

INTERPRETING EARLY WARNINGS OF INFLATION:

A STUDY OF
STATISTICAL INDICATORS

A CBO Technical Analysis Paper

September 1977



CONGRESSIONAL BUDGET OFFICE
U.S. CONGRESS
WASHINGTON, D.C.

**INTERPRETING EARLY WARNINGS OF INFLATION:
A Study of Statistical Indicators**

**The Congress of the United States
Congressional Budget Office**

**For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402
Stock No. 052-070-04222-2**

PREFACE

Identifying inflationary pressures before they are reflected in prices paid by consumers provides valuable information for monitoring the economy and making future economic policy decisions. Interpreting Early Warnings of Inflation presents some relationships between consumer price changes and early indicators of price pressure in markets for raw materials, labor, and finished goods. These relationships should provide a useful advance warning of probably changes in the rate of inflation.

This paper is one of several Congressional Budget Office studies concerning inflation in the economy and possible policies for controlling it. It was prepared by Mary Kay Plantes and Frank de Leeuw at the request of the Senate Committee on the Budget. Antoinette Gibbons capably performed the data adjustments and statistical estimation. Joel Popkin of the National Bureau of Economic Research provided helpful comments. The manuscript was edited by Patricia H. Johnston, and the various drafts were typed by Dorothy J. Kornegay. In keeping with the Congressional Budget Office's mandate to provide nonpartisan analysis of policy options, the report contains no recommendations.

Alice M. Rivlin
Director

TABLE OF CONTENTS

	<u>Page</u>
Preface.....	iii
Chapter I. Introduction.....	1
Chapter II. A Theoretical Framework.....	3
Chapter III. Main Empirical Results.....	7
Disaggregating the Consumer Price Index.....	7
Indicators of the "Abbreviated CPI".....	11
Indicators of Food Price Changes.....	17
Chapter IV. Comparison With Some Alternatives.....	21
Chapter V. Conclusion: Using the Early Indicators.....	25

TABLES

	<u>Page</u>
1. Consumer Price Index: Relative Importance of Selected Items, December 1975.....	9
2. Decomposition of Fitted Change, Abbreviated CPI, 1976.....	26

FIGURES

1. Comparison of Six-Month Changes in Abbreviated CPI and Total CPI.....	10
2. Comparison of Fitted to Actual Values of Six-Month Change, Compounded Annually, in the Abbreviated CPI.....	13

Ultimately, the rate of inflation in an economy depends on factors causing changes in money demands (such as increases in the quantity of money), factors causing changes in market structure (such as the formation of cartels), and factors causing changes in potential supplies (such as growth in productivity). There is, however, an uncertain and often long transmission process from these ultimate determinants through demand and supply conditions in thousands of interrelated markets to the overall inflation rate faced by consumers. For predicting the course of inflation six months to a year ahead, it is more useful to focus on the early and intermediate stages of the transmission process than it is to focus on the ultimate determinants. If prices paid by consumers are going to accelerate or slow down in the next six months to a year, then there are probably already early signals of the coming change in markets for crude materials, labor, or even finished goods themselves.

The approach of this study is to relate the rate of inflation in consumer prices over six-month intervals since 1949 to early indicators of tightening in individual markets. Indicators tested include crude materials prices, commodity futures prices, wage rates, unit labor costs, capacity utilization at various stages of production, unemployment and other measures of labor market disequilibrium, inventory/sales ratios, and unfilled orders. The second chapter of this paper explains this approach in terms of a commonly used theoretical framework for understanding wage and price movements.

The third chapter demonstrates that over the last 30 years in the United States, some indicators have been much more closely related than others to consumer price changes. For explaining changes in an "abbreviated Consumer Price Index" that excludes certain highly volatile and unpredictable items (food, energy, mortgage interest rates, and used cars), the most successful set of indicators, as measured by the goodness of fit of a regression equation, consists of:

- (1) changes in an index of crude materials prices six months earlier,
- (2) an index of help-wanted advertising 12 months earlier, and
- (3) the ratio of inventories to sales both six and 12 months earlier.

The user of this early indicator approach would do well, however, not to confine attention only to these three variables but to look at a range of other indicators that are also significantly related to inflation. The third chapter of this paper presents regression results for a number of alternative sets of indicators.

The early indicator approach may be compared with other single-equation models relating inflation to indirect measures of price expectations, such as interest rates, or to past rates of inflation. The fourth chapter of the paper presents some comparisons with other single-equation approaches. Direct comparison of the early indicator approach with full-scale macroeconomic models is too complex for this paper.

The final chapter discusses the contribution of different indicators to inflation both for the entire 1949-1976 period and for the last year and a half.

Aggregate wage relationships and aggregate price equations are the focus of much recent research about inflation. Combining an aggregate wage relationship and an aggregate price relationship into a single relationship explaining price changes provides a simple framework for the present study. Tobin, among others, set out such a framework in his introduction to the Conference on the Econometrics of Price Determination held at the Federal Reserve Board in 1971. ^{1/} The paragraphs below draw on Tobin's exposition.

According to this framework, aggregate wage changes are explained by labor market pressures and by past and expected price changes. Aggregate price changes depend on changes in the prices of inputs (including wage rates), on changes in productivity, and on demand pressures in goods markets. Eliminating wage changes in the second relationship by substituting the explanatory variables from the first relationship leads to the following determinants of inflation:

- (1) labor market pressures,
- (2) past and expected price changes,
- (3) prices of inputs other than labor,
- (4) productivity changes, and
- (5) demand pressures in product markets.

Labor market pressures are usually represented by an unemployment rate. Unemployment is, however, only one of a set of

^{1/} James Tobin, The Econometrics of Price Determination (Board of Governors of the Federal Reserve System and Social Science Research Council, June 1972), pp. 5-6.

labor market pressure variables that have been found useful in business cycle analysis. Help-wanted advertising, initial claims for unemployment insurance, and average weekly hours are some other useful indicators. In most recent empirical work, it is not the aggregate unemployment rate that is used, but rather an unemployment measure that adjusts for changes in the age-sex composition of the labor force in recent years. Furthermore, unemployment measures are usually found to have a nonlinear effect on wage changes, the impact of a one percentage point change in unemployment being greater when unemployment is low than when unemployment is high.

The strength of past and expected price increases in determining current rates of inflation has been a key theoretical issue in price research. If past and expected inflation is an important enough determinant, then tolerating a higher rate of inflation can buy only a temporary rather than a permanent improvement in unemployment. Since direct measures of expected price changes are not readily available, the issue is very difficult to settle empirically. For the purpose of the present study, it is worth stressing that past rates of inflation are an important element in wage determination not only because of expectations that employers and workers may hold but also because of automatic cost-of-living adjustments in many labor contracts and because of the catching-up with past price increases that is a feature of many multiyear labor negotiations.

If past price changes are highly important in the determination of wages, then there should be long lags in the reduced-form price relationship sketched out above. An important role for past price changes thus increases the value and plausibility of an early-warning indicator approach to projecting inflation rates.

Lagged inflation rates are not the only determinants of expected inflation. Advocates of the so-called "rational expectations" hypothesis about economic behavior have made much of the implausible implications of supposing that past rates of price changes are the only determinants of price expectations. ^{2/} The indicator approach in this paper does not make use of any other

^{2/} For discussions of the information of inflationary expectations, see D.E.W. Parkin and J.M. Laidler, "Inflation: A Survey," Economic Journal (December 1975), pp 741-809, and T.J. Sargeant and N. Wallace, "Rational Expectations and the Dynamics of Hyperinflation," International Economic Review (1973).

measure of expectations, since no direct measure is available over a long time-span. It does, however, make significant use of recent errors in predicting inflation as a factor in projecting inflation into the future. Changing expectations is probably one of the more important "missing" variables represented by this use of recent errors.

Input prices (other than labor costs) are represented in the present study by crude materials prices. Prices of capital goods, the major input other than labor and materials, are not thought to have sufficient influence on the inflation rate over a six-month to one-year horizon to warrant inclusion in this study. Like inflation expectations, their influence may be represented in part by recent errors in inflation prediction.

The use of a crude materials price variable raises the question of why labor market pressures are represented by a quantity measure (for example, unemployment rates, help-wanted advertising, etc.) while pressures in materials markets are represented by a price variable. When activity in a market begins to approach a supply ceiling or constraint, should the earliest warning come in the form of a quantity indicator or price indicator?

It seems likely that in markets where prices are contracted for long periods and after extensive bargaining, a quantity such as utilization, unemployment, or excess capacity would respond to demand pressures earlier than would a price indicator. In contrast, in a market in which prices fluctuate continually to balance supply and demand or where speculators pay a lot of attention to anticipating future price pressures, the first sign of an impending tight market situation might well appear in a price measure rather than in a utilization measure. As the next section of this paper will document, there is some indication that labor markets follow the first pattern and markets for crude materials often follow the second in their foreshadowing of movements in consumer prices.

Productivity, like the cost of capital goods, probably does not have an easily measurable impact on price changes over a six-month to one-year horizon. Most macroeconomic models make use of a long-term average of productivity changes in explaining price movements. The empirical work underlying this study did not uncover any role for current or recent productivity movements in explaining consumer price inflation.

Demand pressures in product markets are the final category of influence in the reduced-form relationship derived earlier. Possible measures include capacity utilization in finished goods industries, the level of unfilled orders, or the ratio of inventories to sales. Past empirical studies have shown mixed results for variables of this kind. As the next section of this paper will document, the present study does find a significant role for inventory/sales ratios.

The framework just described does not take account of any direct government measures that affect prices, such as taxes, payroll taxes, and wage and price guideposts or controls (in contrast to indirect measures such as general monetary and fiscal policy). In the present study, measures of changes in excise taxes or payroll taxes did not improve the explanation of past inflation. A simple "dummy variable" representing periods of guideposts or controls, however, does play a significant role in the results presented in the next section.

DISAGGREGATING THE CONSUMER PRICE INDEX

The framework described in the previous chapter does not apply equally well to all consumer prices. It does not apply to markets in which special developments, such as the formation of an international cartel, can suddenly swamp all other price influences. Nor does it apply to markets in which trading in existing assets, whether financial or real, has a more decisive impact on prices than changes in current costs of production.

For these reasons, the first step in the empirical part of the present study was to exclude from the Consumer Price Index certain components which did not seem to fit into the underlying framework. These components were:

- (1) energy items,
- (2) mortgage interest costs, and
- (3) used cars.

By and large, there is only a very weak relationship between current developments in the overall economy and movements in these price indexes. It is probably better to attempt to forecast these components separately, using whatever special information is available, than to attempt to bring them into the main framework of this study.

Food prices were also excluded from the initial analysis. While the framework used in this study essentially applies to consumer food prices, lags between price indicators and final product prices are much shorter for food than for most other goods and services. Among the reasons for this difference are

the perishability of food and the importance of prices as a short-run market clearing device in food markets. 1/ This section contains some results for consumer food prices which imply that the use of the early indicator approach provides much less advance warning of food price inflation than of inflation in other sectors.

The remainder of the Consumer Price Index can be divided into the following seven categories:

- (1) durable commodities (except used cars),
- (2) nondurable commodities (except food and energy),
- (3) household services (except mortgage interest and utilities),
- (4) rent,
- (5) transportation services,
- (6) medical services, and
- (7) other services.

This analysis has dealt with an aggregate of these seven categories rather than each one separately. The relative importance of these seven categories and of the four special ones are shown in Table 1.

1/ In Okun's or Hicks' terminology, food materials prices are determined in "auction" markets whereas prices of most other goods are determined in "sticky-price" markets in which prices are slower to react to changes in factor market and product market pressures.

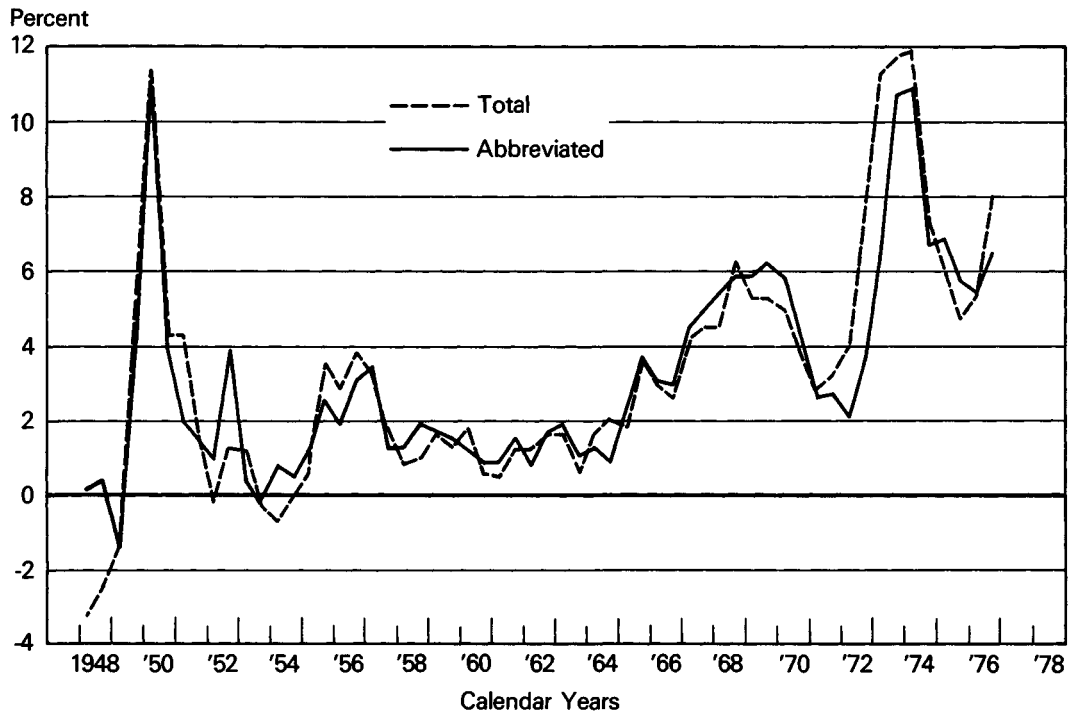
TABLE 1. CONSUMER PRICE INDEX: RELATIVE IMPORTANCE OF SELECTED ITEMS, DECEMBER 1975

Item	Relative Importance
Special Items:	
Food	24.7
Energy	7.3
Interest	4.4
Used cars	<u>2.0</u>
Subtotal	38.4
Abbreviated CPI:	
Durable commodities	13.8
Nondurable commodities	18.3
Rent	4.5
Household services	8.9
Transportation services	5.0
Medical services	5.6
Other services	<u>5.5</u>
Subtotal	61.6
TOTAL	100.6

The "abbreviated CPI," or the Consumer Price Index excluding food, energy, mortgage interest, and used cars, has had four periods of accelerating inflation since 1948. Figure 1 depicts changes in the abbreviated CPI and the total CPI in the form of nonoverlapping six-month changes, compounded at annual rates. The two largest accelerations were in 1973-1974 and at the beginning of the Korean War. The gradual acceleration of inflation in the late 1960s was smaller while the rise in 1956-1957 was only a bit larger than minor variations throughout the period.

Figure 1

COMPARISON OF SIX-MONTH CHANGES IN ABBREVIATED CPI AND TOTAL CPI



The use of nonoverlapping six-month periods is designed to minimize estimation difficulties due to the choice of time intervals. Use of intervals shorter than six months is likely to include so much random noise in the dependent variable that it would be difficult to detect underlying influences. Use of periods much longer than six months is likely to smooth over some of the actual accelerations and decelerations in price movements. Finally, use of overlapping six- or 12-month changes avoids both of the first two dangers but produces a time-series with such a high degree of autocorrelation that statistical analysis is extremely difficult.

INDICATORS OF THE "ABBREVIATED CPI"

In the labor market, movements in quantity indicators such as unemployment or help-wanted advertising provide a better advance indication of inflation than wage measures such as hourly compensation. Numerous empirical wage models in which the lagged unemployment rate is an important determinant of wage changes reflect this market characteristic. Chapter II suggested why quantity indicators might be more sensitive to demand pressures in labor markets.

In materials markets, in contrast, an index of wholesale prices of crude materials (excluding food) leads the Korean and 1973 accelerations in the Consumer Price Index by wider margins than a utilization measure such as the Federal Reserve capacity utilization index for materials. Furthermore, the Federal Reserve utilization index has reached high levels in a number of other periods when crude materials prices did not begin to rise substantially and when there was no subsequent acceleration in consumer prices. One reason for the superiority of the prices indicator is that it includes goods whose prices are set in world markets, while utilization series reflect the situation in domestic markets alone.

The most useful equation explaining six-month changes in the abbreviated Consumer Price Index appears to be the following:

$$\begin{aligned} (1) \quad \Delta \text{CPI} &= 6.30 + 4.78 \text{ HELPWANTED } (t-2) \\ &\quad (3.77) \quad (1.22) \\ &+ 0.12 \Delta \text{WPI}_H (t-1) + 0.03 \Delta \text{WPI}_L (t-1) \\ &\quad (0.03) \quad (0.03) \\ &- 11.79 \text{ INV/SALES } (t-1) + 7.02 \text{ INV/SALES } (t-2) \\ &\quad (4.21) \quad (2.97) \\ &+ 0.99 \text{ CONTROLS } (t) + 0.47 \text{ ERROR } (t-1) \\ &\quad (0.41) \end{aligned}$$

Time span: 1949, 2nd half to
1975, 2nd half

$$\begin{aligned} \bar{R}^2 &= 0.72 \\ \text{DW} &= 1.79 \\ \text{SE} &= 1.32 \end{aligned}$$

Standard errors are in parentheses.

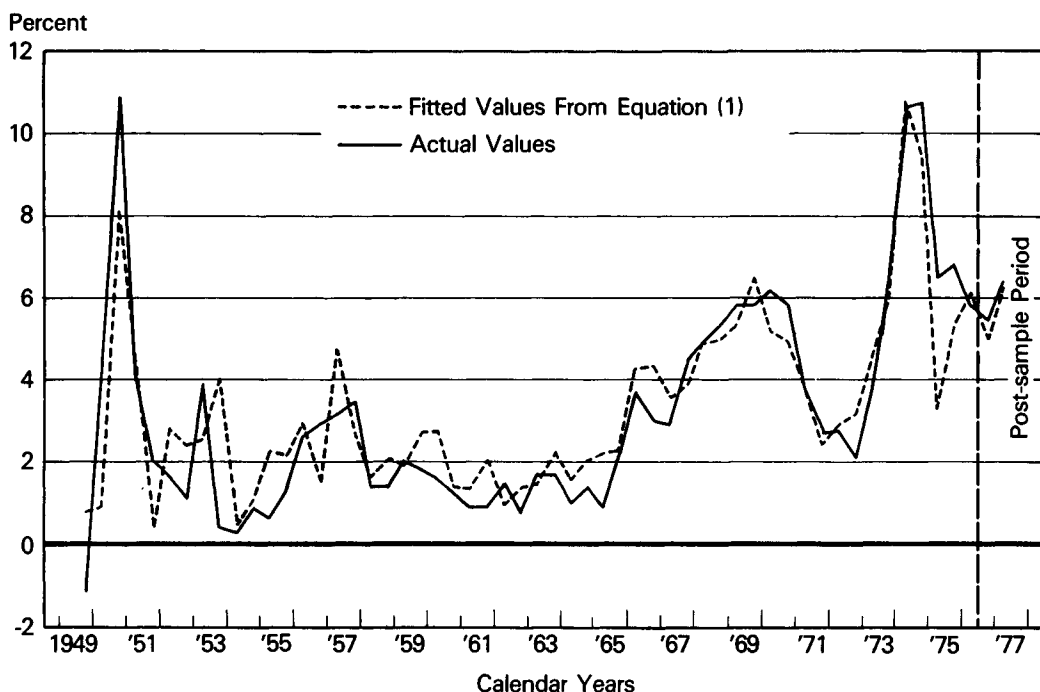
where

Δ CPI	=	percentage change of abbreviated CPI (at annual rates) over six-month spans. Mean value = 3.17.
HELPWANTED	=	index of help-wanted advertising divided by the civilian labor force, <u>lagged one year</u> . Mean value = 0.74.
Δ WPI _H , Δ WPI _L	=	percentage change of Wholesale Price Index (WPI) for crude materials excluding food (at annual rates) over six-month spans, <u>lagged six months</u> . To allow for a nonlinear relation, the variable is divided into high and low series. Δ WPI _H is the percentage change minus 10 when this difference is positive and zero otherwise. Δ WPI _L is the percentage change minus 10 when this difference is negative and zero otherwise. Mean values = 2.75 for Δ WPI _H and -8.50 for Δ WPI _L .
INV/SALES	=	ratio of book value inventories to sales, covering manufacturing and trade. INV/SALES (t-1) is <u>lagged six months</u> and INV/SALES (t-2) is <u>lagged one year</u> . Mean values of INV/SALES (t-1) = 1.538.
CONTROLS	=	dummy variable for Korean War, guide-posts, and Phase I-IV price controls. Equals -1.0 during these periods, zero otherwise.
ERROR	=	regression residual in previous six-month period.

Figure 2 compares actual movements in the abbreviated CPI with fitted values according to this equation.

Figure 2

COMPARISON OF FITTED TO ACTUAL VALUES OF THE SIX-MONTH CHANGE, COMPOUNDED ANNUALLY, IN THE ABBREVIATED CPI



Crude Materials Prices

The separation of the change in crude materials prices into two variables, one measuring the excess (if any) over a 10 percent rate of crude materials inflation and the other measuring the reduction (if any) below 10 percent, is a simple way of representing what evidence suggests is a highly nonlinear relationship. If materials prices are accelerating at a 10 percent rate, an additional 10 percentage point rise in materials prices will cause the abbreviated CPI inflation rate to rise by approximately one percentage point after six months. However, accelerations in materials prices when the initial rate is under 10 percent have practically no effect on the abbreviated CPI, according to equation (1).

If crude materials prices are simply a component of costs, it is hard to see why they should have a nonlinear relationship to consumer prices. If rapid increases in the crude materials index also represent the development of inflationary expectations, however, then a nonlinear effect is easier to understand.

Help-Wanted Advertising

The index of help-wanted advertising is divided by the labor force, which has the effect of eliminating at least some of the trend in the index over time. It is the most successful of a number of indicators of labor market tightness, and enters the equation with a one-year lag. The coefficient implies that at the present size of the labor force a 0.1 rise in the level of this ratio causes about a 0.5 percentage point increase in the abbreviated CPI. An alternative equation using the unemployment rate for males in the 25 to 54 age group gave these results:

$$\begin{aligned}
 (2) \quad \Delta \text{CPI} &= 11.52 - 1.08 \text{ UNEM}_L(t-2) \\
 &\quad (4.39) \quad (0.43) \\
 &+ 0.13 \Delta \text{WPI}_H(t-1) + 0.04 \Delta \text{WPI}_L(t-1) \\
 &\quad (0.04) \quad (0.04) \\
 &- 8.82 \text{ INV/SALES}(t-1) + 3.5 \text{ INV/SALES}(t-2) \\
 &\quad (4.45) \quad (3.13) \\
 &+ 0.79 \text{ CONTROLS}(t) + 0.48 \text{ ERROR}(t-1) \\
 &\quad (0.44)
 \end{aligned}$$

Time span: 1949, 2nd half of
1975, 2nd half

$$\begin{aligned}
 \bar{R}^2 &= 0.70 \\
 \text{DW} &= 1.67 \\
 \text{SE} &= 1.44 \\
 \text{RHO} &= 0.48
 \end{aligned}$$

where

UNEM_L = a six-month average unemployment rate for males, aged 25 to 54, less 4 percent, when this difference is negative; zero otherwise. Lagged one year.

Dividing the prime-age male unemployment series into a high and low series, one measuring the excess (if any) over a 4 percent rate and the other the reduction (if any) below 4 percent, suggests a nonlinear relationship between price inflation and this measure of labor market tightness. The coefficient on the high unemployment series was not significant, and was excluded from the final estimation. A 1 percent fall in prime-age male unemployment starting from a 4 percent rate or below is associated with a 1.08 percent rise in the abbreviated Consumer Price Index after one year.

Too much should not be made of the higher \bar{R}^2 in equation (1) using the help-wanted index than in equation (2) using unemployment. Even after dividing by the labor force, the help-wanted advertising index has an upward trend that may be spuriously correlated with the upward trend in abbreviated CPI inflation.

Inventory/Sales Ratio

The ratio of inventories to sales in manufacturing and trade enters for both the immediately preceding six-month period and for the six-month period before that. The opposite signs for the two coefficients in the equation are best interpreted as saying that both a high level of this ratio and an increase in the ratio cause--after a lag--a reduction in the rate of inflation. The size of the coefficients in equation (1) implies that a ratio which is 0.1 higher produces an inflation rate 1.2 percentage points lower after six months, of which 0.5 percentage points remains in effect after a year.

Regression equations for subperiods of the entire post-World War II period indicate that the inventory/sales ratio is a more significant predictor of inflation earlier in the postwar period than it has been in recent years. The principal contribution of this variable is in explaining why inflation did not continue at a high rate after the initial burst at the start of the Korean War. Labor markets were as tight then, by any quantity measure, as they have been at any time since World War II and yet the inflation rate was close to zero in 1952-1953. 2/ Equation (1)

2/ The effectiveness of controls, furthermore, declined during 1952, and controls were removed in early 1953 with little upsurge in inflation. Thus the low inflation rate is not explained, or not entirely explained, by controls.

implies that the recession in consumer goods in 1952 and its accompanying high inventory/sales ratio is an important part of the explanation. Other measures of product market tightness, such as unfilled orders or capacity utilization, did not indicate low inflation rates in this period and in general added less to the fit of equation (1) than inventory/sales ratios.

Controls or Guidelines

The variable representing price and wage controls or guidelines is very simple. During the intervals 1951: first half to 1952: second half, 1962: first half to 1965: second half, and 1971: second half to 1973: second half, it takes a value of minus 1. In all other six-month periods, it takes on a value of zero. On average, according to equation (1), controls or guidelines lowered the inflation rate by almost 1 percent.

As Chapter II pointed out, the use of the lagged equation error in helping to predict inflation is one way of representing the persistence of inflation due to inflationary expectations. Without the inclusion of the lagged residual, the estimated equation is as follows:

$$\begin{aligned}
 (3) \quad \Delta CPI &= 0.59 + 4.41 \text{ HELPWANTED} + 0.17 \Delta WPI_H (t-1) \\
 &\quad (5.87) \quad (0.97) \quad (0.03) \\
 &+ 0.05 \Delta WPI_L (t-1) - 7.82 \text{ INV/SALES} (t-1) \\
 &\quad (0.03) \quad (4.49) \\
 &+ 6.78 \text{ INV/SALES} (t-2) + 0.93 \text{ CONTROLS} (t) \\
 &\quad (3.39) \quad (0.47)
 \end{aligned}$$

Time span: 1949, 1st half to
1975, 2nd half

$$\begin{aligned}
 \bar{R}^2 &= 0.68 \\
 DW &= 1.05 \\
 SE &= 1.53
 \end{aligned}$$

The fit of equation (3) is not as good as equation (1), but the difference in standard error is probably smaller than might be expected in view of the heavy emphasis in recent discussions on expectations as a major factor in the persistence of inflation.

Other Variables

A number of other variables included in previous inflation studies were tried but rejected. One of them, changes in the ratio of federal excise taxes to GNP, was not significant in any of the equations in which it was tried. Change in the effective social security tax was a significant indicator but its coefficient was so small it did not warrant inclusion in the final equation. Finally, changes in a long-run productivity series did not prove significant; to the extent that the long-run growth in productivity is constant over time, the constant term is picking up its effect on price inflation.

INDICATORS OF FOOD PRICE CHANGES

For food, there are market indicators of price trends at three distinct stages preceding the retail level. Earliest is an index of commodity futures prices, related to retail food prices as follows:

$$(4) \quad \Delta pf = 3.75 + 0.101 \Delta Fut (t-2) \\ (0.83) \quad (0.041)$$

Time span: 1958, 1st half to
1975, 2nd half

$$\begin{aligned} R^2 &= 0.12 \\ DW &= 1.72 \\ SE &= 4.95 \end{aligned}$$

where

Δpf = percentage change in consumer food prices (at annual rates) over six-month spans. Mean value = 4.31.

ΔFut = percentage change over six-month spans (at annual rates) in futures price index of Commodity Research Bureau, lagged one year. ^{3/}

^{3/} The index was obtained from the Commodity Research Bureau. The index at period t represents the average price of futures contracts exercisable anytime within one year. Some nonfood items are included in the index, but it is predominantly composed of grain and livestock futures prices. The index is available back to 1957:1.

A much closer relationship, but one with a much shorter lag, exists between the crude foodstuffs component of the Wholesale Price Index and retail food prices as follows:

$$(5) \quad \Delta pf = 1.84 + 0.571 \Delta WPI_C \\ (0.54) \quad (0.062)$$

Time span: 1958, 1st half to
1975, 2nd half

$$\overline{R}^2 = 0.70 \\ DW = 2.39$$

$$SE = 2.89$$

where

ΔWPI_C = percentage change over six-month spans (at annual rates) in wholesale crude food prices, lagged two months.

Curiously, the relationship of the finished food component of the Wholesale Price Index to retail food prices is not as close as the relationship of crude, and the lag is even shorter:

$$(6) \quad \Delta pf = 3.07 + 0.229 \Delta WPI_f \\ (0.64) \quad (0.038)$$

Time span: 1958, 1st half to
1975, 2nd half

$$\overline{R}^2 = 0.50 \\ DW = 1.31 \\ SE = 3.75$$

where

ΔWPI_f = percentage change over six-month spans (at annual rates) in wholesale prices of finished foods, lagged one month.

There is not a terribly high degree of multicollinearity among these three early indicators of food price changes. Nor are any of them closely correlated with labor market conditions, which appear to have a weak but possibly significant relationship to

retail food price trends. For forecasting, therefore, it is useful to combine all of these indicators into a single predictive equation:

$$(7) \quad pf = 3.05 + 0.09 \text{ fut } (t-2) + 0.08 \Delta WPI_C \\
\begin{matrix} (1.28) & (0.01) & (0.04) \end{matrix}$$

$$+ 0.42 \Delta WPI_f - 0.47 UN (t-2) - 0.53 \text{ ERROR } (t-1) \\
\begin{matrix} (0.08) & (0.22) \end{matrix}$$

Time span: 1958, 1st half to
1975, 2nd half

\bar{R}^2 = 0.86
DW = 2.19
SE = 2.01

where

UN = unemployment rate for males aged 25 to 54, lagged one year.

Figure 2 compares actual movements in consumer food prices with fixed values provided by this equation.

According to equation (7), a 10 percent rise in wholesale food prices at both the crude and the finished level raises consumer food prices by about 5 percent. A 1 percent fall in prime-age male unemployment will raise consumer food prices by 0.47 percent. Other indicators of market pressure were unsuccessful in providing additional explanation of food price changes.

The usefulness of equation (7) in monitoring inflationary pressures is less than the earlier equations for the abbreviated CPI. Forecasts of food price changes more than two months in advance are possible only with the use of predicted values of the WPI indexes for crude and finished food, and these predictions are subject to substantial error.

CHAPTER IV. COMPARISON WITH SOME ALTERNATIVES

Forecasts of inflation often rely on elaborate macroeconomic models, on judgment by experienced observers about collective bargaining trends and price markups, or on some mix of these two. It is not feasible to compare systematically the results of this study with these approaches. If the results of this study prove promising, they may well be incorporated into one or both of these approaches in the future.

What is possible is a comparison of the present approach with two other simple methods of predicting inflation. One is a relation between the current rate of inflation and its own past values. The other is a relationship between inflation and interest rates. As shown below, the indicator approach outperforms both of these alternatives.

The first alternative, an autoregressive relationship, is represented by a regression of the current six-month change in the abbreviated CPI on its own values one and two periods earlier. The equation is:

$$(8) \quad p = 1.16 + 0.83 p (-1) - 0.18 p (-2) \\ (0.42) \quad (0.14) \quad (0.14)$$

Time span: 1949, 2nd half to
1975, 2nd half

$$\begin{aligned} \bar{R}^2 &= 0.49 \\ DW &= 1.89 \\ SE &= 1.93 \end{aligned}$$

where

p = percent change of abbreviated CPI (at annual rates over six-month spans.

p (-1) is lagged one period.

p (-2) is lagged two periods.

The standard error of this equation is 46 percent higher than that of equation (1) in the preceding chapter. Furthermore, the autoregressive approach, as would be expected, regularly lags at turning points.

The view that interest rates are a measure of expected inflation--a view going back to Irving Fisher's writings early in this century--has had a revival recently. A nominal rate of interest is viewed as the sum of a real rate of return and an unbiased expectation of price inflation. To compare this approach to forecasting inflation with the indicator approach, CBO has used the six-month Treasury bill rate as the relevant nominal interest rate and used the velocity of M_1 as a proxy for the real rate of interest. The regression results follow:

$$(9) \quad p = 5.57 + 1.35 R + 0.64 V$$

$$(2.0) \quad (0.21) \quad (0.63)$$

Time span: 1959, 2nd half to
1975, 2nd half

$$\begin{aligned} \bar{R}^2 &= 0.83 \\ DW &= 1.62 \\ SE &= 1.12 \end{aligned}$$

where

- p = the percentage change over six-month spans in the abbreviated CPI.
- R = the beginning and mid-year values of a six-month moving average of the market yield on U.S. Government six-month bills.
- V = semiannual values of M_1 velocity.

The coefficient of the nominal interest rate is significant and of expected sign, but the coefficient of velocity is neither. The standard error, 1.12, should be compared with the standard error of an indicator-type equation to fit to the same time-span, a shorter span than was used for equation (1) (due to the lack of six-month bill rate data for earlier years). Over the identical span, a regression using the same variables as equation (1) of the previous chapter gives a standard error of 0.85, 31 percent lower

than that of equation (9). Furthermore, the indicator approach gives some insight into the sources of inflationary pressures while the nominal interest rate and autoregressive approaches do not.

A third alternative, a regression of the six-month inflation rate on current and lagged percent changes in the money supply (demand deposits plus currency), also provides a significantly worse fit than the indicator approach. Other investigators, however, using specifications somewhat different from the six-month, nonoverlapping changes of this study, seem to have been more successful with a money supply equation.

This concluding chapter expands on the results of the analysis by measuring how much different indicators "contributed" to the abbreviated CPI recently and during the whole range of experience since 1949.

During the two six-month intervals following the end of the period of fit, the early indicators of inflation provided reasonably accurate predictions for the rate of change in the abbreviated CPI. The actual change in the first half of 1976 was 5.8 percent while the predicted change using equation (1) was 6.1 percent. For the second half of 1976 the actual and predicted rates were 5.4 and 4.9 percent, respectively. The predicted values are decomposed into contributions by each explanatory variable in Table 2.

A useful way to gauge the contribution of various indicators to the overall rate of inflation is to look at high and low values for the period since 1949. On this basis, prices of crude materials have accounted for the greatest range of variation in the inflation rate. The change in materials prices (at an annual rate) was under 10 percent, where it contributes very little to explaining the abbreviated CPI, during virtually the entire period from the middle of the Korean War until early 1972. At the start of the Korean War, however, the rate was 30 percent for two half-year periods. It decelerated 36 percent in the second half of 1957, while in 1973-1974 it was over 50 percent for one half-year and 44 percent for another. The additional inflation due to a 50 percent rate of rise in materials prices as compared to a 36 percent fall is 4.8 percentage points.

Labor market pressures have had nearly as large a range in their "contribution" to the rate of inflation. Help-wanted per member of the labor force has ranged from lows of 0.55 in the second half of 1949 and the first half of 1950 and to a high of 1.53 in early 1969. Differences of this range would, according to equation (1), lead to differences of about 4.7 percentage points in the rate of inflation.

TABLE 2. DECOMPOSITION OF FITTED CHANGE, ABBREVIATED CPI, 1976

	Crude Materials Inflation Less 10%, 6-mo. Lag	Help-Wanted Per Member of Labor Force, 1-yr. Lag	Inventory/Sales Ratio		Constant	Residual, 6-mo. Lag	Abbreviated CPI	
			6-mo. Lag	1-yr. Lag			Predicted	Actual
Contribution to 1976: First Half Prediction								
(a) Value with appropriate lag	3.53%	0.904	1.51	1.57	1.00	3.89	.	
(b) Coefficient	0.12	4.78	-11.79	7.02	6.30	0.47	--	--
(c) Value x coefficient	0.24	4.321	-17.803	11.021	6.300	1.828	6.091	5.817
Contribution to 1976: Second Half Prediction								
(a) Value with appropriate lag	3.88	0.931	1.50	1.51	1.00	1.554		
(b) Coefficient	0.12	4.78	-11.79	7.02	6.30	0.47	--	--
(c) Value x coefficient	0.466	4.450	-17.685	10.600	6.300	0.730	4.861	5.360
Highest Value since 1949 (Date)	43.3% (73:2nd half)	1.534 (70:2nd half)	1.690 (75:1st half)					
Lowest Value since 1949 (Date)	-33.1% (49:1st half)	0.554 (49:2nd half)	1.220 (50:2nd half)					

The alternative measure of labor market pressure used in equation (2), the distance below 4 percent of the prime-age male unemployment rate, has ranged from zero in every recession (and a number of other periods as well) to -2.4 in the last half of 1968. According to equation (2), a range of this magnitude would account for only 2.6 points in the abbreviated CPI, or somewhat less than the contribution of labor market pressure as measured by the help-wanted index.

The inventory/sales contribution has generally been the smallest of the factors in equation (1). The ratio was below 1.25 at the start of the Korean War and it reached a one-time high value of 1.69 in early 1975. The difference between these two extremes of 0.27 would initially contribute 5.2 percent to the rate of inflation if the entire difference developed in one half-year but only 2.1 percent when spread out over two or more half-years, because of the opposite signs of the coefficients of six- and twelve-month lags in the ratio.

Preliminary estimates for the first half of 1977 indicate that equation (1) continued to fit closely during this period. The six-month change in the abbreviated CPI from December 1976 through June 1977 (at annual rates) was 6.4 percent, somewhat higher than during 1976. The calculated value based on equation (1) was 6.3 percent. Latest values for the indicators in equation (1) and for a range of other indicators suggest little prospect for a lessening of inflation in the abbreviated CPI in the near future.