

IS THERE AN INFLATION PUZZLE?

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"I have a question mark, and it leads me to recommend vigilance with regard to inflation, but I do have to note that things have turned out well . . . You've either been lucky, in which case the old relationships will reassert themselves, or you've got a new regime underway. And I don't think we know enough at this point to know which of those two things is operative." [Federal Reserve Bank (of San Francisco) President Robert T. Parry - Dow Jones News Service: 1/07/97]

I. Introduction

Since the current expansion began in 1991, the inflation rate has remained at or below 3 percent. But for well over three years, expectations have generally foretold of an inflation pickup: the Blue Chip Consensus forecast (Eggert, various issues) has been predicting such a pickup, and both the yield curve and commodity prices have at times portended a pickup as well.¹ For example, the run-up in commodity prices from November 1993 to April 1995 fueled speculation of higher inflation rates; these higher rates did not materialize. The lack of an acceleration in inflation has led some individuals to conclude that there is an "inflation puzzle".

The purpose of this paper is to investigate the issue of an inflation puzzle and to examine explanations that have been offered in an attempt to resolve this "puzzle". In particular, we consider two competing explanations that attribute the unexpectedly low level of price inflation to events in the labor market. One explanation is that a slowdown in benefit costs has acted as a favorable supply shock that has temporarily lowered inflation relative to its historical proximate determinants. A second explanation is that a secular change in the behavior of wage growth has led to a fundamental shift in the inflation process.

¹Goodfriend (1993) contains a discussion of other "inflation scare" episodes in his case study of the Federal Reserve's interest rate policy from 1979-1992.

It is worth noting that these explanations do not simply offer different accounts for the recent behavior of inflation, but also have important implications for the conduct of monetary policy. In particular, the Phillips curve -- the principal empirical relationship used by macroeconomists and policymakers to explain inflation -- has been subject to systematic over-prediction errors during the past few years. If this series of forecast errors largely reflects the effects of favorable supply shocks, then this explanation suggests that any appearance of a recent shift in the Phillips curve relationship should be ascribed to the influence of temporary factors. On the other hand, if these forecast errors are indicative of a permanent change in the inflation process, then this explanation suggests that it would be misleading to rely on Phillips curves estimated over long historical episodes as a stable guide for predicting future movements in inflation.

We explore the issue of an inflation puzzle and assess the merits of these alternative explanations by estimating Phillips curve models for price inflation in the core consumer price index (CPI) and wage inflation measured by compensation growth. A central part of the analysis focuses on the behavior of the price inflation and wage inflation series over the current expansion. Accordingly, we conduct a variety of tests for instability in the Phillips curve models and any evidence of changes in the estimated relationships over the post-1991 period.

Our findings indicate that while price inflation has appeared to be unusually low, we can account for this feature of the data over most of the current expansion. In particular, the results support the view that the weak increase in compensation growth during the period 1992-94 was a major contributor to the low level of inflation observed through late 1995. Compared to the opinions of some individuals, our study suggests that the inflation puzzle has not been as prevalent as previously believed.

More recently, however, there is evidence of an anomaly in the behavior of inflation. We modify a price-inflation Phillips curve to model the effects of benefit costs and observe that the equation's out-of-sample forecasts consistently over-predict inflation for the last seven quarters. In addition, the results from our estimated wage-inflation Phillips curve indicate that the predictions of the model closely track the movements in compensation growth over the last two years. These findings suggest that the appearance of an inflation puzzle can not be fully explained by either reduced growth in benefit costs or unusually slow wage growth. In other words, slow compensation growth can account for the low level of inflation through late 1995, but since then a "puzzle" remains that can not be explained by labor market phenomena.

The outline of the paper is as follows. We begin by reviewing the recent behavior of inflation. We suggest reasons why forecasters might have been expecting an increase in the inflation rate and we also discuss several factors that have likely helped to mute the inflation rate over the current expansion. The analysis then develops an estimation strategy to evaluate explanations for the inflation puzzle and the recent performance of estimated Phillips curves that center on the behavior of benefit costs and wages.

In section III, we specify a price-inflation Phillips curve model and present the estimation results and tests for stability of the equation over the post-1991 period. We then evaluate the performance of the model after incorporating benefit costs as an additional supply shock variable. In section IV, we explore the behavior of compensation growth in more detail. We specify and estimate a wage-inflation Phillips curve model for compensation growth and document the weak increase in this variable that occurred from 1992-94. Section V concludes.

II. The Nature of the "Inflation Puzzle" and Some Suggested Missing Pieces

Chart 1 presents the behavior of inflation in the core CPI -- the CPI excluding its food and energy components -- since the early 1960s. As the chart shows, previous expansions have been characterized by an initial decline in inflation that occurs over one to two years and a subsequent acceleration. In contrast, this expansion initially witnessed a decline in inflation over roughly three years and has yet to observe an acceleration through its sixth year.

There are other reasons why the recent behavior of inflation might appear surprising. Several variables commonly regarded as inflation indicators have been at levels which historically would be indicative of an inflation pick-up. One such variable is the level of the actual unemployment rate relative to the NAIRU -- the unemployment rate consistent with a constant rate of inflation.² The civilian unemployment rate is shown in the upper panel of **Chart 2**, with an assumed value of 6 percent for the NAIRU. As the chart shows, the unemployment rate series has been below this threshold level since late 1994. Admittedly, there have been discussions about whether the NAIRU has declined somewhat during the 1990s. However, few have suggested that the NAIRU has fallen to a level such that the unemployment rates observed since 1995 imply a constant rate of inflation.³

In a similar fashion, the lower panel of **Chart 2** shows the rate of capacity utilization relative to a level of 83 percent. As Boldin (1996) notes, studies have generally associated accelerating inflation with capacity utilization rates in excess of 82-84 percent. While capacity utilization has since moved off its peak, it nevertheless has been above this threshold level since 1994.

Consistent with these two indicators, the Blue-Chip consensus forecast has over-predicted

²The term NAIRU is used to refer to this non-accelerating inflation rate of unemployment.

³One exception is Gordon (1996) who obtains an estimate of 5.3 percent for the NAIRU starting in 1996.

inflation each year from 1992-95, by progressively larger margins of error (**Chart 3**). In addition, commentators have cited the apparent breakdown in the Phillips curve relationship as more formal evidence of the emergence of an inflation puzzle. Specifically, estimated price-inflation Phillips curves have also displayed systematic over-prediction errors over the last couple of years. This recent forecast performance of the Phillips curve contrasts sharply with its long-standing reliability and usefulness to predict short-run movements in inflation. Thus, using a wide variety of methods and models, forecasters also have been wrongly expecting an increase in the inflation rate.

Various explanations have been offered for the inflation puzzle and the recent failure of estimated Phillips curve models. Because the labor market plays a central role in the inflation process, some of these explanations have been linked to the behavior of compensation growth and its individual components -- benefits and wages (**Chart 4**). While a preliminary examination of these data can only be viewed as suggestive, their observed behavior appear to be consistent with the idea that the labor market may be a key element in understanding the movements in inflation during the current expansion. Specifically, the growth rates for all three series have generally displayed a downward trend since the end of the 1990-91 recession.

In a recent speech, Meyer (1997) has suggested two alternative explanations for the inflation puzzle that draw upon factors and developments emanating from the labor market. The first is that the marked decline in benefit costs from the containment of health care costs has acted as a favorable supply shock to the inflation process. As Meyer notes, the key idea is that this type of supply shock is traditionally excluded from estimated Phillips curves. A second explanation focuses on unusual restraint in wage gains due to a permanent change in the bargaining power of workers. In particular, it is argued that heightened job insecurity has diminished the ability of workers to gain wage increases and consequently has altered the underlying relationship linking wage changes (and other

macroeconomic variables) to price changes.

While it might appear difficult to discriminate between these alternative explanations for the inflation puzzle, they nevertheless yield implications for estimated price-inflation Phillips curves and the time series behavior of compensation growth.⁴ Accordingly, we develop an empirical framework that allows us to test these implications and assess their relative importance.

The previous discussion suggesting that the slowdown in benefit costs has acted as a favorable supply shock argues that the recent over-prediction of inflation is essentially due to models omitting the effects of this variable. This view implies that the Phillips curve is inherently stable and that its forecasting performance can be restored by directly linking inflation to benefit costs, or more generally compensation growth. Within our Phillips curve framework, we use the growth rate of unit labor costs as a proxy for this channel of effect. With unit labor costs defined as compensation (benefits and wages) divided by productivity, the addition of this variable to a Phillips curve model allows us to examine if reduced benefit costs lowered the increase in overall labor costs, and thereby reduced the pressure on firms to raise prices.⁵

⁴While the discussion up to this point has drawn a distinction between benefits and wages, the empirical analysis will instead center on the behavior of compensation growth. This approach is partly motivated by the idea that the pricing decision of a firm should be based on a consideration of its total labor costs, rather than the individual components. In addition, **Chart 4** shows that the behavior of compensation growth has been broadly consistent with that for benefits and wages. Last, the data precludes us from obtaining observations on the separate series over the full sample period. The Employment Cost Index (ECI), which provides a survey of wages and benefits, is only available beginning in 1980 for the nonfarm sector.

⁵We choose unit labor costs, rather than compensation per-hour, as the additional explanatory variable for the Phillips curve because it is the behavior of compensation growth relative to productivity growth that is relevant for describing the dynamics of the inflation process. One might argue, therefore, that our proposed specification may instead be picking up an effect of high productivity growth on inflation. As discussed in section III, the growth rate of unit labor costs over this expansion has been driven by slow compensation growth and not high productivity growth.

The view that the recent behavior of inflation emanates from a longer-lasting change in the bargaining power of workers also yields implications for our analysis. As previously discussed, a change in the process for wage growth is consistent with evidence of a breakdown in estimated price-inflation Phillips curves. However, this argument also suggests that we should observe a structural change in the time series behavior of compensation growth. We explore each of these explanations in turn in the next two sections.⁶

III. A “Traditional” Price-Inflation Phillips Curve and the Favorable Supply Shock Story

The origin of the Phillips curve can be traced back to the work of Phillips (1958) who documented an inverse relationship between the rate of change of nominal wages and the level of unemployment in the United Kingdom. His findings were interpreted as establishing a wage adjustment process where low levels of unemployment represent tight labor markets that portend, or coincide with, an acceleration in wage growth. While the term “Phillips curve” continues to denote the posited relationship between the rate of change of a nominal wage or price and various indicators of real economic activity, the econometric modeling of this relationship has changed considerably over the years. In particular, the work of Gordon (1970, 1975, 1977, 1982, 1990) has featured prominently among research centering on the estimation of the Phillips curve.

⁶Meyer (1997) suggests that the declines in computer prices and import prices over the current expansion may also be acting as favorable supply shocks. Moreover, he cites an increase in international competitive pressures and its constrictive effect on the ability of firms to raise prices as an additional explanation for the inflation puzzle. We do not address these factors in this paper and instead focus only on the decline in benefit costs and a possible change in the wage growth process. We restrict our attention to these two explanations because they both concern labor market phenomena. Further, while our analysis is not exhaustive, we nevertheless believe that it is instructive to evaluate these explanations for the low level of inflation before considering alternative hypotheses.

Modern versions of the Phillips curve, such as those found in King and Watson (1994), Tootell (1994), Fuhrer (1995), King, Stock and Watson (1995) and Gordon (1996), incorporate several features that differentiate them from earlier descriptions of the behavior of nominal wages and prices. One feature is that the dynamics of wage and price changes is assumed to depend on key aggregate demand variables such as the output gap (the log ratio of actual to potential real GDP) or the unemployment gap (the difference between the actual rate of unemployment and the NAIRU). In addition, the current Phillips curve approach recognizes the important role that expected inflation plays in the wage and inflation processes and has typically used past rates of inflation as a proxy for this subjective magnitude.⁷ Finally, these models include variables to control for the effects of supply shocks such as the increase in oil prices in the 1970s. As Fuhrer (1995) notes, many of these developments were anticipated by Phillips in his original discussion.

To evaluate the role of benefit costs in the recent behavior of inflation, we will specify a price-inflation Phillips curve and then extend the model to include the growth rate of unit labor costs. A comparison of the two estimated models provides the basis for determining the extent to which the decline in benefits growth may be the missing element in the inflation puzzle.

As **Chart 5** shows, there is reason to believe that unit labor costs could be an important source of the slow growth in prices over the current expansion. Specifically, not only has growth in unit labor costs been weak, but a gap between unit labor cost growth and core CPI inflation seems to have opened up during most of the expansion. Only recently has this gap narrowed. Thus, an initial examination of the data appears to be consistent with the idea that unit labor costs have helped

⁷The estimation of “expectations-augmented” Phillips curves is largely due to the theoretical work of Phelps (1967) and Friedman (1968) who developed the natural rate hypothesis and drew the distinction between the short-run and long-run Phillips curve trade-off.

to restrain inflationary pressures in the economy.

With unit labor costs providing a measure of the labor cost of production per unit of output, either slow compensation growth or fast productivity growth must be accounting for its weak growth. As **Chart 6** shows, productivity growth has not been unusually strong in the current expansion. During late 1991 and early 1992, the series rose at roughly a 3 percent rate contributing to weaker growth in unit labor costs. But since that time, productivity has grown at rates below one percent. The chart also shows that compensation growth declined to around 2 percent fairly early in the expansion and hovered around that rate for over a year before showing signs of a modest pick-up. This 2 percent growth rate is below any rate recorded over the past 35 years, suggesting that compensation growth appears to be responsible for the slow growth in unit labor costs.

Following conventional practice, our Phillips curve model maintains the view that movements in inflation reflect the influence of a set of key variables as well as various "shock" factors. While the underlying determinants are central to explaining the movements in inflation over longer periods, shocks to the inflation process can be viewed as exerting secondary effects which, at times, can fuel short-term bursts of inflation.

Before turning to a formal discussion of model specification, it is worth noting that some of these shock factors have managed to be well contained during the current expansion. One such factor is the absence of significant commodity price shocks. As the upper panel of **Chart 7** shows, most previous expansions have been characterized by positive commodity price shocks that added to inflationary pressures. However, recent evidence suggests that there is no longer a tight link between commodity prices and inflation. In particular, Blomberg and Harris (1995) document a marked decrease in the predictive power of commodity prices for inflation which they attribute to a decline

in the commodity composition of U.S. output beginning in the middle 1980s. Thus, while a commodity price increase occurred during this expansion, there are strong reasons to believe that its impact and contribution to inflation were considerably smaller than in previous expansions. A second factor concerns the behavior of the dollar. As shown in the lower panel of **Chart 7**, unlike the late 1980s when the 1985-87 dollar decline preceded the 1986-90 rise in inflation, the dollar has maintained its value in this expansion.⁸

For the empirical analysis, we first consider the following “traditional” Phillips curve which will serve as a benchmark model:

$$(1) \quad INF_t = \alpha_0 + \alpha_1 GDPGAP_{t-1} + \alpha_2 (\Delta GDPGAP_{t-1}) + \sum_{i=1}^3 \alpha_{2+i} INF_{t-i} + \sum_{i=1}^2 \alpha_{5+i} OILG_{t-i}^+ + \epsilon_t$$

where:

INF = inflation measured by the growth rate of the core CPI
 GDPGAP = the output gap measured by the log ratio of actual to potential real GDP
 $\Delta GDPGAP$ = the first difference or change in the output gap
 $OILG^+$ = net positive change in the real price of oil
 ϵ = mean zero, serially uncorrelated random disturbance term.

Equation (1) provides a general specification for the rate of change in prices and is representative of the types of models currently adopted in the Phillips curve literature.⁹ In the terminology of Gordon (1996), the specification embodies the “triangle” model of inflation with the set of

⁸Commodity prices and/or an exchange rate term have been used as explanatory variables in some price-inflation Phillips curve models. However, we do not include these terms in our specification because their effects were both small and statistically insignificant. While we recognize that commodity prices and the exchange rate may exert an influence on the inflation rate, they do not appear to be important for the analysis and are therefore categorized as shock factors.

⁹More detailed definitions and sources of the data are presented in the Data Appendix.

explanatory variables intended to capture the effects on inflation stemming from demand, inertial, and supply considerations.

The model uses the output gap (the percentage deviation of real GDP from potential GDP) displayed in **Chart 8** in place of the unemployment rate as a measure of aggregate demand pressures, although the results are little affected by the particular choice.¹⁰ The idea of the effect of the output gap on inflation is that a positive (negative) value is associated with the economy operating above (below) potential GDP and is assumed to generate upward (downward) inflationary pressure on prices. Following Gordon (1977, 1996) and Fuhrer (1995), we also include the quarterly change in this gap variable to allow for a rate-of-change effect. More pressure is likely placed on prices when the output gap narrows quickly rather than more slowly.

The remaining basic determinants of inflation include past rates of inflation and oil prices. Lagged inflation terms are included to incorporate price inertia effects. Early researchers used past inflation rates to proxy expected inflation. In modern versions of the Phillips curve, Gordon (1996) has noted that such an interpretation is overly restrictive. In particular, he suggests that past inflation rates should be viewed as capturing the dynamics of price adjustment related not only to expectations formation, but also to the presence and extent of institutional factors in the economy such as wage and price contracts as well as delivery lags.

The model also includes oil prices to account for the influence of supply shocks. The oil price

¹⁰Potential GDP measures the full-employment level of output or the level of output at which there is no tendency for inflation to accelerate or decelerate. The level of potential GDP grows over time because of the increased availability of resources (land, labor force, capital stock, level of technology). Because potential GDP is not directly observable, several techniques have been developed to calculate estimates of the series. A complete review of these techniques and evaluation of the alternative potential GDP series are beyond the scope of this paper. As noted in the Data Appendix, we employ a staff estimate of potential GDP to construct the output gap variable.

variable provides the only noticeable departure from conventional Phillips curve specifications. In particular, we include a measure of the net positive change in real oil prices (**Chart 9**) to allow for an asymmetric effect of oil price changes on inflation. The nature of the asymmetry, discussed in Fuhrer (1995) and confirmed through our testing procedures, is that while oil price increases appear to affect inflation, oil price decreases do not seem to be important.¹¹ The construction of the supply shock variable follows from the approach in Hamilton (1996) and is designed to not only model the asymmetric effects of oil price changes, but also to account for the change in the behavior of real oil prices and the increased volatility observed over the post-1986 period. Because the core CPI excludes energy prices as a component, our supply shock variable attempts to capture any indirect effect of oil price increases on inflation.

We incorporate benefit costs into the analysis by specifying the following “modified” price-inflation Phillips curve:

$$(2) \quad \begin{aligned} INF_t = & \alpha_0 + \alpha_1 GDPGAP_{t-1} + \alpha_2 (\Delta GDPGAP_{t-1}) + \sum_{i=1}^3 \alpha_{2+i} INF_{t-i} \\ & + \sum_{i=1}^2 \alpha_{5+i} OILG_{t-i}^+ + \sum_{i=1}^2 \alpha_{7+i} UNITG_{t-i} + \epsilon_t. \end{aligned}$$

where:

UNITG = the growth rate of unit labor costs (nonfarm business sector).

Equation (2) augments the regressors in the “traditional” Phillips curve model to include the growth rate of unit labor costs. The addition of unit labor costs as a determinant of inflation can be motivated by the idea of firms setting prices as a markup over costs. More importantly, the model allows for an explicit channel through which slow compensation growth may have acted to offset

¹¹The exclusion of the net negative real oil price change variable from equation (1) results from the variable displaying quantitatively and statistically insignificant effects.

other sources of inflationary pressures over the current expansion, resulting in lower inflation rates than those that would be predicted on the basis of equation (1).¹²

While both models take real oil prices as exogenous, we only allow lagged values of the output gap and the growth rate of unit labor costs to be included as regressors to avoid simultaneity-bias arising from the endogeneity of these variables. The lag lengths in each model are selected by maximizing adjusted R^2 -- a measure of the "goodness of fit" of an equation -- and searching over one to four lags for inflation and the output gap [and the growth rate of unit labor costs in the case of equation (2)] and zero to four lags for the net positive change in the real price of oil.¹³

We estimate equations (1) and (2) by the method of ordinary least squares (OLS) using quarterly data over the 1965:Q1-1996:Q3 period. Parameter estimates are presented in **Table 1**, with heteroskedastic consistent standard errors reported below in parentheses.¹⁴ The values of the adjusted R^2 indicate that the proportion of the variation of inflation that can be explained by each model is quite high. In addition, neither model displays any evidence of serial correlation in the regression residuals.

¹²Note that our model does not allow us to examine whether there has been a shift in the Federal Reserve's inflation fighting credibility that has changed the inflation process by directly altering inflation expectations. Such an examination is beyond the scope of this paper and would involve estimating a separate equation for inflation expectations and including some measure of Federal Reserve credibility as an explanatory variable. However, previous evidence would suggest that such a shift has not taken place. Blanchard (1984) has noted that similar types of Phillips curves remained stable even after the 1979 change in Federal Reserve operating procedures.

¹³The compensation growth Phillips curve presented in section IV includes dummy variables to capture the effects from the imposition and relaxation of wage and price controls during the 1970s. These dummy variables are excluded from the price-inflation Phillips curve because they were statistically insignificant. Alternative dating schemes for the dummy variables [Gordon (1982)] also proved to be unimportant for explaining the dynamics of inflation during the 1971-75 period.

¹⁴The standard errors are computed using the procedure of White (1980).

An examination of the estimation results for the traditional price-inflation Phillips curve indicates that both the level of the output gap variable and its rate-of-change are highly significant and have the expected positive signs. The two lagged values of net positive change in the real price of oil are also highly significant with the anticipated positive signs. It is also worth noting that the three lags of the inflation rate are generally significant and that we are unable to reject the hypothesis that the sum of the coefficients equals unity ($\alpha_3 + \alpha_4 + \alpha_5 = 1$) at conventional significance levels. The latter restriction follows from the natural rate hypothesis and has been previously imposed in the estimation of Phillips curves to constrain the level of potential output (or the unemployment rate) to be independent of inflation in the long-run.

In the case of the modified price-inflation Phillips curve, the two lagged values of unit labor cost growth enter with the anticipated positive sign and lead to a significant improvement in the explanatory power of the model. While the results for the other explanatory variables are broadly similar across the two models, the modified price-inflation Phillips curve yields evidence of a larger rate-of-change effect of the output gap and a smaller level effect. In addition, the estimated version of the model again does not constrain the sum of the coefficients on lagged inflation to equal unity ($\alpha_3 + \alpha_4 + \alpha_5 = 1$). However, we will also present the estimation results of a compensation growth Phillips curve model in section IV. As shown in the Appendix, compensation growth can be solved out from the system of the two estimated equations to yield a reduced form of a price-inflation Phillips curve. The resulting model is characterized by coefficients on lagged inflation whose sum is not statistically different from unity and associates an acceleration in inflation with a positive output gap and a negative unemployment gap.

We also conducted several exercises to determine if a change in either model's fit had

occurred in recent years. To formally address the issue of parameter stability, we applied Chow's (1960) split-sample test to the data. Several versions of the Chow test are available to test the null hypothesis of constant parameters against the alternative hypothesis of a one-time shift in the parameters at some specified date. One method compares the estimates obtained using the data from one subperiod (the beginning of the sample through the 1991 period) to the estimates using the full sample.¹⁵ Another method uses dummy variables for the entire parameter vector for one subperiod (the post-1991 period) and then tests the joint significance of the dummy variables.¹⁶ As shown by the reported values of the two test statistics for each model, we fail to reject the null hypothesis of parameter stability for the post-1991 period at conventional significance levels.¹⁷

To gain additional insight into the issue of model stability, we examined the dynamic out-of-sample forecasts from the estimated regression equations. This exercise provides a more stringent test of model stability because lagged predicted values of inflation, rather than the lagged actual values of inflation, are used to construct the subsequent one-quarter-ahead forecasts of inflation. An additional reason for viewing the dynamic simulation as being more informative about the issue of model stability is that the Chow tests may have low power because they are conducted over a

¹⁵This testing procedure yields an F statistic which is distributed asymptotically as F with (m, n-k) degrees of freedom under the null hypothesis. The values of n and n+m refer to the number of observations in the first subperiod and the total sample, respectively. The value of k refers to the number of parameters in the model.

¹⁶This testing procedure yields a likelihood ratio statistic that is distributed asymptotically as chi-squared (χ^2) with k degrees of freedom under the null hypothesis.

¹⁷We also examined the data for evidence of parameter instability using the CUSUM and CUSUMSQ tests proposed by Brown, Durbin and Evans (1975). The tests are based on recursive residuals, with the CUSUM test primarily used for detecting gradual structural change and the CUSUMSQ test for sudden structural change. The tests also provided no evidence of parameter instability.

relatively small part of the sample period. For this part of the analysis, we estimated equation (1) and equation (2) through 1991:Q4 and then used the estimated equations to forecast inflation over the 1992-96 period. **Chart 10** and **Chart 11** depict the forecasts from this dynamic simulation for equation (1) and equation (2), respectively, along with the actual values of inflation.

In contrast to the results from the Chow tests, the dynamic simulation in **Chart 10** provides stronger evidence of instability in the traditional price-inflation Phillips curve model. Specifically, the out-of-sample forecasts systematically over-predict inflation beginning in 1993:Q3. Moreover, the forecasted inflation series is characterized by a slightly rising trend and generates prediction errors that increase over time. In addition, the out-of-sample forecast performance of the model is robust to the choice of starting dates for the simulation as we obtained similar results performing the same exercise over the 1994-96 period (not shown).

An examination of the out-of-sample forecasts from the modified price-inflation Phillips curve (**Chart 11**) reveals a pattern that differs markedly from the previous dynamic simulation. Specifically, the simulated values from the modified price-inflation Phillips curve now track inflation very closely through 1995:Q3 before displaying evidence of model instability. Importantly, this finding would appear to provide support for the view that compensation growth has acted as a favorable supply shock during the current expansion. However, this finding also makes clear that the additional effects of unit labor costs alone are not capable of reconciling the previously observed discrepancy between actual and predicted inflation for approximately the last two years.¹⁸

In the next section, we will turn to our second hypothesis and examine the possibility that the

¹⁸We performed the same exercise over the 1995-96 period and obtained similar results. We do not report these results to conserve space.

inflation puzzle reflects a change in the wage adjustment process for workers. Before exploring this hypothesis, however, it is important to mention one additional explanation for the recent behavior of inflation that does not rely on the idea of an underlying shift in its time series process. Specifically, this explanation concerns the discrepancy, since the middle of 1994, between estimates of GDP from the income and product sides of the National Accounts, with income estimates of GDP currently exceeding that from the product side.¹⁹

If the product side of the National Accounts is being seriously underestimated, then this may lead to a potentially large upward revision to estimates of real GDP and productivity, and consequently a large downward revision to estimates of the output gap and unit labor costs. This latter implication is particularly important because both the timing and nature of the revisions would act to reduce the out-of-sample forecast error of the modified price-inflation Phillips curve model.²⁰

Because the revised data have not been released, the validity of this explanation can only be judged currently by considering evidence from simulations based on various revision scenarios. Nevertheless, this alternative explanation would suggest that the Phillips curve relationship has remained stable over the current expansion and that its recent forecast performance and the coincidental emergence of an inflation puzzle are largely an artifact of data measurement.²¹

¹⁹See Macroeconomic Advisers, LLC (1996) and the 1997 Economic Report of the President (pages 72-74) for a discussion of this discrepancy in the National Accounts.

²⁰Because of the construction of a dynamic simulation, a prediction error will continue to affect the subsequent quarters' forecasted values. Thus, the effects of a reduction in a prediction error on the improved forecast performance of a model will not be limited to the current period.

²¹It should be noted that the unexpectedly large tax receipts for April 1997 lends additional support to the idea that the product side of the National Accounts is currently underestimating GDP.

IV. A Compensation Growth Phillips Curve and a Change in the Wage Inflation Process

In an exercise that parallels the analysis in section III, we present the results from estimating a wage-inflation Phillips curve for compensation growth. We then examine whether there is evidence to suggest a recent change in the fit of the model to the data and if such a change could be the underlying cause of the inflation puzzle.

As previously noted, the original Phillips curve focused on the relationship between the rate of change in nominal wages and the level of unemployment. For present purposes, we expand the dependent variable, wages, to also include benefits. In recent years benefits have become an increasingly important part of workers' compensation. To analyze the behavior of compensation growth, we specify the following model which represents a modified version of the Phillips curve proposed by Englander and Los (1983):

$$(3) \quad LXNG_t = \beta_0 + \sum_{i=1}^2 \beta_i LXNG_{t-i} + \beta_3 U_{t-1} + \sum_{i=1}^2 \beta_{3+i} INF_{t-i} \\ + \beta_6 SOC_t + \beta_7 UIR_{t-1} + \beta_8 DUM_t + \eta_t$$

where:

LXNG = growth rate of compensation per hour (nonfarm business sector)

U = unemployment rate for males 25-54 yrs. old

INF = inflation measured by the growth rate of the CPI (all items, urban consumers)

SOC = the change in employer social security contributions

UIR = income replacement ratio from unemployment insurance benefits

DUM = dummy variable for the Nixon wage and price controls

η = mean zero, serially uncorrelated random disturbance term.

Equation (3) principally relates the movements in compensation growth to the unemployment rate and other variables reflecting labor market conditions.²² The unemployment rate of prime age males is used as a measure of labor market tightness. We enter the variable in its level

²²Detailed definitions of the data and their sources are reported in the Data Appendix.

form and thereby abstract from any explicit discussion of the NAIRU other than to note that the specification can be viewed as implicitly assuming a constant value for the NAIRU over the sample period.²³ Equation (3) does not include a rate-of-change effect for the unemployment rate because the estimated coefficient on a second lag of the unemployment rate was quantitatively and statistically insignificant and therefore was omitted from the specification.²⁴

The remaining determinants of compensation growth include the change in employer social security tax contributions which is a component of hourly compensation. The income replacement ratio from unemployment insurance benefits attempts to capture changes in compensation growth related to job search. A dummy variable accounts for the restraining effect of the price freeze in 1971:Q4 and the rebound effect after the relaxation of the controls in 1972:Q1.²⁵ The inclusion of lagged values of compensation growth and price inflation parallels the previous discussion concerning wage and price inertia. Last, we only allow lagged values of the unemployment rate and inflation rate to be included as regressors because of endogeneity considerations.

Equation (3) is estimated using quarterly data over the 1967:Q2-1996:Q3 period. The OLS parameter estimates and heteroskedastic consistent standard errors are presented in **Table 2**. As the table indicates, the lagged values of both the dependent variable and price inflation are highly

²³For example, we could follow the approach of Fuhrer (1995) who assumes a value of 6 percent for the NAIRU and use the unemployment gap (the difference between the actual level of unemployment and the NAIRU) instead of the unemployment rate as an explanatory variable in equation (3). However, this will not affect the regression results other than to change the estimated values of the constant term and the coefficient on the unemployment rate.

²⁴This result is consistent with Fuhrer (1995) who also finds an absence of significant rate-of-change effects for the unemployment rate in wage-inflation Phillips curve models.

²⁵The definition of the dummy variable is from Englander and Los (1983).

significant. The unemployment rate is significant and has the expected negative sign. Further, the variables reflecting other labor market conditions are all significant with the expected signs. The adjusted R^2 , although not quite as high as the values reported in Table 1, also indicates that the estimated equation fits the data quite well. In addition, the regression residuals display little evidence of serial correlation.

Drawing upon our previous analysis, we conducted several exercises to address the issue of model stability. As shown by the value of the tests statistics in **Table 2**, the Chow tests do not reject the null hypothesis of parameter stability at conventional significance levels. For the dynamic simulation, we estimated equation (3) over the 1967:Q2-1991:Q4 period and then used the estimated equation to generate predicted values for compensation growth over the 1992-96 period. As shown in **Chart 12**, the out-of-sample forecasts consistently over-predict compensation growth from the middle of 1992 through 1994. In addition, the size of the discrepancy between the actual and predicted values is quite large. Based on the past relationship with its explanatory variables, compensation growth should have been higher by roughly 2.0 percent during this time period. Further, there appears to be a close correspondence between this finding and the results reported in section III. Specifically, the timing of compensation growth shortfall is consistent with the extended improvement in the out-of-sample forecast performance of the modified price-inflation Phillips curve.

Chart 12, however, also indicates a recovery in the model from the 1992-94 episode and that compensation growth now appears to be “back on track”. Specifically, the model displays little evidence of instability over the post-1994 period. This finding indicates that any consideration of a possible shift in the dynamics of the wage process during the 1990s would suggest that it is better

characterized as temporary, rather than permanent in nature. To the extent that factors such as job insecurity or corporate downsizing have played a role in the recent behavior of compensation growth, it was limited to the early years of the current expansion. More importantly, the recovery of the compensation growth equation and the coincidental breakdown of the modified price-inflation Phillips curve would appear to dispel claims suggesting a current link between the low level of inflation and a restructuring in the labor market.

V. Conclusion

In this article we examine the recent behavior of inflation and if the lack of an acceleration in price inflation during the current expansion can be attributed to developments emanating from the labor market. Specifically, we investigate whether the low level of inflation is the result of a favorable supply shock associated with the decline in benefits growth or is due to a change in the behavior of wage growth.

Our results document unusual restraint in compensation growth during the current expansion and indicate that this event has been a major contributor to the low level of inflation. However, the results also indicate that the unusual restraint in compensation growth was a temporary phenomenon that ended by early 1995. Thus, while there is some evidence to support the idea that the slowdown in compensation growth has acted as a favorable supply shock, it appears that this explanation can only provide a partial account for the behavior of inflation over the current expansion. In particular, our findings suggest that there must be other factors responsible for the inflation puzzle for approximately the last two years.

On the surface, our study would seem to support the conclusion that an inflation puzzle currently exists, although it appears to be of a shorter duration than previously thought. While the

analysis can not provide a full account of the behavior of inflation over this expansion, we are careful to temper the conclusions that can be drawn about a possible structural break in the series. As previously discussed, the resolution of the inflation puzzle may be related to future revisions to current estimates of GDP and productivity. The release of the revised data will allow one to determine if this explanation provides the missing piece to the “puzzle”, or if a further exploration into this issue and the testing of additional hypotheses will be warranted.

Table 1
1965:Q1 - 1996:Q3

$$INF_t = \alpha_0 + \alpha_1 GDPGAP_{t-1} + \alpha_2 (\Delta GDPGAP_{t-1}) + \sum_{i=1}^3 \alpha_{2+i} INF_{t-i} \\ + \sum_{i=1}^2 \alpha_{5+i} OILG_{t-i}^+ + \sum_{i=1}^2 \alpha_{7+i} UNITG_{t-i} + \epsilon_t$$

Parameter	Estimate	p-Value	Estimate	p-Value
α_0	0.0786 (0.0782)	0.3146	0.0429 (0.0728)	0.5553
α_1	0.0339** (0.0107)	0.0016	0.0196 (0.0109)	0.0725
α_2	0.1452** (0.0511)	0.0045	0.2594** (0.0522)	0.0000
α_3	0.4080** (0.1209)	0.0007	0.2687* (0.1058)	0.0111
α_4	0.1296 (0.1168)	0.2672	0.1278 (0.1061)	0.2287
α_5	0.3487** (0.1227)	0.0045	0.2932** (0.1015)	0.0039
α_6	0.0186** (0.0056)	0.0009	0.0168** (0.0046)	0.0003
α_7	0.0242** (0.0071)	0.0007	0.0227** (0.0059)	0.0001
α_8	---	---	0.1836** (0.0403)	0.0000
α_9	---	---	0.0718 (0.0400)	0.0725
Chow Forecast Test: 1992:Q1-1996:Q3				
Model	Adjusted R ²	Q(30)	F-Statistic	Likelihood Ratio Statistic
Equation (1)	0.776	22.731 (0.859)	0.192 (0.999)	4.539 (0.999)
Equation (2)	0.812	28.414 (0.600)	0.227 (0.999)	5.471 (0.999)

Note: Asymptotic standard errors are reported below the parameter estimates in parentheses. The Ljung-Box Q test statistic for serial correlation of the regression residuals is distributed asymptotically as chi-square with 30 degrees of freedom. Probability values for the test statistics are reported below in parentheses.

* Significant at the 5 percent level

**Significant at the 1 percent level

Table 2
1967:Q2 - 1996:Q3

$$LXNG_t = \beta_0 + \sum_{i=1}^2 \beta_i LXNG_{t-i} + \beta_3 U_{t-1} + \sum_{i=1}^2 \beta_{3+i} INF_{t-i} + \beta_6 SOC_t \\ + \beta_7 UIR_{t-1} + \beta_8 DUM_t + \eta_t$$

Parameter		Estimate	p-Value	
β_0		0.3944 (0.2238)	0.0780	
β_1		0.1606 (0.0830)	0.0532	
β_2		0.1903** (0.0695)	0.0062	
β_3		-0.0646** (0.0247)	0.0090	
β_4		0.1602* (0.0677)	0.0179	
β_5		0.1858* (0.0722)	0.0101	
β_6		0.0910** (0.0209)	0.0000	
β_7		1.6858* (0.6695)	0.0118	
β_8		-0.7382** (0.0698)	0.0000	
			Chow Forecast Test: 1992:Q1-1996:Q3	
Model	Adjusted R ²	Q(29)	F-Statistic	Likelihood Ratio Statistic
Equation (3)	0.683	21.550 (0.838)	0.767 (0.739)	17.708 (0.542)

Note: Asymptotic standard errors are reported below the parameter estimates in parentheses. The Ljung-Box Q test statistic for serial correlation of the regression residuals is distributed asymptotically as chi-square with 29 degrees of freedom. Probability values for the test statistics are reported below in parentheses.

* Significant at the 5 percent level

**Significant at the 1 percent level

APPENDIX: Derivation Of The Accelerationist Phillips Curve Model

This Appendix provides a brief discussion of the derivation of the accelerationist model of the Phillips curve from equations (2) and (3). The key features of this version can be illustrated by examining the relationship between the output gap (and unemployment gap with a constant NAIRU) and the inflation rate. Abstracting from the influence of other terms, note that the system of equations (2) and (3) can be rewritten as:

$$(4) \quad INF_t = \alpha_1 GDPGAP_{t-1} + \sum_{i=1}^3 \alpha_{2+i} INF_{t-i} + \sum_{i=1}^2 \alpha_{7+i} (LXNG_{t-i})$$

and

$$(5) \quad LXNG_t = \frac{\beta_3 U_{t-1} + \sum_{i=1}^2 \beta_{3+i} INF_{t-i}}{(1 - \beta_1 L - \beta_2 L^2)}$$

where we use the definition of unit labor cost growth as compensation growth less productivity growth in equation (4) and L denotes the lag operator in equation (5) such that $L^k X_t = X_{t-k}$.

Note that we can substitute equation (5) into equation (4) to obtain an expression relating current inflation to the output gap, the unemployment gap, and past rates of inflation. If the sum of the coefficients on lagged inflation equals unity, then it can be shown that there is a "natural rate" value of the output gap (and unemployment gap) of zero that is consistent with a constant rate of inflation. Alternatively, this model would associate a permanent positive value for the output gap with an ever-accelerating inflation rate. Within our system of equations, the condition that the sum of the coefficients on lagged inflation equals unity is given by:

$$(6) \quad \alpha_3 + \alpha_4 + \alpha_5 + \left[\frac{(\alpha_8 + \alpha_9)(\beta_4 + \beta_5)}{(1 - \beta_1 - \beta_2)} \right] = 1.$$

The hypothesis that the coefficients on lagged inflation sum to unity can be tested using the OLS estimates of equations (2) and (3) to construct an estimate of the expression on the left-hand side of equation (6) and its standard error. The standard error is the standard error of a function of several estimated parameters and can be computed using the delta method approximation [Greene (1993) page 297]:

$$SE[g(\theta)] = \sqrt{\frac{\partial g}{\partial \theta'} \cdot VAR(\theta) \cdot \frac{\partial g}{\partial \theta}}$$

where θ denotes the parameters in equation (6), $g(\theta)$ is the function of the parameters in (6), and $VAR(\theta)$ is the variance-covariance matrix of those parameters.

Because of the slight disparity in the sample periods for Table 1 and Table 2, equation (2) and equation (3) were both estimated over the period 1967:Q2-1996:Q3. The estimate for the expression on the left-hand side of equation (6) was 0.87 with an estimated standard error of 0.08. Thus, we are unable to reject the null hypothesis that the sum of the coefficients in (6) is equal to unity at the 5 percent significance level.

DATA APPENDIX

Inflation Equation:

INF: Growth Rate of Core CPI, all urban consumers. Monthly, SA, 1982-84=100.

Source: Department of Labor. Bureau of Labor Statistics. Consumer Price Index

UNITG: Growth in Unit Labor Costs, Nonfarm Business Sector. Quarterly, SA, 1992=100.

Source: U.S. Department of Labor. Bureau of Labor Statistics. "Productivity and Costs."

GDPGAP: Logarithmic ratio of **GDP-to-POTGDP**, where **GDP** is quarterly Real Gross Domestic Product and **POTGDP** is Potential GDP, quarterly. Both variables are in 1987 dollars until 1987:Q3 and in chain-weighted 1992 dollars from 1987:Q4-present. GDP source: National Income and Product Accounts. Potential GDP source: FRBNY Staff estimate.

OILG*: Net positive change in the real price of oil. The percentage change in the current real price of oil from the previous year's maximum if positive and zero otherwise. Source: Data for the price of oil are an extension of Mork's (1989) series which reflect corrections for the effects of price controls during the 1970s. The real price of oil is constructed by deflating the nominal price index by the GDP deflator.

Compensation Equation:

LXNG: Growth rate of Compensation per Hour, Nonfarm Business²⁶. Quarterly, SA, 1992=100.

Source: U.S. Department of Labor. Bureau of Labor Statistics. "Productivity and Costs."

INF: Growth Rate of Consumer Price Index for all items, urban consumers. Monthly, SA, 1982-84=100. Source: Department of Labor. Bureau of Labor Statistics. Consumer Price Index.

U: Unemployment Rate for Male, 25-54 years. Monthly, SA. Source: Department of Labor. Bureau of Labor Statistics. "The Employment Situation", Table A-8.

UIR: Unemployment insurance per job loser, normalized by the average annual earning of a manufacturing worker --- a replacement ratio which shows what fraction of earnings (of manufacturing workers since they are the ones most likely to collect unemployment insurance) is replaced by unemployment insurance = $(YPTU/LUJL)/(YPWF/LAMANU)$, where,

YPTU: Government unemployment insurance benefits. Quarterly, SAAR.

Source: National Income and Product Account. Gross Domestic Product, Table 2.1.

LUJL: Job losers and persons who completed temporary jobs: Monthly, SA. Source: Department of Labor Bureau of Labor Statistics. "The Employment Situation," Table A-6.

²⁶Wages and salaries for workers plus employers' contributions for social insurance and private benefit plans. Except for nonfinancial corporations, the series also includes an estimate of wages, salaries, and supplemental payments for the self-employed.

YPWF: Wage and salary disbursements in Manufacturing. Quarterly, SAAR.
Source: National Income and Product Account. Personal Income, Table 2.1.

LAMANU: Nonfarm Payroll Employees in Manufacturing. Monthly, NSA.
Source: Department of Labor. Bureau of Labor Statistics. "The Employment Situation", Table B-1.

SOC: Quarterly, Source: FRBNY Staff Estimate.

DUM: accounts for the restraining effect of the wage and price freeze in 1971:Q4 and the rebound after the relaxing of the controls in 1972:Q1 (=1 in 71:Q4, -0.6 in 72:Q1, and 0 elsewhere).

Additional Variables Examined:

Commodity Price Index: Spot commodity price index for all commodities. Monthly, 1967=100.
Source: K.R. CRB Commodity Index Report. Knight-Ridder Financial.

Trade-Weighted Value of the Dollar: U.S. vs eighteen countries, based on 1984 bilateral trade weights for the eighteen currencies. Monthly, 1980=100. Source: Federal Reserve Bank of Atlanta.

Bibliography

Blanchard, Olivier J. (1984), "The Lucas Critique and the Volcker Deflation," American Economic Review Papers and Proceedings 74, pgs. 211-215.

Blomberg, S. Brock and Ethan S. Harris (1995), "The Commodity-Consumer Price Connection: Fact or Fable?" Federal Reserve Bank of New York Economic Policy Review, October, pgs. 21-38.

Boldin, Michael D. (1996), "Problems in Determining the Capacity-Inflation Link," Memorandum, The Conference Board.

Brown, R.L., J. Durbin, and J.M. Evans (1975), "Techniques for Testing the Constancy of Regression relationships Over Time," Journal of the Royal Statistical Society 37, pgs. 149-192.

Chow, Gregory C. (1960), "Tests of Equality Between Sets of Coefficients in Two Linear Regressions," Econometrica 28, pgs. 591-605.

Economic Report of the President, (1997), Published by the United States Printing Office, Washington D.C.

Eggert, Robert, ed. "Blue Chip Economic Indicators," Published by Capitol Publications, Inc. Alexandria Va. 1991-95.

Englander, Steven A., and Cornelis A. Los (1983), "The Stability of the Phillips Curve and Its Implications for the 1980s," Federal Reserve Bank of New York Research Paper No. 8303, February.

Friedman, Milton (1968), "The Role of Monetary Policy," American Economic Review 58, pgs. 1-17.

Fuhrer, Jeff (1995), "The Phillips Curve is Alive and Well," New England Economic Review, March/April, pgs. 41-56.

Goodfriend, Marvin (1993), "Interest Rate Policy and the Inflation Scare Problem: 1979-1992," Federal Reserve Bank of Richmond Quarterly Review, Winter, pgs. 1-24.

Gordon, Robert J. (1970), "The Recent Acceleration of Inflation and its Lessons for the Future," Brookings Papers on Economic Activity vol. 1, pgs. 8-41.

_____ (1975), "The Impact of Aggregate Demand on Prices," Brookings Papers on Economic Activity vol. 6, pgs. 613-62.

_____ (1977), "Can the Inflation of the 1970s Be Explained?" Brookings Papers on Economic Activity vol. 8, pgs. 253-77.

_____ (1982), "Inflation, Flexible Exchange Rates, and the Natural Rate of Unemployment," In Baily, M. N., ed., Workers, Jobs and Inflation. Washington: Brookings Institution, pgs. 88-152.

_____ (1990), "U.S. Inflation, Labor's Share, and the Natural Rate of Unemployment," In König, Heinz, ed., Economics of Wage Determination. Berlin and New York: Springer Verlag, pgs. 1-34.

_____ (1996), "The Time-Varying NAIRU and its Implications for Economic Policy," NBER Working Paper No. 5735, August.

Greene, William H. (1993), Econometric Analysis. New York: Macmillan Publishing Company.

Hamilton, James D. (1996), "This is What Happened to the Oil Price-Macroeconomy Relationship," Journal of Monetary Economics 38, pgs. 215-20.

King, Robert G., and Mark W. Watson (1994), "The Post-War U.S. Phillips Curve: A Revisionist Econometric History," Carnegie-Rochester Conference Series on Public Policy 41, pgs. 157-219.

King, Robert G., James H. Stock, and Mark W. Watson (1995), "Temporal Instability of the Unemployment-Inflation Relationship," Federal Reserve Bank of Chicago Economic Perspectives, May/June, pgs. 2-12.

Macroeconomic Advisers, LLC, (1996), "The U.S. Economic Outlook," October 8.

Meyer, Laurence H. (1997), "The Economic Outlook and Challenges for Monetary Policy," Remarks at the Charlotte Economics Club on January 16.

Mork, Knut A. (1989), "Oil and the Macroeconomy When Prices Go Up and Down: An Extension of Hamilton's Results," Journal of Political Economy 97, pgs. 740-44.

Passell, Peter (1995), "Has This War Been Won?" New York Times, October 25, pg. D1.

Phelps, Edmund S. (1967), "Phillips Curves, Expectations of Inflation and Optimal Unemployment Over Time," Economica 34, pgs. 254-81.

Phillips, A.W. (1958), "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957," Economica 25, pgs. 283-300.

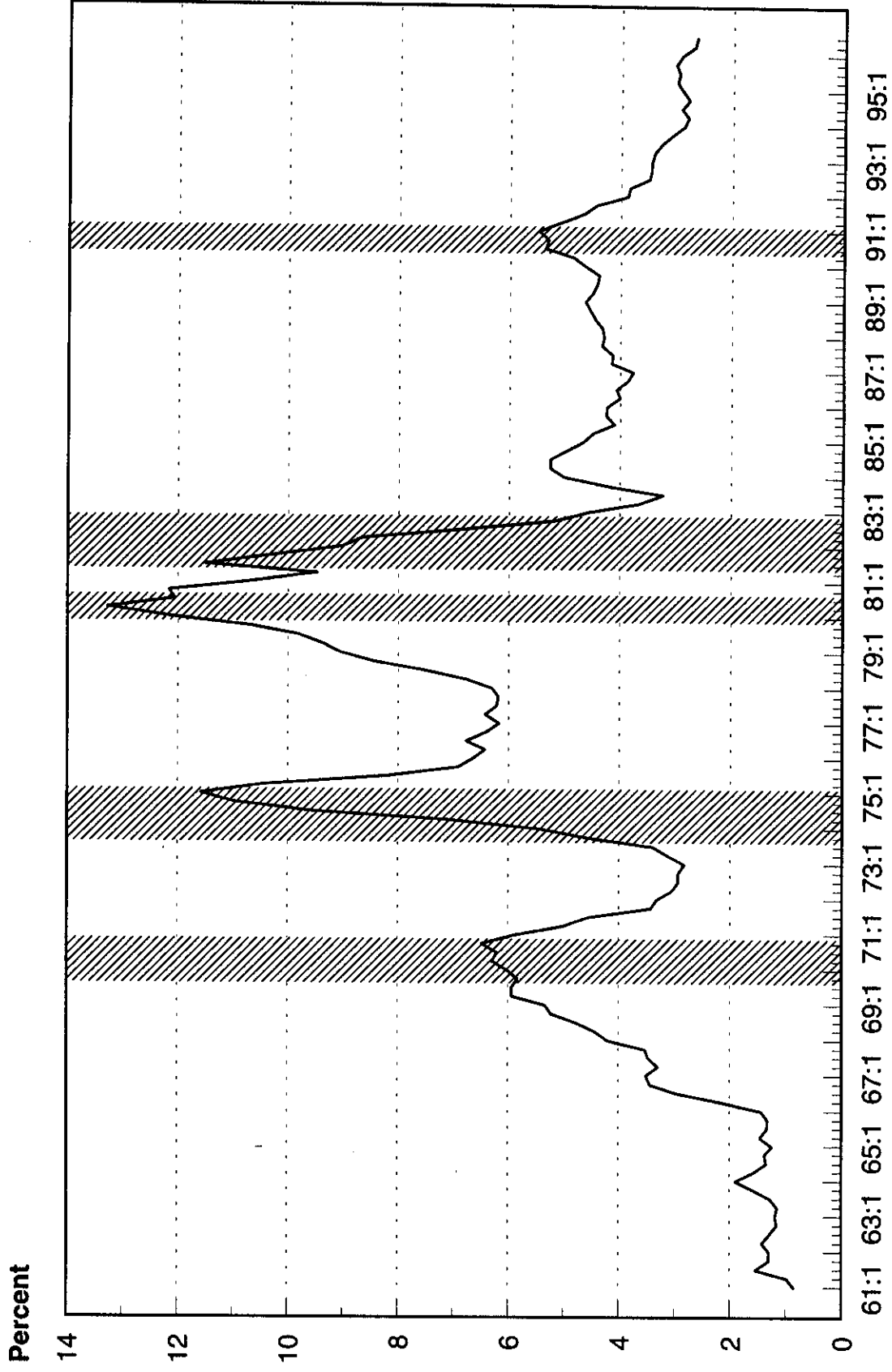
Tootell, Geoffrey M.B. (1994), "Restructuring, the NAIRU, and the Phillips Curve," New England Economic Review, September/October, pgs. 31-44.

White, Halbert (1980), "A Heteroskedasticity-Consistent Covariance Matrix Estimator and Direct Test for Heteroskedasticity," Econometrica 48, pgs. 817-38.

Chart 1

Core Consumer Price Index

Percent change from 4 quarters earlier
1961:Q1 - 1996:Q3



Note: Shading refers to NBER recessions.

Chart 2

Inflation Thresholds?

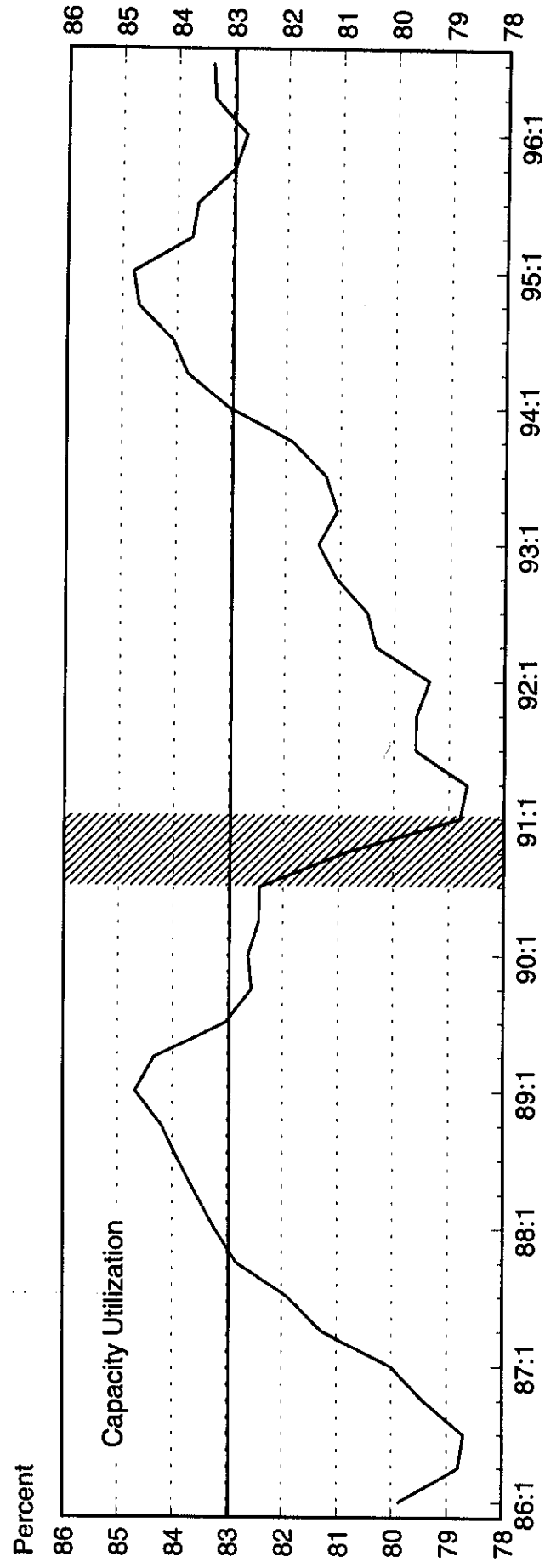
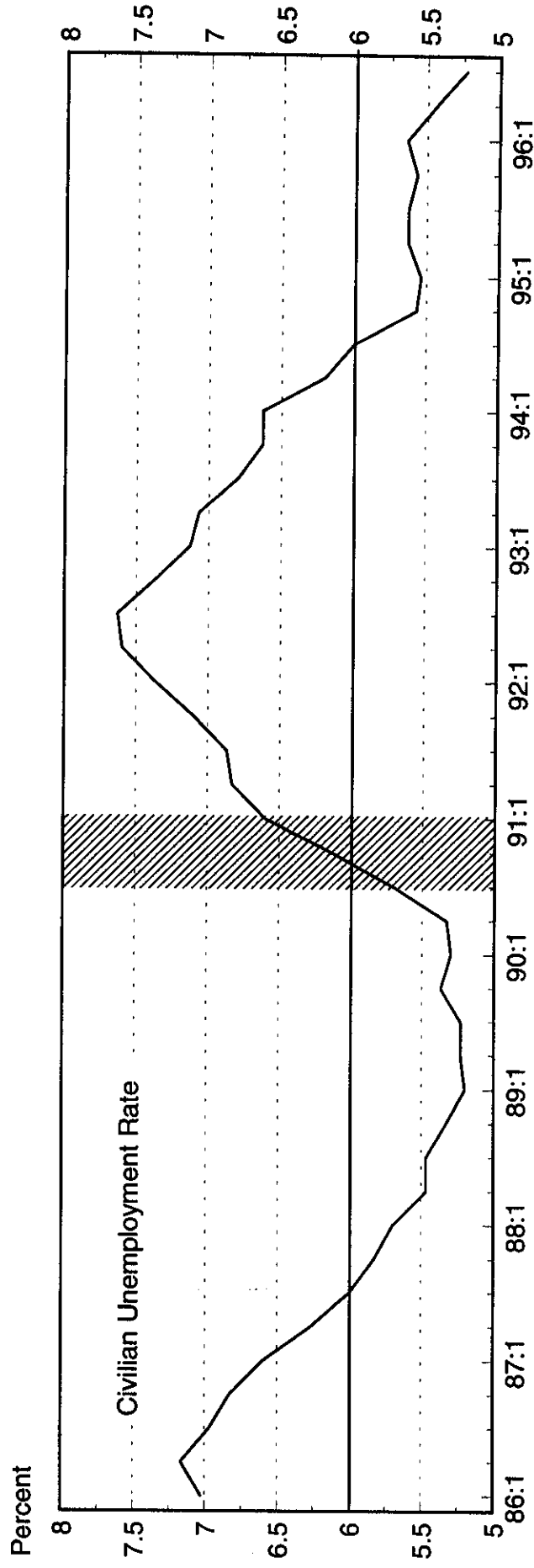


Chart 3
CPI Inflation: Actual and Forecast

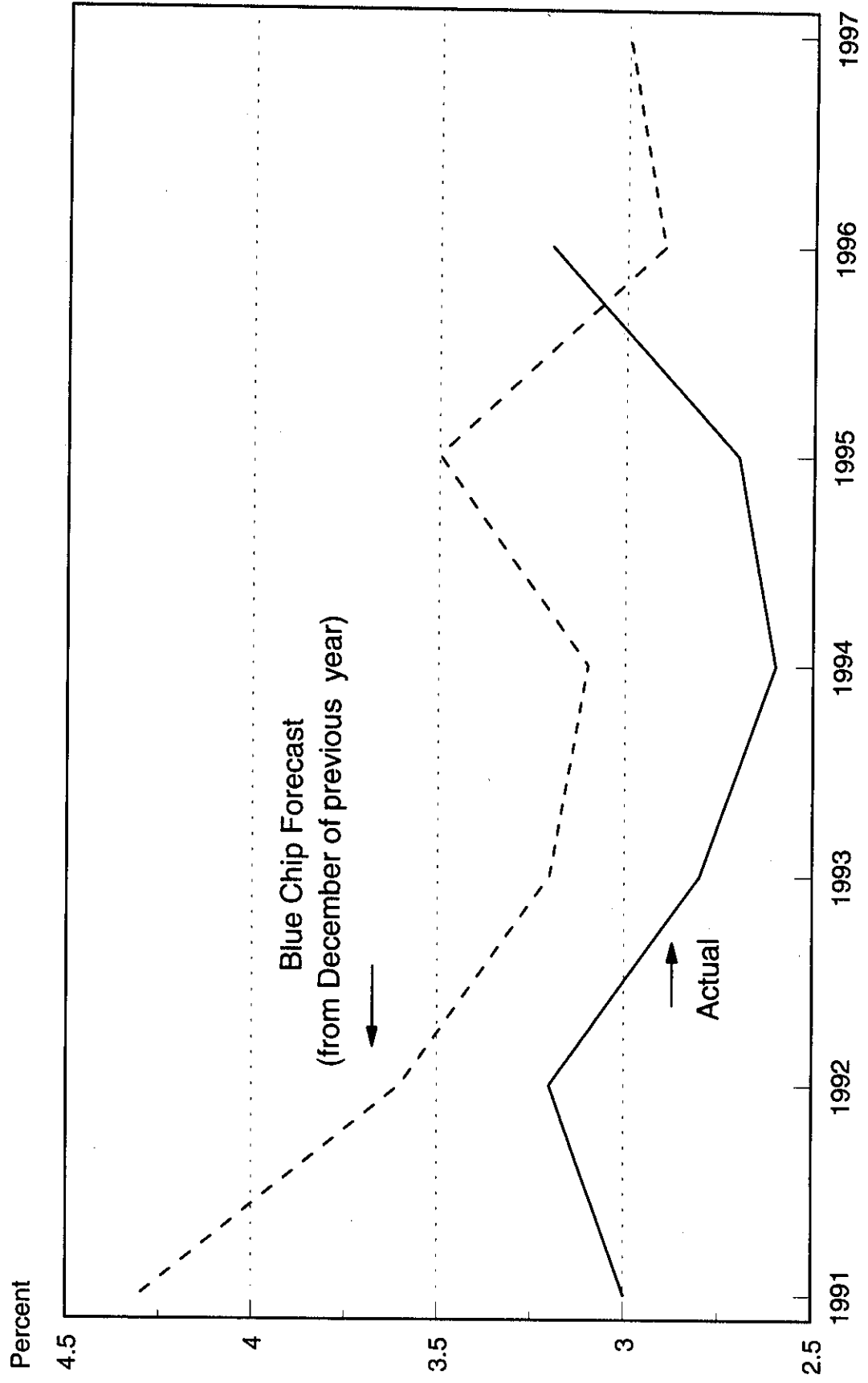
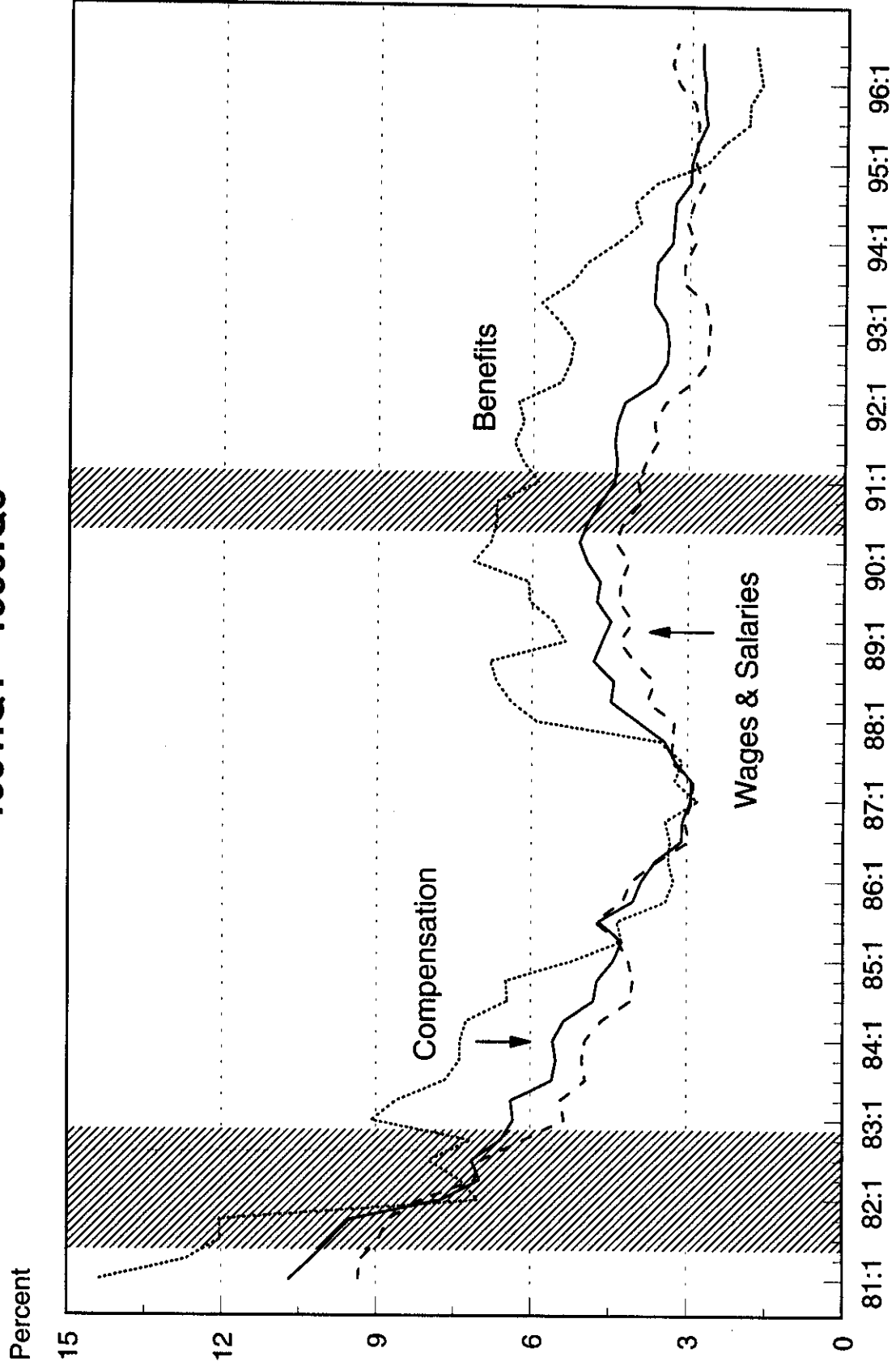
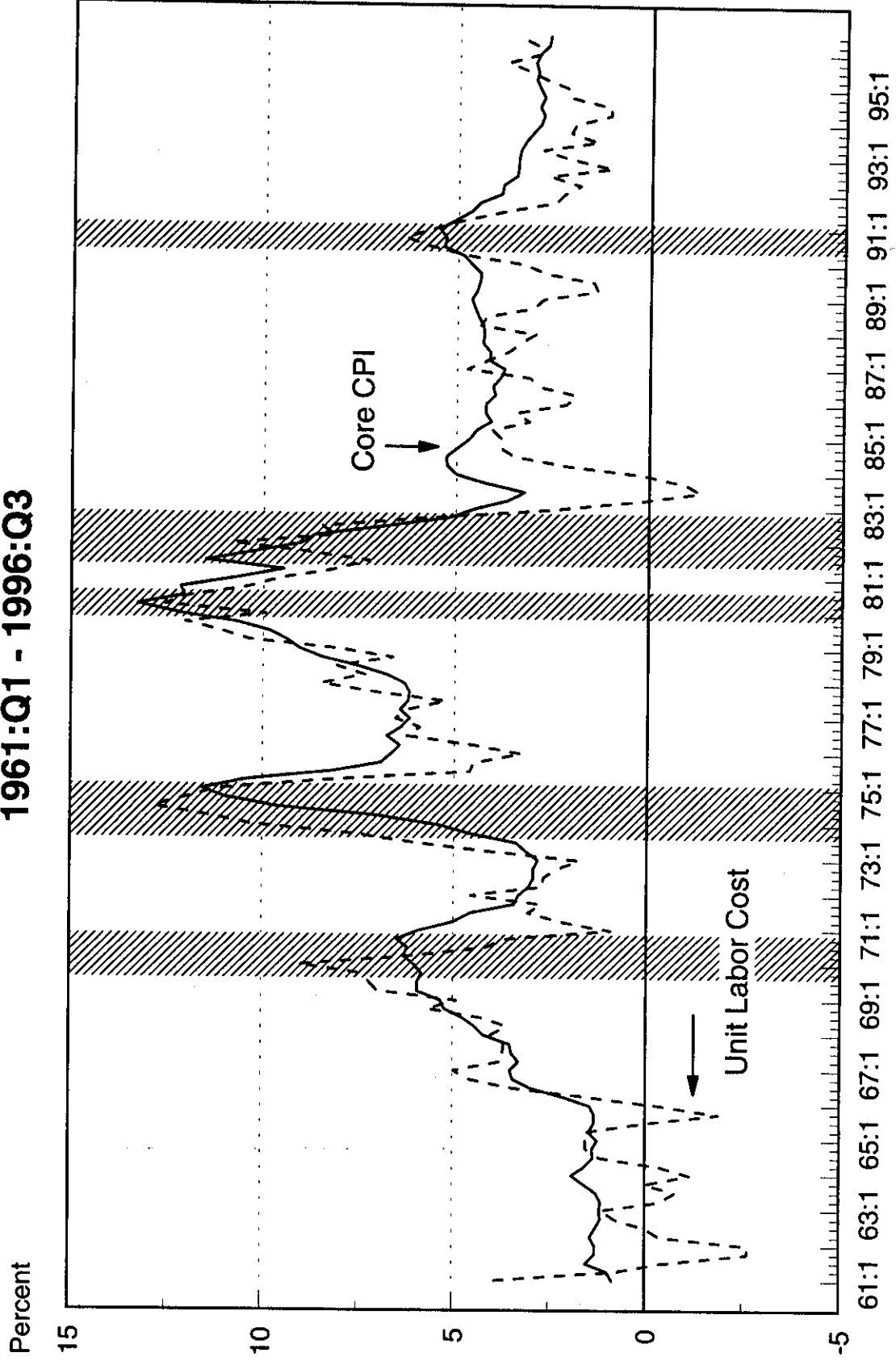


Chart 4
Employment Cost Index: Private Industry
 Percent change from 4 quarters earlier
 1981:Q1 - 1996:Q3



Note: Shading refers to NBER recessions.

Chart 5
Core CPI and Unit Labor Cost
 Percent change from 4 quarters earlier
 1961:Q1 - 1996:Q3



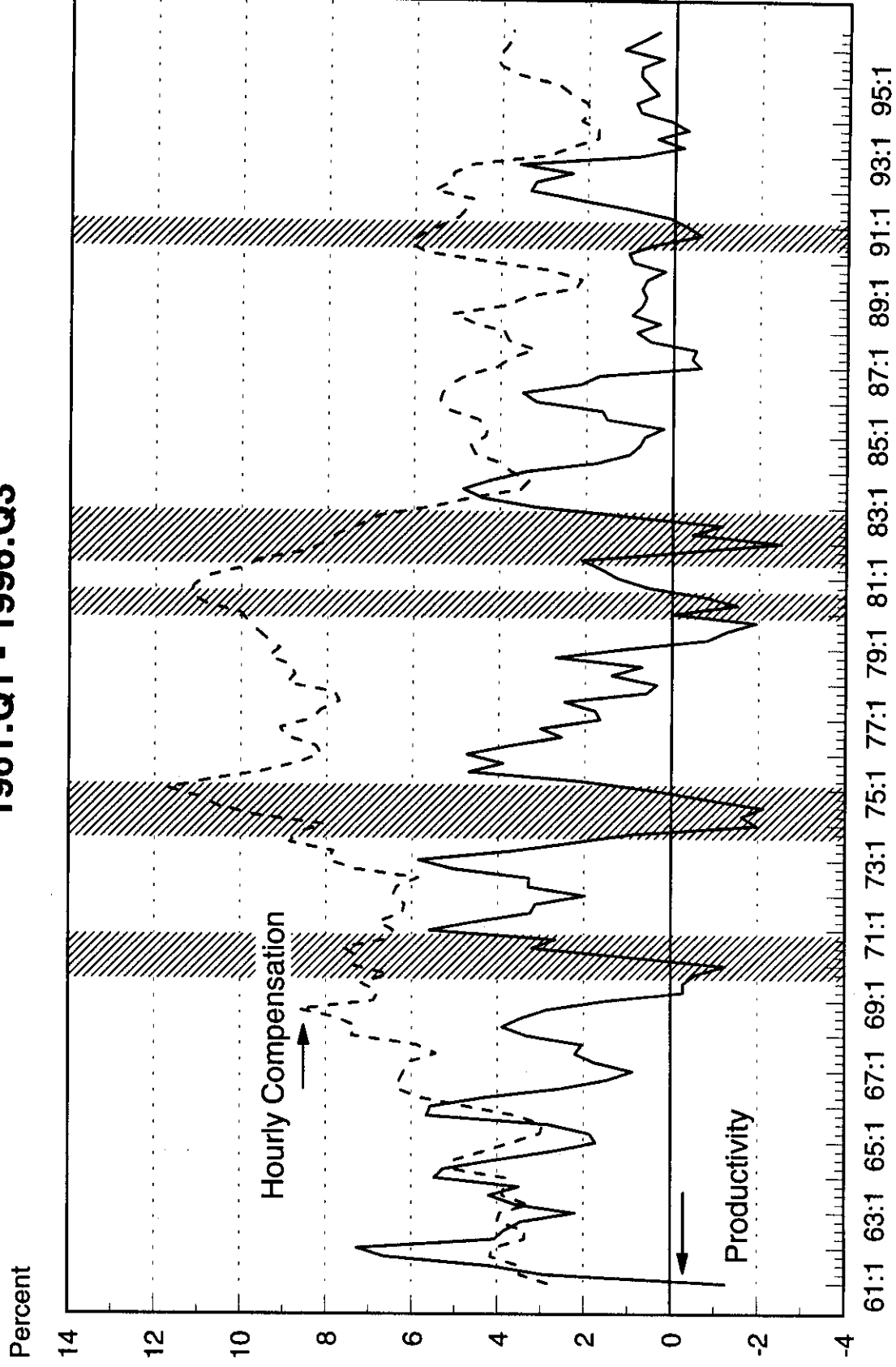
Note: Shading refers to NBER recessions.

Chart 6

Productivity and Hourly Compensation

Percent change from 4 quarters earlier

1961:Q1 - 1996:Q3

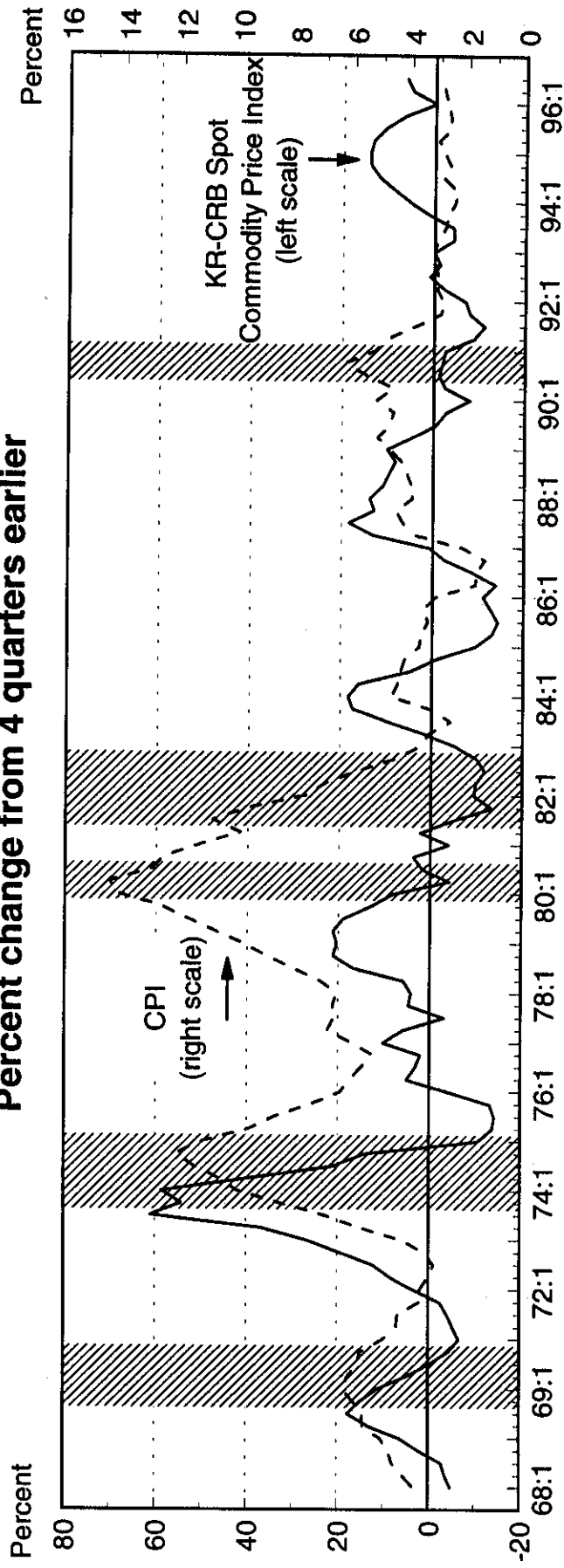


Note: Shading refers to NBER recessions.

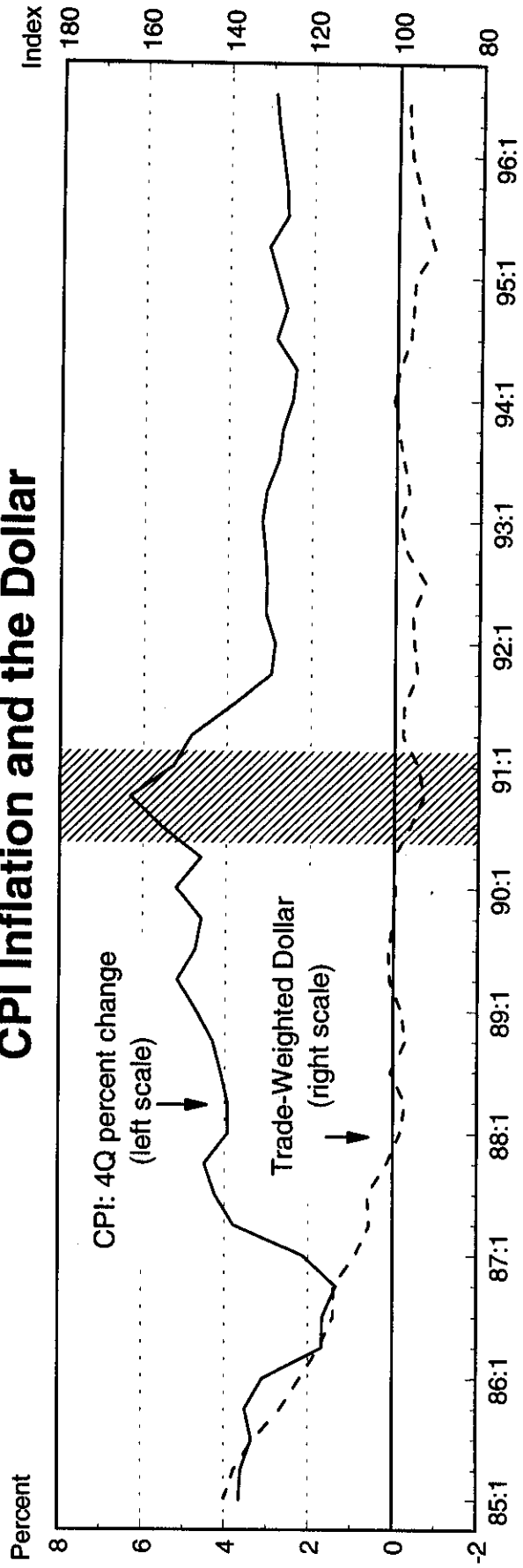
Chart 7

CPI Inflation and Commodity Price Inflation

Percent change from 4 quarters earlier

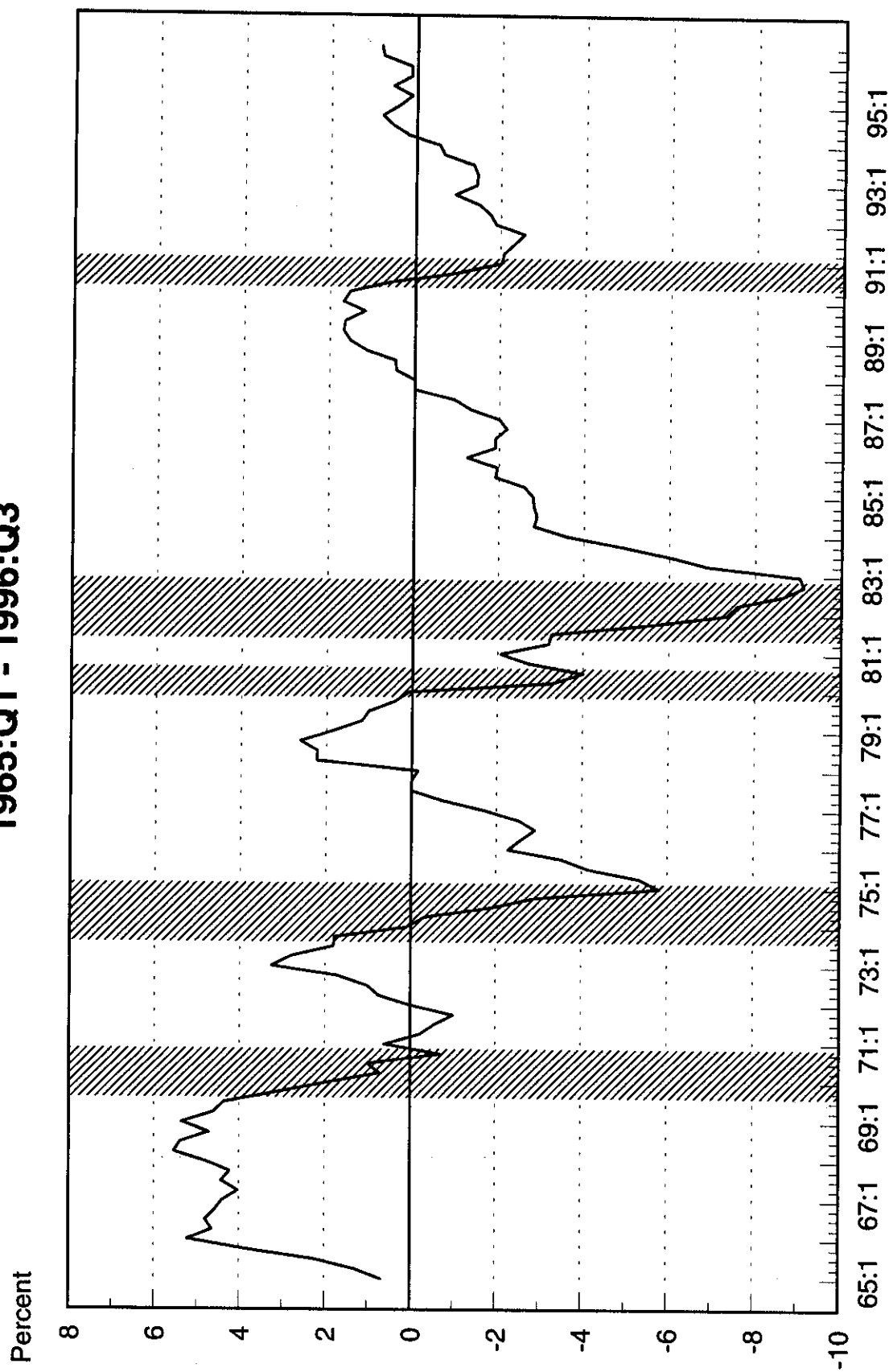


CPI Inflation and the Dollar



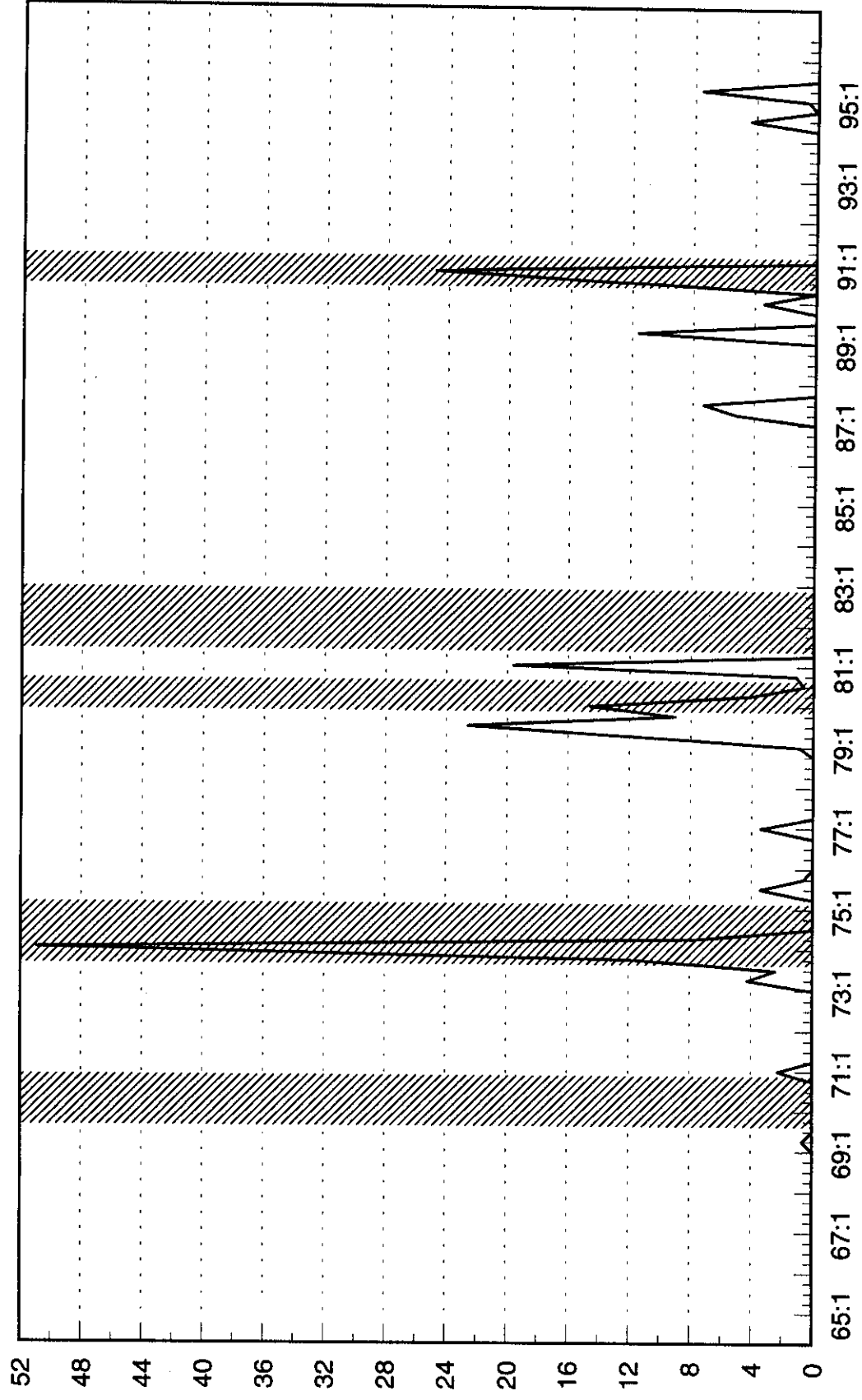
Note: Shading refers to NBER recessions.

Chart 8
The Output Gap
Percentage Difference between Actual and Potential GDP
1965:Q1 - 1996:Q3



Note: Shading refers to NBER recessions.

Chart 9
Net Positive Change in Real Oil Prices
1965:Q1 - 1996:Q3

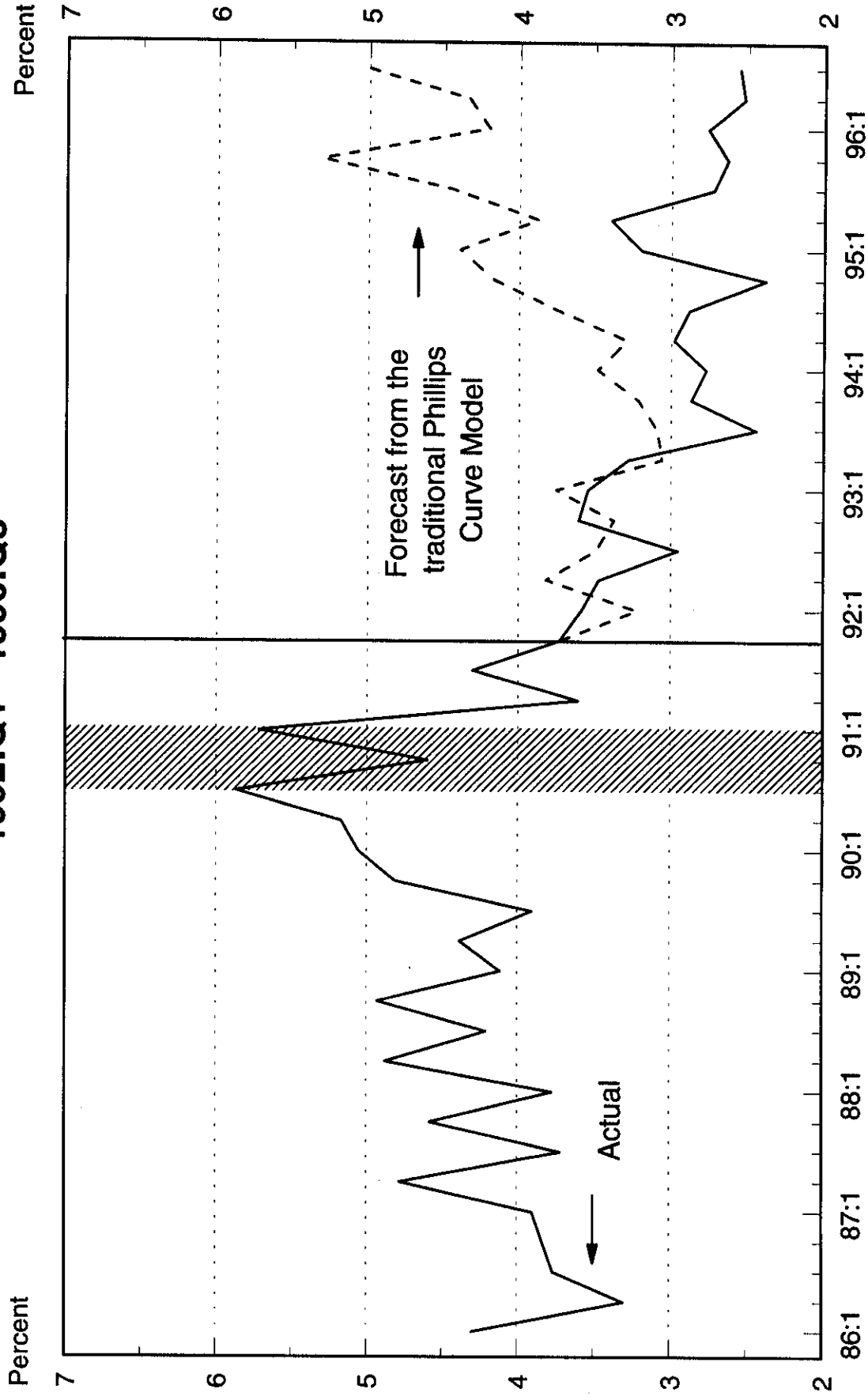


Note: Shading refers to NBER recessions.

Chart 10

Core CPI Out-of-Sample Forecast (Traditional Phillips Curve)

1992:Q1 - 1996:Q3



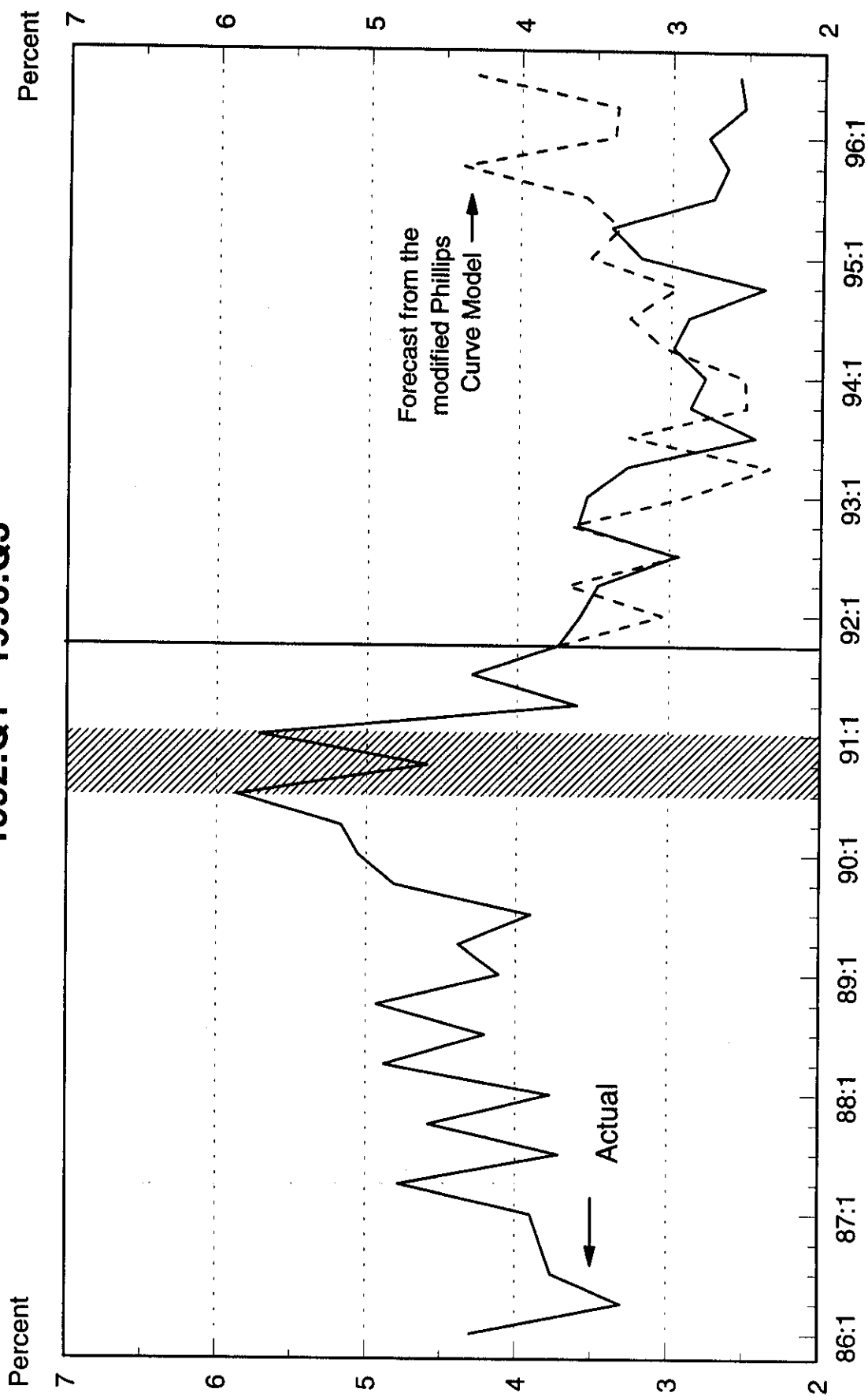
Note: Shading refers to NBER recession.

Chart 11

Core CPI Out-of-Sample Forecast

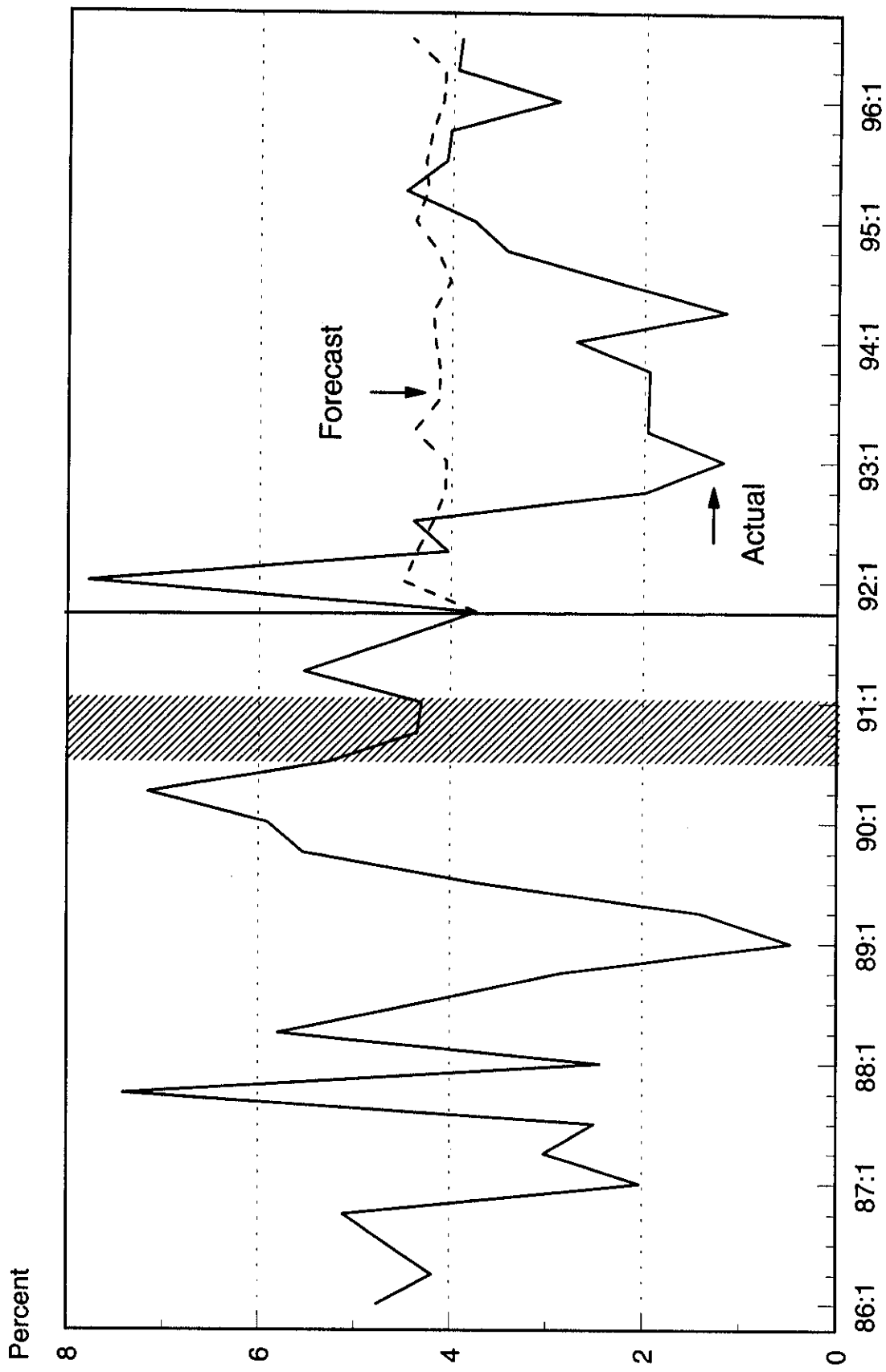
(Modified Phillips Curve)

1992:Q1 - 1996:Q3



Note: Shading refers to NBER recession.

Chart 12
Compensation Growth Out-of-Sample Forecast
1992:Q1 - 1996:Q3



Note: Shading refers to NBER recession.

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