A look at the US inflation puzzle[1]

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Despite weaker-than-anticipated inflation the past year, Federal Reserve Bank (of San Francisco) President Parry stressed continued vigilance on the price front. "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" – contrary to his expectations and most economic models, he noted.

He acknowledged being puzzled over the reasons why inflation has remained below expectations, despite robust growth, tight labor markets and rising wages.

"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," which means extra caution on inflation.

[Dow Jones News Service: 7th January 1997]

Introduction

Since the current expansion began in 1991, the inflation rate has remained at or below 3%. 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.[2] 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 inflation increase has led some individuals to conclude that there is an "inflation puzzle".

One possible explanation for this "puzzle" is that it reflects a fundamental shift in the dynamics of the inflation process. Changes in labor market behavior, increased international competition, and changes in the way monetary policy is conducted have been cited as support for this explanation. Alternatively, one could argue that forecasters and market makers have simply "missed the boat," creating the perception of an inflation puzzle that does not exist.

The purpose of this paper is to investigate the issue of an inflation puzzle and, in particular, to assess the merits of the preceding arguments concerning its existence. We explore this issue by estimating Phillips-curve models for price inflation in the core consumer price index (CPI) and wage inflation measured by compensation growth and evaluating their forecast performance. 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 price inflation over the current expansion has *not* been unusually low relative to its historic proximate determinants. In particular, the results suggest that our

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[2] Goodfriend (1993) contains a discussion of other "inflation scare" episodes in his case study of the Federal Reserve's interest rate policy from 1979-92.

price-inflation Phillips-curve model – modified to include unit labor costs – fits the data quite well, with stability tests and out-of-sample forecasts providing little evidence of a change in the behavior of inflation over the past few years. However, the results also indicate that compensation growth was markedly lower than the corresponding forecasts from our wage-inflation Phillips-curve model during the period 1992-94. While the current behavior of compensation growth appears to be consistent with the levels of other related macroeconomic variables, this relatively weak increase in compensation growth was a major contributor to the low level of inflation observed over the current expansion.

Our study also builds upon previous Phillips-curve research which has postulated that the dynamics of price and wage changes depend on both the level and rate-of-change of 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 – the nonaccelerating inflation rate of unemployment). For the price-inflation Phillips curve, the estimation results provide evidence of a statistically and economically significant rate-of-change effect for the output gap. In the case of the wage-inflation Phillips curve, we implicitly assume a constant NAIRU and observe that the estimated compensation growth equation performs quite well in terms of its within-sample predictions and out-of-sample forecasts. These findings suggest that the debate concerning time-variation in the NAIRU and a possible decline in its value during the 1990s may not be particularly important for gauging the behavior of compensation growth.

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 factors that have likely helped to mute the inflation rate over the current expansion. In Section 2, we specify a price-inflation Phillips-curve model, present the estimation results and tests for stability of the equation over the post-1991 period.

We then continue our exploration into the issue of an inflation puzzle and examine whether the recent movements in inflation may instead reflect unusual behavior in its underlying determinants. In Section 3, we analyze 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. In Section 4, we investigate if any changes in the behavior of labor market variables can account for this previous shortfall in compensation growth. The final section concludes.

1. The nature of the "inflation puzzle"

Chart 1 presents the behavior of core CPI – the CPI excluding its food and energy components – since the early 1960s. As the chart shows, inflation has typically accelerated during each of the four previous expansions. In contrast, inflation was slowly declining during the first few years of the current expansion and, more recently, has remained roughly constant.

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 have signaled an inflation pick-up. One such variable is the level of the actual unemployment rate relative to the NAIRU – the unemployment rate that is consistent with a constant rate of inflation. The civilian unemployment rate is shown in the upper panel of Chart 2, with an assumed value of 6% 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 researchers 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]

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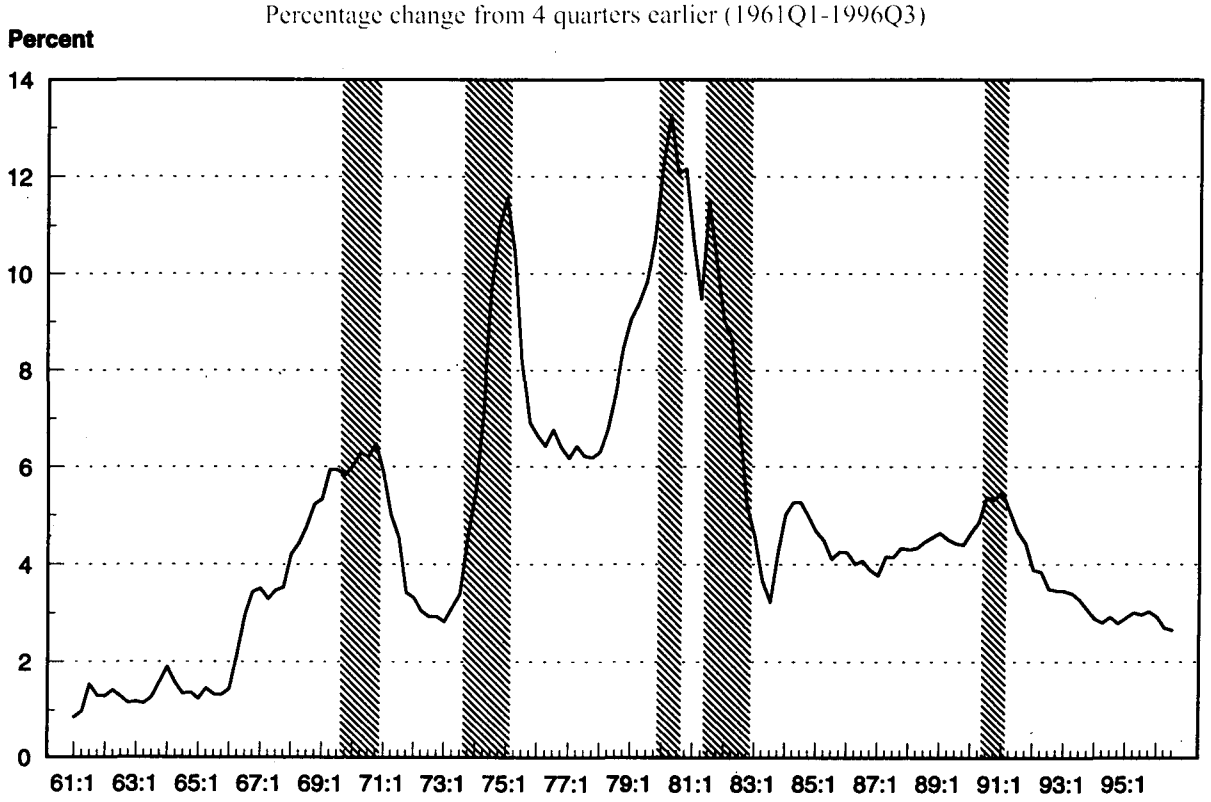
[3] One exception is Gordon (1996) who obtains an estimate of 5.3% for the NAIRU starting in 1996.

Chart 1

Core consumer price index

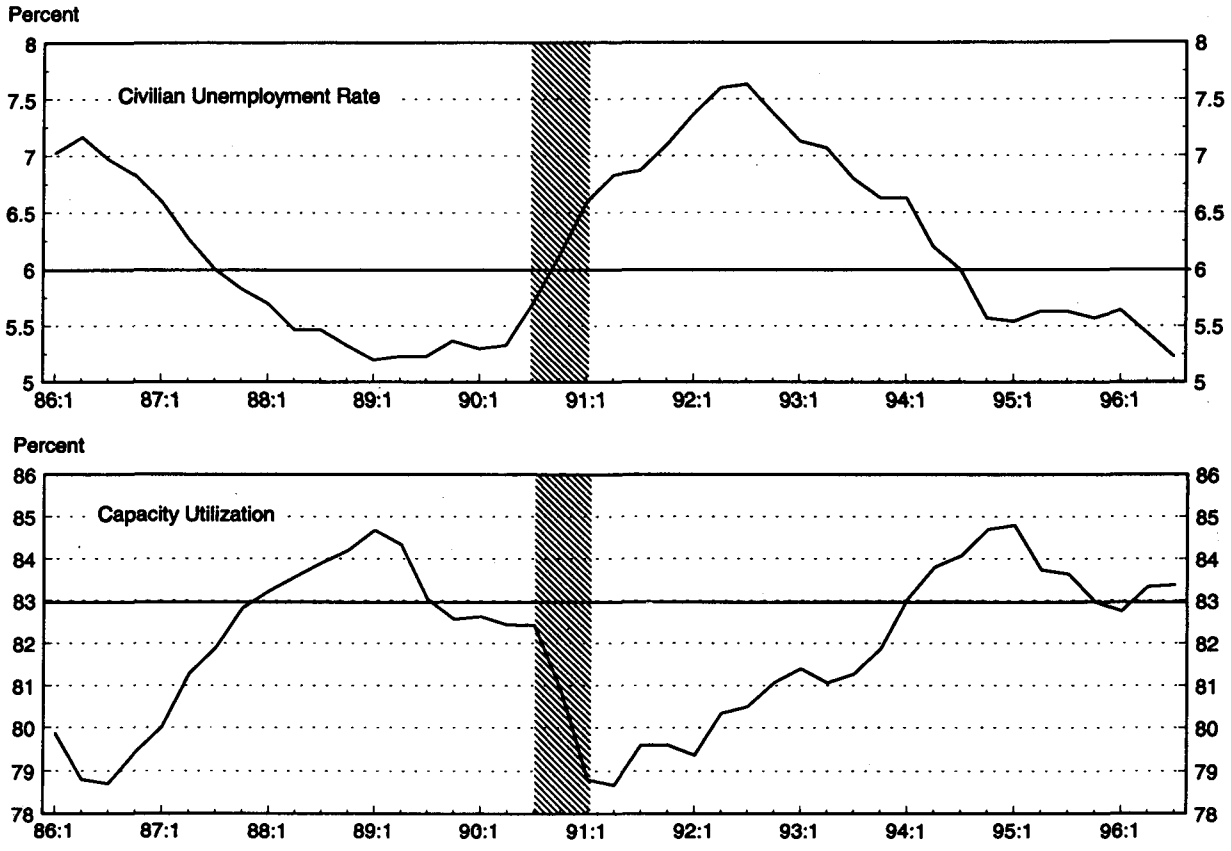
Percentage change from 4 quarters earlier (1961Q1-1996Q3)



Note: Shading refers to NBER recessions.

Chart 2

Inflation thresholds?

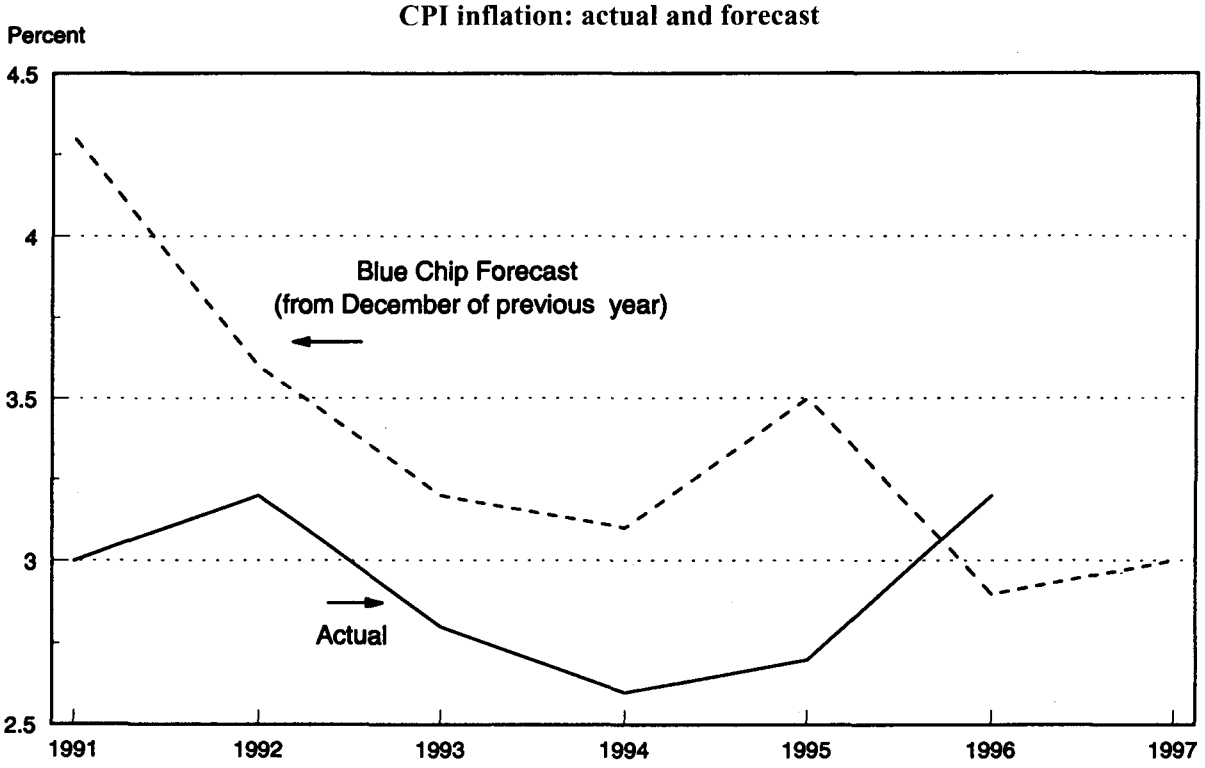


In a similar fashion, the lower panel of Chart 2 shows the rate of capacity utilization relative to a level of 83%. As Boldin (1995) notes, studies have generally associated accelerating inflation with capacity utilization rates in excess of 82-84%. While capacity utilization has since moved off its peak, it nevertheless remains quite high.

Consistent with these two indicators, the Blue Chip consensus forecast has, until recently, overpredicted inflation every year since the current expansion began (Chart 3). And, with the exception of this past year, the magnitude of the forecast errors continued to increase. Thus, using a wide variety of methods and models, forecasters also have been wrongly expecting an increase in the inflation rate.

While commentators have cited the type of evidence in Charts 1-3 to support their claims that inflation has remained unexpectedly low, these data only offer impressionistic evidence concerning a possible shift in the inflation process. To gain deeper insight into the recent behavior of inflation, one must examine the inflation process in a more formal manner. Following conventional practice, we interpret the movements in inflation as reflecting 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.

Chart 3
CPI inflation: actual and forecast

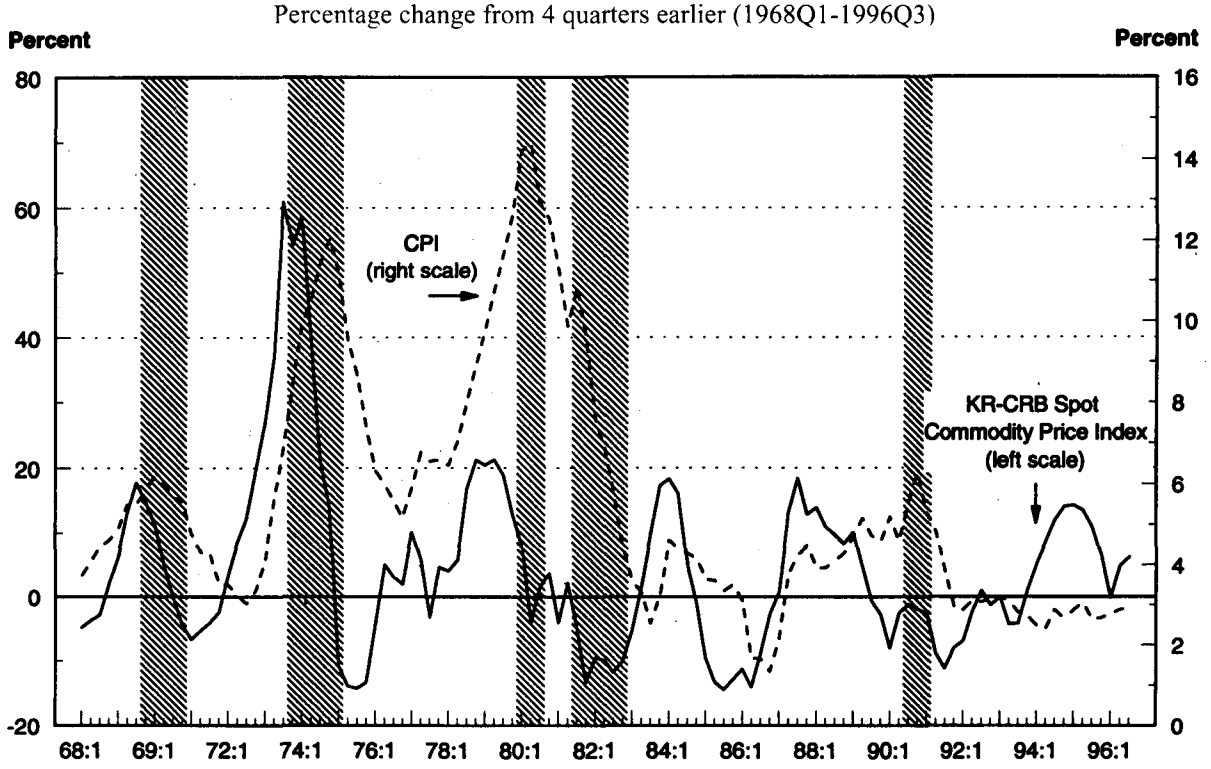


It is worth noting that some of these shock factors have managed to be well contained during the current expansion. One such factor is the absence of significant commodity price shocks. As Chart 4 shows, during most previous expansions, positive commodity price shocks occurred which added to inflationary 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 US 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.

Chart 4

KR-CRB spot commodity price index and consumer price index

Percentage change from 4 quarters earlier (1968Q1-1996Q3)

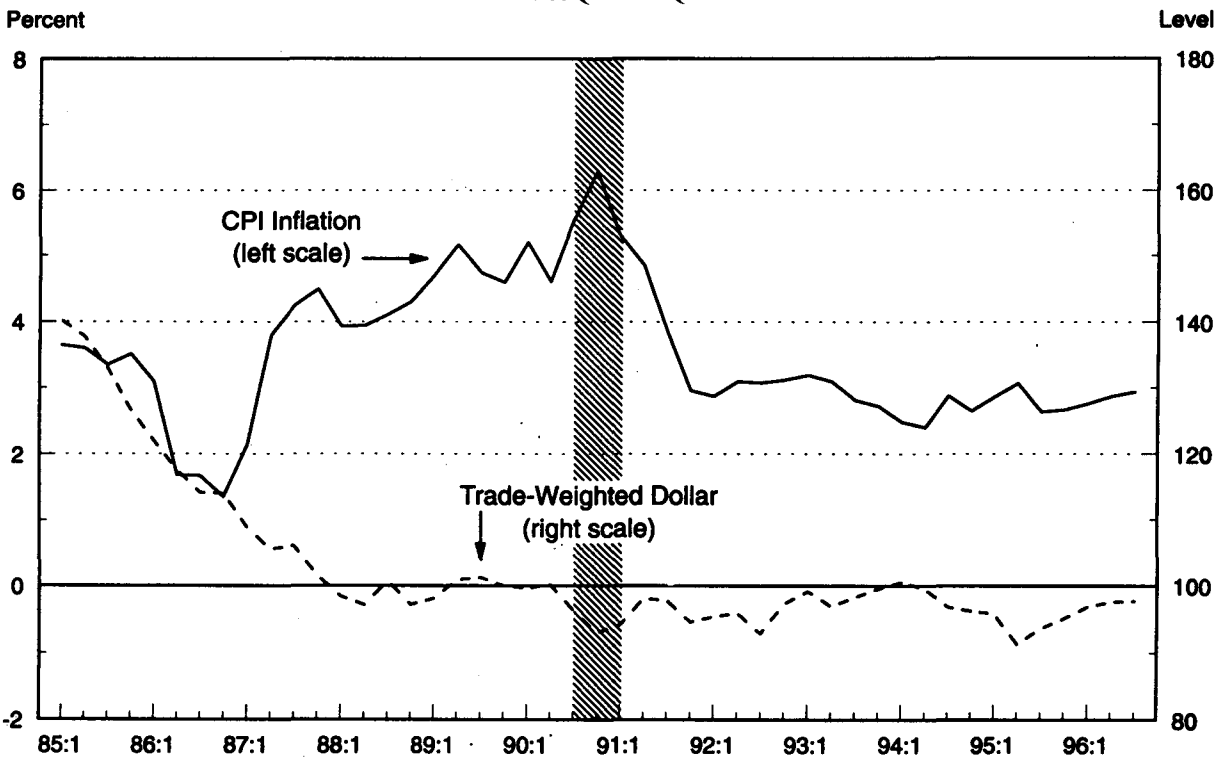


Note: Shading refers to NBER recessions.

Chart 5

CPI inflation and trade-weighted value of the dollar

1985Q1-1996Q3



Note: Shading refers to NBER recession.

A second factor concerns the behavior of the dollar. As shown in Chart 5, 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.

In the next section, we formulate a model to describe the movements in inflation over time. We briefly provide some background for our specification and report our estimation results. We then present several diagnostic tests, including out-of-sample forecasts, to determine how well our equation can account for the recent behavior of inflation.

2. A price-inflation Phillips-curve model

The "Phillips curve" refers to the posited relationship between the rate of change of a nominal wage or price and various indicators of real economic activity. The origin of the Phillips curve can be traced back to the work of Phillips (1958) who documented a strong 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. Subsequent versions of the Phillips curve recast the equation as a relationship between price inflation and unemployment, with the set of explanatory variables augmented to allow for the effects of expected inflation and other factors.[4] As Fuhrer (1995) notes, many of these subsequent additions were anticipated by Phillips in his original discussion.

In this section, we draw upon the Phillips-curve literature to specify and estimate a relationship between price inflation and its key determinants. We then use the estimated relationship to examine whether there is any evidence of a recent structural change in the inflation process. The price-inflation Phillips-curve model is given by:

$$INF_t = \alpha_0 + \alpha_1 GDPGAP_{t-1} + \alpha_2(\Delta GDPGAP_{t-1}) + \sum_{i=1}^{3}\alpha_{2+i}(INF_{t-i}) + \sum_{i=1}^{2}\alpha_{5+i}(OILG^*_{t-i}) + \sum_{i=1}^{2}\alpha_{7+i}(UNITG_{t-1}) + \varepsilon_t \quad (1)$$

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 GDP;

$\Delta GDPGAP$ = the first difference (or change) in the output gap;

$OILG^*$ = net positive change in the real price of oil;

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

ε = mean zero, serially uncorrelated random disturbance term.

Equation (1) uses the output gap (Chart 6) in place of the unemployment rate as a measure of aggregate demand, although the results are similar when the latter is used.[5] The idea of the effect of the output gap on inflation is similar to that of the unemployment gap: the economy operating above potential GDP is assumed to generate upward pressure on prices.[6] We also include

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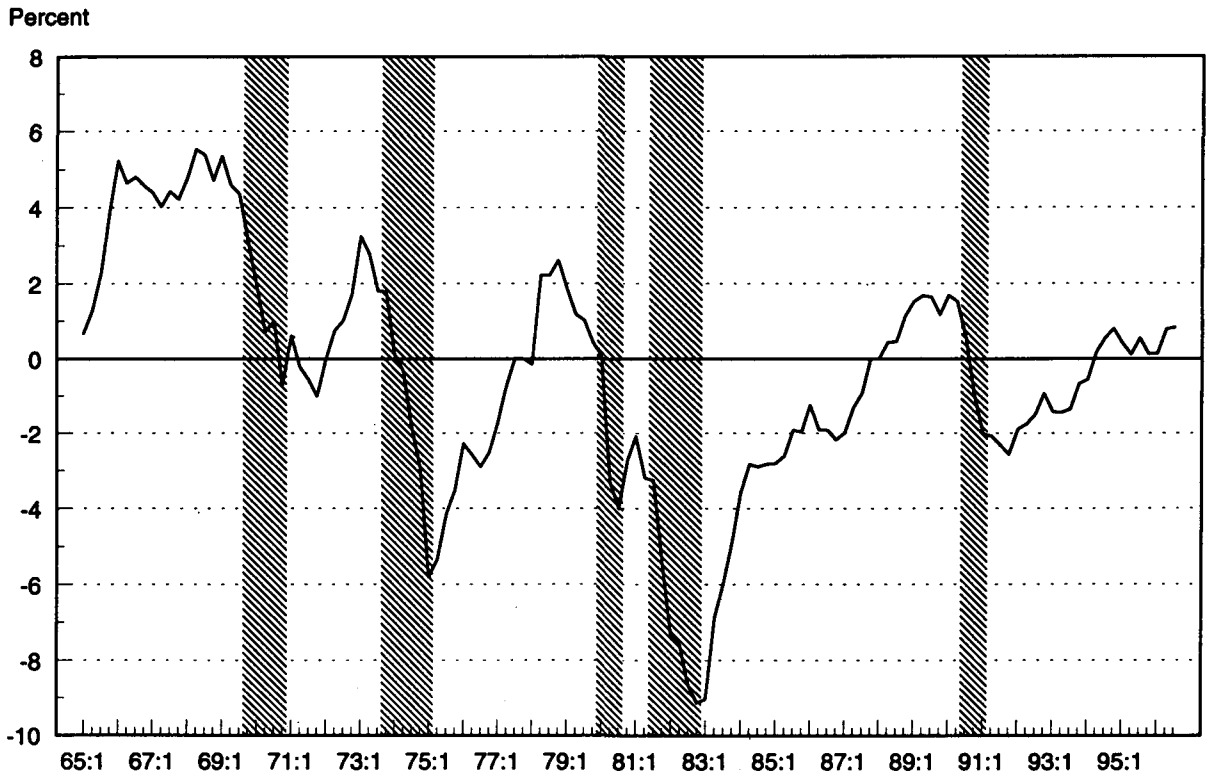
4 The theoretical development of the natural rate hypothesis and the distinction between the short-run and long-run Phillips-curve trade-off is due to the work of Friedman (1968) and Phelps (1967). There is a large empirical literature that has estimated current "expectations-augmented" Phillips curves. This literature includes the studies of Gordon (1970, 1975, 1977, 1982, 1990, 1996), Fuhrer (1995), Tootell (1994), King and Watson (1994), and King, Stock and Watson (1995).

5 More detailed definitions and sources of the data are presented in the Data appendix.

6 Fuhrer (1995) also uses the output gap as a measure of aggregate demand pressures.

Chart 6
The output gap
Percentage difference between actual and potential GDP (1965Q1-1996Q3)



Note: Shading refers to NBER recessions.

the first difference in the output gap to allow for a rate-of-change or "speed of adjustment" effect. More pressure is likely placed on prices when the gap narrows quickly rather than more slowly.[1]

The remaining basic determinants of inflation include past rates of inflation, oil prices, and unit labor costs. 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 allows for the influence of supply shocks. While changes in the relative price of inputs and the change in the real effective foreign exchange rate have been used as supply shock variables, we include a measure of the net positive change in real oil prices (Chart 7) in our specification. Because the core CPI excludes energy prices as a component, our supply shock variable attempts to capture any indirect channel of effect of oil prices on inflation. The construction of the supply shock variable follows from the approach of Hamilton (1996) and is designed to account for the change in the behavior of real oil prices and its increased volatility over the post-1986 period.[2]

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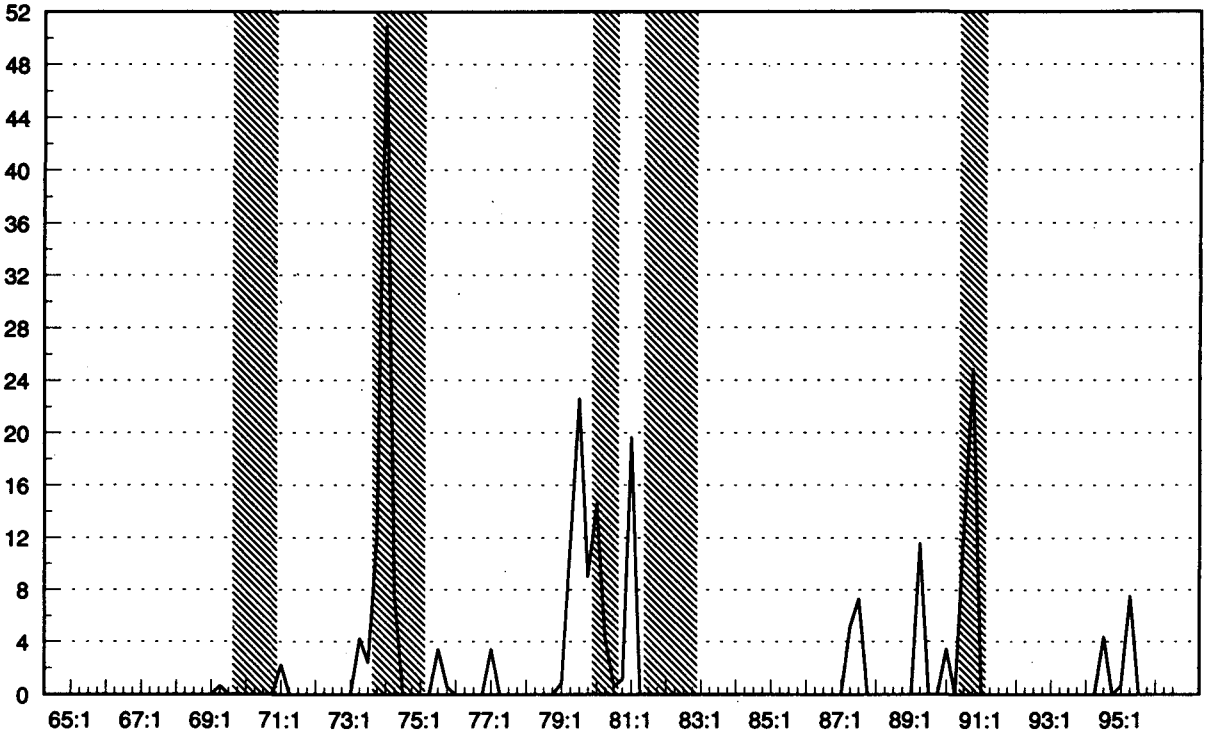
1 Gordon (1977, 1996) and Fuhrer (1995) have argued that rate of change effects for the output gap or unemployment gap are important for explaining the dynamics of the inflation process.

2 Net negative changes in real oil prices were excluded from equation (1), as they proved to be quantitatively and statistically insignificant.

Chart 7

Net positive change in real oil prices

1965Q1-1996Q3

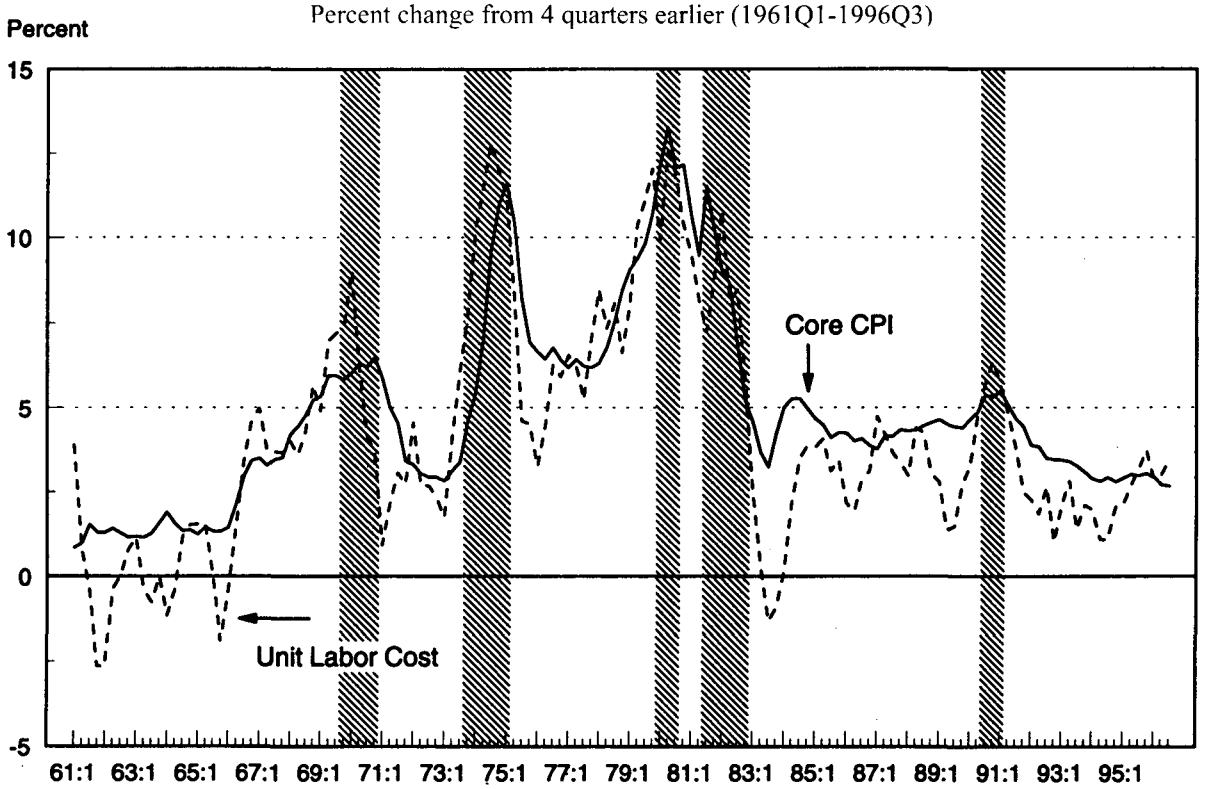


Note: Shading refers to NBER recessions.

Chart 8

Core CPI and unit labor costs

Percent change from 4 quarters earlier (1961Q1-1996Q3)

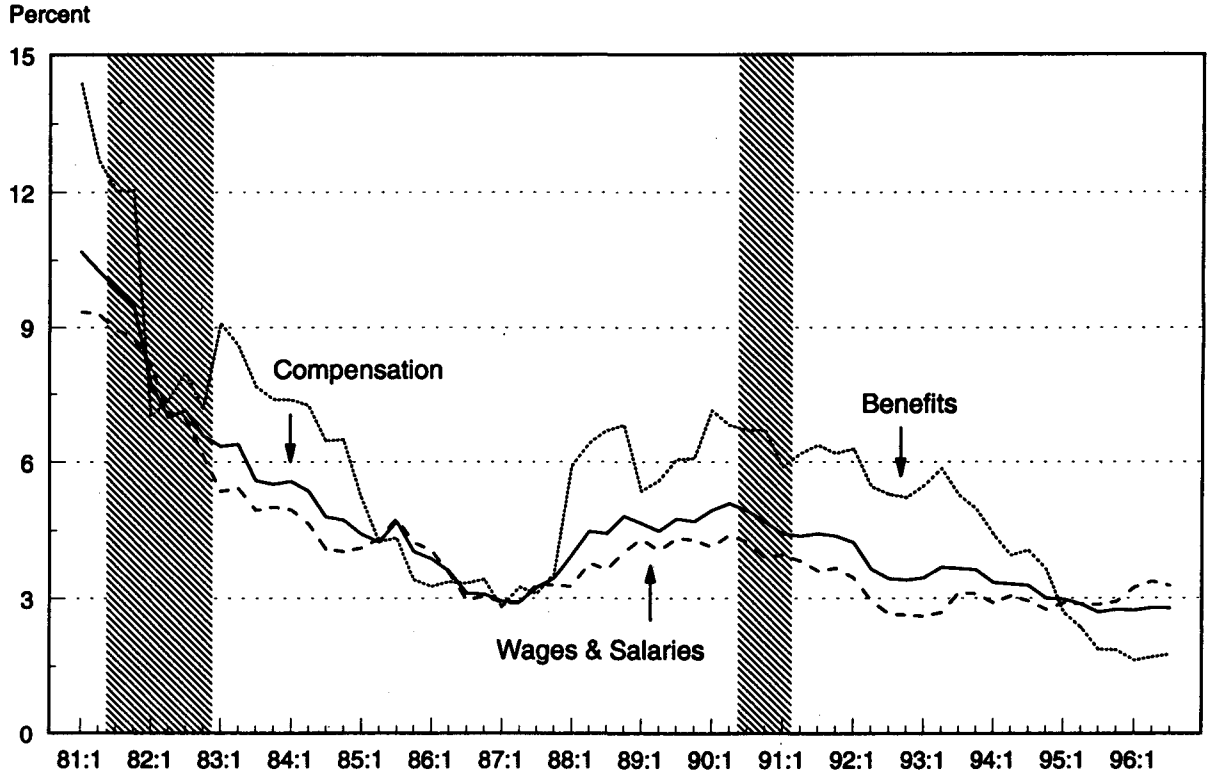


Note: Shading refers to NBER recessions.

The inclusion of the growth rate in unit labor costs (Chart 8), defined as compensation growth less productivity growth, allows for the notion that firms set prices as a markup over costs. Thus, when wage growth exceeds productivity growth, unit labor costs rise and so ultimately do prices. It is important to note that "traditional" price-inflation Phillips-curve models typically do not include unit labor costs as an explanatory variable. However, our specification allows us to account for the possibility that slow compensation growth during this expansion may have acted to offset other sources of inflationary pressures in the economy. Several commentators have suggested that the recent appearance of an inflation puzzle may be due to price-inflation Phillips curves neglecting to incorporate the effects of the decline in benefits growth and/or the restraint on wage growth that has occurred during this decade.[3] In particular, it is argued that these factors may have acted to lower the increase in overall labor costs and thereby reduced the pressure on firms to raise prices.

An examination of the behavior of compensation growth and its individual components (Chart 9) offers some support for this idea. Specifically, the growth rates for the three series are below the levels observed at the beginning of the current expansion, with benefits growth displaying the most dramatic decrease over this period.

Chart 9
Employment cost index: private industry
Percentage change from 4 quarters earlier (1981Q1-1996Q3)



Note: Shading refers to NBER recessions.

While the model takes real oil prices as exogenous, we only allow lagged values of the output gap and unit labor cost growth to be included as regressors to avoid simultaneity bias arising from the endogeneity of these variables. The lag lengths in equation (1) are selected by maximizing adjusted R^2, searching over one to four lags for inflation, the output gap, and unit labor cost growth

[3] Meyer (1997) is among those who have recently discussed this point.

and zero to four lags for the net positive change in the real price of oil.[4]

Equation (1) is estimated by the method of ordinary least squares (OLS) using quarterly data over the period 1965Q1-1996Q3 and results are presented in Table 1. As the table shows, both the level of the output gap variable and its rate-of-change are highly significant and have the expected positive sign. The two lagged values of both unit labor cost growth and the net positive change in the real price of oil are also highly significant with the expected positive signs.

Table 1
1965Q1-1996Q3

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

Parameter	Estimate	Standard error	t-statistic	p-value
α_0	0.0430	0.0682	0.6303	0.5297
α_1	0.0196*	0.0098	2.0000	0.0478
α_2	0.2603**	0.0427	6.0961	0.0000
α_3	0.2681**	0.0778	3.4456	0.0008
α_4	0.1279	0.0841	1.5207	0.1310
α_5	0.2928**	0.0744	3.9334	0.0001
α_6	0.0169**	0.0047	3.5558	0.0005
α_7	0.0227**	0.0048	4.6934	0.0000
α_8	0.1842**	0.0415	4.4368	0.0000
α_9	0.0721*	0.0329	2.1886	0.0306

Adjusted R-squared	0.812	Chow forecast test	1992Q1-1996Q3
Standard error of regression	0.292	F-statistic	0.218 (0.999)
Number of observations	127	Log likelihood ratio	5.265 (0.999)
Q(30)	28.314 (0.554)		

Note: 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% level. ** Significant at the 1% level.

It is also worth noting that the three lags of the inflation rate are generally significant, but that our estimated version of the price-inflation Phillips curve does not constrain the sum of the

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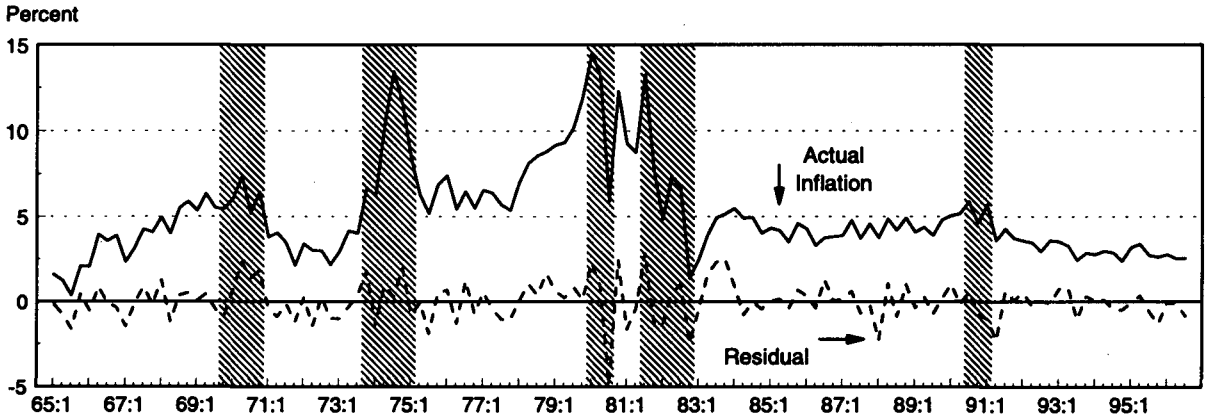
4 The compensation growth Phillips curve presented in Section 3 includes dummy variables to capture the effects from the imposition and relaxation of wage and price controls during the 1970s. These dummy variables are excluded from the price-inflation Phillips curve because they were statistically insignificant. 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.

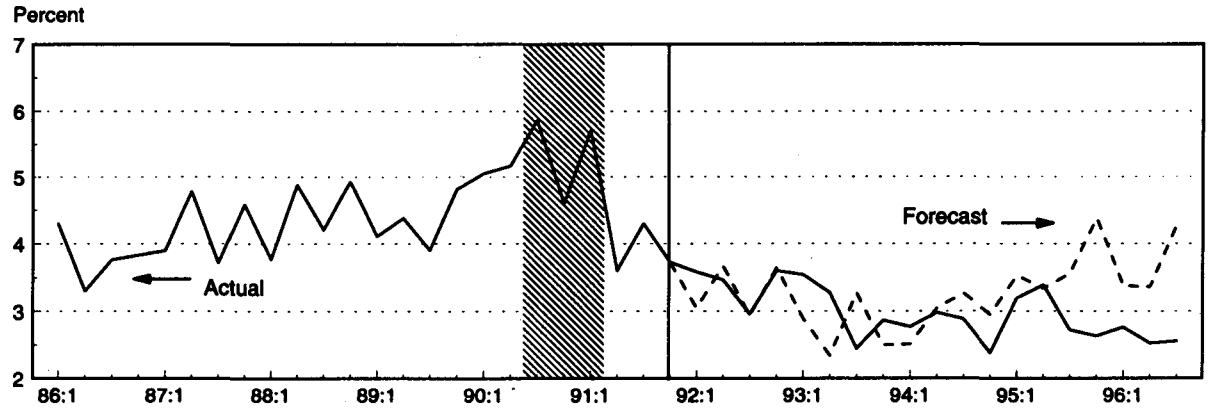
coefficients to equal unity ($\alpha_3+\alpha_4+\alpha_5=1$). This might initially suggest that equation (1) is inconsistent with a natural rate or accelerationist formulation of the Phillips curve. However, we will also present the estimation results of a compensation growth Phillips-curve model in Section 3. 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.

The adjusted R^2 indicates that the proportion of the variation of inflation that can be explained by the independent variables is quite high. We conducted several exercises to determine if any deterioration in the equation's fit had occurred in recent years. First, casual inspection of the estimated residuals plotted in the upper panel of Chart 10 shows no signs of deterioration.

Chart 10
Core CPI inflation and within-sample residuals
1965Q1-1996Q3



Core CPI out-of-sample forecast
1992Q1-1996Q3



Note: Shading refers to NBER recessions.

We also applied Chow's (1960) split-sample test to the data to formally address the issue of parameter stability. There are several methods 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 subsample (the beginning

of the sample through the 1991 period) to the estimates using the full sample and yields a test statistic which is distributed asymptotically as F with $(m, n-k)$ degrees of freedom under the null hypothesis.[5] Another method uses dummy variables for the entire parameter vector for one subsample (the post-1991 period) and then tests the joint significance of the dummy variables. This latter method yields a test statistic that is distributed asymptotically as chi-square (χ^2) with k degrees of freedom under the null hypothesis. As shown by the values of these two test statistics reported in the table, we fail to reject the null hypothesis of parameter stability for the post-1991 period at conventional significance levels.[6]

We examined the equation's out-of-sample forecast performance as well. This dynamic simulation differs from the previous (within-sample) estimation exercise by using lagged forecasted values of inflation, rather than the lagged actual values of inflation, to generate the subsequent quarter's forecast. For this part of the analysis, we estimated the equation through 1991Q4 and then used the estimated equation to forecast inflation over the 1992-96 period. The lower panel of Chart 10 shows this forecast along with the actual values of inflation. As the chart indicates, the equation was fairly accurate in forecasting inflation through the middle of 1995. Over the last year, however, some large discrepancies between actual and forecasted inflation have occurred. In particular, it appears that an oil price shock in 1995Q2 was the principal contributor to the sizable overprediction of inflation in 1995Q3. Because the model is being used to generate dynamic forecasts, the prediction error in 1995Q3 continues to affect the subsequent quarters' forecasted values. We performed the same exercise over the 1994-96 period with similar results (not shown).[7]

Having established that the relationship between inflation and its historic proximate determinants has remained relatively stable over this expansion, we next examine the key variables in the inflation equation and their relevance as possible sources of the slow growth in prices.[8] The two obvious contenders are the output gap variable and unit labor cost growth. We explore each of these two variables in turn.

The relatively low inflation rates experienced over the current expansion could have been the result of slow and steady output growth leading to only a gradual narrowing of the gap between actual and potential output (Chart 6). Whereas in previous expansions this gap variable rose to 2% or more, in this expansion it has barely remained above zero. This fact suggests that the lack of "hot" quarters of economic growth might be playing a role in keeping inflation low.

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5 The values of n and $n+m$ refer to the number of observations in the first subsample and the total sample, respectively. The value of k refers to the number of parameters in the model.

6 We 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 provided no evidence of parameter instability and corroborate the previous results that the low rates of inflation observed during this expansion are not indicative of any structural change.

7 One possible explanation for the recent divergence between actual and forecasted inflation is the discrepancy, since mid-1994, between the income and product sides of the National Accounts. If the product side is revised up to align better with the income side, as some have suggested, then productivity will also be revised up and both the output gap and unit labor costs will be revised down. These latter revisions would lower our out-of-sample forecast for the 1995-96 period. (See Macroeconomic Advisers, LLC, 1996 for a discussion of the discrepancy in the National Accounts.)

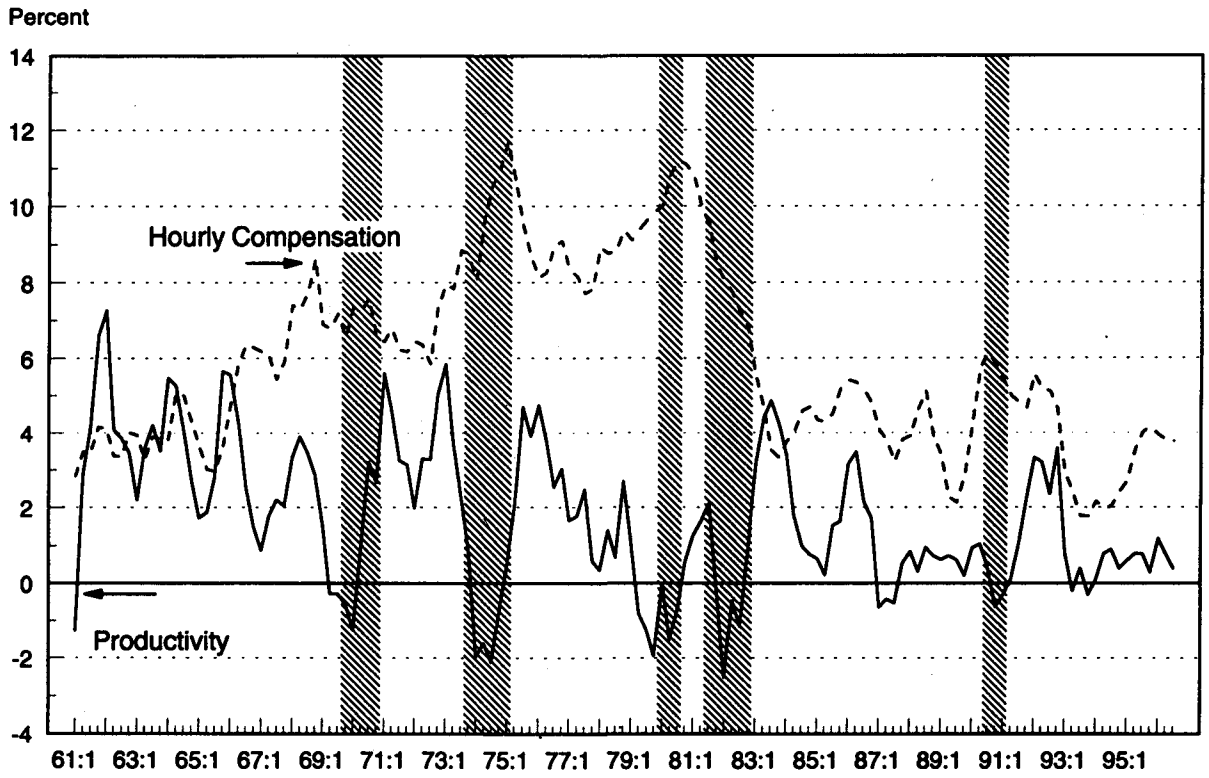
8 Note that our model does not allow us to examine whether there has been a shift in the Federal Reserve's inflation fighting credibility that could have changed the inflation process by directly altering inflationary expectations. Such an examination is beyond the scope of this paper: it would involve estimating a separate equation for inflationary expectations with some measure of Fed credibility included as an explanatory variable. However, the stability of the equation's structure strongly suggests that such a shift has not taken place. Blanchard (1984) has noted that Phillips curves of this type remained stable even after the 1979 change in Federal Reserve operating procedures.

The problem with the preceding argument is, however, that while it might explain why inflation has not accelerated, it does not account for the slow *decline* in the inflation rate that has occurred in more recent years. As can be seen in Chart 6, the difference between actual and potential output was not all that large at the start of the current expansion. In addition, it has not taken any longer for the gap variable to turn positive in this expansion relative to others. Thus, we do not believe that relatively modest output growth has played the principal role in the inflation story.

The second variable to consider is unit labor cost growth. As Chart 8 shows, not only has growth in unit labor costs been weak during this expansion, but a gap between unit labor cost growth and CPI inflation 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 view that unit labor costs may have played an important role in restraining the pressure on firms to raise prices.

With unit labor costs defined as compensation (wages and benefits) divided by productivity, either slow compensation growth or fast productivity growth must be accounting for its weak growth. As Chart 11 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% rate contributing to weaker growth in unit labor costs. But since that time, productivity has grown at rates below 1%. The chart also shows that compensation growth declined to around 2% fairly early in the expansion and hovered around that rate for over a year before showing signs of a modest pick-up. This 2% 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. In the next section, we examine compensation growth and its recent behavior in more detail.

Chart 11
Productivity and hourly compensation
Percentage change from 4 quarters earlier (1961Q1-1996Q3)



Note: Shading refers to NBER recessions.

3. Compensation growth Phillips curve

In an exercise that parallels the analysis in Section 2, we present the results from estimating a wage-inflation Phillips-curve model for compensation growth. We then examine whether there is evidence to suggest a recent change in the fit of the model to the data.

As previously noted, the original Phillips curve focused on the relationship between the 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. The compensation growth Phillips-curve model is given by:

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

where:

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

U = unemployment rate for males 25-54 years 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 (2) principally relates the movements in compensation growth to the unemployment rate and other variables reflecting labor market conditions.[9] The unemployment rate of prime age males is used as a measure of labor market tightness. We enter the variable in levels 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.[10] Equation (2) 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.[11]

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 1971Q4 and the rebound effect after the relaxation of the controls in 1972Q1.[12] The inclusion of lagged inflation terms 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.

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9 Detailed definitions of the data and their sources are reported in the Data appendix.

10 For example, we could follow the approach of Fuhrer (1995) who assumes a value of 6% 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 (2). 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.

11 This result is consistent with Fuhrer (1995) who also finds no significant rate-of-change effects for the unemployment rate in wage-inflation Phillips-curve models.

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

Equation (2) is estimated using quarterly data over the period 1967Q2-1996Q3 and the OLS results are presented in Table 2. As the table indicates, the first lagged values of the dependent variable and price inflation are not significant at the 5% level, while these variables' second lags are both significant. The unemployment rate is significant and has the expected negative sign. Finally, the variables reflecting labor market conditions are all significant with the expected signs. The adjusted R^2, although not quite as high as the value reported in Table 1, also indicates that the estimated equation fits the data quite well. The Chow break test does not reject the null hypothesis that the discrepancies between the actual and predicted values are statistically insignificant. However, inspection of the equation's residuals depicted in the upper panel of Chart 12 reveals some evidence of a modest break beginning in the early 1990s.

Table 2
1967Q2-1996Q3

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

Parameter	Estimate	Standard error	t-statistic	p-value
β_0	0.4247	0.2299	1.8476	0.0674
β_1	0.1591	0.0850	1.8713	0.0640
β_2	0.1854*	0.0830	2.2326	0.0276
β_3	-0.0662**	0.0243	2.7188	0.0076
β_4	0.1599	0.0879	1.8201	0.0715
β_5	0.1863*	0.0885	2.1044	0.0376
β_6	0.0905**	0.0206	4.4232	0.0000
β_7	1.6440*	0.8223	1.9994	0.0481
β_8	-0.7396*	0.3419	2.1633	0.0327

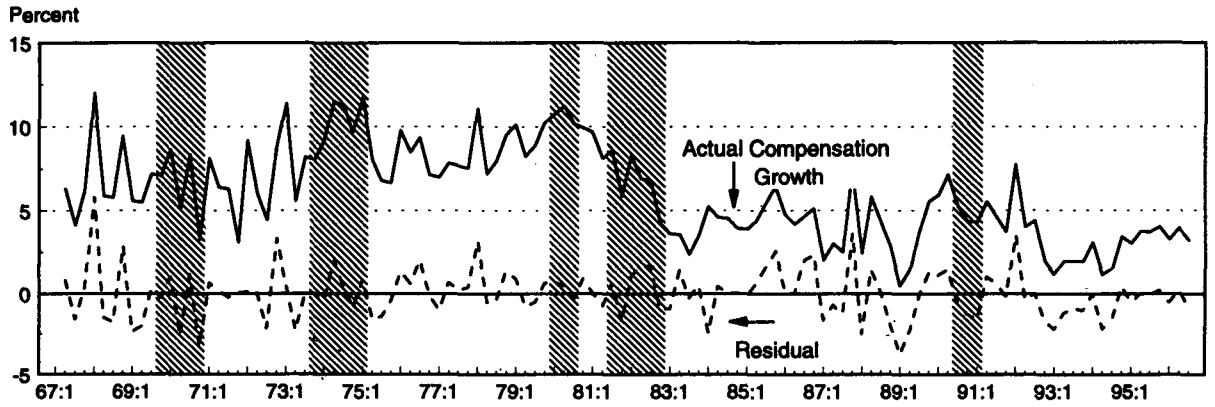
Adjusted R-squared	0.681	Chow forecast test	1992Q1-1996Q3
Standard error of regression	0.391	F-statistic	0.722 (0.787)
Number of observations	118	Log likelihood ratio	16.749 (0.607)
Q(30)	20.778 (0.895)		

Note: 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% level. ** Significant at the 1% level.

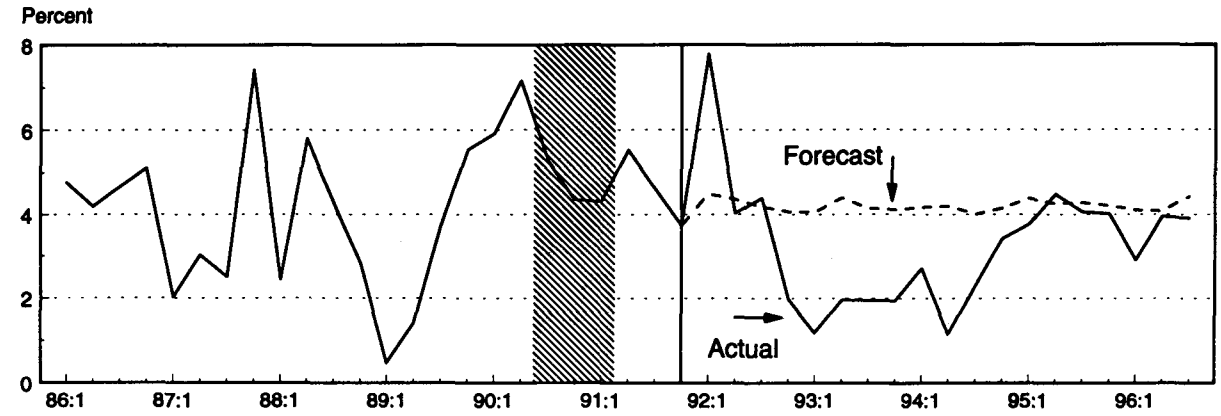
To gain further insight into the issue of a possible structural break, we estimate equation (2) over the period 1967Q2-1991Q4 and then use this estimated equation to generate predicted values for compensation growth over the 1992-96 period. When the estimated equation is used to generate a dynamic out-of-sample forecast, the model appears to consistently overpredict compensation growth from roughly 1992 until 1994 (lower panel of Chart 12). Based on the past relationship with its explanatory variables, compensation growth should have been higher by roughly 2% during this time period. Further, the timing and magnitude of this shortfall appears to be consistent with the observed breakdown of various indicators (Charts 1-3) that signaled an imminent

acceleration in inflation and provides additional support for the view that unit labor costs may be the key element in understanding the origin of the inflation puzzle. Although compensation growth now appears to be "back on track", and price-inflation was never "off-track", it is still of interest to try to understand the factor(s) responsible for the temporary shortfall in compensation growth.

Chart 12
Actual compensation growth and within-sample residuals
1967Q1-1996Q3



Compensation growth out-of-sample forecast
1992Q1-1996Q3



Note: Shading refers to NBER recessions.

Countless numbers of newspaper articles, along with several more rigorous pieces, have been written discussing whether changes in the behavior of labor markets have served to mitigate inflationary pressures during the current expansion.[13] One view is that labor markets are not as tight as traditional measures such as the unemployment rate might indicate. For our purposes, this explanation suggests that if an alternative labor market variable can be identified and included in our regression equation, then the 1992-94 overprediction of compensation growth can be greatly reduced or possibly eliminated. A second view is that a real or imagined decline in workers' power has occurred which is serving to reduce workers' willingness to ask for higher wages. Among the factors cited as support for this theory is the decline in the number of union members, the increase in the number of contingent workers, or in the number of firms moving their operations abroad where labor

[13] See for example Bradsher (1995), Passell (1995), Spiers (1995, 1996) and Valletta (1996).

is relatively cheap. Once again, our ability to assess the validity of this explanation will depend on the extent that we can quantify these particular phenomena. In the next section, we examine a number of series that attempt to measure these possible changes in labor market behavior.

4. Possible factors underlying compensation growth shortfall

To provide a further investigation into the 1992-94 compensation growth shortfall and the underlying causes, we proceed in two steps. First, we conduct an informal analysis. Specifically, we consider whether the movements in a particular series appear different in this expansion and could possibly explain the recent shortfall in compensation growth. If the informal evidence suggests that a particular series may be playing a role, then we turn to a more formal analysis. In particular, the second step involves testing whether the series adds significant explanatory content to our compensation growth equation as well as examining its quantitative importance for the recent weakness in compensation growth.

Admittedly, this second step is a difficult hurdle. Some of the factors may not have mattered in the early years of our sample period, and therefore might not display statistical significance over the entire period. On the other hand, if we only consider the effects of a variable during the 1990s, then this approach could potentially generate a significant correlation that is spurious in nature. Consequently, our empirical analysis will only consider the predictive content of variables based on the entire sample period. However, we recognize that any conclusions must be interpreted as suggestive, not definitive, and that the informal evidence might need to be given more weight than is customary.

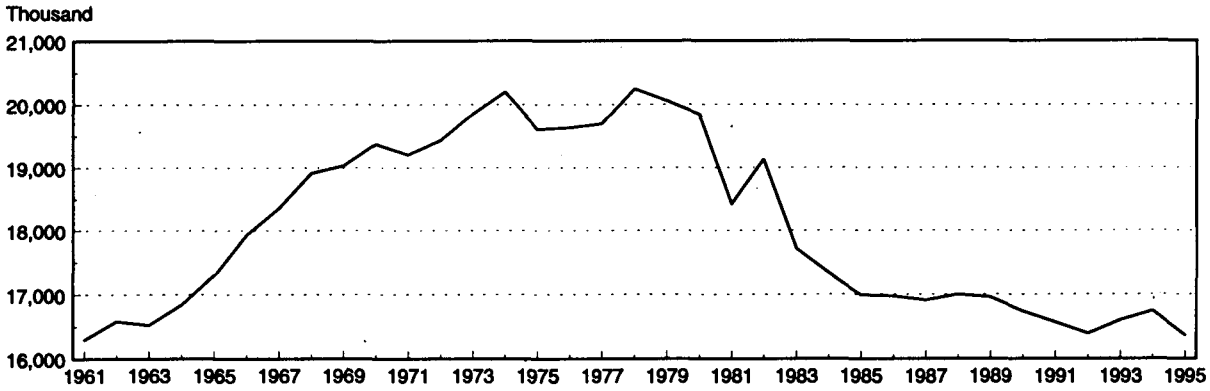
The labor market measures we examine are: union membership, the number of contingent or temporary workers, the average duration of unemployment, the number of job losers, consumer confidence concerning job prospects, and the number of job leavers. Each of these measures has been either explicitly or implicitly linked to weak compensation growth in one or more articles. We now discuss each of these measures in turn.

Decline in union membership. The upper panel of Chart 13 presents the number of union members since the early 1960s. As the chart indicates, union membership peaked in the early 1970s and has been declining ever since. The fact that this series has been declining for 20 years and has recently leveled off makes it hard to believe that a recent weakening of union power is responsible for the somewhat unexpected softness in compensation growth during the 1990s. The only basis for believing that the decline in union membership is playing a role is if its importance is only now evident because of a threshold effect, i.e. a decline in union membership only matters when it moves below some critical level. But such a hypothesis is difficult to test empirically. Related measures, such as the number of work stoppages occurring each year, have behaved in a similar fashion. Thus, the behavior of this series makes it doubtful that it can explain the 1992-94 overprediction in compensation growth.

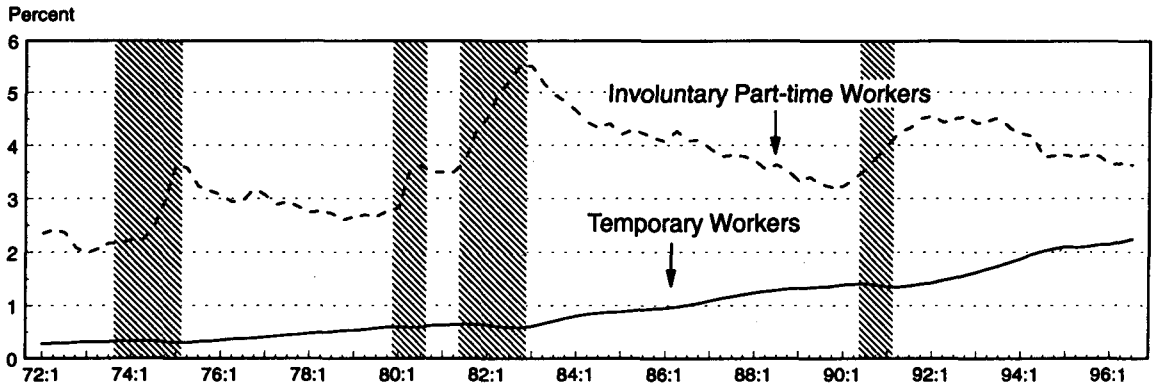
Contingent workers. A second possibility is that the growth in the number of contingent workers, those hired on a temporary basis who presumably have little or no bargaining power, has served to keep compensation growth weak. There are three categories of contingent workers: temporary workers, involuntary part-time workers and the self-employed. Because of the difficulty in separating the temporary from the permanent self-employed, our discussion focuses on only the first two categories.

The lower panel of Chart 13 presents temporary workers and involuntary part-time workers as a percent of nonfarm payroll employment. As the chart shows, the percentage of the labor force that consists of temporary workers has been growing steadily since the early 1970s. Yet even today, temporary workers make up only 2% of the workforce. This low percent makes it hard to believe that growth in temporary workers can account for the recent weakness in compensation

Chart 13
Union members
1961-1995



Temporary and involuntary part-time workers: percentage of nonfarm employment
1972Q1-1996Q3



Note: Shading refers to NBER recessions.

growth. Moreover, given the behavior of the series, one would again have to rely on a threshold effect for this series to account for the overprediction of compensation growth.

The involuntary part-time workers series behaves countercyclically, rising during recessions and falling during expansions. This category of workers was larger during the 1981-82 recession than it was during the 1990-91 recession, suggesting that these workers are not the source of any recent change in labor market behavior. Relative to its previous behavior, however, this series has been falling at a slower rate in this expansion. This slower decline could be playing some role in keeping wage growth modest.

When the involuntary part-time workers series is included in our compensation growth equation, the estimated coefficient has the expected negative sign, but it is not statistically significant. Thus, we are not able to find solid evidence that contingent workers are playing a key role in the shortfall in compensation growth during the early 1990s.

Average duration of unemployment. Some articles have claimed that the average duration of unemployment provides a better measure of slackness in labor markets than is suggested by the unemployment rate.[1] Some articles also have argued that this increase in unemployment duration has contributed to worker anxiety. As shown in Chart 14, the average duration of unemployment has

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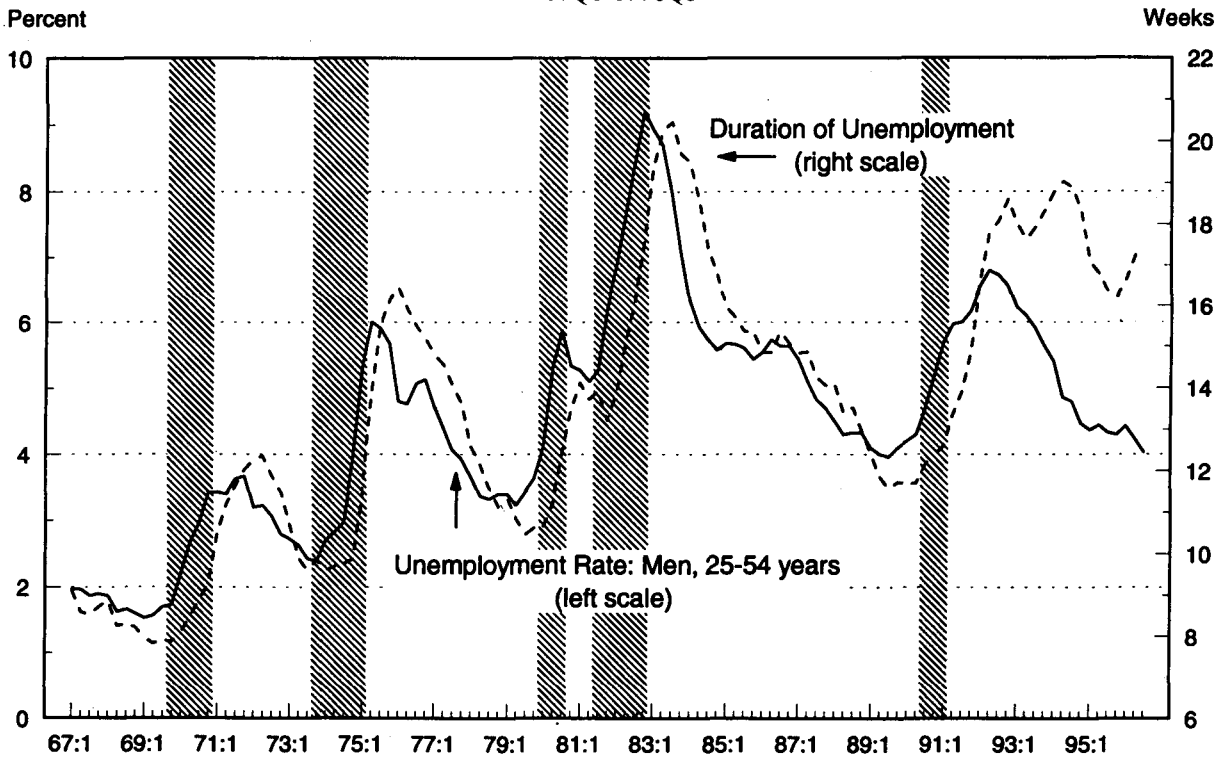
[1] See Sullivan (1996) for a discussion of this issue and some evidence that suggests the data do not support such a claim.

behaved somewhat differently in this expansion. In previous business cycles, the peak of this variable typically coincided with the start of an expansion. In this expansion, average duration remained near its peak for several years and only recently has begun to fall. Further, as the chart shows, the duration of unemployment has been high in this expansion relative to the unemployment rate. Thus, at least impressionistically, the average duration of unemployment appears to reflect some change in labor market behavior.

Chart 14
Average duration of unemployment and the unemployment rate
1967Q1-1996Q3



Note: Shading refers to NBER recessions.

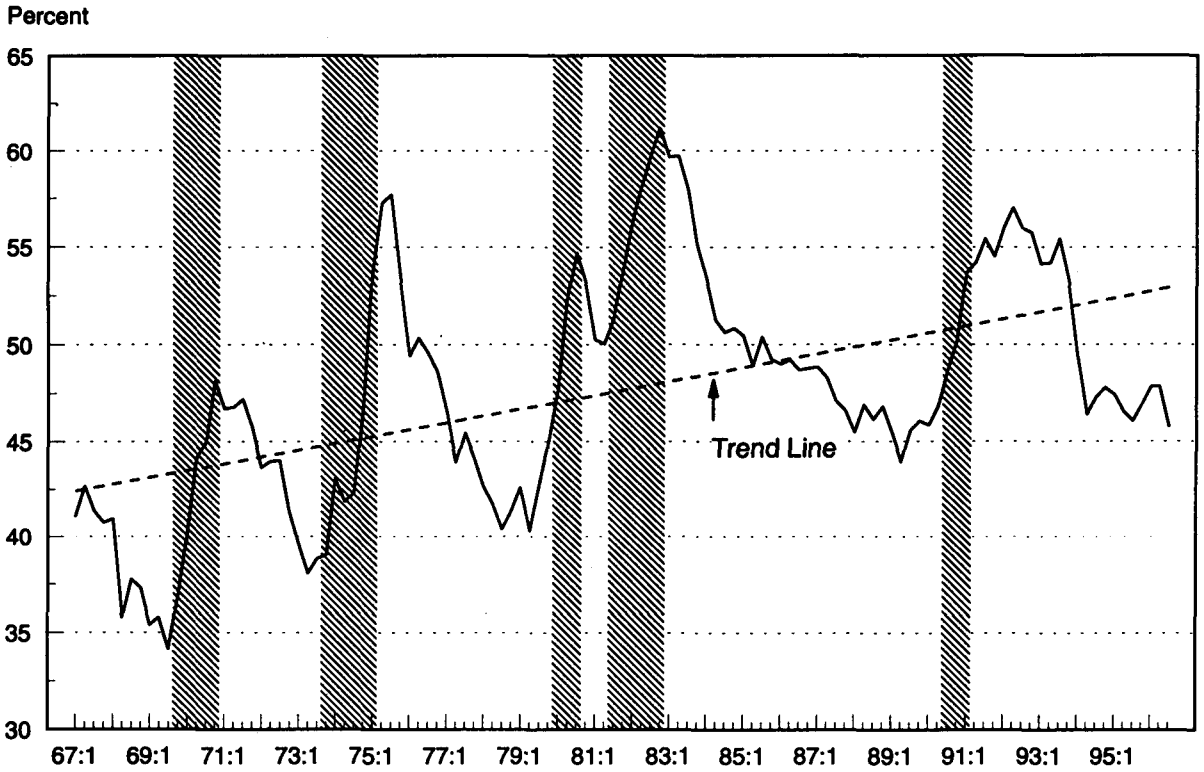
Adding unemployment duration as a regressor to our compensation growth equation is problematic because of its high correlation with the unemployment rate (correlation 0.82). This variable is significant when the unemployment rate is excluded, although no more significant than the unemployment rate. Most importantly, the inclusion of unemployment duration in the equation does nothing to eliminate the 1992-94 compensation growth shortfall.

Job losers. Another variable that might be affecting workers is job security. If job security has fallen, workers might be less willing to ask for increases in compensation. Valletta (1996) argues that to examine this issue one should examine job dismissals (job losers plus temporary job completers as a percent of total unemployment). He notes, as Chart 15 indicates, that there has been a positive trend in permanent job dismissals, indicating that job security has decreased. But with the most recent data included, this trend seems to be less apparent in the 1990s. However, the series did not decline at the start of the expansion, as it had in previous expansions, so perhaps job security has been relatively worse in this expansion.

When job dismissals are included as an additional variable in our compensation growth equation, we find it is not statistically significant. The job dismissal series is significant when the unemployment rate is excluded, although no more significant than is the unemployment rate. Further, replacing the unemployment rate with the job dismissal series does nothing to improve the equation's

out-of-sample forecasting ability. Overall then, the job dismissal data provides no additional information for compensation growth.

Chart 15
Job losers and temporary job completers as a percent of total unemployed
1967Q1-1996Q3



Note: Shading refers to NBER recessions.

Consumer confidence concerning job prospects. In addition to increases in the average duration of unemployment and declines in job security measures, some observers have argued that continued corporate restructuring and talk of companies moving abroad have raised workers' fears of job loss. This increased fear could be serving to keep compensation growth in check. To consider such a linkage, we examine an index of consumers' views about future job prospects – what might be called a consumer apprehension index.[2] This is shown, along with the unemployment rate, in Chart 16.

As the chart shows, the recent behavior of this index differs from its behavior in previous expansions: the index has been quite high relative to the observed unemployment rate. The only other time the relationship between the two series looked similar was during the years 1971-73, and at that time the gap between them narrowed much faster. However, much like the other variables, this index provides no additional information about compensation growth when it is included in the regression equation, nor does it improve the out-of-sample forecast.

Job leavers. The one measure that seems to help modestly in explaining compensation growth is job leavers as a percent of the civilian labor force. This variable measures the number of workers who have chosen to leave their jobs. If workers now have increased concerns about the

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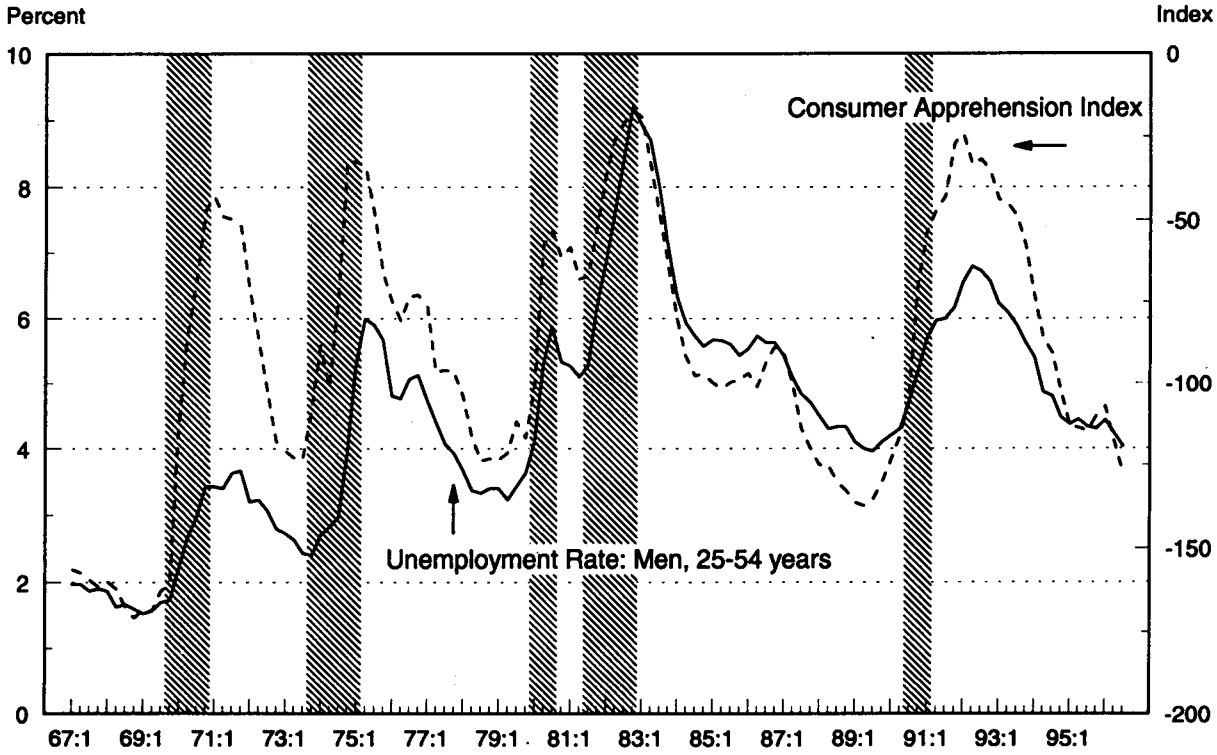
2 This series is constructed as the negative of the present employment situation component of the Consumer Confidence Index. For further detail see the Data appendix.

Chart 16
Consumer apprehension concerning job loss and the unemployment rate
1967Q1-1996Q3



Note: Shading refers to NBER recessions.

robustness of the labor market, one might expect that workers would be less likely to quit their present job. As the upper panel of Chart 17 indicates, this series has also behaved somewhat differently in this expansion and is currently at levels not seen since the 1960s. When included in our regression, this variable proves to be statistically significant at the 10% level. However, as shown in the lower panel of Chart 17, the series brings the out-of-sample forecasts only slightly closer to the series' actual values.

In summary, while numerous accounts have suggested that recent changes and developments in the labor market have affected compensation growth, we are able to find little confirmation of such a change. The impressionistic evidence suggests that there are differences in the behavior of some labor market variables in this expansion, but these differences appear to be statistically and economically unimportant. With the exception of job leavers, no labor market variable plays a significant role in explaining compensation growth. Moreover, the job leavers series does not lead to an appreciable improvement in the out-of-sample forecast of compensation growth during the early 1990s. While it is possible that labor market changes are occurring that can not be quantified, our findings suggest that the "hype" about such changes is likely overblown.[1]

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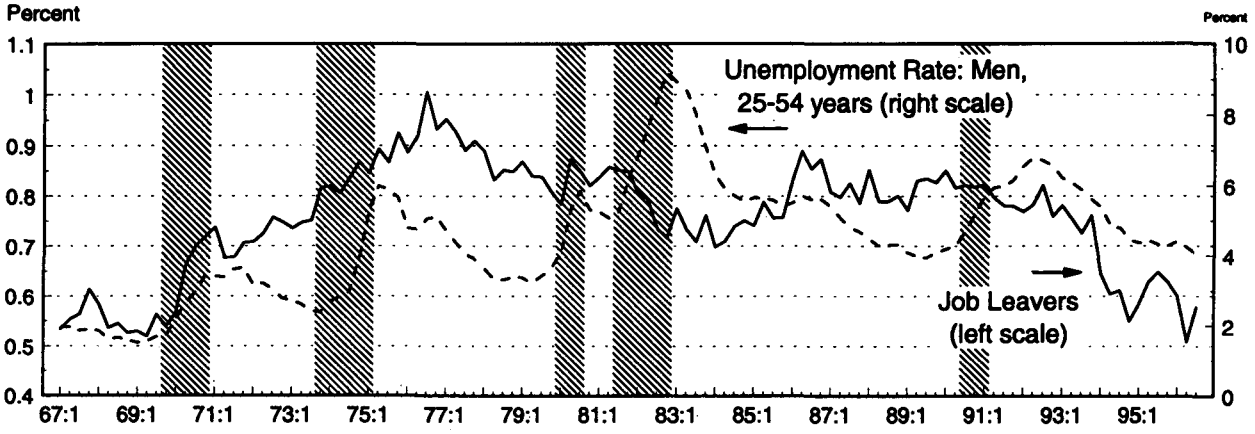
[1] We also extended our investigation beyond a consideration of only the individual predicitve content of the labor market variables for compensation growth. Specifically, we augmented the set of regressors in equation (2) to include the average duration of unemployment, job losers, jobleavers, involuntary part-time workers, and the job apprehension index, but we were unable to reject the null hypothesis that their coefficients are jointly equal to zero. In addition, we used principal components analysis and extracted the first principal component from the above set of variables. However, when the first principal component was included as a regressor in equation (2), it displayed a statistically and quantitatively insignificant effect.

Chart 17

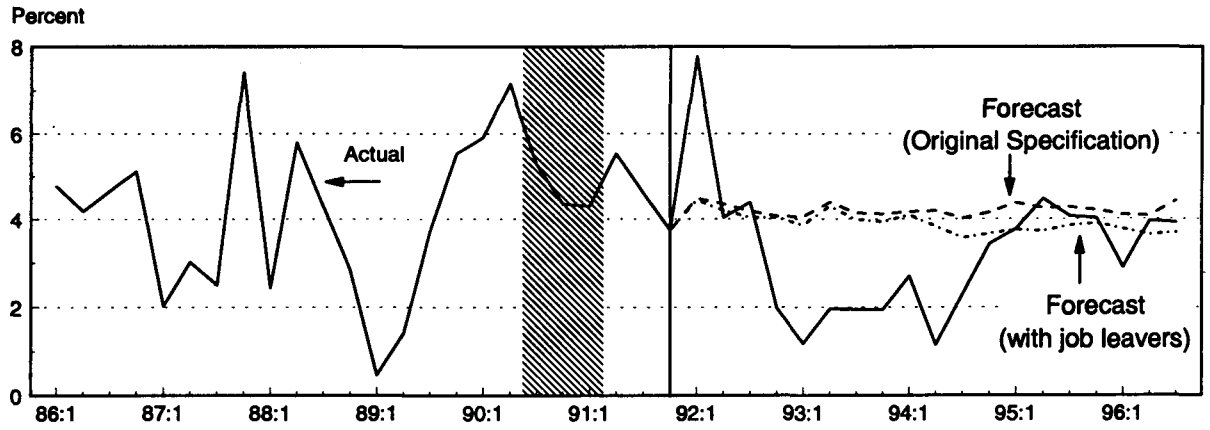
Job leavers as a percent of civilian labor force and the unemployment rate

1967Q1-1996Q3



Compensation growth out-of-sample forecast

1992Q1-1996Q3



Note: Shading refers to NBER recessions.

Conclusion

In this article we explored the issue of an inflation puzzle and the lack of acceleration in price inflation during the current expansion. In particular, we investigated whether the appearance of an inflation puzzle reflected a shift in the inflation process or could be linked to factors or developments emanating from the labor market. Drawing upon the Phillips-curve literature, we specified a model for the rate of change in prices and found little evidence of instability in the estimated relationship over the post-1991 period.

The analysis then examined the key determinants of price inflation and uncovered evidence suggesting that unusual restraint in unit labor costs – principally through the behavior of compensation – has been central to the continued low inflation environment observed over the current expansion. Paralleling the exercise for price inflation, we estimated a Phillips-curve model for compensation growth and documented the marked weakness in this variable during the period 1992-94.

In an attempt to understand the source(s) of the compensation growth shortfall, we examined several hypotheses concerning possible changes in labor market behavior. Our results provided little support for such explanations. Aggregate data series representing the decline in the number of union workers, the increased number of contingent workers, the increased average duration of unemployment, the decline in job security, and the level of consumer confidence concerning job prospects all failed to provide much of an account for the compensation growth shortfall. Only one series – job leavers as a percent of the civilian labor force – seemed to play a role in the compensation growth shortfall, although its explanatory content was limited and quite modest. Thus, it now appears that it is the behavior of compensation growth and its dramatic slowdown during the early 1990s that remain a topic for debate and an area for future research.

Appendix: Derivation of the accelerationist Phillips-curve model

This Appendix provides a brief discussion of the accelerationist model of the Phillips curve from equations (1) and (2). The key feature 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 (1) and (2) can be rewritten as:

$$INF_t = \alpha_1 GDPGAP_{t-1} + \sum \alpha_{2+i}(INF_{t-i}) + \sum \alpha_{7+i}(LXNG_{t-i}) \tag{3}$$

and

$$LXNG_t = (\beta_3 U_{t-1} + \sum \beta_{3+i} INF_{t-i}) / (1 - \beta_1 L - \beta_2 L^2) \tag{4}$$

where we use the definition of unit labor cost growth as compensation growth less productivity growth in equation (3) and L denotes the lag operator in equation (4) such that $L^k X_t = X_{t-k}$.

We can substitute equation (4) into equation (3) 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 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:

$$\alpha_3 + \alpha_4 + \alpha_5 + \left[(\alpha_8 + \alpha_9)(\beta_4 + \beta_5) / (1 - \beta_1 - \beta_2)\right] = 1. \tag{5}$$

The hypothesis that the coefficients on lagged inflation sum to unity can be tested using the OLS estimates of equations (1) and (2) to construct an estimate of the expression on the left-hand side of equation (5) 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), p. 297):

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

where θ denotes the parameters in equation (5), $g(\theta)$ is the function of the parameters in (5), 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, equations (1) and (2) were both estimated over the period 1967Q2-1996Q3. The estimate for the expression on the left-hand side of equation (5) 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 (5) is equal to unity at the 5% 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: US 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 1987Q3 and in chain-weighted 1992 dollars from 1987Q4-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 Business.[2] Quarterly, SA, 1992=100.
Source: US 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.

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[2] Wages 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.

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.

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 1971Q4 and the rebound after the relaxing of controls in 1972Q1 (=1 in 1971Q4, -0.6 in 1972Q1, 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: United States vs. eighteen countries, based on 1984 bilateral trade weights for the eighteen currencies. Monthly, 1980=100.
Source: Federal Reserve Bank of Atlanta.

Number of Union Members: Wage and salary employees who are members of unions. Also includes members of employee associations which are similar to labor unions. Unbenchmarked and available on an annual basis.
Source: Department of Labor, Bureau of Labor Statistics, *Employment and Earnings.* (January) Table 58.

Number of Work Stoppages: Work stoppages (beginning in period) involving 1000 or more workers. Monthly, NSA.
Source: US Department of Labor, Bureau of Labor Statistics, *Compensation and Working Conditions.*

Job Leavers: Number of civilians unemployed who left their job. Monthly, SA.
Source: Department of Labor, Bureau of Labor Statistics, "The Employment Situation", Table A-6.

Average (Mean) Duration of Unemployment: Monthly, SA.
Source: Department of Labor, Bureau of Labor Statistics, "The Employment Situation", Table A-5.

Temporary Workers: Temporary employees on nonfarm payroll. Monthly, NSA. Source: Department of Labor. Bureau of Labor Statistics. "The Employment Situation", Table B-1.

Involuntary Part-Time Workers: Part time workers for economic reasons (frequently referred to as "partially unemployed"), non-agricultural industries. Excludes workers who usually work full time but worked part time (1 to 34 hours) during the reference weeks for holidays, illness and inclement weather. Monthly, SA.
Source: Department of Labor, Bureau of Labor Statistics, "The Employment Situation", Table A-3.

Consumer Apprehension about Job Loss: Constructed variable: negative of present employment situation component of the Consumer Confidence Index (= 2.5 (*CCIN* - 0.6**CCIEN*), where *CCIN*: Consumer confidence, 1985=100 and *CCIEN*: Consumer expectations, 1985=100).
Source: The Conference Board.

Bibliography

Blanchard, Olivier J. (1984): "The Lucas Critique and the Volcker Deflation". *American Economic Review Papers and Proceedings* 74, pp. 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, pp. 21-38.

Boldin, Michael D. (1995): "Problems in Determining the Capacity-Inflation Link". *Mimeo*, Federal Reserve Bank of New York.

Bradsher, Keith (1995): "Greenspan Says Fears Over Jobs Have Held Down Wage Growth". New York Times, October 20, p. D8.

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*, No. 37, pp. 149-192.

Chow, Gregory C. (1960): "Tests of Equality Between Sets of Coefficients in Two Linear Regressions". *Econometrica*, No. 28, pp. 591-605.

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*, No. 58, pp. 1-17.

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

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

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

Gordon, Robert J. (1975): "The Impact of Aggregate Demand on Prices". *Brookings Papers on Economic Activity*, Vol. 6, pp. 613-62.

Gordon, Robert J. (1977): "Can the Inflation of the 1970s Be Explained?" *Brookings Papers on Economic Activity*, Vol. 8, pp. 253-77.

Gordon, Robert J. (1982): "Inflation, Flexible Exchange Rates, and the Natural Rate of Unemployment", in M. N. Baily (ed.), *Workers, Jobs and Inflation*. Washington: Brookings Institution, pp. 88-152.

Gordon, Robert J. (1990): "US Inflation, Labor's Share, and the Natural Rate of Unemployment", in Heinz König (ed.), *Economics of Wage Determination*. Berlin and New York: Springer Verlag, pp. 1-34.

Gordon, Robert J. (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*, No. 38, pp. 215-20.

King, Robert G. and Mark W. Watson (1994): "The Post-War US Phillips Curve: A Revisionist Econometric History". *Carnegie-Rochester Conference Series on Public Policy*, No. 41, pp. 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, pp. 2-12.

Macroeconomic Advisers, LLC (1996): "The US Economic Outlook", October 8.

Meyer, Laurence H. (1997): "The Economic Outlook and Challenges for Monetary Policy". Remarks at the Charlotte Economics Club, 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*, No. 97, pp. 740-44.

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

Phelps, Edmund S. (1967): "Phillips Curves, Expectations of Inflation and Optimal Unemployment Over Time". *Economica*, No. 34, pp. 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*, No. 25, pp. 283-300.

Sullivan, Daniel (1996): "Unemployment Duration and Labor Market Tightness". *Federal Reserve Bank of Chicago Letter*, March.

Spiers, Joseph (1995): "Why Inflation Will Keep Falling". *Fortune Magazine*, October 2, p. 59.

Spiers, Joseph (1996): "It's Fear of Inflation That's Spooking the Market". *Fortune Magazine*, June, p. 22.

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

Valletta, Robert (1996): "Has Job Security in the US Declined?" *Federal Reserve Bank of San Francisco Weekly Letter*, No. 96-07, February 16.

Comments on: "A look at the US inflation puzzle" by Cara S. Lown and Robert W. Rich

by Gabriele Galati

This paper addresses the question of whether there is an inflation puzzle, in the sense that core CPI inflation has been lower since 1991 than unemployment and capacity utilisation figures appear to tell us. It is an interesting paper that comes up with a story behind the observed behaviour of these variables and follows a straightforward estimation strategy to test it. The story is that the inflation dynamics have not changed during the recent expansion, and the only fundamental determinant of inflation that behaved differently is compensation growth. On the other hand, there is no evidence of recent changes in labour market conditions. The authors conclude therefore that there is no evidence of an inflation puzzle and that low compensation growth in the early 90s is the major factor behind the low level of inflation.

To provide evidence for their story, the authors follow a strategy based on three steps. First, they estimate an equation that describes a price-inflation Phillips curve (equation (1) in the paper) which differs from standard specifications in that it includes unit labour costs among the explanatory variables. The authors then perform structural break tests and dynamic out-of-sample forecasts to investigate its stability. They find a reasonably good fit and no evidence of structural breaks and conclude that the inflation dynamics haven't changed recently.

It may be useful to start off with estimating a more "traditional" price-inflation Phillips curve that does not include unit labour costs as a right-hand side variable and examine whether the inflation dynamics described by this equation have changed recently. It might well be that this equation exhibits a structural break around 1991. I would then add the variable measuring unit labour costs to the right-hand side variables and report that this modified price-inflation equation is stable over the whole period. These two results together could then be used to argue that compensation growth may be a factor explaining the recent lack of acceleration of inflation as opposed to other factors such as monetary policy having become more credible.

The paper also needs some more motivation of the choice of explanatory variables. It seems that the authors include variables on the basis of the significance of their coefficient. For example, they include an oil shock variable that measures only positive real oil price changes because a variable measuring negative oil price changes turned out not to have a significant coefficient. There is some discussion in Section 1 of fundamental factors that drive inflation and what the authors call "shock factors". This distinction enters the price-inflation equation, for example with an oil shock variable that is meant to capture exogenous supply shocks, but not in a systematic way. It may be useful to report how the inclusion of variables that capture the other shock factors that are mentioned, for example commodity prices or the exchange rate, affects the results.

The authors then examine whether the behaviour of the determinants of price inflation (the right-hand side variables in equation (1)) has changed since 1992. Graphical evidence suggests that unit labour costs have exhibited an unusually weak growth rate after 1991, and that this has been caused mainly by weak compensation growth. To test more formally for a change in the determination of compensation growth, the authors estimate a compensation growth Phillips curve (equation (2) in the paper) which explains hourly compensation growth in terms of the lagged unemployment rate, lagged inflation and other variables capturing labour market conditions. They then subject this equation to the same stability tests performed on the price inflation Phillips curve. Although different tests fail to provide evidence of structural breaks, the out-of-sample forecasts consistently overpredict actual compensation growth between 1992 and 1994. The authors suggest that recent changes in the labour market may therefore explain the low inflation observed during the current expansion.

To test this hypothesis, the authors first carry out an informal, graphical analysis of the behaviour of different indicators of labour market conditions. Once they find an indicator that has behaved differently over the last few years, they use it in the compensation growth equation as an explanatory variable. Since none of the indicators has a significant coefficient or improves the fit and out-of-sample forecasting ability of the equation, they conclude that there is no empirical evidence supporting the hypothesis.

One problem with this strategy is that compensation growth (the left-hand side variable in equation (2)) and labour market conditions (a right-hand side variable) are endogenous and jointly determined. It is therefore difficult to infer any causal relation from labour market conditions to compensation growth based on single coefficient estimates or measures of performance of the whole equation. Some labour market variables may be relevant even if their coefficients are not significant in the compensation growth equation. One way to solve this problem – although difficult to follow in practice – is to look for truly exogenous variables that may have affected labour market conditions over the recent years and then test for their significance in the compensation growth equation. Examples include changes in the laws on subsidies for hiring unemployed, changes in tax breaks, etc.

Another problem is how to measure the effect of labour market variables that matter only in last part of the sample period. The authors solve this problem by adding the variable to the equation and verifying its coefficient over the whole period but admit that this makes it difficult to capture appropriately the effect of a change in labour market conditions. An alternative testing strategy would be to use a more flexible specification and introduce the exogenous variables measuring changes in labour markets both as dummy variables and as interaction term with other explanatory variables. The impact of these on the fit and forecasting ability of the compensation growth equation may lead to different conclusions on the role of changing labour market conditions.