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Abstract

Standard Phillips curve analyses of nominal wage growth performed poorly over the Seventies. Because wage pressures arising from sectoral shocks largely balance out, only that portion of unemployment that is net of the effects of compositional shifts in the structure of labor demand should influence nominal wage growth. Sectoral disturbances in the Seventies caused the unemployment rate to rise independently of cyclical activity. Once unemployment has been corrected to reflect the effects of sectoral shifts, the apparent instability of the Phillips curve is resolved. This result holds for both an employment and a stock price dispersion measure of sectoral shifts.

1 Introduction

Advocates of the Phillips curve approach to modeling the inflation process typically relate wage or price inflation to some measure of current economic activity and an inflationary expectations variable. Economic activity is usually proxied by the unemployment rate or some function of the unemployment rate, and expected inflation is specified as a function of lagged values of actual inflation.

This traditional approach to the inflation process appears to have dwindled in popularity in recent years as many researchers have found that the parameters of the Phillips curve changed over the Seventies. Cagan (1975), Sachs (1980), and O'Brien (1985) argue that the trade-off between inflation and unemployment has worsened in that a given decline in the rate of wage inflation requires a larger increase in the rate of unemployment than previously needed, i.e. the short run Phillips curve has become flatter. In contrast, Wachter (1976) and Schultze (1981) suggest that the opposite is true with wage inflation becoming more cyclically sensitive, implying a steeper short run Phillips curve.

Attempts to resurrect the Phillips curve have typically fallen along two lines of reasoning. First, unstable parameters may be the result of an initial misspecification of the inflationary expectations process. Noting this, several researchers including Sachs (1980) and more recently Neumark and Leonard (1991) have experimented with alternative expectations formulations and more sophisticated models of wage and price dynamics. However, as Sachs (1980) observes, the evidence indicates that more complicated models of expected price inflation do not account for what appears to be a significant change in the short run trade-off between inflation and unemployment.

Omitted variables offer an alternative explanation for the parameter instability. Several researchers, including Gordon (1977), Perry (1980), and Hamilton (1983), have suggested that demographic changes combined with oil price shocks, the acceleration and termination of the Vietnam War, and the implementation of wage and price controls account for the instability of the Phillips curve. These theories have met with only modest success. Others, including Sachs (1980), Barro (1977), and Taylor (1980), argue that there has been a change in the underlying structure of the inflation process. For example, an increase in the use of longer term labor contracts and a belief held by the public that monetary and fiscal policy will be used so as to promote high employment and stable prices have worsened the trade-off. Although there is some theoretical justification for this hypothesis, empirical evidence on this point is lacking.

Oddly, in light of research on sectoral shifts and their relation to the unemployment rate, the search for alternative specifications of the Phillips curve has led to relatively little consideration of the appropriate measure of economic activity to be employed in the analysis.[1] Typically, the unemployment rate or some function of the unemployment rate is used to capture the disequilibrium aspect although some researchers, including Sachs (1980) and Gordon (1977), have chosen instead to use alternative measures such as deviations of real Gross National Product from potential. These variables are all meant to measure the current level of economic activity.

While rigorous theoretical underpinnings of the Phillips curve phenomenon are conspicuously absent in these works, discussion of wage inflation is typically expressed in terms of labor market tightness. Controlling for inflationary expectations, the negative coefficient on the unemployment rate in a reduced form regression of wage inflation is interpreted as indicating that tight labor markets, as signaled by lower unemployment rates, put upward pressure on wages and, therefore, on prices through some sort of markup equation.

According to the sectoral shifts hypothesis of unemployment [Lilien (1982)], changes in the distribution of demand, given its level, cause the unemployment rate to increase as it is costly both for the employer and employees to adjust instantaneously. Therefore, the sectoral shifts hypothesis suggests that higher unemployment is not necessarily indicative of a weakening economy, while similarly lower unemployment need not signify stronger aggregate demand. In the case of structural realignment, the unemployment rate is no longer an accurate measure

[1]Recent works on the topic of sectoral shifts and the unemployment rate include Lilien (1982, 1990), Neumann and Topel (1991), Loungani (1985), Loungani, Rush, and Tave (1990), Davis (1985), Abraham and Katz (1986), and Brainard and Cutler (1990). Abraham and Medoff (1982) examine different measures of economic activity but do not relate this to the sectoral shifts hypothesis.

of labor market activity.

Unemployment resulting from sectoral reallocations does not affect the wage inflation process in the same way as cyclical unemployment since any upward wage pressure that results in one sector will be tempered by downward wage pressure in another. If the sectoral shifts hypothesis is correct and sectoral reallocation was responsible for the higher unemployment rates in the Seventies, the Phillips curve would then appear to be unstable over this time period. Specifically, a higher unemployment rate would be required to induce a given reduction in wage inflation than needed when sectoral shifts were relatively unimportant.

The purpose of this paper is to analyze the effect of permanent sectoral shifts on the wage inflation process. The remainder consists of four sections. In Section 2 two different measures of sectoral shifts are examined, namely Neumann and Topel's (1991) construction of permanent changes in the distribution of employment across industries and the stock market dispersion index of Loungani, Rush, and Tave (1990). These measures are then used in Section 3 to construct estimates of the natural rate of unemployment.

In Section 4 the stability of the Phillips curve is examined with particular emphasis given to the role of sectoral shifts. A test of the sectoral shifts hypothesis in its strictest form is proposed that tests whether the coefficients on the natural and actual rates of unemployment are of equal and opposite signs as would be expected if sectoral shifts are noninflationary. Conclusions and suggestions for further research are found in Section 5.

2 Measuring Sectoral Shifts

Generally, two distinct ways have been proposed in the literature for measuring sectoral shifts. One is based upon dispersion in employment growth across industries and the other upon stock price dispersion.[2] Abraham and Katz (1986) argue that employment-based dispersion measures poorly capture sectoral shifts since, if a declining industry is also relatively more cyclically sensitive, a positive correlation between an employment-based dispersion index

[2]Lilien (1982, 1990) and Neumann and Topel (1991) have focused on the former while Loungani, Rush and Tave (1990) and Brainard and Cutler (1990) have examined the latter.

and the unemployment rate can result purely from aggregate disturbances. They suggest that these two factors have been present in post-War U.S. data so that a sectoral shifts interpretation of employment growth dispersion is inappropriate. As a result of their criticism, researchers have attempted to both refine their employment-based measures of sectoral shifts and create new measures that do not suffer from the Abraham and Katz critique.

If changes in the distribution of employment across industries are fundamentally related to the business cycle, then a given industry's employment response should be consistent over the various cycles after controlling for the intensity of the cyclical shock. Define g_i as the growth rate of employment in the i^{th} industry from business cycle peak to subsequent trough. Similarly, define g as aggregate employment growth. Relative employment growth, g_i/g, for the 20 two-digit manufacturing industries over the eight post-War business cycles is found in Table 1. The industry response varies greatly from cycle to cycle. For example, Non-Electrical Equipment lost over twice as much as the industry average in the recession of 1949 but in 1974 the industry lost almost no workers, even though the '74 recession was more severe. Similarly, Electrical Equipment was particularly hard-hit in 1970 but fared relatively well in the 1960 downturn.

If the business cycle hypothesis is correct, then the cross-cycle variance of g_i/g should be relatively small. In testing this hypothesis, a fundamental problem arises in determining how small the variance should be under the null. A somewhat weaker variant of the business cycle hypothesis is that the underlying distributions of the observations are the same across cycles. A likelihood ratio test of the equality of the variances of the observations across cycles can be easily constructed from the sample within-cycle variances.[3] The hypothesis of constant

[3]The computed test statistic, $-2\log\lambda$, equals 33.73 and is asymptotically distributed as χ^2 with (8-1) degrees of freedom. The likelihood ratio is given by:

$$\lambda = \prod_{j=1}^{8} (\hat{\sigma}_j^2)^{10} \Big/ \left[\sum_{j=1}^{8} \hat{\sigma}_j^2/8\right]^{80}$$

where

$$\hat{\sigma}_j^2 = \frac{1}{20}\sum_{i=1}^{20}\left(g_i/g - \left[\frac{1}{20}\sum_{i=1}^{20} g_i/g\right]\right)^2$$

variance across cycles is rejected.

Although some industries may fare relatively better than others in terms of employment over the course of the business cycle, there is sufficient variation in the employment response of a given industry across cycles to suggest that changes in the sectoral composition of employment over time are driven by more than simply general cyclical fluctuations. While a cyclical interpretation is not precluded, any cyclical explanation must necessarily explain the differing character of these cycles.

2.1 Dispersion Measures

In the analysis that follows, two different measures of sectoral shifts are examined: Neumann and Topel's (1991) employment-based measure, Δ^P, and Loungani, Rush, and Tave's (1990) stock price dispersion measure SQ. Unlike Lilien's (1982) original measure, each of these is constructed in such as way as to capture *permanent* shifts in the relevant distribution. Neumann and Topel (N–T) focus on decomposing deviations in employment shares from trend into two components—one predictable from observations on future employment shares and one which is orthogonal to it. Loungani, Rush, and Tave (LRT) suggest that a stock market dispersion index is weighted towards capturing permanent shifts in an industry's expected profitability. Since stock prices reflect the present discounted value of expected industry profits over an infinitely long horizon, the impact of a current innovation in profits on stock price depends on whether that innovation is expected to be temporary or permanent.[4]

The Abraham and Katz critique suggests that an appropriate measure of sectoral shifts should be independent of past unemployment, i.e. that the unemployment rate should not Granger-cause sectoral shifts. The advantage to the stock price dispersion measure is that movements in stock prices precede changes in unemployment.[5] However, reallocation timing arguments such as proposed by Hamilton (1983), Davis (1985), and Rogerson (1987) suggest

and $j = 1, \dots, 8$ indexes the cycles. The small sample properties of the test statistic are unknown.

[4]First differences in Δ^P and SQ have a correlation coefficient of -0.11.

[5]To summarize the results of Granger-causality tests, unemployment appears to Granger-cause Δ^P but does not Granger-cause SQ.

that reallocation in response to a sectoral disturbance will occur when the economy is in a low state and the opportunity cost is smallest. In light of the reallocation timing arguments, one would expect to see unemployment Granger-causing dispersion to the extent that the unemployment rate also reflects cyclical disturbances.

Both Δ^P and SQ have the benefit of being forward looking and capturing permanent changes. However, the interpretation of SQ is unclear if markets are not efficient. In addition, there may be factors that affect the return on capital that do not necessarily influence labor demand. To that extent, stock market dispersion would be a poor measure of those sectoral shifts that entail some reallocation of labor. For this reason an employment-based measure of sectoral shifts seems better able to capture those disturbances that do influence the pattern of labor demand and presumably have some bearing on the unemployment rate.

3 The Natural Rate

3.1 Sectoral Shifts and Unemployment

There are many factors which may affect the unemployment rate. According to the standard sectoral shifts theory of unemployment as suggested in Lilien (1982), permanent changes in the distribution of employment across industries should increase the unemployment rate in the short run as a mismatch between workers and employers results. Over time the long term effects of a sectoral shift disappear as agents adjust to the disturbance.

The demographic composition of the labor force has been cited as one cause for the rise in the unemployment rate over the Seventies as a larger proportion of those groups having traditionally higher levels of unemployment, namely women, nonwhites, and youths, entered the labor market. In the analysis that follows a Perry-weighted unemployment rate (WUR) that has been adjusted to reflect the age-race-sex composition of the labor force in 65Q1 is used to capture this demographic effect.

Traditional macroeconomic models focus on cyclical factors as the driving force behind movements in the unemployment rate. Following Lilien (1982), this cyclical effect is assumed to be captured by 'unanticipated money growth', DM_t, and deviations of real Gross National Product from trend, $DGNP_t$.[6]

Finally, unemployment insurance and other social welfare programs are thought to have an effect on the unemployment rate. On the one hand, such programs subsidize job search with the effect of encouraging a longer period of unemployment. On the other hand, the extended length of job search that results should lead to better employee/employer matches and a reduction in future unemployment. The net effect is ambiguous. The effect of social welfare expenditures is assumed to be measured by social insurance expenditures expressed as a percentage of Gross National Product, SI_t.[7] Because social insurance expenditures typically rise during economic downturns, the ratio of such expenditures to GNP is countercyclical. Thus, SI may simply proxy for additional cyclical information independent of any hypothesized effect it may have upon job search or job matching.

Unemployment rate regressions were estimated of the form:

$$[1 - b_0(L)L]WUR_t = c + b_1(L)DGNP_t + b_2(L)DM_t + b_3(L)SI_t + b_4(L)\sigma_t + \epsilon_t \qquad (1)$$

where the $b_i(L)$ are polynomials in the lag operator, L, and σ_t is some dispersion measure of sectoral shifts.[8] For $\sigma = \Delta^P$, the preferred regression includes $b_0(L)$ and $b_4(L)$ as first order polynomials, with $b_1(L)$ and $b_2(L)$ as second order polynomials, and $b_3(L)$ as a constant. The preferred regression for $\sigma = SQ$ is of the same form as for the employment-based dispersion measure with the exception that $b_4(L)$ has a lag length of 16 quarters.

[6]As defined in Barro (1978), unanticipated money growth is constructed as the least squares residuals from a regression of $M1$ growth on a vector of explanatory variables. The construction varies slightly from that described in Barro since the data employed here are quarterly while Barro's estimates were computed from annual data. Aside from a constant, the vector of explanatory variables includes eight lags of money growth, current and three lags of the log of real federal government expenditures calculated as deviations from a one-sided moving average of past values, and four lags of the ratio of unemployment to employment expressed in logarithms. Current and eight lags of the log of real federal government expenditures are used to calculate the moving average with geometrically declining weights that sum to unity and adaptive parameter of 0.2. The variable $DGNP_t$ is the deviation in the log of real GNP from a linear trend.

[7]The data are reported annually in the Social Security Administration's *Social Security Bulletin: Annual Statistical Supplement.* Linear interpolation was used to obtain quarterly figures.

[8]Detailed results are available from the author.

3.2 Construction of the Natural Rate

The "natural rate of unemployment", according to Lilien (1982), is the rate of unemployment that would occur in the absence of cyclical fluctuations. In Lilien's formulation it reflects only the unemployment that occurs as a consequence of sectoral shifts and the resulting temporary mismatch of workers and employers. The terminology is somewhat misleading as the "natural rate" has typically referred to the rate of unemployment compatible with nonaccelerating or nondecelerating wage growth and has usually been derived from a relation between unemployment and nominal wage growth. The natural rate that Lilien refers to does not necessarily have any bearing on the question of nominal wage growth. In fact, one can view equation (1) above as derived from a production function or Okun's Law with sectoral shifts affecting the production possibility frontier. In this context the "natural rate of unemployment" is unrelated to the Phillips curve phenomenon. Perhaps a more accurate expression for the construct that Lilien proposed is 'structural unemployment' as it refers to that unemployment which is the result of the changing structure of labor demand. However, in keeping with the literature on sectoral shifts, I will continue to use the 'natural rate' terminology.

The natural rate of unemployment, in this context, is simply calculated as the rate of unemployment that occurs when the cyclical variables, namely $DGNP$ and DM, are set identically equal to zero over the entire time period analyzed. How one treats other variables in constructing the natural rate is open to some debate. If one is concerned exclusively with a measure of unemployment associated with sectoral reallocation, then the natural rate should be constructed holding these other variables equal to their mean values as in Lilien (1982) for example. However, a broader measure that is consistent with an interpretation of the natural rate as non-cyclical or structural unemployment would permit these other variables to vary over time. The latter approach is taken here.[9]

Figure 1 presents the actual age-weighted unemployment rate and estimates of the nat-

[9]To implement these computations, it is necessary to specify initial values of the natural rate, NUR. Initial values of the natural rate are taken to be the actual values of the demographically-weighted unemployment rate. The effect of these initial values on the calculations decreases over time.

ural rate of unemployment calculated from the estimated parameter values of the preferred equations (1). The natural rate series calculated from Δ^P and SQ are denoted as NUR_{NT} and NUR_{LRT} respectively. It should be noted that because the dependent variable in the regression analysis, WUR, is a demographically fixed-weight unemployment rate, the estimates of the natural rate constructed are also independent of demographic effects.

Generally, it is presumed that low unemployment rates signal a healthy economy while high unemployment rates indicate low aggregate demand. Such an interpretation is valid only if other non-cyclical factors influencing unemployment are stable. In this case, movements in the unemployment rate correspond to changes only in the cyclical component of unemployment. The estimates of the natural rate constructed above indicate that the importance of such other factors has varied considerably over the time period examined. The series NUR_{LRT} is more or less level in the Sixties at about 5.5% and climbs over 2 percentage points during the Seventies to a peak of 7.5% in the fourth quarter of 1982. This measure of the natural rate falls to 6.4% by the end of the sample period.

The natural rate series constructed from SQ is much smoother than that constructed from Δ^P. However, the time series patterns are more or less consistent. The two natural rate series have a correlation of 0.87 in the levels but only 0.17 in first differences. The natural rate constructed from Δ^P has varied considerably being as high as 8.0% in '83 and as low as 4.7% in '66.

The relation between the natural rate and the actual rate of unemployment has changed considerably over time. NUR_{NT} remained fairly stable until the late Sixties while the actual unemployment rate fluctuated around it. The natural rate exceeded the actual rate of unemployment for a brief period from '55 to '57 and then for a much longer period of time from 65Q2 until 74Q3. However, between 69Q1 and 71Q3 the natural rate of unemployment rose over 1.5 percentage points in response to underlying sectoral shifts. Between 74Q3 and 77Q3 actual unemployment exceeded the natural rate. This was followed by a brief period of tight labor markets in the late Seventies. Both the natural rate and actual rate of unemployment continued to rise during the early Eighties with labor markets appearing slack. From 85Q4 until the end of the sample period labor markets again appear to be tight with the natural rate exceeding the actual rate by a small amount.

4 Wage Inflation and the Natural Rate

4.1 Standard Analysis

Traditional approaches to modeling the inflation process describe the rate of change of wages or alternative price variable in terms of its equilibrium and disequilibrium components. Thus, it is hypothesized that the rate of growth of wages, $\dot{w}$, is a function of expected price inflation and the difference between labor demand and labor supply. Assuming that wage inflation is a linear function of these variables, then wage growth is expressed as:

$$\dot{w}_t = \delta_0 + \delta_1(L_t^d - L_t^s) + \delta_2\dot{p}_t^e \tag{2}$$

where $\dot{w}$ is the logarithmic rate of change of wages at time t, and L_t^d and L_t^s are respectively labor demand and labor supply at time t, $\dot{p}_t$ is the inflation rate at time t, and the superscript 'e' indicates that the variable is in expectations form. The parameter δ_1 is hypothesized to be positive.

In estimating equation (2) the labor market conditions variable, $L_t^d - L_t^s$, is usually proxied by the actual unemployment rate. It has been suggested that the wage response is larger as labor market conditions become tighter. Therefore, the unemployment rate is usually entered in inverse form to capture this nonlinearity.

Implementation of equation (2) also requires that the expectations process be specified. Various forms have been investigated in the literature. Typically it is assumed that expected inflation depends upon lagged realizations of actual inflation so that $\dot{p}_t^e = b(L)\dot{p}_t$, where $b(L)$ is a polynomial in the lag operator L. In the analysis that follows it is assumed that expected inflation is described by a second order polynomial distributed lag model so that the coefficient on the i^{th} lag, b_i, is expressed as $(a_0 + a_1 i + a_2 i^2)$. The inclusion of beginning and endpoint constraints changes this three parameter model to a one parameter model. Finally, for purposes of estimation it is assumed that an additive error term is included at the end of equation (2).[10]

Table 2 provides OLS parameter estimates and associated t-statistics for the wage inflation model described above using quarterly observations for two sample periods. The restricted sample extends from 60Q2 to 81Q3 while the full sample includes data through 87Q1. There are two reasons for separating the data in this way. First, it is widely accepted that the parameters of the Phillips curve shifted over the Seventies.[11] The restricted sample facilitates comparison with previous results. Second, as noted by Neumark and Leonard (1991), the rapid decline in nominal wage growth over the Eighties suggests that the parameters of the Phillips curve may have changed yet again. For this reason, the full sample is analyzed.

The dependent variable in the analysis is the difference in logarithms of average hourly earnings for production workers in manufacturing and nonsupervisory workers in nonmanufacturing. The labor market activity variable is the demographically-weighted unemployment rate, WUR, entered linearly. Price inflation is calculated as the difference in logarithms of the Consumer Price Index for urban workers. The coefficient on $\dot{p}^e$ reported is the estimate of $\delta_2 a_2$ in an eight quarter polynomial distributed lag on past inflation with beginning and endpoint constraints. A negative sign on the coefficient estimate indicates that the b_i are all positive and concave in i assuming that $\delta_2 > 0$.

In column (1) of Panel A the coefficient estimates of the standard specification are found. The sign of the coefficient on the unemployment rate is negative and clearly significant at traditional confidence levels. In addition, higher expected price inflation is associated with higher wage growth as indicated by the parameter estimate on $\dot{p}^e$.[12] The relatively low

[10]Any measure of expected price inflation that may be used in the regression analysis is measured with error. It is well known that such a classical errors in variables problem biases the OLS parameter estimates. Specifically, the coefficient on the expected inflation variable will be biased towards zero with the magnitude depending upon the variance of the measurement error relative to the true series. Furthermore, the other parameters of the model are also biased with the direction depending upon the variance-covariance matrix of the observations. Without prior knowledge of the variance of the errors, it is difficult to correct for the problem. However, the estimates of the coefficient on expected inflation are surprisingly robust to alternative specifications. Therefore, it is hoped that the biases introduced are small.

[11]See Cagan (1975), Sachs(1980), Gordon (1977), Wachter (1976), and Schultze (1981).

[12]The estimation was carried out using a one-step procedure. Several other lag structures were tested that

Durbin-Watson statistic suggests that some underlying factors have not been properly included in the analysis and that the estimated standard errors are incorrect.

Various alternative specifications were estimated to investigate the idea that the wage inflation process was somehow different over the Seventies. The results are presented in columns (2) through (4) of Panel A. A dummy variable D is defined equaling 1 after the second quarter of 1971, when wage and price controls were introduced, and 0 otherwise. The regression reported in column (2) tests if the trade-off between wage inflation and unemployment worsened in recent years, holding all other parameters constant over the entire time period, by checking the significance of the interaction term $D \times WUR$. The results appear to support the contention of Cagan (1975) and Sachs (1980) that the trade-off between inflation and unemployment worsened over the latter partof the sample. The Durbin-Watson statistic improves with this specification.

The regressions in columns (3) and (4) test whether a change in the effect of expected inflation on wage growth occurred post-'71. There is no significant change in the effect of the expected price variable in the latter part of the sample when the coefficient on WUR is held constant over the entire period. However, when both WUR and $\dot{p}^e$ are permitted to change in the latter part of the sample, both interaction terms are significant and the Durbin-Watson statistic increases to 1.9.

Various other specifications were tried testing whether the shift in the parameters could be explained by the wage and price controls of the early Seventies, changes in the union composition of the labor force, and changes in the competitive position of the economy as

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are less restrictive. However, the regression results did not improve significantly and are unreported here due to space limitations. In addition, the estimation was also performed with the unemployment rate variable entered in inverse form. These regressions in general had lower Durbin-Watson statistics and lower values of R^2.

A two-step procedure which is unreported in the text was also performed. First, the parameters of the polynomial $b(L)$ were estimated by an unrestricted regression of current price inflation on eight lagged values. The sum of the coefficients was 0.95. An F-test of whether the coefficients sum to unity produced an F-value of 2.70 which is below the 5% critical value of 3.91. The predicted values from this model were then used as the expected inflation regressor in estimating equation (2). The estimate of δ_2 calculated in this way is 0.50 with a standard error of 0.05. Because of the errors in variables problem that occurs, this estimate of δ_2 is more properly thought of as a lower bound. By calculating the variance-covariance matrix of the observations, the coefficient estimate on the unemployment rate is also found to be biased towards zero.

measured by the ratio of imports to Gross National Product. Although inclusion of these variables helped explain some of the apparent instability of the Phillips curve, the coefficient on $D \times WUR$ remained positive and significant in the restricted sample period.

The remaining columns in Table 2 reproduce the analysis for the full sample period. The only difference in specification is that a dummy variable, $DUMMY$, has been included that takes on a value of 1 from 81Q4 to 87Q1. It appears that post-'81 nominal wage growth dropped independently of any changes in the coefficients on WUR and $\dot{p}^e$. The similarity of the results between the two sample periods once a change in the intercept has been permitted is quite striking. The estimated parameters are of similar magnitudes and are estimated with similar accuracy as those estimated on the restricted sample. Various other specifications were tried that permitted the coefficients on WUR and $\dot{p}^e$ to change post-'71 while keeping the intercept constant. In general, these regressions did not perform well.

4.2 Adjustment for Sectoral Shifts

Unemployment due to sectoral reallocation does not affect the wage inflation process in the same way as cyclical unemployment since any upward wage pressure that occurs in one sector would be tempered by downward wage pressure in another. These tendencies for wages to rise or fall in response to the the shifting composition of labor demand would net out on average. Unemployment could be high as a result of sectoral shifts while aggregate demand is also high and wage inflation would result.

This suggests that the Phillips curve as typically estimated may well be misspecified if the unemployment rate is not a good indicator of the performance of the economy overall. A more appropriate measure of labor market tightness would filter out the effects of factors such as sectoral shifts. A natural way to measure only cyclical fluctuations is to calculate the difference between the actual and natural rates of unemployment, a measure which by construction reflects only cyclical variations provided that the measure of sectoral shifts is independent of the cycle.

The regression results reported in Table 3 include the age-weighted unemployment rate and the natural rate of unemployment, NUR_{NT}, as separate explanatory variables with tests of the hypothesis that the estimated coefficients are of equal and opposite signs. If the hypothesis is accepted, then it suggests that the difference between the actual rate and the constructed natural rate is a good indicator of general economic performance and supports the sectoral shifts hypothesis.[13]

Panel A reports regression estimates from the restricted data set. From column (1) it appears that the natural rate provides additional information independent of the level of unemployment that is relevant to the modeling of the wage inflation process. Increases in the natural rate relative to the actual signal a tightening of labor market conditions. A one percentage point increase in the natural rate relative to the actual causes quarterly wage growth to rise by 0.3 percent. Similarly, given the natural rate, increases in the actual unemployment rate are associated with a weakening economy and, therefore, wage inflation is lower. An F-test of equal and opposite signs on the actual and natural rates cannot reject the hypothesis, suggesting that the difference between actual and natural unemployment is a good measure of general economic conditions. Both the R^2 and Durbin-Watson statistic improve with this specification.

Inclusion of NUR_{NT} clearly adds to the performance of the estimating equation. The parameter instability of the modified Phillips curve is examined in the regression results found in columns (2) through (4). As in the preceding analysis, a dummy variable D is defined taking on the value of 1 for the period from the third quarter of 1971 through the end of the sample period, and 0 otherwise. From column (2), once compositional changes in employment are accounted for via the natural rate series, there is no evidence that the trade-off between inflation and unemployment worsened over the latter part of the sample given that the other parameters, namely the coefficient on inflationary expectations and the intercept, have been constrained to be constant throughout the sample period.

Stability of the coefficient estimate on expected inflation, assuming constant parameters

[13]The errors in variables problem is more complicated for this model than for the previous one. Both expected price inflation and the natural rate of unemployment are measured with error and OLS may either underestimate or overestimate the true parameters of the model.

on the other variables, is tested in column (3). The results suggest that over the earlier part of the sample, inflationary expectations was not an important determinant of the wage inflation process. In fact, over this period the parameter estimate on $\dot{p}^e$ is insignificantly different from zero. However, the latter part of the sample shows a significant positive effect of expected inflation on wage growth. Because inflationary expectations exhibit relatively little variation in the earlier part of the sample, the effect is picked up in large part by the constant term. In column (4) the coefficients on both the labor market tightness variables and the expected inflation variable are permitted to vary over the sample period. Due to multicollinearity, most of the coefficient estimates are insignificant at traditional confidence levels with the exception of the intercept, expected inflation, and the interaction term $D \times NUR_{NT}$.

The basic regression of column (1) was reestimated with the added constraint that the coefficients on the unemployment rate and the natural rate be of equal and opposite signs. The results are reported in column (5). In summary, once sectoral shifts have been included in the analysis, there is very little support for the claim that wage growth has become less cyclically sensitive. It would appear that much of the debate about the stagflation of the Seventies is in large part attributable to a failure to distinguish among the sources of the underlying disturbances to the economy.

Regression results for the full sample are found in Panel B. Even after the inclusion of the natural rate of unemployment as an explanatory variable, the Phillips curve still appears to have an unstable intercept, ceteris paribus, as wage growth declined by between 0.6 and 0.8 percent post-'81.[14] It has been argued that inflationary expectations were somehow different over the Eighties as monetary policy shifted its focus. However, even after inclusion of the inflationary expectations variable in columns (3) and (4), the intercept still seems to have changed significantly since '81.[15]

[14]The coefficient estimates on WUR, NUR_{NT}, and $\dot{p}^e$ are similar to those found in the restricted sample. To summarize the results, inclusion of the natural rate as an explanatory variable seems to improve the fit of the equation. The coefficient on the unemployment rate no longer rises significantly over the latter half of the sample. The expected inflation variable appears to differ post-'71. The same caveats apply here as in the above discussion.

[15]Inflationary expectations are calculated here from past inflation rates. If there were a fully anticipated regime change that affected expected future inflation, it would only be incorporated in the expected inflation

The decline in wage growth observed over the Eighties has many potential explanations including the decline in union strength, changes in "wage norms," import penetration, deregulation, and a change in the inflationary expectations mechanism. Union strength, as measured by the percentage of the labor force claiming union membership, has been declining continuously since the Sixties. As an empirical matter, it is unlikely that unionism can explain only a relatively recent decline in wage growth. In addition, the decline in union membership is predominantly a phenomenon encountered in manufacturing industries and other traditional union strongholds. These industries have all been undergoing a long term decline in employment share. Thus, it is quite possible that the shift in employment captured by the measure of sectoral redistribution and the decline in union membership are simply two different aspects of the same phenomenon.

The relation between union wages and membership is difficult to disentangle. Rissman (1987) suggests that an optimizing monopolistic union facing deregulation and reductions in barriers to trade may initially increase wages and then permit wages to decline to their new long run equilibrium level as unions weigh short term wage gains against long term employment losses. In terms of wage growth, import penetration results in higher short term wage growth immediately after a change in trade barriers with lower wage growth thereafter. This explanation of declining wage growth focuses on the effect of imports on predominantly unionized industries. However, it is unlikely that the broader-based phenomenon that appears to have occurred can be explained by industry-specific factors. This criticism is also relevant to the deregulation explanation.

The idea of a shifting wage norm is consistent with the data. However, the hypothesis offers little insight into wage determination and is more a description of the data than an explanation of it. Finally, the evidence supplied in Neumark and Leonard (1991) does not support the hypothesis that a change in the inflationary expectations mechanism was responsible for the declining wage growth. In fact, they suggest that there was a true structural shift in the Phillips curve in the Eighties. In accord with their findings, there is no significant

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measure used here with some lag, thereby giving misleading results.

change in the coefficient on expected inflation over the Eighties and the intercept still appears to have shifted downwards.

The coefficient estimates of expected inflation and the actual and natural rates of unemployment are surprisingly robust to alternative specifications. In addition to modifying the Phillips curve specification by concentrating on an alternative measure of labor market tightness, the role of demographics, unionization, and wage and price controls were also examined. Gordon (1977) and Perry (1980) suggest that the changing demographic composition of the labor force has had an effect upon wage growth. However, the proportion of females, nonwhites and youths in the labor force were insignificant in the examined regressions, suggesting that demographics has an impact on wage growth only via its affect on unemployment. Gordon (1977) argues that wage and price controls were responsible for the parameter instability of the Seventies. A test of this hypothesis was performed by creating a dummy variable for when the controls were in effect. After controlling for sectoral unemployment, wage and price controls did not significantly affect wage growth, suggesting that the impact of wage and price controls may be on the distribution of employment. Finally, union strength, measured as a percentage of employment, did not significantly affect wage growth.

4.3 The Phillips Curve and Alternative Natural Rate Series

Regression results for an alternative natural rate series constructed from the stock price dispersion index NUR_{LRT} are found in Table 4. These results are surprisingly similar to those based upon NUR_{NT}. Coefficient estimates are generally of the same sign and magnitude as those found in Table 3 and their standard errors are similar. The natural rate enters positively in this set of regressions and is generally significant except when the interaction term $D \times NUR_{LRT}$ is included. This occurs because this particular estimate of the natural rate varied little in the earlier part of the sample.

F-tests of the strict sectoral shifts hypothesis, i.e. that the coefficients on the actual rate and the natural rate are equal and opposite in sign, are somewhat less strong than those based upon employment dispersion, Δ^P. However, with a 5% critical value of approximately

3.96 the hypothesis cannot be rejected.

5 Conclusions

Standard specifications of the Phillips curve employ the unemployment rate as a proxy for the general level of economic activity. However, unemployment can be high either because of sectoral realignment or because of low aggregate activity. Because wage pressures arising from sectoral shocks largely balance out, only that portion of unemployment that is net of the effects of compositional shifts in the structure of labor demand should influence nominal wage growth.

The worsening of the trade-off between inflation and unemployment over the Seventies is illusory. Much of the nominal wage growth over this period can be explained by sectoral shifts that caused the natural rate of unemployment to rise relative to the actual. Rather than having slack labor markets, as indicated by the high level of unemployment, the opposite occurred with sectoral realignment attenuating the traditional linkage of unemployment to the general level of economic activity. Once the natural rate is explicitly considered, it appears that the cyclical sensitivity of wages has not changed over time.

The results reported here are consistent with the sectoral shifts hypothesis of unemployment. Sectoral shifts should not give rise to persistent inflationary pressures as wage movements are averaged out across sectors. Only increases in the general level of economic activity are inflationary. If sectoral shifts are truly independent of the cycle, then the difference between the actual rate of unemployment and the constructed natural rate series is the appropriate explanatory variable to use in a nominal wage growth regression. Tests of the hypothesis that the actual and natural rates of unemployment enter with equal and opposite signs are generally supported by the data.

The experience of the Eighties poses a somewhat different problem. The Phillips curve appears to be unstable over this period even after sectoral shifts have been explicitly considered. Although the natural rate still enters the wage growth regressions with the hypothesized sign and is of the appropriate magnitude, there appears to be a downward shift in the intercept term that is as yet unexplained. These results, specifically the stability of the trade-off, the shifting of the intercept, and the coefficient restrictions, are generally robust to markedly different measures of the natural rate.

Finally, the sectoral shifts hypothesis and its relation to the wage inflation process has potentially important insights to yield for the role of government policy. First, and perhaps most obviously, the sectoral shifts hypothesis suggests that a countercyclical policy may be not be implementable because of the difficulty in interpreting movements in the unemployment rate. An expansionary policy adopted at the wrong time in the cycle may serve only to increase inflation rather than decrease the unemployment rate. Second, traditional monetary and fiscal policy effectiveness may depend in large part on the composition of unemployment. Such policies seem better suited to dealing with unemployment that is cyclical in nature but may prove to be largely ineffective in reducing unemployment that is attributable to long term sectoral shifts. Therefore, a combination of monetary and fiscal stimuli combined with an industrial and jobs policy may be a more effective means of dealing with the problem of unemployment. Third, although the Phillips curve relations estimated here are reduced form expressions, they suggest that there may be a trade-off that policymakers can exploit between cyclical unemployment and the inflation rate. Before running monetary policy as if the relation is stable, a better understanding of the downward shift in wage growth in the Eighties is warranted. Finally, monetary policy may impact industries differentially, having a larger effect upon those industries that are relatively more interest-sensitive. Changes in policy may therefore affect the natural rate of unemployment and, hence, the nature of the trade-off between unemployment and inflation.

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Table 1: Relative Employment Growth Rates, Peak to Trough

Manufacturing Industries

Trough	49Q4	54Q2	58Q2	61Q1	70Q4	75Q1	80Q3	82Q4
Food and Kindred	0.1870	0.1481	0.2037	0.1395	0.1189	0.4533	0.1130	0.1779
Tobacco	0.7301	-0.0392	0.1913	0.7588	0.0512	0.3845	-0.2017	0.3661
Textiles	0.5858	1.3147	0.8313	1.1760	0.5892	2.0448	1.2078	1.1537
Apparel	-0.0084	0.7475	0.4685	0.6880	0.5779	1.8173	0.5494	0.8533
Lumber and Wood	0.7495	0.7356	0.9208	2.0548	0.4155	2.5514	2.4544	0.9440
Furniture and Fixtures	0.3643	1.1439	0.7816	1.6467	0.7176	2.2149	1.9006	0.8869
Paper	0.3448	0.1369	0.1940	0.2241	0.5202	0.8473	0.6003	0.5021
Printing and Publishing	0.0854	-0.1044	-0.0249	-0.0837	0.1656	0.1732	0.1383	0.0110
Chemicals	0.8005	0.4067	0.2831	0.2480	0.3589	0.2349	0.3076	0.4425
Petroleum	0.2425	0.2026	0.3704	0.8369	-0.0663	0.2537	-3.4369	0.5965
Rubber and Plastic	0.9235	1.3431	1.2619	1.3716	0.0000	1.4406	2.0872	0.8544
Leather	0.5777	0.5432	0.6333	0.3554	1.1004	1.6489	0.9319	1.3616
Stone, Clay, and Glass	0.9833	0.7543	0.7304	1.2942	1.1528	1.2675	1.8818	1.2228
Primary Metals	3.9298	1.7375	2.2966	3.0539	1.2381	0.6968	2.6628	3.1209
Fabricated Metals	1.5214	1.3775	1.1944	1.4187	1.4564	1.1608	1.6891	1.5431
Non-Electical Equipment	2.2828	1.1431	1.8257	1.1531	1.0608	0.0864	0.7189	1.8902
Electical Equipment	1.3763	1.7443	1.1522	0.4529	3.5602	1.5333	0.9491	0.6776
Transportation Equipment	1.2793	1.7906	2.1732	1.5374	3.6392	1.2951	1.3834	1.2114
Instruments	1.1461	1.1825	0.8194	0.7971	-3.8166	0.6101	0.2858	0.5228
Miscellaneous	0.5261	1.0771	0.5253	1.1513	0.8592	1.2008	1.3883	0.9879

Table 2
Parameter Stability of the Standard Phillips Curve Specification

	Panel A: 60Q2 to 81Q3				Panel B: 60Q2 to 87Q1			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
WUR	−0.0013	−0.0017	−0.0014	−0.0015	−0.0010	−0.0014	−0.0010	−0.0013
	(3.519)	(4.216)	(3.281)	(3.810)	(3.225)	(4.062)	(2.949)	(3.981)
$\dot{p}^e$	−0.0050	−0.0039	−0.0047	−0.0060	−0.0048	−0.0038	−0.0048	−0.0063
	(10.065)	(5.516)	(4.612)	(5.890)	(10.795)	(6.467)	(5.150)	(6.773)
$D \times WUR$	–	0.0005	–	0.0015	–	0.0005	–	0.0014
		(2.247)		(3.619)		(2.512)		(4.282)
$D \times \dot{p}^e$	–	–	−0.0003	0.0041	–	–	0.0000	0.0041
			(0.331)	(2.785)			(0.012)	(3.375)
c	0.0145	0.0168	0.0150	0.0142	0.0134	0.0154	0.0133	0.0130
	(8.235)	(8.427)	(6.617)	(6.655)	(8.915)	(9.235)	(7.158)	(7.540)
$DUMMY$	–	–	–	–	−0.0036	−0.0053	−0.0036	−0.0082
					(3.010)	(3.939)	(2.996)	(5.311)
R^2	0.569	0.594	0.570	0.630	0.636	0.657	0.636	0.692
$D-W$	1.505	1.693	1.516	1.883	1.443	1.614	1.443	1.812

NOTE: The dependent variable is the first difference in the logarithm of Average Hourly Earnings reported in various issues of *Employment and Earnings* by the BLS. T-statistics are in parentheses.

Table 3: The Phillips Curve and Sectoral Shifts

	Panel A: 60Q2 to 81Q3					Panel B: 60Q2 to 87Q1				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
WUR	−0.0020	−0.0022	−0.0031	−0.0004	−0.0020	−0.0016	−0.0023	−0.0019	−0.0002	−0.0015
	(4.403)	(3.482)	(4.944)	(0.331)	(4.366)	(4.128)	(4.029)	(4.105)	(0.204)	(4.046)
NUR_{NT}	0.0027	0.0027	0.0046	−0.0011	0.0020	0.0022	0.0026	0.0027	−0.0028	0.0015
	(2.517)	(2.397)	(3.534)	(0.423)	(4.366)	(2.476)	(2.639)	(2.759)	(1.189)	(4.046)
$\dot{p}^e$	−0.0041	−0.0031	−0.0009	−0.0080	−0.0044	−0.0041	−0.0028	−0.0029	−0.0098	−0.0044
	(6.758)	(3.230)	(0.606)	(2.521)	(10.966)	(8.228)	(3.851)	(2.593)	(3.365)	(12.018)
$D \times WUR$	–	−0.0009	–	−0.0017	–	–	0.0014	–	−0.0002	–
		(0.652)		(1.160)			(1.416)		(0.207)	
$D \times NUR_{NT}$	–	0.0014	–	0.0031	–	–	−0.0008	–	0.0020	–
		(1.157)		(1.946)			(0.914)		(1.463)	
$D \times \dot{p}^e$	–	–	−0.0026	0.0055	–	–	–	0.0011	0.0076	–
			2.429	(1.620)				(1.208)	(2.479)	
c	0.0047	0.0055	0.0017	0.0132	0.0079	0.0049	0.0071	0.0043	0.0177	0.0080
	(1.102)	(1.342)	(0.391)	(2.112)	(10.801)	(1.316)	(1.891)	(1.149)	(3.145)	(11.922)
$DUMMY$	–	–	–	–	–	−0.0057	−0.0080	−0.0062	−0.0073	−0.0047
						(3.952)	(4.699)	(4.140)	(4.292)	(5.294)
R^2	0.600	0.644	0.627	0.655	0.597	0.657	0.680	0.662	0.698	0.654
$D-W$	1.654	1.991	1.902	2.004	1.631	1.554	1.768	1.616	1.814	1.532
F − value	0.563	0.381	2.781	1.047	–	0.715	0.117	1.235	3.687	–

NOTE: The dependent variable is the log first difference in the BLS's Average Hourly Earnings. T statistics are in parentheses. The F statistic reports tests for equal and opposite signs on the coefficients of WUR and the natural rate, NUR_{NT}.

Table 4: The Phillips Curve and Sectoral Shifts

	Panel A: 60Q2 to 81Q3					Panel B: 60Q2 to 87Q1				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
WUR	−0.0018	−0.0015	−0.0017	−0.0010	−0.0018	−0.0014	−0.0016	−0.0013	−0.0010	−0.0014
	(4.728)	(2.617)	(4.208)	(1.753)	(4.529)	(4.302)	(3.137)	(3.826)	(1.964)	(4.169)
NUR_{LRT}	0.0036	0.0018	0.0045	0.0011	0.0018	0.0031	0.0028	0.0040	0.0016	0.0014
	(3.216)	(0.984)	(3.479)	(0.600)	(4.529)	(3.127)	(1.752)	(3.604)	(0.999)	(4.169)
$\dot{p}^e$	−0.0035	−0.0038	−0.0044	−0.0066	−0.0044	−0.0036	−0.0033	−0.0047	−0.0065	−0.0044
	(5.150)	(4.378)	(4.558)	(5.624)	(11.061)	(6.268)	(4.695)	(5.402)	(5.842)	(12.093)
$D \times WUR$	–	−0.0008	–	−0.0004	–	–	0.0005	–	0.0005	–
		(0.827)		(0.435)			(0.643)		(0.651)	
$D \times NUR_{LRT}$	–	0.0010	–	0.0017	–	–	−0.0003	–	0.0007	–
		(1.052)		(1.831)			(0.377)		(0.928)	
$D \times \dot{p}^e$	–	–	0.0013	0.0048	–	–	–	0.0015	0.0046	–
			(1.337)	(3.328)				(1.737)	(3.604)	
c	−0.0023	0.0056	−0.0081	0.0052	0.0073	−0.0011	0.0013	−0.0075	0.0028	0.0076
	(0.420)	(0.646)	(1.159)	(0.637)	(9.458)	(0.230)	(0.175)	(1.243)	(0.392)	(10.761)
$DUMMY$	–	–	–	–	–	−0.0053	−0.0060	−0.0059	−0.0081	−0.0039
						(4.204)	(3.728)	(4.542)	(4.958)	(3.906)
R^2	0.617	0.625	0.626	0.671	0.603	0.668	0.741	0.677	0.709	0.657
$D-W$	1.702	1.752	1.703	2.017	1.629	1.596	1.645	1.610	1.860	1.532
F – value	3.096	0.052	4.907	0.0042	–	3.293	0.741	6.207	0.167	–

NOTE: The dependent variable is the first difference in the logarithm of the BLS's Average Hourly Earnings. T-statistics are in parentheses. The F statistic reports tests for equal and opposite signs of the parameters on WUR and the natural rate, NUR_{LRT}.