provided by owner-occupied housing.

### *The Producer Price Index*

Another well-known U.S. price index is the producer price index (PPI), which measures average changes in prices received in primary

markets by producers of commodities in all stages of processing. While the CPI is a measure of prices paid by consumers in the final commercial transaction, the PPI is a measure of prices received by producers in the first commercial transaction.

**History**—The PPI is one of the oldest economic time series compiled by the federal government. Known as the wholesale price index until 1978, the index originated in an effort to investigate the effect of tariff laws on trade, domestic production and prices of agricultural and manufactured goods. The series, first published in 1902, is available from 1890 to the present time.

The index initially was a simple unweighted average of the prices of about 250 commodities. A system for weighting was introduced in 1914, and other major changes were introduced in 1952, 1967 and 1978. Such changes primarily expanded the samples of commodities. By 1987, the index covered more than 3,000 commodities.

In 1978, the analytical focus was shifted from a classification by commodity (there are two major classifications: farm products and processed foods, and feeds and industrial commodities) to one based on stage-of-processing, that is, degree of fabrication (finished goods, intermediate goods and crude materials). The commodities framework had organized products by similarity of end use or material composition and, as a result, reflected many stages of processing. Although still published, this classification has been de-emphasized because of the possibility of counting price changes more than once through several stages of processing.<sup>17</sup> The stage-of-processing classification is an improved measure of price change.

<sup>14</sup>For example, energy prices rose at an annual rate of 12.9 percent between 1972-73 and 1982-84, compared with a rate of increase of 8.4 percent for the all-items CPI. Although the weight for energy products in the consumer's market basket changed from 8.6 percent in 1972-73 to 7.4 percent in 1982-84, the CPI from January 1978 through 1987 was calculated using the 1972-73 weights. This is just one example of substitution bias.

<sup>15</sup>Triplett (1975), pp. 30-48. The objective in constructing a price index is to compare prices of goods of constant quality. Triplett reviews studies of this problem, focusing on automobiles, household appliances and medical care services.

The Labor Department uses several methods of adjusting for quality change. The usual method is to collect data from companies on costs involved in connection with the

quality change. For example, if the selling price of a new model car increases by \$500 and companies report that \$200 of that increase is attributable to government-mandated safety equipment, the price increase is estimated at \$300. For further discussion, see Bureau of Labor Statistics (1988), p. 127.

<sup>16</sup>Alchian and Klein (1973), p. 178.

<sup>17</sup>The Bureau of Labor Statistics (1982) example is that, according to the commodity classification, if the price of cotton were to rise and be passed through to producers of cotton yarn, then to cotton fabric, and finally to shirts, the initial price increase would have been recorded four times. If prices were increasing at the same rate at all stages, there would be no major distortion. Otherwise, multiple counting can provide biased and misleading results.

**Table 5**  
**Producer Price Indexes by Stage of Processing**

	1988 index (1982 = 100)	Relative importance (December 1988)
Finished goods	108.0	100.0
Finished consumer goods	106.2	74.2
Finished consumer foods	112.6	25.8
Finished consumer goods, excluding foods	103.1	48.4
Nondurable goods less food	97.3	32.8
Durable goods	113.7	15.6
Capital equipment	114.3	25.8
Intermediate materials, supplies and components	107.1	100.0
Materials and components for manufacturing	113.2	50.9
Materials for food manufacturing	105.9	3.3
Materials for nondurables manufacturing	112.9	16.3
Materials for durable manufacturing	118.8	12.1
Components for manufacturing	112.3	19.2
Materials and components for construction	116.1	12.7
Processed fuels and lubricants	71.3	11.3
Containers	120.1	4.2
Supplies	113.7	21.0
Crude materials for further processing	95.9	100.0
Foodstuffs and feedstuffs	106.0	43.8
Crude nonfood materials	85.5	56.2

**Coverage**—The coverage of the PPI differs from the CPI (compare tables 4 and 5). Producer price indexes do not reflect changes in prices for services, housing and used cars, all of which are in the consumer price index. Producer price indexes measure changes in capital equipment and materials purchased by businesses but not by consumers. In addition, for the most part, the PPI is not available on a regional basis.

In the preparation of stage-of-processing price indexes, products are categorized by degree of fabrication—finished goods, intermediate materials, supplies and components, and crude materials for further processing. Finished goods are commodities that are ready for sale to final user, whether it is the consumer or a business. Intermediate materials, supplies and components

are commodities that have been processed but require further processing. Crude materials are products entering the market for the first time.

A fixed-weight procedure is used in calculating the PPI. Weights are based on the total net selling value of commodities flowing into primary markets. They are based on values of shipments in the 1982 economic censuses.

**Uses and limitations**—The PPI is often interpreted as an indicator of inflation, with the stage-of-processing framework supposedly facilitating the analysis of the inflation transmission process. For example, the news media treat movements in the PPI as predictors of future movements in the CPI. Generally, however, the coverage of the CPI and the PPI differ so much

that the relationship between them is tenuous.<sup>18</sup> For example, the PPI includes no services, while services receive a weight of about one-half in the CPI. In addition, the PPI excludes prices of imported goods which are included in the CPI.

The PPI index is used as a deflator for certain economic time series to obtain estimates of physical volume. These series relate to specific producer activities like inventories, sales, shipments and capital equipment purchases. According to the Department of Labor, the PPI is used in the private sector for industry analyses since it is the only index available that is consistent with the Census Bureau's Standard Industrial Classification (SIC) code. It is also used as an escalator in sales contracts.

**Evaluation**—The coverage of the PPI is even more limited than that of the CPI. It does not cover retail transactions or services; instead, it covers only newly produced goods and captures only the price of the first transaction. The chief defect of the PPI, according to the Department of Labor, is that it has been formulated in an *ad hoc* fashion, not corresponding to any underlying theoretical construct.<sup>19</sup> Although this theoretical deficiency has been corrected to some extent, since the PPI focuses on prices paid by producers of goods, it still is unclear whose well-being is really being measured with the PPI.<sup>20</sup>

### *The GNP Implicit Price Deflator*

The most general measure of prices for the U.S. economy is the GNP implicit price deflator. Included are the prices of consumption, investment, government services and net exports. In contrast to the CPI and the PPI, it is released quarterly; these quarterly data are revised monthly, however, as information becomes available.

In general, the procedure for obtaining the GNP deflator is as follows:

- (1) divide detailed components of current dollar GNP by the price index corresponding to the component of spending;
- (2) sum these deflated spending components to obtain an estimate of constant dollar, or real, GNP; then
- (3) divide the estimate of current dollar GNP by the estimate of real GNP to obtain the estimate of the GNP implicit price deflator.

The price indexes are obtained from many sources, including the Bureau of Labor Statistics, Census Bureau, Department of Agriculture and the Interstate Commerce Commission. The implicit deflator that results from the procedure described above is a weighted average of the component price indexes, where the weighting is determined by the composition of constant-dollar GNP. Since this composition changes from one period to the next, movements in the implicit price deflator reflect changes in GNP composition as well as prices.<sup>21</sup>

To avoid problems associated with changing GNP composition, the Commerce Department also prepares fixed-weight price indexes for GNP and its components; these reflect price changes alone. Currently, the weights used for the fixed-weight price indexes are based on the composition of output in 1982 (see table 6).

**History**—The mobilization for World War II and its aftermath was primarily responsible for the development of the GNP accounts. As Ruggles points out, "The central questions posed by the war were how much defense output could be produced and what impact defense production would have upon the economy as a whole."<sup>22</sup> Concern with real output meant that deflators had to be developed. The GNP deflator, as it is currently known, was initially published in 1951, although there were implicit measures of GNP prices as early as 1942.

<sup>18</sup>Coverage of the PPI differs substantially from that for the CPI. The relative importance (weighting) of various components in 1988 are as follows:

	Consumer prices	Producer prices		
		Finished goods	Intermediate materials	Crude materials
Food	16.2%	25.8%	5.2%	43.8%
Energy	7.3	8.8	11.4	36.9
Less food and energy	76.5	65.3	83.4	19.3
Services	50.8	0.0	0.0	0.0
Commodities	25.7	65.3	83.4	19.3

Moore (1983), pp. 172-73, concludes that the value of the PPI in predicting the CPI is poor.

<sup>19</sup>Bureau of Labor Statistics (1982), p. 51.

<sup>20</sup>See Bureau of Labor Statistics (1986) for discussion of theoretical considerations.

<sup>21</sup>For an example illustrating the effect of changing GNP composition, see Bureau of Economic Analysis (1985), p. 6. It concludes that the GNP implicit deflator "can give misleading signals of price change, and therefore its use as a measure of price change should be avoided."

<sup>22</sup>Ruggles (1983), p. 17.

**Table 6**  
**GNP Implicit Price Deflators by Major Type of Product**

	1988 deflator (1982 = 1.00)	Constant dollar weight
GNP	1.217	100.0%
Goods	1.100	44.1
Personal consumption	1.144	32.8
Business investment	0.972	10.3
Federal purchases	0.960	2.4
State and local purchases	1.027	1.9
Net exports		-3.2
Exports	0.942	
Imports	0.956	
Services	1.335	46.4
Personal consumption	1.348	32.1
Federal purchases	1.241	5.5
State and local purchases	1.363	8.1
Net exports		0.7
Exports	1.212	
Imports	1.218	
Structures	1.182	9.5
Residential investment	1.196	4.8
Nonresidential investment	1.148	3.0
Federal purchases	1.218	0.3
State and local purchases	1.200	1.4

**Uses and limitations**—The GNP deflator was not designed as a price index, because it reflects changes in the composition of GNP, as well as prices. The fixed-weight deflator is designed as a measure of price change. The differences between the GNP deflator and the fixed-weight index can be significant over either short or long periods, if there are large changes in GNP composition.

GNP-based deflators are useful primarily to government policymakers and academicians because they provide a measure of price change for the economy as a whole. Foreign and domestic investors, as well as the general public, also find them of interest because they have been used as a measure of the success or failure of macroeconomic policy.

**Evaluation**—Of the three major U.S. price indexes, the GNP deflator has the broadest coverage: it covers all currently produced goods and services. Compared with our theoretical measure of well-being, the GNP price indexes are subject to the same criticism as were the CPI and the PPI because the prices of existing assets and financial assets are excluded.

However, the GNP price indexes include prices of newly produced tangible assets; if their prices and prices of existing assets move together, the GNP price index might contain reliable information about the prices of future consumption goods and services. Generally, however, the usefulness of the deflator to individuals in assessing changes in their well-being is questionable because the deflator reflects many prices that are of only marginal interest to the individual. Examples are business investment, government purchases and exports. The exclusion of financial and existing assets also indicates that the deflator is limited in coverage compared with the theoretical measure discussed above.

### *Summary and References*

The features associated with the major U.S. price indexes are summarized in table 7. For additional details on these indexes including their construction, the reader is referred to the *BLS Handbook of Methods* for the CPI and the PPI and the July 1987 *Survey of Current Business* for the GNP deflator. These also contain extensive references for even further detail.<sup>23</sup>

<sup>23</sup>Another useful reference, although dated, is Backman and

Gainsbrugh (1966).

**Table 7**  
**Measures of U.S. Prices**

	<u>Consumer Price Index</u>	<u>Producer Price Index</u>	<u>Implicit Price Deflator</u>
Basic description	Measure of price change for a fixed market basket of goods and services purchased by all urban consumers	Measure of average change in prices received in primary markets by producers of commodities in all stages of processing	Weighted average of the detailed price indexes used in the deflation of GNP, where weights are composition of constant-dollar output
Source	Bureau of Labor Statistics, U.S. Dept. of Labor	Bureau of Labor Statistics, U.S. Dept. of Labor	Bureau of Economic Analysis, U.S. Dept. of Commerce
Frequency	Monthly, released about the 20th day of the following month	Monthly, released about the 10th day of the following month	Quarterly, first estimate released about the 20th day of the following quarter
Publication	Summary data from the Consumer Price Index news release and <i>Monthly Labor Review</i>	Summary data from the Producer Price Index news release and <i>Monthly Labor Review</i>	Gross National Product news release and <i>Survey of Current Business</i>
Base year	1982-84 = 100	1982 = 100	1982 = 100
Weighting	Derived from Consumer Expenditure Survey for 1982-84	Derived from net selling value of all commodities. Weights based on 1982 economic censuses.	Composition of constant-dollar output in current period (fixed-weight deflators use composition of output in 1982)
Revisions	The not seasonally adjusted CPI is never revised. Seasonally adjusted CPI is revised each January.	Data for four months earlier are revised each month, and seasonally adjusted estimates are revised each January.	Each quarter's estimates are revised for two successive months and again for previous three years in July.
Historical data	Monthly to Jan. 1913	Monthly to Jan. 1890. Prior to 1978, called wholesale price index	Quarterly to 1946 and annually to 1929

## INFLATION MEASUREMENT AND MONETARY INFLATION

The discussion thus far has focused on the U.S. price indexes as measures of changes in the cost of maintaining an individual's level of well-being. Although policymakers are interested in movements in the general level of prices, they are also interested in the composition of the price change. In particular, policymakers

focus on that portion of inflation that is related to their actions in stabilizing economic activity. Most of the better-known measures of price change reflect both policy-induced inflation as well as relative price changes caused by sectoral shifts in supply or demand (for example, the effects of drought and supply cutbacks by oil cartels). Policymakers have to be able to identify the sources of price movements in order to control inflation. This involves formulating a causal definition of inflation and testing it empirically.

The particular definition chosen here is that inflation is a monetary phenomenon. To assess the usefulness of the price indexes to policy-makers, one must adopt a specific measure of monetary action. While several measures are available, only the monetary measure preferred by Friedman is examined here. The Friedman measure is the ratio of the M2 money stock relative to trend real GNP.<sup>24</sup> His choice of measure is based on the quantity theory of money as well as extensive empirical research.<sup>25</sup> The presumption is that M2 can be controlled by the monetary authority and that trend output changes only slowly in response to such factors as population change and the rate of productivity advance. Consequently, policy-induced inflation is related to the growth rate of M2.<sup>26</sup>

By examining the U.S. price indexes in comparison with the money-output measure, we are asking which index provides the best information about policy-induced inflation or disinflation. Since the money-output measure is an empirical generalization, one must continuously monitor its performance as a policy guide. Because the general level of price change reflects both temporary relative price movements and the effects of policy with a lag, the relationship between the indexes and the money-output measure must be scrutinized carefully.

### *U.S. Price Indexes and the Money-Output Measure*

The performance of each of the major U.S. price indexes in comparison with the money-output measure is summarized in figure 1. The causal definition of inflation indicates that the focus should be on general trends of different measures rather than year-to-year movements. A casual analysis of figure 1 suggests that, while there is generally a positive relationship between each price index and the money-output measure, these measures diverge considerably at times.

Recalling that these indexes include the influence of temporary factors, which might mask the movement of policy-induced inflation, two "special" indexes are charted in figure 2 along with the money-output measure. The fixed-

weight deflator was mentioned previously as a better measure of price change than the GNP deflator, although it includes the influence of temporary factors. The other measure charted in figure 2 is consumer prices excluding the prices of food and energy. This index is prepared by the Department of Labor, and some analysts have suggested that it could be used as a measure of policy-induced inflation.<sup>27</sup> Comparing figure 2 with figure 1, it is not immediately obvious that these special indexes provide better information to policymakers about their contribution to inflation.

Because there is a general similarity of upward movement in all of the indexes, it is not possible to discern if the relationship between a particular price measure and the money-output measure is superior to the others. Also, the figures do not allow for a presumed lag from money to prices. Friedman and other economists generally agree that money affects prices with a long, and possibly variable, lag.<sup>28</sup> These issues can be investigated by examining in detail the rates of change of the different measures. Using rates of change permits a more rigorous analysis of the strength of the relationship between an index and the money-output measure.

Table 8 summarizes the results of a correlation analysis. The rates of change of each price index were lagged behind the money-output measure from zero to four years. For the contemporaneous (no lag) and one-year lag, the correlation coefficients were not statistically significant from zero. When the money-output measure was lagged two or three years, the correlation coefficient was significant for all of the price measures. For the four-year lag, all coefficients were significant except for producer prices. The lagged effect of money to prices is clear, but whether the most highly correlated lagged relationship is two, three or four years is not. The *differences* in the significant correlation coefficients for a given price measure across the different lag lengths were not significant.

The question of whether one price measure is consistently related more closely with the money-output measure is not answered by this

<sup>24</sup>M2 includes mainly currency held by the nonbank public, demand deposits, other checkable deposits, money market deposit accounts and savings and small time deposits.

<sup>25</sup>Friedman and Schwartz (1963, 1982). See also Hallman, Porter and Small (1989).

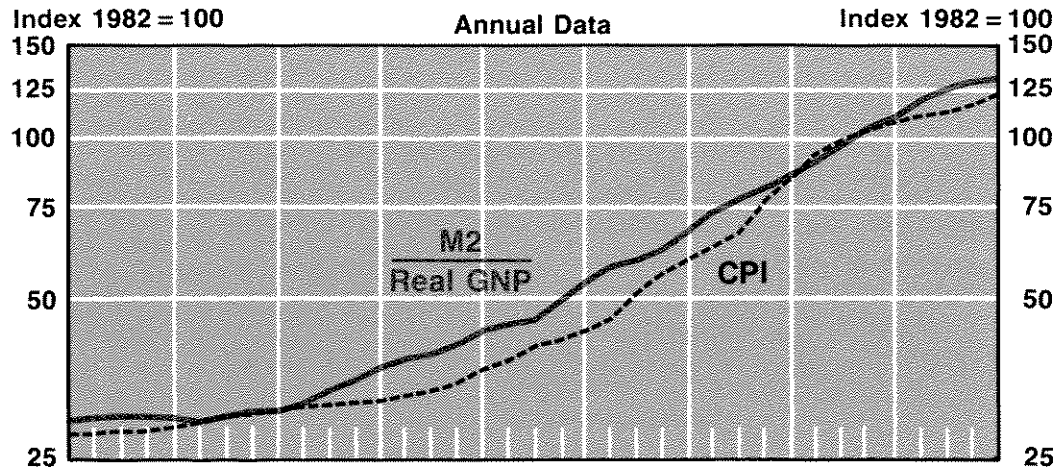
<sup>26</sup>This relationship is simple to understand because the velocity (turnover) of M2 has shown little trend over the years.

<sup>27</sup>Eckstein (1980) and Gordon (1987).

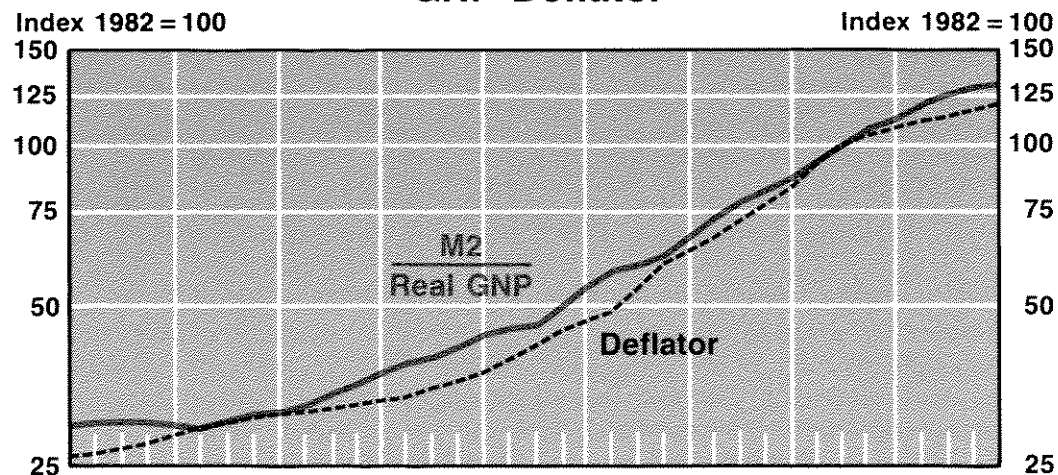
<sup>28</sup>Friedman and Schwartz (1982), and Friedman (1989).

# Figure 1 Money (M2) Relative to Trend Output and U.S. Price Measures

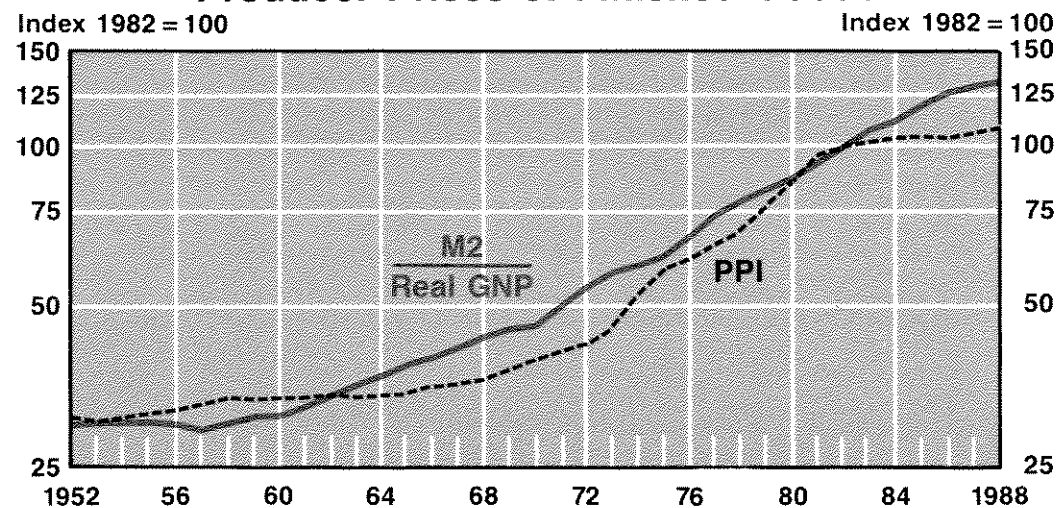
## Consumer Prices, All Items



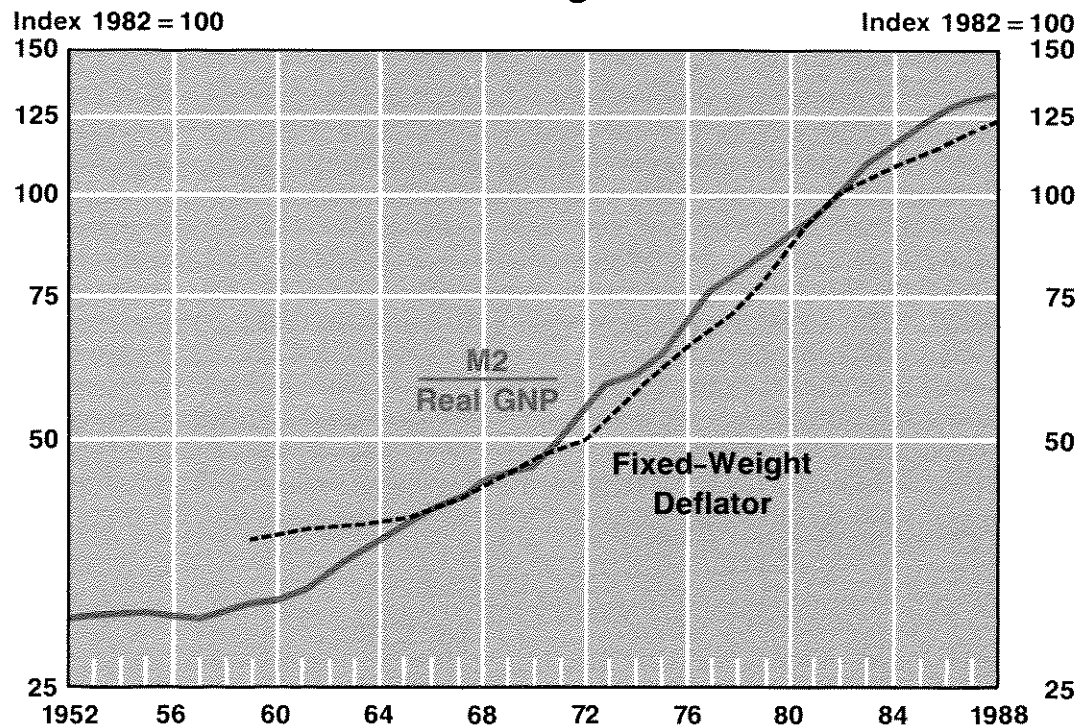
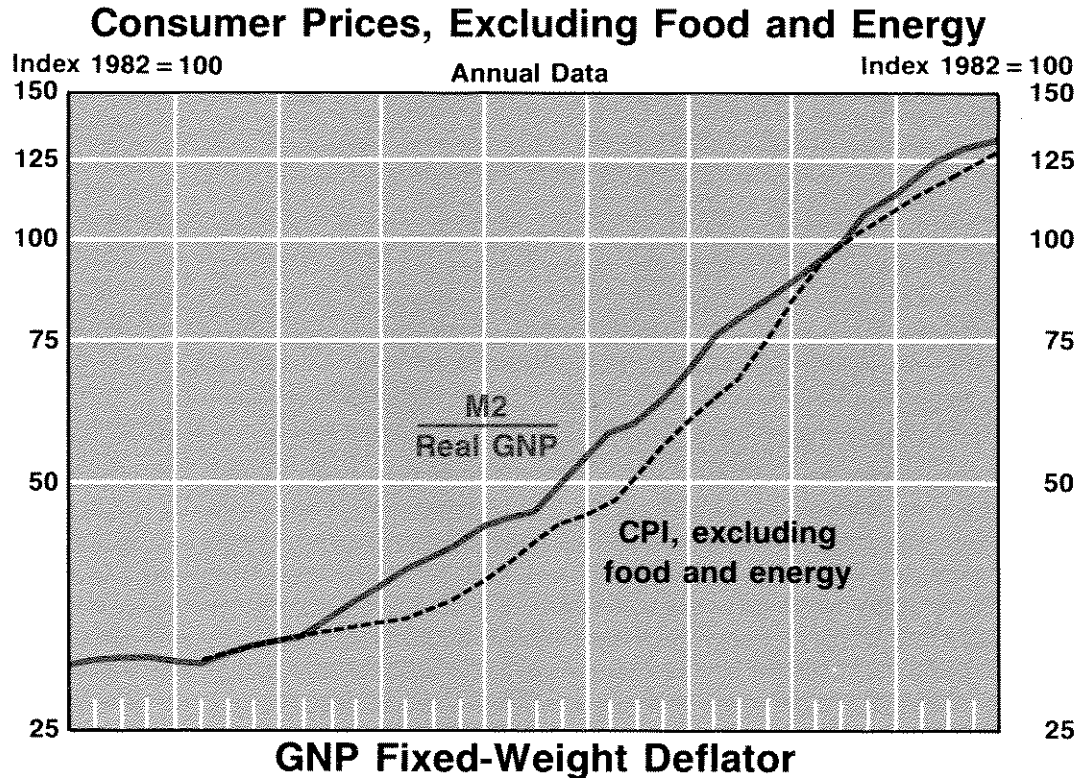
## GNP Deflator



## Producer Prices of Finished Goods



## Figure 2 Money (M2) Relative to Trend Output and Alternative Price Measures





**Table 8**  
**Correlation of Price Indexes with Money-Output Index (1960-88)**

Rates of change	Money (M2) minus trend growth of GNP				
	No lag	1-year lag	2-year lag	3-year lag	4-year lag
Consumer prices, all items	.10	.25	.54*	.62*	.50*
Consumer prices, excluding food and energy	.14	.19	.46*	.70*	.63*
GNP deflator	.27	.29	.48*	.57*	.52*
GNP fixed-weight deflator	.21	.31	.56*	.65*	.60*
Producer prices of finished goods	.09	.29	.56*	.52*	.32

\*Significant at 5 percent level

**Table 9**  
**Rates of Change of Money and U.S. Prices**

	Full period	Average rate of change subperiods			
	1952-88	1982-88	1972-82	1965-72	1952-65
Money (M2) relative to trend output	4.3%	5.0%	6.2%	4.8%	2.1%
Consumer prices, all items	4.2	3.5	8.7	4.1	1.3
Consumer prices, excluding food and energy	N.A.	4.3	8.1	4.3	N.A.
GNP deflator	4.4	3.3	8.0	4.7	2.2
GNP fixed-weight deflator	N.A.	3.7	7.1	3.3	N.A.
Producer prices of finished goods	3.6	1.3	9.1	2.9	0.8

analysis. For the three- and four-year lag, consumer prices, excluding food and energy, and the GNP fixed-weight deflator appear to be the most highly correlated, but the closeness of fit is not significantly different from that for the other measures for a given lag.

Another way of examining these alternative price measures is to compare their trends for the 1952-88 period. Table 9 summarizes the movements of the same price measures shown in table 8. The subperiods are the same as in table 2 and conform with periods of marked

and sustained change in the growth of money relative to output. For the full period, 1952-88, all of the price measures for which data are available conform closely with the rate of change of the money-output measure. The possible exception is producer prices, which increased at a 3.6 percent average rate compared with a 4.3 percent rate for money-output.

An examination of rates of change indicates that, without exception, accelerations and decelerations in the money-output measure were accompanied by movements in the same

direction for each of the price measures. The rates of change of the price measures were more closely associated with the money-output measure in the two earliest periods than in the 1972-88 period. This generally reflects volatile movements in the prices of energy and agricultural products during the 1970s and 1980s. These sharp movements in relative prices can produce rates of change that differ for periods as long as 10 years from those for the money-output measure. They tend to cancel over longer periods, however, as shown by the rates of change for the full period.

Comparing each price measure with the money-output measure does not indicate a clear superiority of one measure over another, although producer prices have shown the largest average absolute deviation. For the subperiods chosen, there is not enough information to draw a definite conclusion. For each of the subperiods in the 1965-88 period, however, the consumer price measure excluding food and energy appears to conform more closely to movements in the money-output measure than does consumer prices for all items. Similarly, the fixed-weight deflator has accompanied movements in the money-output measure more closely than the GNP deflator during the 1972-88 period.

## CONCLUSIONS

Because inflation is a vital concern in making economic decisions, it is important to understand the price indexes used to measure it. Consumers, businesses and governments need to understand changes in price trends so they can make rational economic decisions. Policymakers, in particular, must be keenly aware of price trends so they can take appropriate actions. This article described these indexes and analyzed them to determine what they tell us about inflation. The indexes were examined from two perspectives: that of the individual, attempting to maximize his well-being, and that of the policymaker, attempting to control inflation.

For the United States, there are three major price indexes: the consumer price index, the producer price index and the GNP implicit price deflator. To measure and analyze inflation properly, more information is required than these conventional price indexes provide. The price system encompasses many more markets than those for currently produced goods and services. A theoretical measure of price change

would include, for example, prices of common stock, real estate, land, etc. Although no such broad measure of price change is available, the concept is useful for decisionmakers.

A broad theoretical price measure should be of interest to policymakers, but their focus is generally on the causes of inflation. In particular, their interest is in discovering the composition of price change and identifying the portion associated with policy actions. Using the Friedman monetary measure of money relative to trend output as a standard for comparison, we found that, with the possible exception of producer prices, all of the well-known measures of price change were closely related to his measure when examined over the full period since 1952. The lag between money growth and inflation was confirmed, although we could not be precise about the length of the lag. Although less closely related than over the full period, all the price measures that were examined moved with marked and sustained changes in the growth rate of money relative to output. No price measure, however, performed consistently better than another from one period to the next.

## REFERENCES

- Alchian, Armen A. *Economic Forces at Work* (Liberty Press, 1977).
- Alchian, Armen A., and Benjamin Klein. "On a Correct Measure of Inflation," *Journal of Money, Credit and Banking* (February 1973), pp. 173-91.
- Allen, Roy G. D. *Index Numbers in Theory and Practice* (Aldine Publishing Company, 1975).
- Backman, Jules, and Martin R. Gainsbrugh. *Inflation and the Price Indexes*, Materials Submitted to the Subcommittee on Economic Statistics of the Joint Economic Committee of the Congress of the United States (U.S. Government Printing Office, July 1966).
- Bronfenbrenner, Martin. "Inflation and Deflation," *International Encyclopedia of the Social Sciences*, Vol. 7 (Macmillan and The Free Press, 1968), pp. 289-300.
- Bureau of Economic Analysis, U.S. Department of Commerce. *Survey of Current Business* (GPO, May 1985 and July 1987).
- Bureau of Labor Statistics, U.S. Department of Labor. *BLS Handbook of Methods*, Bulletin 2285 (GPO, April 1988).
- \_\_\_\_\_. *Producer Price Measurement: Concepts and Methods* (June 1986).
- \_\_\_\_\_. *BLS Handbook of Methods*, Volume 1, Bulletin 2134-1 (GPO, December 1982).
- Diewert, W. Erwin. *The Early History of Price Index Research*, Working Paper No. 2713 (National Bureau of Economic Research, September 1988).
- Eckstein, Otto. *Tax Policy and Core Inflation*, A Study Prepared for the Use of the Joint Economic Committee of the Congress of the United States (GPO, April 10, 1980).

Friedman, Milton. "Whither Inflation?" *Wall Street Journal*, July 5, 1989.

\_\_\_\_\_. "What Price Guideposts?" in George P. Schultz and Robert Z. Aliber, eds., *Guidelines, Informal Controls, and the Market Place* (University of Chicago Press, 1966), pp. 17-39.

Friedman, Milton, and Anna J. Schwartz. *Monetary Trends in the United States and the United Kingdom* (University of Chicago Press, 1982).

\_\_\_\_\_. *A Monetary History of the United States, 1867-1960* (Princeton University Press, 1963).

Frisch, Helmut. *Theories of Inflation* (Cambridge University Press, 1983).

Gordon, Robert J. *Macroeconomics*, 4th ed. (Little, Brown and Co., 1987).

Hallman, Jeffrey J., Richard D. Porter, and David H. Small. *M2 Per Unit of Potential GNP as an Anchor for the Price Level*, Staff Study 157 (Board of Governors of the Federal Reserve System, April 1989).

Moore, Geoffrey H. *Business Cycles, Inflation, and Forecasting*, 2nd ed. (Ballinger, 1983).

Ruggles, Richard. "The United States National Income Accounts, 1947-1977: Their Conceptual Basis and Evolution," in Murray F. Foss, ed., *The U.S. National Income and Product Accounts: Selected Topics* (The University of Chicago Press, 1983), pp. 15-105.

Triplett, Jack E. "The Measurement of Inflation: A Survey of Research on the Accuracy of Price Indexes," in Paul H. Earl, ed., *Analysis of Inflation* (Lexington, 1975), pp. 19-82.

Webb, Roy H., and Rob Willems. "Macroeconomic Price Indexes," Federal Reserve Bank of Richmond *Economic Review* (July/August 1989), pp. 22-32.