Is Inflation Dead?

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In the past few years the United States has enjoyed the unique economic duet of very low unemployment and declining price inflation. For decades, we have come to associate tight labor markets with accelerating wages and prices. But in 1997, the unemployment rate sank below 5 percent and neither wage nor price inflation became a problem. Have our inflation processes fundamentally changed for the better? Are we in a new era of permanently better economic performance due to new behavior by our citizens? Or are we simply enjoying good luck in the form of positive supply shocks?

The overwhelming majority of research economists had previously estimated that an unemployment rate of about 6 percent was the lowest level that could be sustained. Below the vicinity of 6 percent, employers would compete aggressively for scarce labor by offering wage increases exceeding prevailing norms. The lower the unemployment rate, the greater the percentage wage gain would likely be. As wage increases pushed above existing price inflation and productivity gains, producers would raise prices to cover higher costs. The ensuing wage-price inflation spiral would not be broken until unemployment once more moved above 6 percent, a development typically caused by rising interest rates, as financial markets and the Federal Reserve reacted to the growing inflation problem.
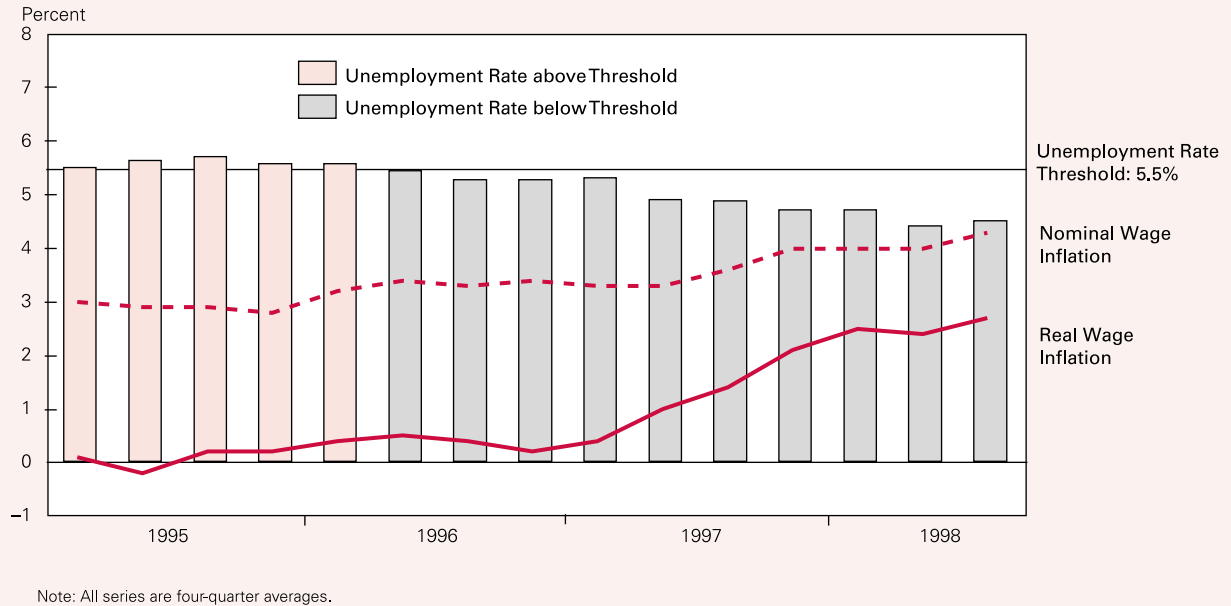
The experience of the late 1980s seemed to confirm the modern validity of this decades-old perspective. The national unemployment rate fell from 6.2 percent in 1987 to 5.5 percent in 1988 and 5.3 percent in 1989; in response, wage increases jumped from 3.1 percent to 3.7 percent and then 4.2 percent. Wholesale price inflation rose from 1.9 percent in 1987 to 2.4 percent in 1988 and then to 3.9 percent in 1989; consumer price inflation jumped from 3.7 percent to 4.1 percent and on to 4.8 percent. Rising prices for imported goods, including oil, contributed significantly to the nation's inflation problems, but most of the blame was placed on excessive tension in domestic labor markets. In other words, lessons

Figure 1

Real Wages Accelerated As Usual in 1997, As Unemployment Fell Below 5.5 Percent

Percent

Legend:
- Unemployment Rate above Threshold
- Unemployment Rate below Threshold

Unemployment Rate Threshold: 5.5%

Nominal Wage Inflation

Real Wage Inflation

1995 1996 1997 1998

Note: All series are four-quarter averages.

learned in the high-inflation 1970s had apparently been reinforced.

At first glance, the experience of recent years seems different. Price inflation remained in check from 1996 through 1998 even though unemployment rates fell further and further below 6 percent. It appeared natural to suspect that the balance point for U.S. labor markets should be recalibrated. Perhaps workers' insecurity was so intensified by the heavily publicized layoffs of the early 1990s that a lower unemployment rate was required before existing employees would demand norm-breaking pay increases.

Unfortunately, a more careful reading of the full inflation story reveals a different conclusion. *Nominal* wage inflation has been subdued by exceptionally modest price inflation. As can be seen in Figure 1, *real*, or price-adjusted, wage inflation has been increasing in response to low unemployment, just as in past decades. Price inflation has been held down by a set of "supply shocks," including a strong dollar, falling energy prices, and a cost-reducing regime shift in the health care industry. Moreover, most of these supply shocks are not novel ingredients of the inflation process in the United States. They have been studied and

successfully used to understand price behavior for decades.

Inflation is not dead. However, recent supply shocks have shifted wage and price inflation to a lower zone. According to a revalidated, standard model of U.S. inflation, inflation can stay this low only if the unemployment rate rises to between 5.5 and 6 percent over the next year. Otherwise, as supply shocks shift to neutral or worse, tight labor markets will create a traditional inflation problem.

I. The Evolution of the Standard Model of Inflation

The original "Phillips Curve" (of the 1960s) presented a simple, inverse association between wage inflation (w) and the unemployment rate (u).

$$w = a0 - a1 * U \quad (\text{where } a1 > 0). \tag{1}$$

In equation (1) and subsequent notation, a lower-case letter refers to the percentage change in the variable and an upper-case letter to the level. Thus,

"*w*" is the percentage change in the hourly wage and "*p*" is the percentage increase in the aggregate price level. The constant term "*a0*" includes the average effect of all other influences on wages.

This model of wage inflation was informally paired with a simple view of price inflation. If prices are a markup on wages adjusted for trend productivity growth (*q*), then price inflation (*p*) equals wage inflation minus productivity growth. If, in addition, the markup is sensitive to the business cycle and, thus, to the unemployment rate, the price inflation model takes the form

$$p = w - q - b1 * U \quad \text{(where } b1 > 0\text{).} \qquad (2)$$

Equations (1) and (2) can be combined to create a reduced form model of price inflation driven by only the unemployment rate.

$$p = a0 - a1 * U - q - b1 * U \qquad (3)$$

$$= (a0 - q) - (a1 + b1) * U$$

$$= c0 - c1 * U.$$

The rule-of-thumb derived from estimates of Equation (3) told policymakers in the 1960s that they had to choose between low inflation and low unemployment. The actual economic performance, displayed in Figure 2, was offered as good evidence of

Figure 2

*Apparent Policy Options in the 1960s:
The Simple Phillips Curve*
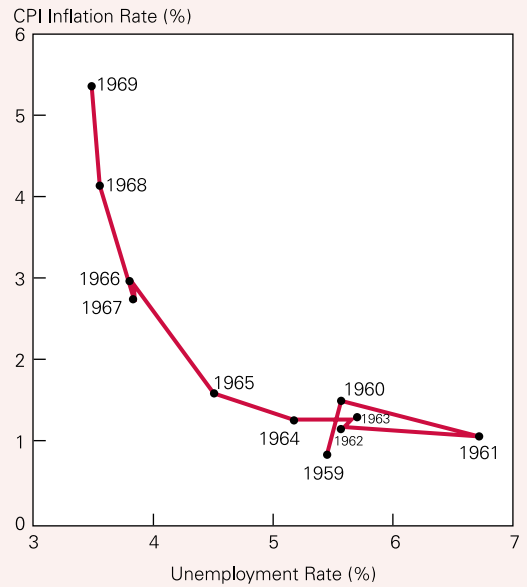
In the 1960s it seemed that those responsible for making the big economic decisions for the country—the President, the Congress, the Federal Reserve System—had to make a choice between low inflation and low unemployment.

this trade-off. It seemed that those responsible for making the big economic decisions for the country—the President, the Congress, the Federal Reserve System—had to make a choice. If they wanted to hold inflation down to 2 or 3 percent, they had to accept an unemployment rate of 6 percent. If they wanted the

unemployment rate near 4 percent, they had to accept inflation of 6 percent.

In the early 1970s, cheaper computing power and more extensive time series data permitted more complete multiple regression analysis, and applied economists were able to improve these simple models. Economic theory argues that real wages, not nominal wages, should adjust to the excess demand for labor. Indeed, Phillips and Lipsey, in their original works, had agreed that prices mattered, although they did not include prices in their final quantitative models. However, in the early 1970s, researchers added approximations of expectations of future price inflation to Equation (1), transforming it to (1a).

$$w - p(exp) = q + a0 - a1 * U. \qquad (1a)$$

Although considerable creative debate took place over how to represent inflation expectations, many researchers adopted the simple approach of making expected inflation equal to inflation in the recent past. This approach was found to fit the data well, while

Demographic Influences on the "Natural Rate of Unemployment"

In the regressions in Table 1 (below), the degree of excess demand pressure in the labor market is measured by the official civilian unemployment rate minus an adjustment for the changing demographic composition of the labor force. Even when the economy is at full employment, not all age–sex groups have the same unemployment rates. Therefore, when defining an indicator of excess labor demand for wage inflation equations, it is desirable to remove shifts in the unemployment rate caused solely by the changing composition of the labor force.

Unemployment exists when a new person enters the labor force before finding a job, when an existing employee quits a job to search for a better position, or when an individual is fired or laid off. Young people therefore have the highest characteristic unemployment rates and experienced, middle-aged workers the lowest. Women historically have had higher unemployment rates than men of the same age because of discrimination and more frequent movements into and out of the official work force. As their societal roles and labor force participation rates have changed, women's unemployment rates have dropped to near-equality with those of similarly aged men.

Given these differences in normal unemployment rates, two time periods sharing a 6 percent unemployment rate could have very different pressures on wages. If one period had a higher proportion of younger or female workers, the 6 percent unemployment would actually imply a tighter labor market. George Perry and others proposed simple adjustments to reflect this, which the author and colleagues at then DRI/McGraw-Hill updated using the following methodology.

The years 1962 and 1963 can reasonably be described as fitting the definition of full employment with stable inflation. The unemployment rate was 5.6 percent in both years, and CPI inflation was 1.2 percent followed by 1.3 percent. Moreover, the bordering years reinforce this image of stability. A time series is constructed by multiplying the unemployment rates of specific age–sex groups in 1962 and 1963 by the labor force shares of these groups in prior and subsequent quarters. Changes in the characteristic unemployment rates of each group are also varied through time based on regressions that estimate the difference between group rates and the rate for men aged 35 to 54 as a function of the group's population share and participation rate. This new series portrays how the unemployment rate varies through time relative to the early 1960s, based on changes in basic demographics.

These demographic shifts do not have a huge impact. The highest "full-employment" unemployment rates (equivalent to the 5.6 percent unemployment rate in 1962 and 1963) are 6.2 percent in 1980 and 6.1 percent in the years from 1974 to 1979. The lowest equivalent rates are 5.3 to 5.4 percent in the early 1950s and the years 1990 to 1993. The equivalent for 1997 is 5.5 percent. Most of the variation can be traced to fluctuations in the share of young adults in the labor force (Figure 3). The fraction of workers aged 16 to 24 rose from 16 percent of the labor force in the mid 1950s to 24 percent in the early 1970s, and then fell back toward 16 percent by the mid 1990s. These demographic changes allow the economy to operate at a lower unemployment rate, 5.5 percent today, compared to 6.1 to 6.2 percent 15 years ago, with the same inflation pressure arising in the labor market.

being consistent with the view that workers are not subject to "money illusion" and that excess demand affects real rather than nominal wages.

The simplest form of this relationship is shown in Equation (1b).

$$p(exp) = p(t - 1), \qquad (1B)$$

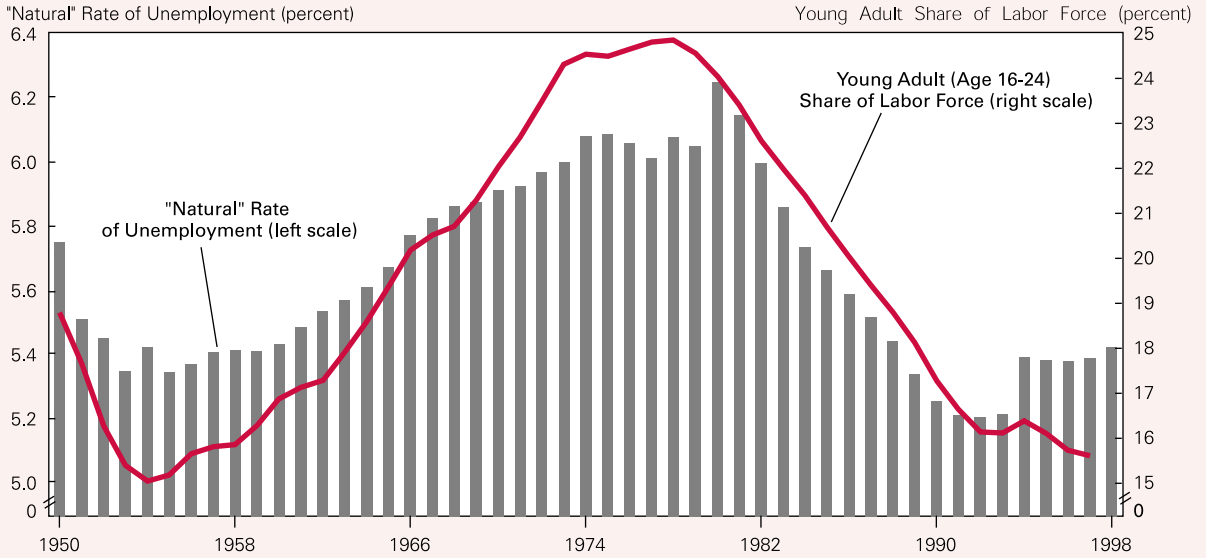in which $(t - 1)$ refers to the prior year.

In practice, expected inflation is generally represented as a weighted sum of inflation rates over the past several years, with the estimated weights constrained to equal one.

Shifts in trend productivity growth (q) also can reasonably be expected to affect real wage growth. The new econometricians took demographic shifts into account as well: The entry into the labor force of the baby boom generation and rising female involvement in paid work focused attention on the potential importance of these shifts. As described in the accompanying Box, the typical approach to addressing

Figure 3

Changes in the Unemployment Rate
Due to Demographic Shifts

"Natural" Rate of Unemployment (percent)

Young Adult Share of Labor Force (percent)

Young Adult (Age 16-24)
Share of Labor Force (right scale)

"Natural" Rate
of Unemployment (left scale)

changing demographics involved adjusting the reported unemployment rate to remove the influence of changes in the composition of the labor force. For the purpose of this discussion, consider (U) to include the effect of such adjustments.

The price inflation model was extended to recognize the influences of certain non-labor costs such as energy and imported goods, producing Equation (2a). The inclusion of changes in energy prices relative to changes in other domestic costs (pe) was natural following the radical shift of this cost element after the OPEC oil embargo sent energy prices soaring in the mid 1970s. Similarly, the end of the fixed exchange rate regime in the early 1970s made it appropriate to separately include shifts in the cost of imports relative to domestic goods (pm), as an indicator of an important component of domestic production costs and the price pressure presented by global competitors.

$$p = w - q - b1 * U + b2 * pe + b3 * pm. \quad (2a)$$

This richer model produced a strikingly different view of long-run policy options. Specifically, only one unemploy-

ment rate is consistent with stable wage and price inflation, holding other factors constant.

Substituting (1b) into (1a) produces (1c):

$$w - p(t - 1) = q + a0 - a1 * U. \quad (1c)$$

And substituting (1c) into (2a) produces (2b):

$$p - p(t - 1) = a0 - (a1 + b1) * U$$
$$+ b2 * pe + b3 * pm. \quad (2b)$$

Equation (2b) describes what is referred to as an "accelerationist" Phillips' Curve, because the acceleration in prices ($p - p(t - 1)$) has replaced price inflation (p) as the phenomenon that responds to variations in the unemployment rate.

The balance point for the economy, defined as the rate of unemployment that preserves existing inflation, is found by setting (2b) equal to zero and solving for the unemployment rate. This unemployment rate has been called the "NAIRU" (*n*on-*a*ccelerating-*i*nfla-tion *r*ate of *u*nemployment).

If inflation is unchanging, then $p - p(t-1) = 0$, and

$$NAIRU = (a0 + b2 * pe + b3 * pm)/(a1 + b1). \qquad (4)$$

If the relative prices of energy and imports are not changing, then NAIRU = $a0/(a1 + b1)$. Most researchers who have estimated these relationships conclude that the NAIRU is close to 5.5 percent today, given the current demographic composition of the labor force.

Equation (4) also indicates that the economy can achieve decelerating price inflation, that is, disinflation, even with an unemployment rate below 5.5 percent—if the relative prices of energy or imported goods are falling sufficiently. In these circumstances, which we have enjoyed in 1997 and 1998, the NAIRU is *temporarily* below 5.5 percent. However, when these favorable supply shocks end, the unemployment rate must increase to 5.5 percent or else inflation will rise.

Similarly, (2a) can be substituted into (1b) and this new expression can then be substituted into (1a) to obtain an accelerationist model of *wage* inflation, (1d):

$$w - w(t - 1) = a0 - (a1 + b1) * U + b2 * pe + b3 * pm.$$
$$(1d)$$

As will be shown below, this model is not at all surprised by the current phenomenon of relatively moderate nominal wage increases despite low unemployment. Small increases in *nominal* wage inflation are fully explained by the supply shocks that have damped down price inflation increases; larger *real* wage increases have occurred as anticipated by this standard model—in use for almost three decades.

II. Statistical Validation of the Wage Inflation Model

Most of the recent controversy about a new economy without the risk of inflation has focused on an allegedly lower NAIRU. However, careful testing demonstrates that the magnitudes of the critical coefficients of the standard model are quite stable over time, suggesting no improvement. Table 1 presents regressions that test the basic model and that demonstrate a high degree of explanatory power and coefficient stability over recent decades.

The sensitivity of wage inflation to the unemployment rate (b1) has been found to be roughly 50 percent by many researchers over many years. In other words, for each 1 percentage point that the unemployment rate falls below the NAIRU for one year, wage infla-

tion rises by roughly 0.5 percentage point. Many researchers also include the change in the unemployment rate in their equations, but this inclusion changes only the short-run dynamics, not the long-run relationship produced by the core model.

The regressions presented in Table 1 follow a form that the author has used for forecasting purposes over many years with considerable success. Wage inflation, represented by inflation in the wage and salary component of the employment cost index, is estimated as a function of the unemployment rate adjusted for demographic shifts, the change in the adjusted unemployment rate, and two measures of price inflation. The regressions show that wage inflation increases by somewhat more than 0.5 percent for each percentage point decline in the level of the unemployment rate, consistent with most previous estimates.

Two tests of the stability of the coefficients appear in Table 1. The first test introduces a filter variable equal to 0 in the first half of the sample (1976 to 1986) and 1 in the second half. This filter is introduced in three dimensions: as a constant term and as cross-products with both the level and the change in the unemployment rate. The results appear in the second pair of columns of Table 1. As can be seen, the t-statistics of all three of these coefficients are too low to indicate that a statistically significant change has occurred since the mid 1980s. Moreover, the absolute magnitudes of the coefficients are generally small, although the effect of the change in the unemployment rate is larger in the later period.[1]

An alternative test examines the stability of the coefficients for all terms by running separate regressions for each half of the time period. These regression results are reported in column pairs (3) and (4). Although the coefficients may look somewhat different, using the F-statistic to compare the sums of squared residuals in the two separate equations with the sum of squared residuals in the original equation (where the coefficients are restricted to be the same throughout the period) yields a value of 0.39, well below the critical threshold that would indicate that a change had taken place.[2]

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[1] The constant term for the second half is estimated to be just 0.06 lower than the first half, with a standard error of 0.26. The coefficient for the level of the unemployment rate is estimated to be very slightly smaller (0.005 higher, with a standard error of .0.18). The coefficient for the change is estimated to be stronger by 0.48 in the second half, with a standard error of 0.27.

[2] The critical value of the F(4.80)-statistic at the 95 percent confidence level is 5.7.

Table 1
Regressions Results for Wage Inflation

Dependent variable: Employment Cost Index Inflation[a]

Explanatory Variables	(1) Full Sample 1976:Q2–1998:Q1		(2) Full Sample with Estimated Coefficient Shifts 1976:Q2–1998:Q1		(3) First Half of Full Sample 1976:Q2–1986:Q4		(4) Second Half of Full Sample 1987:Q1–1998:Q1	
Sample Period	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	.65	4.41	.69	2.59	.61	1.79	.74	4.78
Adjusted Unemployment Rate	−.58	−5.86	−.60	−4.01	−.55	−2.85	−.67	−5.38
Change in Adjusted Unemployed Rate	−.67	−5.45	−.54	−3.79	−.56	−3.22	−.98	−5.45
Output Price Inflation	.76	12.07	.78	10.74	.75	7.69	.91	7.08
Consumer Price Inflation (price inflation sum must = 1)	.24		.22		.25			
			Tests for Shifts:					
'87–'98 Filter (= 0 '76–'86; = 1 '87–'98)			−.06	−.22				
'87–'98 Filter × Adjusted Unemployment Rate			−.01	−.03				
'87–'98 Filter × Change in Adjusted Unemployment Rate			−.47	−1.79				
R-Bar Squared	.765		.765		.786		.690	
Durbin-Watson Statistic	2.160		2.260		2.260		2.320	
Standard Error of the Regression	.700		.700		.840		.531	
Sum of Squared Residuals	41.00		39.44		27.55		11.56	

[a]Notes on variable definitions:

All inflation rates are calculated as annual rate of change equivalents, using changes in logarithms of the underlying variables. "Employment Cost Index" is calculated as 400 ∗ log (eci/eci(t-1)), where "eci" is the employment cost index for wages and salaries. "Output price inflation" is calculated as 400/14 ∗ log (price(t-1)/price (t-15)), where "price" is the nonfarm private output deflator excluding housing, government, and excise tax components. "Consumer price inflation" is calculated as 100 ∗ log (CPI(t-1)/CPI(t-5)).

The dependent variable equals "wage inflation" minus two constrained effects: 1) "consumer price inflation" and 2) a special adjustment for changes in the minimum wage (estimated as 3 percent times the quarterly increase in the real minimum wage).

The "adjusted unemployment rate" is a moving average over the current and four prior quarters of the official civilian unemployment rate minus the demographic adjustment described in the text. The "change in adjusted unemployment rate" is the current level minus the average of this, lagged two and three quarters.

The time structures, such as the 14-quarter average of output price inflation, were chosen from earlier full-sample regressions using polynomial distributed lags. To simplify presentation and verification of coefficient stability, the results reported here use the results of such regressions to select the length of the appropriate simple moving averages.

Finally, Figure 4 compares the actual path of wage inflation with that estimated by the base equation. The comparison gives no indication that historic relationships have broken down in recent years. Thus, any novelty in the U.S. inflation process is not centered in the labor markets. Worker demands and employer responses appear to be unchanged.

Expectations of Price Inflation

According to the regressions in Table 1, price inflation enters the wage adjustment process as a blend of past output prices received by employers and consumer prices paid by employees. The former represent the value of work to the demander of labor; the latter represent the cost of living to the supplier of labor. Wage inflation appears more sensitive to changes in output prices than to changes in consumer prices. This is consistent with a fairly inelastic supply of labor compared with a relatively elastic demand for labor.

The sum of the coefficients for these two inflation rates is forced to equal one by subtracting the CPI inflation rate from both the wage inflation dependent variable and the output price inflation explanatory variable. This constraint reflects the assumption that

Inflation Expectations of American Households[a]

Dependent variables: Median Expected Inflation over the Next 12 Months

Explanatory Variables	Coefficient	Standard Error	T-Statistic
Constant	1.25	.14	8.78
Lagged CPI Inflation (Polynomial distributed lag, 4th order, 30 potential lags, no other constraints)			
Sum of Impacts	.93	.05	15.93
Current Quarter	.18	.02	
First Year Sum	.52		
Second Year Sum	.19		
Change in Inflation (Current quarter at annual rate less prior year CPI inflation)	.06	.03	1.96
Current Treasury Bill Rate	−.19	.04	−4.89
Current Unemployment Rate (Adjusted)	−.44	.10	−4.58
R-Bar Squared	.964		
Durbin-Watson Statistic	1.433		
Standard Error of the Regression	.408		

[a]University of Michigan Survey Research Center Quarterly Data, 1978:I to 1998:I.

real wages, rather than nominal wages, respond to prevailing unemployment conditions.[3]

The high explanatory power of this simple model of wage inflation, plus its consistency through time, gives credibility to the underlying assumption that expectations of price inflation are based on the momentum of inflation in the previous three to four years. During the 1970s and 1980s, considerable theoretical discussion focused on the importance of "rational expectations," the view that economic actors look forward in time and will adjust their expectations to incorporate likely policy actions. Some of the arguments for rational expectations challenged the validity of traditional inflation models, but little empirical testing was reported. Fortunately, a good source of directly measured inflation expectations can shed light on this issue: the University of Michigan Survey Research Center's time series of median expected inflation rates, derived from a sample of 500 households.

Table 2 presents a regression of inflation expectations from the University of Michigan's survey on past rates of inflation. Expected inflation, as measured by the survey, closely matches the momentum of inflation (Figure 5). The sum of the lagged inflation coefficients is 0.93. Expectations are also affected by the unemployment rate and by interest rates, measured here by the Treasury bill rate. Apparently, the public implicitly believes in the Phillips Curve. The estimated impact of the unemployment rate on expectations of price inflation is 0.44, very similar to the estimate of the response of price inflation to unemployment that we develop below.

The negative effect of interest rates can be interpreted as evidence that the public views monetary policy as effective in reducing inflation. According to the regression, each percentage point boost in interest rates is thought to cut inflation by 0.2 percentage point relative to its momentum. (This expected inflation response is a little higher than most econometric models would estimate for the first year after monetary tightening.)

Thus, the process whereby the American public forms expectations of inflation closely matches the approach assumed in conventional econometric models. These tests of a simple model of the public's inflation expectations also tend to validate the core wage inflation model just presented.

III. Complementary Model of Price Inflation

The absence of a significant change in the relationship between the unemployment rate and wage inflation suggests that the explanation for our recent favorable inflation experience lies with supply shocks directly affecting prices. The supply shocks that have been cited most frequently in this regard are as follows:

1. Fluctuations in oil prices. After rising sharply in 1990, oil prices declined in the early 1990s. They jumped up in 1996 but retreated in 1997 and plummeted in 1998.

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[3] A test of this constraint, not reported in Table 1, added CPI inflation to the regression. The estimated coefficient was −0.05 with a standard error of 0.04. In other words, the freely estimated sum of the inflation coefficients is 0.95 and is insignificantly different from 1.0.

Figure 4

*Actual and Fitted Values
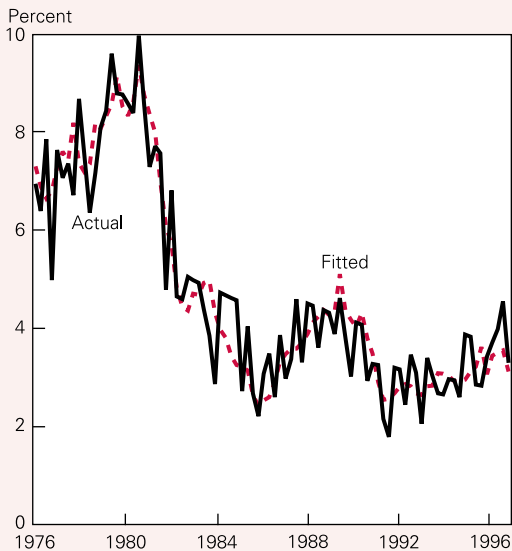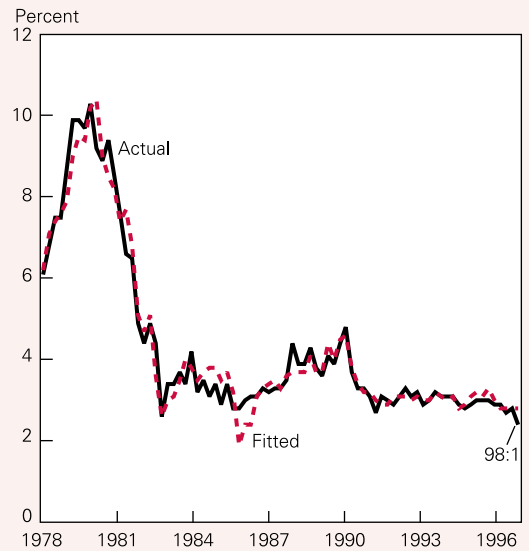of Wage Inflation*

Percent

Figure 5

*Inflation Expectations:
Actual Survey versus Regression-Fitted*

Percent

2. Lower costs for imported goods because of a strong U.S. dollar. Besides their direct effect, lower import prices also cut component costs and increase competitive pressure on domestic producers.

3. The favorable effect of a rising stock market on pension costs for employers providing defined benefit pension plans.[4]

4. Reduced inflation in health care costs because of structural changes in the industry arising from increased competition and pressures from employers and government.

Equation (2a), developed earlier, has been estimated to quantify the size of these shocks and to test the stability of the price inflation process (Table 3). The measure of price inflation used in the regressions in Table 3 is "Finished Goods Wholesale Price Inflation." This measure is closely correlated with both the consumer price index (CPI) and the GDP deflator-based measure of output prices in Table 1. In the author's judgment, however, it provides a cleaner measure of underlying inflationary pressures than the other mea-

sures. It has the virtue, relative to the CPI, that its methodology has not been subject to periodic improvements and, thus, it provides a more consistent measure of inflation over time.[5] It also does not include services, the prices of which are generally acknowledged to be measured imperfectly. The same conceptual model has been estimated for CPI and GDP deflator inflation rates, yielding wholly consistent conclusions. The estimated impacts of energy and imported goods prices are smaller, logically so, given the composition of the goods and services covered by these alternative inflation indexes.

"Finished Goods Wholesale Price Inflation" has been even lower in recent years than CPI inflation. Nevertheless, the results in Table 3 indicate that this moderation is readily explicable. As was true for wages, there is no evidence of a novel inflation process

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[4] Rising stock prices mean that employers do not have to contribute as much to fund their plans as they would otherwise.

[5] At times changes have been made to the methodology used to measure the Consumer Price Index. In the early 1980s, for example, a switch was made to the calculation of the cost of home ownership, changing to a rental equivalence cost from an estimate of the cost of home purchase. Such changes are thought to have made the CPI a more accurate measure of "true" inflation. However, because the CPI is not revised historically to reflect these methodological enhancements, it does not provide a measure of inflation that is consistent over time.

Figure 6

Actual and Fitted Values of Inflation
(Wholesale Price Index, Finished Goods)

Percent
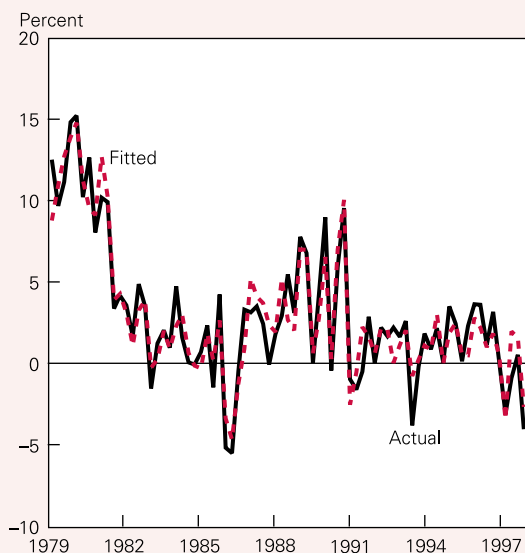
at work. Figure 6 compares actual inflation with the fitted values from the full sample regression.

For reader reference, the equation took the form:

$$p = w - q - b1 * U + b2 * pe + b3 * pm. \quad (2a)$$

The coefficient $b2$ measures the sensitivity of wholesale price inflation to relative energy prices. Its value of 0.11 means that a 10 percent rise in relative energy prices adds 1 percent to prevailing inflation. No significant lag was found. The coefficient $b3$ measures the sensitivity of inflation to relative import prices. A 10 percent rise in the relative cost of imported goods adds 2 percent to average wholesale prices; the impact is spread over a year.

Since the sensitivity of inflation to shocks from energy and import prices should relate to the relative size of these inputs in domestic costs and to competitive pricing calculations, the coefficients could vary through time. There is no indication of a shift for energy: The coefficient is 0.11 with a small standard error in all time periods tested. Consistent with the U.S. economy's rising openness to trade, however, the impact of changes in imported goods prices increases from 0.18 in the first half of the sample

period to 0.25 in the second half. The speed of response is also faster, with more impact felt in the current quarter.

Prices reflect total labor costs, not just wages. Therefore, any surprise reduction in the cost of fringe benefits relative to base wages would also trim price inflation. To take account of supply shocks from health care, pensions, and other fringe benefits, the regression includes the inflation rate for total compensation relative to that for wages only. Any gap between inflation in total compensation and base wage inflation should translate into an equal-sized percentage point change in the rate of wholesale price inflation. The freely estimated coefficient of the gap between total compensation inflation and base wage inflation is 1.06, right on the mark.

Cyclical variations in the markup of prices over costs are captured in Table 3 by the same demographically adjusted unemployment rate used in the wage model. A 1 percentage point shift in the unemployment rate is estimated to produce a 0.36 percentage point reverse shift in prices relative to wages. An insignificant increase in this sensitivity (from 0.4 percent to 0.5 percent) is detected in the second half of the sample period.

The unemployment rate is used here to conform to the compact model of wage-price inflation developed earlier. However, another common indicator of excess demand in the goods market, used in many price inflation regressions in the literature, is the "vendor performance index." This is the percentage of purchasing managers surveyed who report slower deliveries. Substitution of a distributed lag of this indicator for the adjusted unemployment rate produced no significant change in any of the other coefficients.

IV. Summary and Conclusion

Figure 7 summarizes the estimated roles of the key factors shifting inflation during the past two decades, while Figure 8 provides a close-up view of recent years. The bold line shows the total impact of cycles in excess demand, as indicated by variations in the unemployment rate multiplied by the coefficients in the wage and price regressions. The dotted, dashed, and ordinary lines are the similarly estimated effects of shocks: The dotted line shows the impact of imported goods prices, the dashed line indicates the effect of energy costs, and the thin solid line shows the influence of surges in fringe benefits relative to wages.

Table 3
Regressions Results for Price Inflation

Dependent variable: Finished Goods Wholesale Price Inflation[a]

Explanatory Variables	(1) Full Sample 1979:Q1–1998:Q1 Coefficient	T-Statistic	(2) Full Sample with Estimated Coefficient Shifts 1979:Q1–1998:Q1 Coefficient	T-Statistic	(3) First Half of Full Sample 1979:Q1–1987:Q4 Coefficient	T-Statistic	(4) Second Half of Full Sample 1988:Q1–1998:Q1 Coefficient	T-Statistic
Constant	−.66	−2.58	−.81	−1.87	−.76	−1.53	−.45	−1.13
Inflation Rate of Employment Cost Index	1.00		1.00		1.00		1.00	
Inflation Rate of Fuel and Power WPI	.11	13.09	.11	12.85	.11	7.33	.11	10.18
Inflation Rate of Imported Goods Prices (Chain-Weight Deflator, Goods Except Oil and Computers)	.20		.22		.18		.25	
Current quarter	.11	3.65	.12	2.17	.05	.63	.20	2.62
Prior quarter	.09	2.66	.10	2.72	.13	2.68	.05	.80
Adjusted Unemployment Rate	−.36	−2.00	−.23	−.90	−.39	−1.23	−.50	−1.59
Inflation Rate of Total Compensation Relative to Wages	1.06		1.38		1.32		.99	
Current quarter	.56	2.07	.63	2.21	.47	1.14	.77	2.01
Prior quarter	.50	1.83	.75	4.21	.85	2.00	.22	.53
			Tests for Shifts					
'88–'98 Filter (= 0 '79–'87; = 1'88–'98)			.30	.53				
'88–'98 Filter × Adjusted Unemployment Rate			−.33	−.82				
R-Bar Squared	.800		.795		.817		.756	
Durbin-Watson Statistic	2.031		2.045		2.018		2.045	
Standard Error of the Regression	1.502		1.516		1.628		1.451	
Sum of Squared Residuals	157.9		156.3		76.9		71.6	

[a]Notes on variable definitions:
All inflation rates are calculated as annual rate of change equivalents, using changes in logarithms of the underlying variables. "Finished Goods Wholesale Price Inflation" is calculated as $400 * \log(wpi/wpi(t-1))$, where "wpi" is the quarterly average of monthly prices.

The inflation rates for fuel and power, for imported goods, and for total compensation including fringes are the difference between the gross inflation rates for these categories and the inflation rate of the employment cost index. In other words, these terms reflect the shocks from these sources beyond prevailing inflation.

The "adjusted unemployment rate" is a moving average over the four prior quarters of the official civilian unemployment rate minus the demographic adjustment described in the text.

The bar is the sum of all effects. As can be seen, the bar is often close to the bold line. In other words, for most periods, unemployment is the dominant influence on inflation. This close relationship explains why public and professional discussion often focuses on this indicator to the exclusion of others.

However, the inflation surge in the late 1980s, described earlier and generally seen as validating the concept of the NAIRU, was actually due to a confluence of adverse inflation shocks from all other identi-fied sources. The drop of unemployment to 5.3 percent had only a small impact.

Conversely, the moderate inflation of recent years is due to a confluence of beneficial shocks from all factors other than unemployment. This can be seen most clearly in Figure 8. Tight labor markets in 1997 and early 1998 were tending to add a full percentage point to prevailing inflation. But declining prices for imported goods and energy were each pushing infla-tion sharply down. Slower growth in the cost of fringe

Figure 7

Key Factors Affecting Inflation, First Quarter 1979 to First Quarter 1998
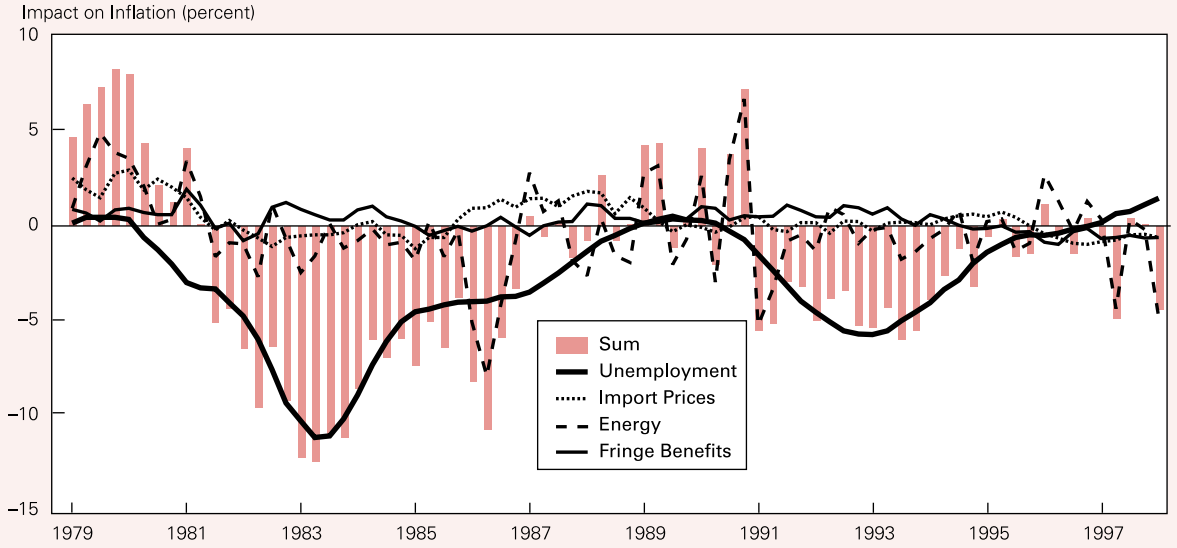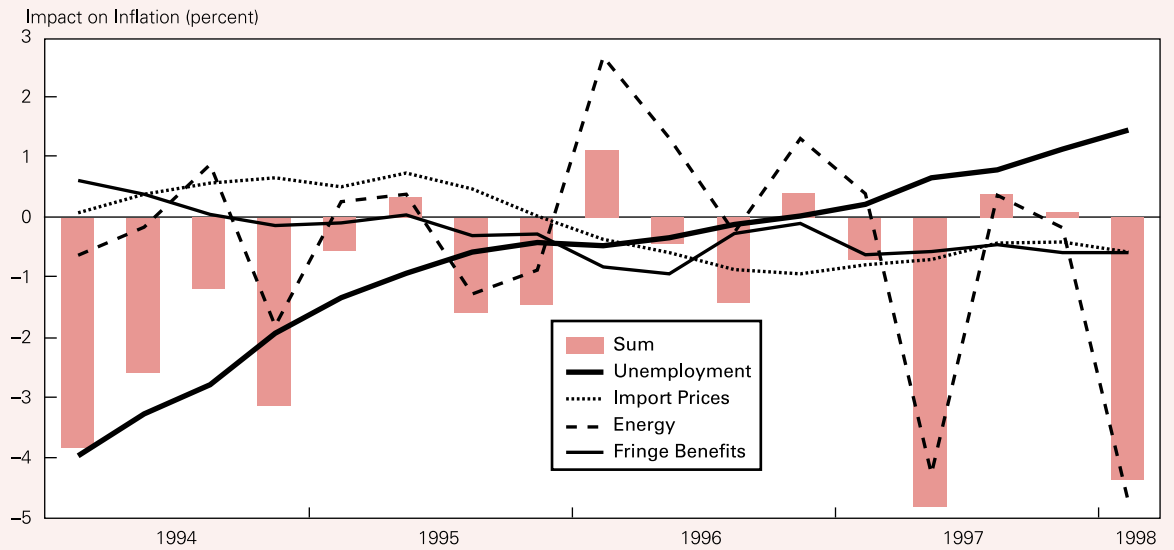(Wholesale Price Index, Finished Goods)

Impact on Inflation (percent)

Figure 8

Key Factors Affecting Inflation:
Close-Up on First Quarter 1994 to First Quarter 1998
(Wholesale Price Index, Finished Goods)

Impact on Inflation (percent)

benefits was also tending to relieve inflationary pressures. In other words, the increasingly tight labor market of 1997 and 1998 would have produced accelerating inflation, were it not for declining energy and import prices and the slow growth in fringe benefit costs.

Although the combination of low unemployment and low inflation in the mid and late 1990s was remarkable, it did not herald a new economy, forever destined to enjoy high growth and low inflation. Rather, it reflected an unusual confluence of favorable supply shocks operating through traditional channels.

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