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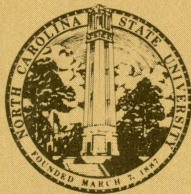
FACULTY WORKING PAPERS

CHANGES IN THE CYCLICAL SENSITIVITY OF WAGES
IN THE UNITED STATES, 1891-1987

Steven G. Allen

Working Paper No. 151

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ABSTRACT

The conventional wisdom among economists today is that wages have become less sensitive to aggregate economic conditions, mainly because of changes in labor market structure and changes in wage contracting mechanisms brought about by countercyclical policy and social insurance. This is re-examined here by using a wider range of data sets and a longer time frame than in any previous study and by paying close attention to differences in the way the prewar and postwar wage series were constructed and the effects of aggregation across industries. The results show that the response of nominal wages to unemployment and output, conditional on previous inflation, is about the same today as it was 100 years ago.

I. INTRODUCTION

Nominal wages are generally believed to be less sensitive to the business cycle today than they were before World War II. Labor markets have changed considerably since the turn of the century in terms of occupational and industrial mix, collective bargaining coverage, methods of wage payment, average job duration, workforce demographics, and government regulation. At the cost of some oversimplification, employer-employee matches today are much more likely to be long term contracts with a focus on lifetime compensation as opposed to spot market relationships with the wage rate being the key instrument for market clearing. If the fix-wage sector of the economy has been growing relative to the flex-wage sector, then it follows as a first approximation that in the aggregate wages should have become more rigid.

Even if labor market structure were the same today as at the turn of the century, the wage-setting process is likely to have adapted to stabilization policies and the widespread availability of social insurance. Forward-looking workers and employers today anticipate that if the economy contracts or if it expands too rapidly, steps will be taken to attempt to return to a sustainable growth path. Expecting a return to full employment, wages need not adjust, especially if the unemployed have other means of support. Such rigidity would have been irrational before World War II, especially in periods when the gold standard was being followed.

On the surface, increased rigidity in wages is difficult to reconcile with the apparent increase in the stability of output since World War II. One possibility, suggested by Taylor (1986), is that shocks in the postwar period have been less frequent and less severe. (Henceforth, the terms prewar and

postwar should be understood to refer to World War II.) Romer (1986a, 1986b) has presented evidence suggesting that the greater instability of the prewar economy is partly attributable to the poor quality of the data. She speculates that the gains from stabilization policy could have been offset by greater instability caused by rigid wages and prices. The conventional view that wage rigidity results in larger employment fluctuations has been challenged by DeLong and Summers (1986) who argue that whenever there is a fall in wages and prices, expectations of further decreases develop. Despite the supply stimulus, the increase in real interest rates generated from deflationary expectations reduces aggregate demand and in many cases the net effect is contractionary. They conclude that the greater stability of the postwar economy can be attributed at least in part to more rigid wages and prices.

Even though the premise that wages have become more rigid has a theoretical foundation and is widely accepted as a stylized fact, the evidence is conflicting. Sachs (1980) is most frequently cited as evidence of increased wage rigidity between the pre- and postwar periods; Gordon (1982, 1983), Mitchell (1985), and Taylor (1986) reach similar conclusions. However, Schultze (1981) finds no change in wage rigidity and Gordon (1975) finds wages to be less rigid in 1954-1970 than in 1900-1914. A number of early Phillips curve studies also made prewar and postwar comparisons and their results, summarized in Gordon (1975), are also conflicting.

The purpose of this paper is to re-examine the issue of whether wages have become more rigid in the postwar period. The main contributions of this study are the use of a large number of data sets at both the macro and industry level and the careful analysis of the sensitivity of the results to sample period, aggregation, and the different ways in which prewar and postwar data on wages,

output, and unemployment were constructed. Even if the hypothesis of increased wage rigidity withstands closer scrutiny, it is impossible to determine with aggregate data whether the rigidity is a consequence of structural change or economic policy. With industry wage data and historical information about structural change within each industry, this question can be examined more closely.

This study does not test theoretical models of aggregate labor market behavior. (Kniesner and Goldsmith (1987) provide a good summary of both theory and evidence regarding such models.) It is beyond the scope of this paper to resolve the differences within the profession on how the relationship between wages and output should be specified. The focus on nominal wages is traditional in the Phillips curve literature and in many theoretical models of aggregate supply. The econometric approach is to estimate relatively few unrestricted coefficients with a simple, standard methodology over all available data sets. The robustness of the results is established by developing new data series rather than examining alternative estimators. This is necessary because of the large number of data-related issues involved in historical comparisons. Also, the use of widely used and understood procedures facilitates comparisons of the results reported below to the studies cited above, all of which used similar procedures. I begin by using the business cycle as the unit of observation.

II. WAGE ADJUSTMENTS OVER THE BUSINESS CYCLE

The introductory sections of Cagan's (1975) and Sachs' studies of wage and price behavior over the business cycle focused on contractions. Here wage

behavior in expansions is also examined. Table 1 reports the rate of change of wages at the beginning and the end of contractions, based upon annual wage data from Rees (1960, 1961) for 1890 through 1941 and from CITIBASE for 1947 through 1987. The dating of peaks and troughs comes from the NBER calendar year business cycle chronologies in Moore and Zarnowitz (1986). Wage flexibility in each contraction is indicated by the difference in the rate of wage change between the trough and the peak.

The overall pattern suggests that wages were much more flexible during contractions before World War II than afterwards. Wage growth dropped by an average of 1.7 percent during postwar contractions, a much smaller figure than the 8.3 percent average drop in wage growth during prewar contractions. The rate of wage growth never dropped by more than 5.3 percent in the postwar period, whereas it dropped by more than 6 percent in eight of the 13 prewar contractions. Postwar wage growth in expansions never accelerated by more than 3.6 percentage points; wages swung upwards by a wider margin in seven of 13 prewar expansions.

Raw comparisons of prewar and postwar cycles can be misleading if the amplitude or duration of business cycles varies significantly between the two periods. Following Sachs and others, the peak to trough change in the output gap is used here to measure the severity of contractions. Potential output is estimated by regressing the industrial production index on a cubic time trend, unemployment and a constant and then calculating predicted values at the mean unemployment rate. One equation was estimated for 1890 through 1941 using the Nutter (1962) output index; another was estimated for 1919 through 1987 using the Federal Reserve Board index. (Details about data sources and the methods used to construct variables used in the analysis below are reported in the data

Table 1. Percentage change in manufacturing wages during contractions and expansions

Peak	Trough	Year before peak to peak (1)	Peak to trough (2)	Change during contraction (2) - (1)	Change during previous expansion (1) - (2 in row above)
1890	1891		0.0		
1892	1894	0.7	-7.9	-8.6	0.7
1895	1896	-0.7	4.3	5.0	7.2
1899	1900	6.6	3.4	-3.2	2.3
1903	1904	3.0	-0.6	-3.6	-0.4
1907	1908	3.8	-3.7	-7.5	4.4
1910	1911	6.4	2.0	-4.4	10.1
1913	1914	6.8	-0.4	-7.2	4.8
1918	1919	32.0	14.4	-17.6	32.4
1920	1921	15.9	-11.8	-27.7	1.5
1923	1924	10.6	3.4	-7.2	22.4
1926	1927	0.8	1.0	0.2	-2.6
1929	1932	1.5	-12.2	-13.7	0.5
1937	1938	11.8	-0.5	-12.3	24.0
1948	1949	9.1	3.8	-5.3	
1953	1954	5.7	2.2	-3.5	1.9
1957	1958	4.7	2.8	-1.9	2.5
1960	1961	3.2	2.4	-0.8	0.4
1969	1970	6.0	5.1	-0.9	3.6
1973	1975	7.0	9.2	2.2	1.9
1979	1980	8.5	8.6	0.1	-0.7
1981	1982	9.9	6.3	-3.6	1.3

Sources: Business cycle dating by NBER, as reported in Moore and Zarnowitz (1986); prewar average hourly earnings is from Rees (1960, 1961) as discussed in text; postwar average hourly earnings was drawn from CITIBASE in May 1988.

appendix.) The average of the two estimates of the change in the output gap is used for peaks and expansions when values from both indexes were available.

These estimates of the change in the output gap were used to sort contractions into three groups of roughly equal size with relatively few cases near the boundary lines: mild contractions where the change in the output gap is less than 7.5 percent; moderate contractions where the change in the output gap is between 7.5 and 15 percent; and severe contractions where the change in the output gap is 15 percent or more. Table 2 reports the change in the output gap and the acceleration of wage growth for each contraction.

The results for mild and severe contractions are consistent with the conventional wisdom that wage rigidity increased in the postwar era. Even though the mild postwar contractions were somewhat more severe than the mild prewar contractions, the rate of wage growth slowed by a mere 0.5 percentage points in postwar contractions versus a modestly higher 2.5 percentage points in the prewar contractions. Comparisons based upon severe contractions are problematic as there is only one such contraction (1973-75) in the postwar era and it took place during a time of sharply rising energy prices. Yet the average 14.6 percentage point decline in wage growth between the peak and trough of the prewar contractions is completely out of line with the postwar experience. Today's workforce has not charted such territory.

In moderate contractions the prewar and postwar rates of wage deceleration run counter to the conventional wisdom. Wage growth slowed by 3.6 percentage points in moderate postwar contractions. In prewar contractions it slowed by 3.2 percentage points. The severity of these contractions is identical (a 10 percentage point swing in the output gap) for the prewar and postwar era.

Table 2. Percentage change in manufacturing wages during contractions, by severity of contraction

Peak - Trough	Change in wage growth	Change in output gap
<u>Mild contractions</u>		
1899-1900	-3.2	-1.6
1910-11	-4.4	-7.4
1926-27	0.2	-3.4
1960-61	-0.8	-3.5
1969-70	-0.9	-7.3
1979-80	0.1	-5.5
<u>Moderate contractions</u>		
1895-96	5.0	-12.3
1903-04	-3.6	-9.0
1913-14	-7.2	-9.7
1923-24	-7.2	-9.4
1948-49	-5.3	-10.0
1953-54	-3.5	-9.9
1957-58	-1.9	-10.8
1981-82	-3.6	-10.9
<u>Severe contractions</u>		
1892-94	-8.6	-24.7
1907-08	-7.5	-20.9
1918-19	-17.6	-16.4
1920-21	-27.7	-27.3
1929-32	-13.7	-74.2
1937-38	-12.3	-28.0
1973-75	2.2	-18.2

Sources: Wage data from Table 1; derivation of change in output gap is discussed in the text.

Romer's (1986b) evidence indicates that estimates of industrial production before 1914 exaggerate cyclical variability. If so, then the groupings in Table 2 may not really hold the severity of these contractions constant. Throwing out all contractions before 1914 leaves very few degrees of freedom but is instructive nonetheless. This leaves two mild and moderate prewar contractions with average wage deceleration of 3.0 percentage points. The average rate of wage deceleration in all seven mild or moderate postwar contractions is a slightly smaller 2.3 percentage points.

Another way to test for changes in cyclical wage rigidity is to regress the rate of wage acceleration in each contraction on the change in the output gap, the duration (in months) of the contraction, a postwar binary variable, and an interaction term between the binary and output gap variables. The following results were obtained:

$$\begin{aligned} \text{Wage acceleration} = & -.103 + .351 * \text{Gap} + .048 * \text{Postwar} \\ & (.040) \quad (.118) \quad (.060) \\ & -.213 * \text{Postwar} * \text{Gap} + .004 * \text{Duration}, R^2 = .485 \\ & (.515) \quad (.002) \end{aligned}$$

The coefficients of the binary and interaction variables indicate that for swings in the output gap of less than 22.5 percentage points, wage growth actually declines more in the postwar than the prewar era.

Table 3 reports acceleration of wage growth for expansions grouped into three categories: mild expansions where the change in the output gap is less than 10 percentage points; moderate expansions where the output gap changes between 10 and 20 percentage points; and sharp expansions where the output gap grows by more than 20 percentage points. There are only two sharp expansions, both in the prewar era. Wages accelerated by an average of 23.2 percentage

Table 3. Percentage change in manufacturing wages during expansions, by sharpness of expansion

Peak - Trough	Change in wage growth	Change in output gap
<u>Mild expansions</u>		
1891-92	0.7	2.0
1919-20	1.5	3.2
1924-26	-2.6	8.8
1927-29	0.5	6.1
1954-57	2.5	5.2
1958-60	0.4	5.3
1970-73	1.9	6.8
1980-81	1.3	-1.4
<u>Moderate expansions</u>		
1894-95	7.2	11.3
1896-99	2.3	14.6
1900-03	-0.4	12.7
1904-07	4.4	13.8
1908-10	10.1	15.2
1911-13	4.8	12.3
1914-18	32.4	17.2
1949-53	1.9	18.0
1961-69	3.6	18.5
1975-79	-0.7	11.7
<u>Sharp expansions</u>		
1921-23	22.4	31.6
1932-37	24.0	44.8

Sources: Same as Table 2.

points in these two cases; once again this is beyond the realm of postwar experience.

A comparative analysis must focus on mild and moderate expansions. Wage acceleration is more sluggish in the prewar (.02 percent) than postwar (1.5 percent) periods for mild expansions. In contrast, wages were much more upwardly flexible in moderate expansions in the prewar than the postwar period, even if one excludes the 1914-1918 expansion as a wartime outlier. Regression analysis of the rate of wage acceleration during expansions also indicates that wages were more upwardly flexible in the prewar period for expansions, except when the upswing in the output gap is below 3.2 percentage points.

On balance the strongest evidence in favor of the hypothesis of greater wage rigidity over the business cycle in the postwar period is the failure of wage growth to sharply decelerate in the severe 1973-75 contraction and the greater wage acceleration found in moderate prewar expansions. These results are considerably weaker than those reported by Sachs. This is partially attributable to making corrections in the wage data and business cycle dating that were pointed out by O'Brien (1985). The other difference between the approach used here and that used by Sachs concerns the construction of the output gap variable. Potential output is estimated with a cubic instead of a linear time trend and the prewar sample extends through 1941 instead of ending in 1929.

The combined effect of a different dating scheme and a different estimating equation has a significant impact on the way some contractions are classified. For instance Sachs classifies the recession beginning in January 1893 and ending in June 1984 as a mild contraction. Under the annual dating system the peak occurs in 1892 and the decline in output between 1982 and 1983 is large enough to make this episode a severe contraction in Table 2.

Output and employment growth generally vary considerably within each business cycle. This is most evident in quarterly and monthly data, but even in the annual data that must be used here there is no small amount of intracyclic variation. The remainder of this paper reports the results of annual wage change equations estimated over various data sets for the prewar and postwar periods.

III. SPECIFICATION AND DATA

Viewed strictly from a univariate perspective, there is no question that wages were much less rigid in the prewar period. The amplitude of the average wage cycle was much greater in the prewar period, as shown in Table 4 and Figure 1. Wages grew by no less than 1.8 percent and no more than 9.9 percent in the postwar period, whereas wage growth in the prewar period ranged between -12.2 and 32.0 percent. The standard deviation of annual wage growth was more than three times larger in the prewar than the postwar period, even though mean wage annual growth was considerably larger in the postwar period.

The duration of wage cycles was also much shorter in the prewar period. Figure 1 shows that the usual pattern was two or three years of wage growth followed by one or two years of decline. In contrast the postwar period is marked by what is essentially a 20 year wage cycle beginning in 1960 and culminating in 1980. This phenomenon is indicated more precisely by the simple autocorrelation coefficients reported in Table 4. Wages in the postwar period are autocorrelated for five years, whereas in the prewar period autocorrelation vanishes after one year.

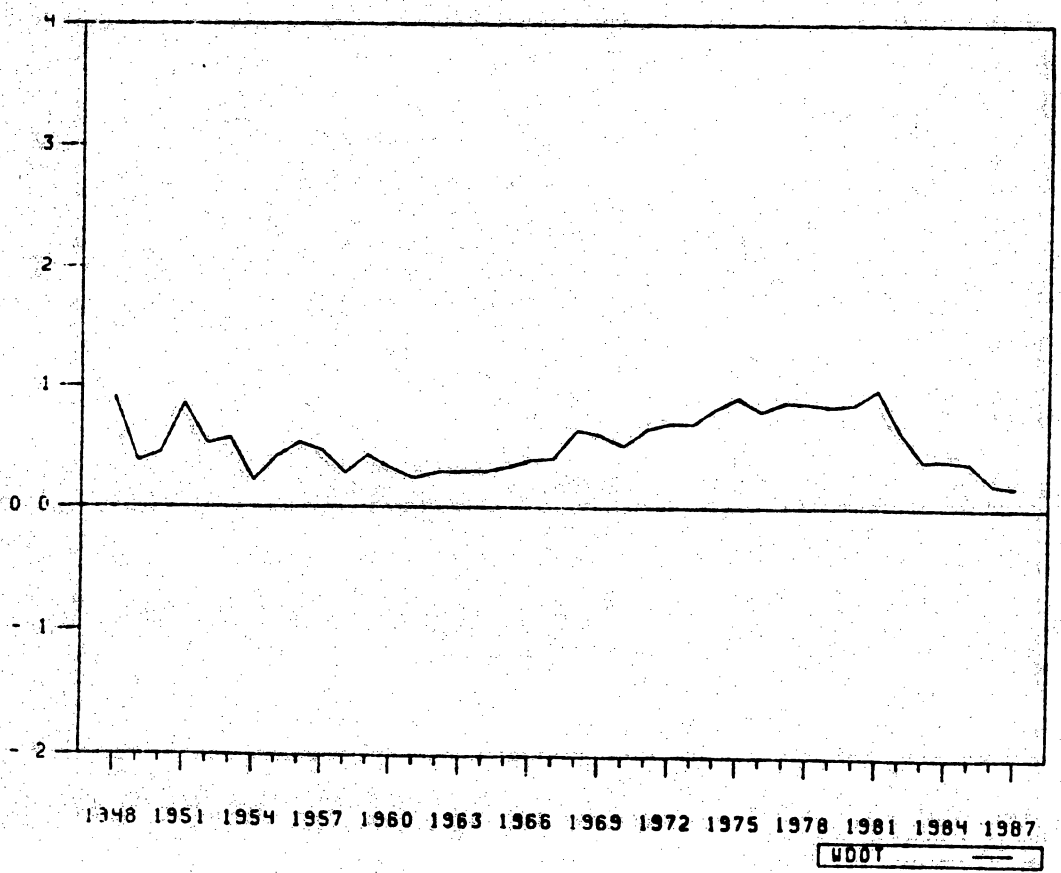
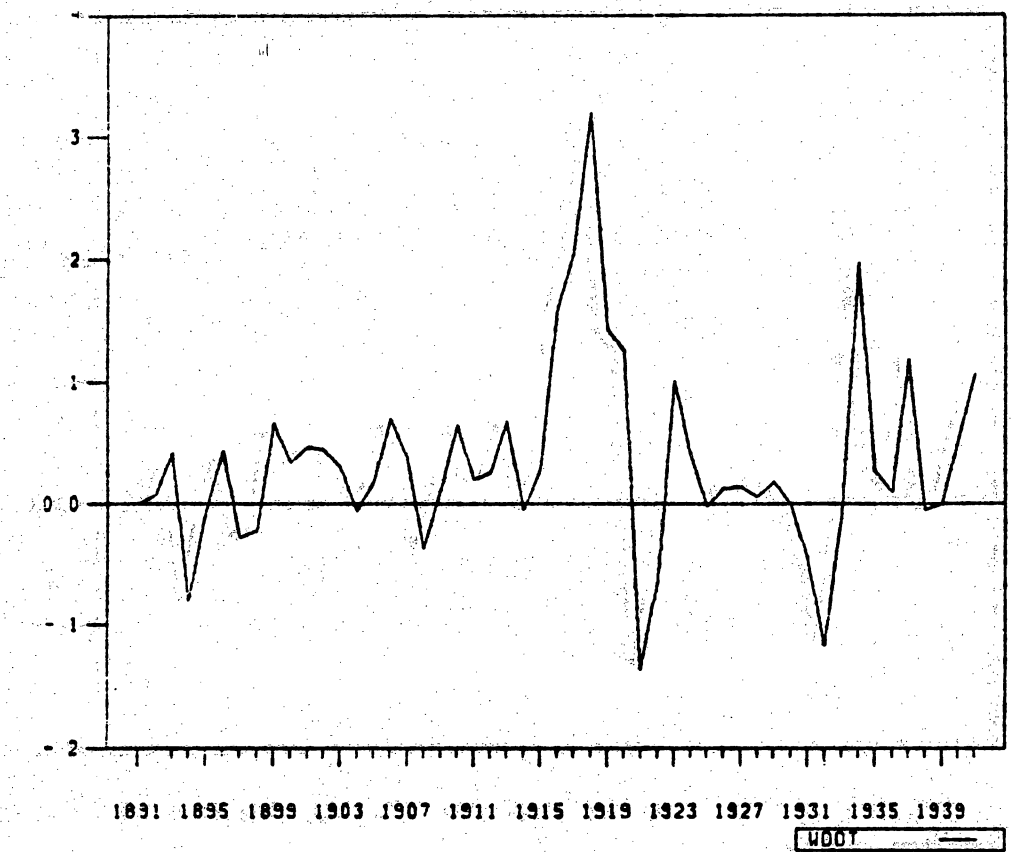


Figure 1. Percentage change in average hourly earnings, 1891-1941 and 1948-1987.

Table 4. Summary statistics for percentage change in wages,
1891-1941 and 1948-1987

	1891-1941	1948-1987
Mean	3.4	5.4
Standard deviation	7.9	2.4
Minimum	-12.2	1.8
Maximum	32.0	9.9
Autocorrelation:		
1 year	.397	.667
2 years	.050	.528
3 years	.053	.515
4 years	-.074	.374
5 years	-.105	.220
6 years	.030	.053
7 years	.091	-.028

Sources: Same as Table 1.

Despite these striking differences, the question of whether wages have become more rigid in the postwar period cannot be answered solely with univariate evidence. By definition wage rigidity implies a failure to respond to some kind of shock. The conventional focus is on the relationship between wage growth and aggregate economic activity, as indicated by either the output gap or the unemployment rate. The patterns in Figure 1 need not indicate that wages were more responsive to the business cycle in the prewar period. These patterns could also be attributable to (1) fewer and less severe swings in output, (2) improvements in price stability, (3) changes in labor market structure, or (4) differences in the way the data were constructed.

Phillips curves are conventionally estimated by regressing the rate of change of wages on an excess demand variable and expected inflation. Because the purpose of this paper is to compare the slopes of Phillips curves from different historical periods, a time trend is also included in the model to prevent trend differences from being incorporated into other coefficients. In some periods serial correlation is present, presumably reflecting autocorrelated variables that have been omitted from the equation and are independent from the other right-hand side variables. To make valid historical comparisons, a common specification is necessary so an AR(1) term is included in all the results reported here. The primary specification analyzed below is the equation

$$(1) \quad Dw_t = \alpha_0 + \alpha_1 U_t + \alpha_2 U_{t-1} + \sum_{i=1}^3 \alpha_{2+i} Dp_{t-i} + \alpha_6 T + \epsilon_t,$$

where Dw_t = percentage change in nominal wage, U_t = excess demand in the labor market, Dp_t = percentage change in price level, T = time trend, and

$\epsilon_t = \sigma\epsilon_{t-1} + \mu_t$. The equation is estimated using Beach and MacKinnon's (1978) maximum likelihood procedure that produces estimates of σ without losing any observations.

A few comments about the particulars of this specification are in order. Two different variables are used as measures of excess demand in the labor market: the unemployment rate and the difference between actual and potential output (as constructed in Section II). Despite the well-known limitations of the Lebergott unemployment series, it is used here because (1) unemployment is generally believed to be the best indicator of aggregate labor market conditions; (2) it permits an additional check on the robustness of the output gap results; and (3) it has been used widely in previous studies. The prewar analysis uses the output gap measure derived from Nutter (1962); the postwar analysis is based on the FRB's industrial production index. These prewar data series on unemployment and output are thought to be excessively volatile; the sensitivity of the results to this issue is examined in Section V.

Blanchard and Summers (1986) and Gordon (1988), among others, have included lagged excess demand variables to test for the presence of hysteresis. In preliminary data analysis, the restriction $\alpha_2=0$ could not be rejected in a number of the prewar data sets. Some would argue that this indicates the presence of hysteresis, although Kennan (1986) points out that such a finding can be interpreted in a number of different ways. Below results with and without the $\alpha_2=0$ restriction are reported.

Expected changes in prices are proxied by including three lagged inflation rates. Even by the standards of the Phillips curve literature of the 1970s this is not a "state of the art" specification, but there are some sound reasons for believing that it is the most appropriate one in this case. The

price level was stable or declining during almost all of the prewar period. The only significant inflation was that which occurred during and after World War I. In such an environment it is difficult to believe that inflation rates from more than three years ago had a systematic effect on inflationary expectations. Many postwar studies have used four or more years of lagged inflation rates, but such an approach in the prewar era is likely to only reduce the efficiency of the estimates.

It is also common practice in postwar equations to restrict the sum of the coefficients of the lagged inflation terms to equal one. This makes little sense in a study comparing prewar and postwar wage rigidity because the prewar price indexes are based on less information. To the extent that prewar inflation is measured with error, restrictions on the inflation coefficients are likely to produce biased estimates of α_1 .

Dummy variables for wars, oil shocks, wage guidelines, or wage controls are not included in the model. Parameterization of residuals can give a false impression about precision of the estimates and allocate an undue influence on the coefficients to particular observations. Further, there is no objective criterion other than goodness-of-fit for defining such variables.

The measure used as the dependent variable is the percentage change in average hourly earnings. There is no adjustment in any of the prewar data sets for overtime. Benefits are excluded from the analysis as well because data are unavailable until 1929. The percentage change in prices is based on the Consumer Price Index (CPI-U). All of the postwar data were obtained from CITIBASE in March 1988.

Rees (1959) is the standard source of prewar wage data. This series is based on data from the Census of Manufactures and the Annual Surveys of

Manufactures, with interpolating data from the Conference Board for 1920-1931 and BLS for 1932-49. The procedures that Rees had to follow to splice these various series together to get consistent estimates of wage levels are reported in Rees (1960). In some cases they produce erroneous estimates of the percentage change in wages. For instance Rees noticed that the Conference Board data probably underrepresented the South and overrepresented large firms and should be adjusted downward to mesh with the rest of the series. To do this he adjusted the Conference Board data downward by 6.4 percent in 1920 and 11.4 percent in 1932. Between 1920 and 1932 the adjustment factors are obtained through linear interpolation. Thus, the observed rate of change in wages in the Rees (1959) series is a weighted average of the actual rate of change in the underlying data and the induced rate of change created by Rees' interpolation procedure. Also, the Rees (1959) series does not incorporate revisions later made for 1890-1898 and 1920-1931 in Rees (1961, 1960). These revised estimates are used in this study.

A limitation of all these series is that there are no controls for variations in industrial mix across or within different data sets. Also, the data for 1890-1919 rely heavily on three states: Massachusetts, New Jersey, and Pennsylvania. To learn more about the prewar Phillips curve, (1) is estimated over the Conference Board data and the series for 1890-1926 constructed by Douglas (1930). The main advantage from using these two data sets is that they provide additional information about prewar wage behavior. An additional advantage of the Conference Board data is that there are no interpolations, whereas an additional advantage of the Douglas data is that it extends beyond manufacturing.

The Conference Board data are examined in two different formats. Beney (1936) reports monthly data for June 1920 through June 1936, with a six month gap in the first half of 1922. The percentage change in wages from one June to the next is used below. Conference Board (1946) reports annual average wages for 1920-1945, allowing the analysis to extend through 1941. These averages omit the first five months of 1920 and the first six months of 1922. Following Rees (1961), Creamer's series is used as a benchmark for estimating average wages in those months.

In comparing wage rigidity from 1890 to before World War I, both the Rees (1961) and Douglas data sets can be used. The Douglas data set extends through 1926 and overlaps with the Conference Board data. Thus, the results reported below will be based on multiple comparisons, thereby reducing the burden of any single data set.

IV. RESULTS

Before examining the econometric results, it is useful to look at the raw data on wage growth and unemployment for the prewar and postwar periods displayed in Figure 2. Data points for adjacent years are connected so that each graph displays three variables: unemployment, wage growth, and time. The scales of each graph are set to make the slope of the tradeoff between unemployment and wage growth comparable for the prewar and postwar period.

At first glance, the slope of the tradeoff between wage growth and unemployment seems to be much greater in the prewar period. Figure 2 shows that prewar wage growth tends to be much higher when the unemployment rate was below 6 percent than at higher levels of unemployment. In contrast, the

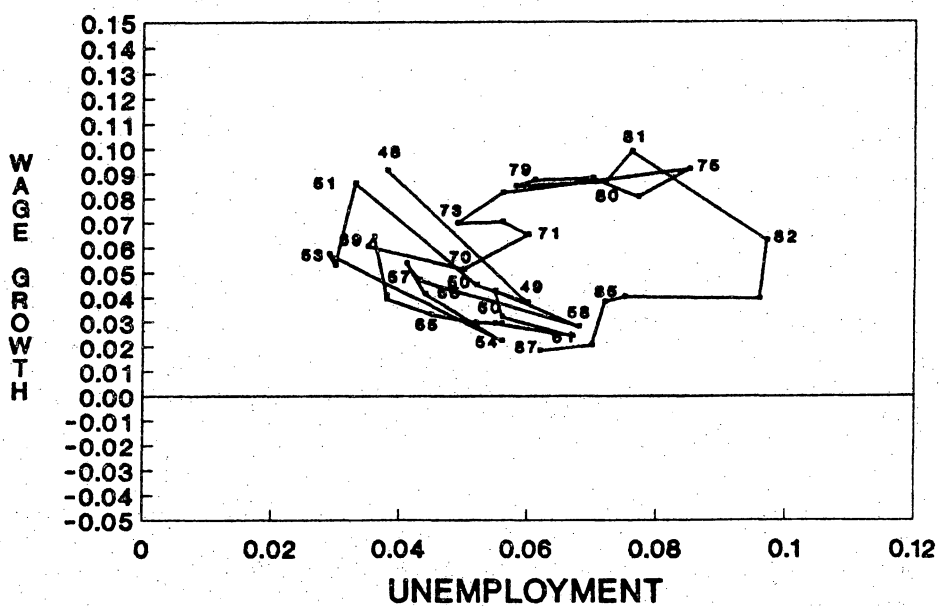


Figure 2. Percentage change in average hourly earnings and unemployment, 1891-1941 and 1947-1987.

average level of wage growth in the postwar period varies only slightly with the unemployment rate.

Conclusions about the prewar period are sensitive to inclusion of 1916 through 1923, a sharp wartime expansion followed by a severe contraction. Wage growth accelerated during World War I from 2.7 percent in 1915 to 32.0 percent in 1918, while unemployment was falling from 8.5 to 1.4 percent. By 1920 wage growth had decelerated to 15.9 percent and unemployment rose to 5.2 percent. Another large swing in wage behavior followed in 1921, when wages fell by 11.8 percent and unemployment rose to 11.7 percent. Wages fell by another 7.6 percent in 1922, but then rebounded in 1923 to increase by 10.6 percent. At the same time unemployment was falling to 6.7 percent in 1922 and 2.4 percent in 1923. If these eight observations were removed from the prewar graph in Figure 2, it would be much more difficult to claim that there was a sizable difference in wage rigidity between the prewar and postwar periods.

Estimates of four different specifications of equation (1) (current unemployment rate, current and lagged unemployment rate, current output gap, current and lagged output gap) are reported in Table 5. The key result can be seen by comparing the excess demand coefficients for 1891-1941 in row 1 to those for 1948-1987 in row 2. Between 1891 and 1941 a one percentage point increase in the unemployment rate is associated with a 1.1 to 1.2 percentage point decrease in the rate of wage growth. The same change in unemployment in the postwar period is associated with a 1.0 percentage point decrease in the rate of wage growth. There is no economically or statistically meaningful difference between these two sets of estimates. Table 5 reports the excess demand coefficients only. Summary statistics appear in Appendix Table 1;

Table 5. Business cycle coefficients from Phillips curves, 1891-1987

Period and Source	Unemployment coefficients			Output gap coefficients		
	(1) U_t	(2) U_t	U_{t-1}	(3) G_t	(4) G_t	G_{t-1}
1891-1941, Rees (1960, 1961)	-1.129 (.254)	-1.181 (.242)	1.084 (.255)	.314 (.072)	.316 (.076)	-.205 (.088)
1948-1987, CITIBASE	-.987 (.246)	-.982 (.244)	.294 (.224)	.208 (.036)	.215 (.040)	-.016 (.042)
1891-1914, Rees (1961)	-.543 (.144)	-.649 (.175)	.215 (.198)	.247 (.084)	.210 (.093)	.102 (.106)
1891-1926, Douglas	-.604 (.259)	-.902 (.254)	.805 (.262)	.411 (.101)	.421 (.109)	-.234 (.140)
1921-1936, Beney	-.429 (.433)	-1.336 (.432)	1.223 (.394)	.162 (.128)	.332 (.130)	-.296 (.130)
1921-1941, Conference Board	-.538 (.256)	-1.076 (.241)	.993 (.268)	.161 (.068)	.234 (.076)	-.176 (.094)

Note: Standard errors appear in parentheses.

complete regression coefficients, in Appendix Tables 2 through 5; residuals, in Appendix Tables 6 and 7.

The output gap results indicate that the prewar-postwar difference in wage rigidity is modest at best. A one percentage point decrease in the output gap is correlated with a 0.3 percentage point increase in wages in the prewar period versus a 0.2 percentage point increase in the postwar period. Although this is a slightly larger difference than obtained for the unemployment rate variable (regardless of which version of Okun's Law is used to make the comparison), it would be difficult to claim that it resulted from any factor other than the imprecision of each estimate. In contrast, Sachs' output gap coefficients were 3.8 to 6.1 times larger in the prewar than the postwar sample.

Why should the findings in the first two rows of Table 5 be considered more persuasive than the conflicting results obtained in previous comparisons of prewar and postwar wage rigidity by Sachs, Gordon, Schultze and others? One way to answer this question is to estimate (1) over other sources of prewar data. The 1891-1941 series analyzed in row 1 is actually a blend of series developed by Rees and the Conference Board. It is natural to ask whether the results still hold up when these two series are examined separately. The results may differ because of differences in the ways the series are constructed or because the relationship is not stable over the entire 1891-1941 period. The series constructed by Douglas is also worthy for examination for the same reasons. The results for these additional data sets appear in rows 3 through 6 of Table 5.

The findings across all prewar data sets are very comparable to each other. The unemployment rate coefficients obtained with the Rees (1961) and

Douglas data and the output coefficients based on the Rees (1961) data are actually smaller than the corresponding estimates in row 1. The estimates based on two different versions of the Conference Board data are practically identical to those in row 1. The output gap coefficients obtained with the Douglas data are larger than in row 1, but only slightly so.

The robustness of the results in rows 1 and 2 in Table 5 can also be checked by examining the sensitivity of the coefficients to the timing of the sample period. The obvious place to start is to examine what happens when the depression years are deleted from the prewar sample. As shown in Table 6, restriction of the prewar sample to 1891 through 1929 increases the unemployment coefficient only slightly, but almost doubles the output gap coefficient. On the surface this appears to suggest that one should seriously reconsider the findings of row 1 in Table 5, given the unusual circumstances prevailing after 1929. However, the results based on the Conference Board data in rows 5 and 6 of Table 5 also are based on data from the Great Depression and they are very comparable to the findings for the entire 1891-1941 period.

The key to resolving this apparent paradox is a more careful examination of wage behavior in a period that turns out to be more unusual than the Great Depression, namely the period during and following World War I. Figure 2 has already demonstrated that the wage growth and unemployment patterns in 1916 through 1923 were extraordinary. The influence of these years on the results can be ascertained by examining how the results for 1891-1915 and 1924-1941 change when 1916-1923 is added to the sample period. The results in each case are dramatic. The unemployment rate and output gap coefficients in Table 6 for 1891-1915 and 1924-1941 double across almost all specifications when 1916-1923 is included.

Table 6. Sensitivity of Phillips curve estimates to choice of sample period

Sample Period	Unemployment coefficients		Output gap coefficients	
	U_t	U_{t-1}	G_t	G_{t-1}
A. Prewar estimates				
1891-1929	-1.442 (.338)	.996 (.361)	.551 (.106)	-.003 (.136)
1891-1915	-.619 (.154)	-.114 (.247)	.234 (.098)	.034 (.111)
1891-1923	-1.346 (.358)	.990 (.378)	.543 (.115)	-.025 (.147)
1916-1941	-1.293 (.375)	1.569 (.389)	.323 (.118)	-.312 (.141)
1924-1941	-.883 (.309)	.946 (.354)	.174 (.081)	-.164 (.114)
1900-1941	-1.581 (.302)	1.536 (.325)	.351 (.085)	-.207 (.102)
1900-1929	-2.409 (.405)	2.498 (.458)	.730 (.111)	-.001 (.165)
B. Postwar estimates				
1948-1976	-.840 (.246)	.434 (.247)	.161 (.052)	-.051 (.054)
1952-1987	-.827 (.205)	.033 (.018)	.192 (.034)	.021 (.034)
1952-1976	-.538 (.220)	.034 (.194)	.128 (.046)	.008 (.042)

Source: Prewar estimates are estimated using average hourly earnings reported in Rees (1960, 1961); postwar estimates, CITIBASE.

The influence of the 1916-1923 period can also be measured by allowing the coefficients for those years to vary from those for the rest of the sample by interacting the excess demand variables with a binary variable equal to one for 1916-1923. In this specification (using current and lagged excess demand, not reported in Table 6) a one percentage point decrease in the output gap is associated with a 0.7 percentage point increase in the wage growth rate between 1916 and 1923, in contrast to a 0.2 percentage point decrease in the rest of the sample. The results are similar for a one percentage point increase in the unemployment rate. This is associated with a 1.9 percentage point decrease in wage growth between 1916 and 1923, in contrast to a 1.1 percentage point decrease in all other years.

When viewed together, these findings indicate that the implicit weight given to the 1916-1923 period is a critical factor influencing the size of the business cycle coefficient. We have already shown that deleting the Great Depression can increase the output gap coefficients for the entire prewar period by a sizable amount even though the output gap coefficients for 1924 through 1941 are relatively modest in size. This phenomenon can also be demonstrated by deleting years from the beginning of the sample. When the 1890s are excluded, the unemployment coefficient increases (in absolute value) to -1.6. When the 1890s and the Great Depression are both excluded, the unemployment coefficient becomes -2.4 and the output gap coefficient increases to 0.7.

This seems to explain why Sachs obtained much larger estimates of the slope of the Phillips curve in the prewar period than those obtained here. Sachs' prewar samples started in 1894 or 1897 and ended in 1929. Similarly

restricting the sample period over the data sets used in this study yields results that are very comparable to his.

There is still the question of why the postwar coefficients reported in row 2 of Table 5 are much larger than those obtained in previous studies. Once again the answer seems to be largely in the sample period examined, rather than the specification. As shown in Table 6, the coefficients for the postwar period are much smaller (in absolute value) if the sample period ends in 1976 instead of 1987. Needless to say, Sachs, Gordon, and Schultze could hardly have been expected to be aware of this at the time they did their studies. The inclusion of 1948 through 1951 in the postwar sample also increases the excess demand coefficients by a modest amount.

Another check on the robustness of the findings in Table 5 is to determine the sensitivity of the results to changes in the specification of equation (1). Two alternate functional forms of U_t were examined: $1/U_t$ and $\ln(U_t)$. The coefficients (all statistically significant from zero at the 5 percent confidence level) are reported below:

	<u>1891-1941</u>	<u>1948-1987</u>
$1/U_t$.230	.271
$1/U_{t-1}$	-.195	-.125
$\ln(U_t)$	-.071	-.056
$\ln(U_{t-1})$.070	.022

These results indicate once again that there is very little difference between the prewar and postwar periods in the immediate impact of a change in the unemployment rate on wage growth. The coefficients obtained with $1/U_t$ are slightly larger in the postwar period, whereas those with U_t are somewhat larger in the prewar period. The best equation in terms of goodness of fit for the prewar period is the linear form in Table 5, followed closely by the

logarithmic form. The fit of the $1/U_t$ equation is markedly inferior in the prewar period (R^2 of .435 versus .547 for the linear form). There is relatively little difference in the goodness of fit of the estimates across all three specifications of the unemployment rate in the postwar equations. The results for 1891-1941 in Table 5 also did not change when I used Darby's (1976) revised unemployment series for 1934-41.

The results are insensitive to the number of lagged inflation variables. When this was changed from three to either one or four, the output gap and inflation coefficients in both the prewar and postwar periods were essentially unaffected.

The results were sensitive to the inclusion of contemporaneous inflation, as one might expect given the simultaneity between wages and prices. In the specification where both current and lagged business cycle variables are included in (1), the postwar unemployment coefficient declined (in absolute value) to -.529, whereas the prewar value plummeted to -.109. The prewar output gap coefficient dropped to -.026, considerably smaller than the postwar coefficient of .150. Thus when current price inflation is included as a right-hand-side variable, the evidence indicates that nominal wages were actually more rigid in the prewar period.

The next logical question to ask is what happens when the current price inflation coefficient is constrained to be minus one and the lagged inflation terms are omitted from the equation. Real wages are mildly procyclical in both the prewar and postwar period. The prewar and postwar output gap coefficients were .061 (.047) and .075 (.048); the unemployment coefficients, -.368 (.137) and -.133 (.237). Once again it would be hard to claim any overall pattern from this evidence.

Even though many previous studies have used the industrial production index as the basis for their output gap measure, its use is problematic in two regards. First, Romer (1986b) has shown that the index is excessively volatile before 1914. Second, the relevance of the index to aggregate labor market conditions has become increasingly dubious in the postwar period given the shrinking share of the goods-producing sector. Accordingly I derived an output gap measure from GNP data, using the same procedure as in section I. Separate gap estimates were obtained for the prewar GNP series recently compiled by Romer (1989) and Balke and Gordon (1989). The results are as follows:

	G_t	G_{t-1}	R^2
Prewar, Romer (1989)	.583 (.180)	-.545 (.187)	.433
Prewar, Balke and Gordon	.504 (.147)	-.456 (.152)	.446
Postwar	.479 (.103)	-.152 (.097)	.754

There is still very little difference between the prewar and postwar estimates. The coefficients are considerably larger than those obtained from the industrial production index in Table 5, but the R^2 are slightly smaller.

The growth of the service sector in the postwar period also dictates an examination of total private wages across all industries. This is a straightforward exercise for the postwar period and the results are about the same as in Table 5. The unemployment gap coefficient rises slightly to -1.014 (.216) and the output gap estimate falls a bit to .198 (.036). In the prewar period, Douglas derived a series for wages in all sectors (including some government employees). Using this series, the results for 1891-1926 are also very close to those in Table 5 for manufacturing -- -.855 (.212) for unemployment and .380 (.094) for the output gap.

So far the comparison of the prewar and postwar estimates has focused only on how a current change in unemployment affects wage growth. Another important difference is that wage growth in the prewar period is a function of the change in unemployment, not the level of unemployment. The coefficients of the current and lagged excess demand variables in the prewar equations are almost identical in magnitude and opposite in sign. When the Great Depression is deleted from the prewar sample period, this result continues to hold for the unemployment rate variable but not the output gap.

There is no obvious reason for this difference in wage behavior. Theoretically, wages could respond to the change rather than the level of unemployment because of either hysteresis or adjustment costs. Casual empiricism suggests that adjustment costs in the labor market must be considerably larger in the postwar period for a number of reasons. Lower quit rates and longer job durations indicate greater expenditures on firm specific training. Hiring costs are also larger, as indicated by the growth of personnel departments and the influence of equal employment opportunity legislation. The costs of reducing the size of one's workforce have also likely increased in response to Unemployment Insurance and higher rates of unionization. The same logic casts doubt on hysteresis models of the labor market. There would seemingly be more human capital and insider influence in the postwar period.

Three other differences between the prewar and postwar estimates are noteworthy. First, inflation from one to three years ago has an impact on wage growth in the postwar period, whereas inflation from more than one year ago has no effect on wage growth in the prewar period. Second, residuals are autocorrelated in the postwar equation but not in the prewar equation. Both of

bias the prewar estimates of α_1 downward. The magnitude of this bias must be established as accurately as possible.

The first concern can be addressed by applying Romer's technique of replicating the prewar series for the postwar period. Rees' series for manufacturing between 1890 and 1919 is the ratio of average annual earnings to the product of days per year and hours per day. Rees computed average annual earnings from the Census of Manufactures for 1889, 1899, 1904, 1909, 1914, and 1919. Estimates for the remaining years are interpolations based on reports of the state labor bureaus of Massachusetts, New Jersey, and Pennsylvania. The average number of days that manufacturing establishments were open is also obtained from these state labor bureaus. The hours series is compiled from the 1909, 1914 and 1919 Censuses and various BLS Bulletins. Rees set hours per day equal to average weekly hours divided by six.

The Rees series is clearly based on more limited information than the modern BLS series. The days per year estimates and the intercensal earnings estimates reflect the experience of a mere three states; the intercensal hours estimates relate only to the handful of industries for which BLS did studies. At a minimum this raises the noise-to-signal ratio on the left-hand side of the equation.

A more serious issue is whether Rees' procedure has any systematic cyclical bias. His data on employment, days, and hours all come from different sources and there is some degree of double counting. For instance suppose a factory employing 48 workers for 20 days a month closes for three months. Average employment will be reported as 36 and days in operation will be reported as 180, resulting in overestimated levels of average hourly earnings in recessions. The same problem can result from double counting of hours per

week and days per year. The empirical issue is whether these factors are offset by a current running in the opposite direction -- a possible tendency to report workers as being on the payroll even when they are not at work. Rees compares his average hourly earnings estimates to the available evidence on wage rates and finds that his series neither systematically understates or overstates wage levels. As for cyclical patterns, Rees cautions (p. 17):

Although our work may have some value for cyclical problems, it must be used for such problems with great caution, for, at times, our data or our procedures would be inadequate or inappropriate for an investigation of cyclical fluctuation.

The properties of Rees' procedures can be gauged by developing modern counterparts to the three key components of his wage series: average annual earnings, days worked per year, and hours worked per day. Average annual earnings in manufacturing can be computed using Rees' methods for 1972 through 1986 by setting benchmarks with the Censuses of Manufactures and interpolating with data for Massachusetts, New Jersey, and Pennsylvania from County Business Patterns for payrolls and data from the same three states from Employment and Earnings for average employment. These estimates are reported in the first column of Table 7.

To my knowledge, no state currently surveys its manufacturing establishments about days in operation each year. To estimate this variable one needs a measure that reflects within-year variation in employment among establishments that are open in that year. Days worked by the average manufacturing employee was estimated by the following procedure over Employment and Earnings data for the three states noted above. Assume that the typical manufacturing plant operates on weekdays and is closed only on federal holidays. Annual employee days can then be estimated by multiplying the number of workdays (obtained from the perpetual calendar and lists of federal holidays

Table 7. Modern replication of Rees' method for estimating average hourly earnings compared to BLS estimates.

Year	Average annual earnings: Rees method (1)	Estimated days per worker (2)	Average hourly earnings: Rees method (3)	Average hourly earnings: BLS (4)
1972	9155	247	4.57	3.82
1973	10100	248	5.01	4.09
1974	10700	247	5.42	4.42
1975	11743	246	6.04	4.83
1976	12613	249	6.32	5.22
1977	13477	246	6.80	5.68
1978	14572	246	7.32	6.17
1979	15804	248	7.94	6.70
1980	17183	248	8.72	7.27
1981	18693	248	9.47	7.99
1982	19882	243	10.51	8.49
1983	20851	245	10.62	8.83
1984	22051	248	10.91	9.19
1985	23334	248	11.61	9.54
1986	24615	248	12.20	9.73

Sources: Columns (1) through (3), see text; column (4), same as Table 1.

The derived average hourly earnings measure based on Rees' approach and the BLS measure are reported in columns 3 and 4 of Table 7. The constructed measure shows more rapid growth (167 percent) than the BLS measure (155 percent) over the entire period, but this is entirely attributable to less rapid growth in the BLS series since 1984. Once the 1987 Census benchmark becomes available, it is quite possible that the trends in each series will once again be identical. There is no pronounced trend in either the days or hours variables so that almost all of the trend movement in the "Rees method" measure reflects growth in annual earnings.

The year to year percentage changes in the "Rees method" variable are much more volatile than those for the BLS measure, especially around turning points in the business cycle. In 1974 both measures grew at a rate of approximately 8 percent. The growth rate of the "Rees method" measure accelerated to 11.4 percent in 1975, but then dropped to 4.6 percent in 1976. In contrast the BLS measure grew by 9.3 percent in 1975 and 8.1 percent in 1976. An even more dramatic swing in wage inflation takes place between 1981 and 1983 for the "Rees method" measure, going from 8.5 percent in 1981 to 11.0 percent in 1982 and then falling to 0.1 percent in 1983. Wage inflation according to BLS also fell during this period, but at a much more gradual pace of 9.9 percent in 1981 to 6.2 percent in 1982 to 4.0 percent in 1983. Wage inflation ranges between 0.1 and 11.4 percent for the "Rees method" measure, whereas it ranges from 2.0 to 9.9 percent for the BLS measure.

The standard deviation of the BLS series is 18.5 percent smaller than the standard deviation of the "Rees method" series between 1973 and 1986, which implies a corresponding upward bias in the output gap and unemployment coefficients in the prewar estimates based on the Rees data. However, the

replication of the Rees methodology reported here varies in significant ways from the technique actually used by Rees. Also, comparisons of standard deviations may be sensitive to the choice of sample period.

Evaluating the impact of prewar-postwar differences in the industrial structure of the economy is, relatively speaking, a much more straightforward exercise. Rees (1961) reports for the nine major industries (textiles, boots and shoes, leather, electrical machinery, paper and paper products, rubber, glass, foundry and machine shops, iron and steel) used in his study the employment coverage of the state earnings data both in absolute terms and as a percentage of Census employment for Census years between 1899 and 1914. To construct a postwar wage series based on the industrial definitions used by Rees, average employment levels in these Census years were used to weight the modern counterparts of Rees' nine industries (SICs 22, 314, 31 minus 314, 36, 26, 30, 321 and 322, 35, and 331 and 332). Although the industry definitions match up fairly well, a clear limitation of this exercise is that the prewar products within each of these categories are not identical to the postwar products. Even in cases where the product has remained more or less the same, the technology can be dramatically different. Nonetheless, as the analysis in Section VI will show quite clearly, the sensitivity of wages to the business cycle varies tremendously across different industries and this approach is the only way to control for prewar-postwar differences in industry mix.

Limiting the wage variable to these nine industries in the postwar period turns out to have very little effect on the results. The standard deviation of wage inflation is slightly larger (.027 as compared to .024 in the BLS series), as is the range between the minimum and maximum values (.016 to .126 for the nine industry series versus .018 to .099 for BLS). As shown in rows 1 and 2 of

Table 8, there is no systematic difference between the business cycle coefficients for the two series.

A related concern is that the structure of compensation differs between the prewar and postwar labor market. Slichter (1941, p. 282) points out that almost half of all workers were covered by some type of incentive system, frequently piece rates. Self employment was also much more widespread in the prewar than the postwar period. The impact this has on the wage equations cannot be ascertained because of data inadequacies in both periods. Another major difference between the prewar and postwar compensation structure is the role of employee benefits. Rees (1960) estimates that benefits accounted for 0.7 percent of hourly compensation in 1929. According to the national income accounts, benefits represented 10 percent of total compensation by the late 1960s and 16 percent today.

The average annual percentage change in average hourly compensation is slightly larger than the average change in average hourly earnings, as one would expect given the growth of benefits in the postwar period, but the other summary statistics for the two series are very close to each other. As shown in Table 8, the business cycle coefficients for the two variables are also very similar.

Valid historical comparisons of Phillips curves depend not just on comparable wage data but also on comparable unemployment and output gap data. Romer (1986b) has shown that the Federal Reserve Board's index of materials production is very similar to the pre-1914 output series constructed by Frickey that was used in the earlier analysis. To gauge the impact of using an excessively volatile output measure on the business cycle coefficients, I constructed an output gap measure based on the FRB materials index following

Table 8. Sensitivity of output gap coefficient estimates to alternative wage and output gap variables, 1948-1987.

Specification	G_t	G_{t-1}
1. Standard (from Table 5)	.215 (.040)	-.016 (.042)
2. Wages in nine industries in Rees (1961)	.229 (.055)	-.056 (.060)
3. Average hourly compensation	.219 (.044)	.009 (.044)
4. FRB materials production index	.184 (.037)	.008 (.037)

the same procedures outlined in Section II and used this variable in the wage equation reported in the last row of Table 8. The output gap coefficient based on the materials measure was 16 percent smaller than the coefficient based on industrial production.

Romer (1986a) has argued that Lebergott's unemployment series is excessively volatile because it (1) assumes no cyclical shifts in the size of the labor force and (2) interpolates employment with output on a one-to-one basis in many cases. There is little question that these limitations lead to exaggerated swings in unemployment in certain years, but the magnitude of the problem remains unclear. There is no evidence yet on how the size of the labor force changed over the business cycle. Cyclical changes in the postwar labor force are mainly attributable to youths, women, and older men. In the prewar period, youths left school at an earlier age, most women were not in the labor force, and few older men were retired. Also, a much larger share of the labor force was in agriculture or were self-employed, two sectors where discretionary changes in labor force participation are unlikely. As for Okun's Law in the prewar period, the evidence in Frickey (1942), Bernanke and Powell (1986), and Weir (1986) is conflicting. Nonproduction workers were certainly a much smaller share of prewar employment than they are today. Because of these questions, it is far from certain that Romer's unemployment series for 1890-1930 is more appropriate than Lebergott's for the analysis of wage rigidity. However, even when Romer's series is used in place of Lebergott's, the results are not radically changed. The unemployment coefficient in row 1 of Table 5 is 28 percent smaller than that obtained with Romer's series.

To summarize, the evidence reported in this section indicates that after standardizing for important differences in the way in which the prewar and

postwar data were constructed, there seems to be no systematic bias in the prewar business cycle coefficients. The excess volatility of the wage measure contributes a bias that I roughly gauge to be of the same order of magnitude as the excess volatility of the output gap and unemployment measures. Differences in industry mix and the growth of benefits in the postwar period seem to have no effect on the results. The "bottom line" is that differences in the way the prewar and postwar data were constructed do not overturn the results reported above.

VI. AGGREGATION ACROSS INDUSTRIES

Year to year movements in manufacturing wages reflect not only wage changes within industries, but also changes in employment across industries. If there is a systematic tendency for the employment share of high wage jobs to fall in a recession, then manufacturing wages will automatically decline even if wages within each industry stay the same. Once again this raises concerns that (1) both prewar and postwar data on aggregate wage behavior give misleading signals about the true sensitivity of nominal wages to the business cycle and (2) comparisons of prewar and postwar estimates based on such data lead to false inferences about whether wage behavior has really changed in the postwar period.

To deal with this issue, this section of the paper reports the results of two types of experiments. First, I create and analyze an average hourly earnings series with fixed employment weights for 1890-1914, based on seven major industries in Rees (1961) for 1890-1914 and another for 1947-1987, based on two-digit SIC industries. Second, there are seven major industries for

which wage data are available in the prewar and postwar period. By estimating separate equations by industry, one can get behind the veil of aggregation to see whether there have been any cases where wages have become more or less rigid in the postwar period. This experiment also yields information about whether changes in labor market institutions have affected wage behavior over the business cycle.

Aggregation using variable instead of fixed employment weights has a noticeable effect on our analysis, as shown in Table 9. The fixed-weight wage change measure for the prewar period has a much smaller standard deviation and range than the variable-weight measure, whereas the summary statistics for the two measures in the postwar period are essentially the same. The magnitude of the changes in the prewar data is sufficiently large to eliminate most of the prewar-postwar difference in wage change variability.

The regression results point to an even more dramatic conclusion. In the postwar period, the unemployment rate coefficients decline by 27 percent and the output gap coefficients drop by 19 percent when average employment for the entire period is used to weight wage growth by industry. The movement is more dramatic in the prewar estimates, where the unemployment coefficient drops by 54 percent and the output gap coefficient drops by 40 percent. Before these adjustments, the output gap coefficients estimated over the Rees data were somewhat larger than those for the postwar period. Now they are either smaller or the same size, depending on the specification. More strikingly, the postwar unemployment coefficients are now roughly twice the size of the coefficients for 1890-1914.

Looking across all of these results, there is now an indication that wages may very well be more strongly procyclical today than they were in the prewar

Table 9. Business cycle coefficients, variable and fixed employment weights in wage growth estimates, 1891-1914 and 1948-1987.

Period and weighting procedure	Wage growth				Unemployment rate coefficients		Output gap coefficients	
	Mean	S.D.	Minimum	Maximum	U_t	U_{t-1}	G_t	G_{t-1}
1891-1914, variable	.018	.037	-.079	.070	-.649 (.175)	.215 (.198)	.210 (.093)	.102 (.106)
1891-1914, fixed	.017	.028	-.044	.059	-.300 (.133)	-.175 (.149)	.127 (.065)	.158 (.074)
1948-1987, variable	.054	.024	.018	.099	-.982 (.244)	.294 (.224)	.215 (.040)	-.016 (.042)
1948-1987, fixed	.053	.023	.021	.096	-.716 (.225)	.203 (.205)	.175 (.037)	.007 (.039)

era. Such a conclusion would be premature because the fixed-weight series for 1890-1914 is limited to seven industries and thereby omits such major sectors as printing, furniture, chemicals, and automobiles which were included in Rees' aggregate wage series. Also, it obviously omits much of the prewar period. These two shortcomings can be overcome by focusing on industry wage series not only from Rees (1961) and BLS, but also the Conference Board. These results are reported in Table 10, using the same specifications as before.

The industry wage equations constitute one final piece of evidence that wages have definitely not become more cyclically rigid in the postwar period. The unemployment and output gap coefficients in most industries tend to be considerably larger in the postwar period than between 1890 and 1914. No strong pattern emerges in the comparison of the 1921-1941 and the postwar estimates; the former tend to be slightly larger in most industries but the differences are rarely immense.

It is very difficult to find any noticeable prewar-postwar distinctions within any of the industries and impossible at this stage to link them to any institutional changes. For instance unionization is usually associated with wage rigidity. Union workers are thought to be more insulated from the business cycle than their nonunion counterparts because of multiyear contracts and their ability to use the strike-threat as leverage during contract negotiations. Thus, one would think that union organization of the iron and steel, paper, rubber, and machinery industries would be reflected in smaller postwar coefficients for at least some of those industries. This is decidedly not the case.

Table 10. Business cycle coefficients, by industry, 1891-1914, 1921-1941, and 1948-1987.

Industry	1891-1914		1921-1941		1948-1987	
	G _t	U _t	G _t	U _t	G _t	U _t
Boots and shoes	.171 (.056)	-.282 (.109)	.167 (.084)	-.657 (.332)	.177 (.060)	-.939 (.334)
Leather	.114 (.086)	-.277 (.178)	.230 (.090)	-.168 (.110)	.111 (.045)	-.524 (.259)
Paper and paper products	-.119 (.125)	-.050 (.311)	.120 (.102)	-.656 (.367)	.148 (.041)	-.570 (.244)
Rubber	-.126 (.071)	.181 (.166)	.190 (.089)	-.887 (.299)	.172 (.058)	-.645 (.320)
Foundry and machine shops	.200 (.055)	-.262 (.130)	.222 (.078)	-1.082 (.253)	.207 (.044)	-.916 (.257)
Textiles	.139 (.099)	-.222 (.206)	.297 (.118)	-1.319 (.397)	.285 (.050)	-1.437 (.270)
Iron and steel	.275 (.164)	-.998 (.321)	.346 (.132)	-1.697 (.441)	.300 (.092)	-1.209 (.517)
Chemical			.237 (.092)	-1.172 (.287)	.102 (.042)	-.442 (.234)
Electrical manufacturing			.139 (.079)	-.780 (.273)	.077 (.040)	-.352 (.229)
Furniture			.259 (.098)	-1.179 (.317)	.179 (.034)	-.982 (.188)
Lumber			.391 (.098)	-1.617 (.329)	.236 (.058)	-.634 (.341)
Printing			.027 (.046)	-.170 (.178)	.109 (.024)	-.548 (.131)

Note: The textiles estimates reported for 1921-1941 are based on wool manufacturing, the largest of the four textile industries in the Conference Board data. Estimates for the other three textile industries (cotton, hosiery and knit goods, silk) were very similar to the estimate for wool. The paper industry estimate for 1921-1941 is based on pulp and paper manufacturing, which was a much larger part of the paper industry than paper products. The estimates for the paper products industry were almost identical to those reported in the table. The printing industry estimate for 1921-41 is based on book and job printing, which had about four times as many employees as news and magazine printing.

VII. CONCLUSION

The main finding of this paper is that, on balance, there is no evidence that wages in the postwar era have become either more or less responsive to cyclical fluctuations in output than in the prewar period. Those who wish to continue to believe that wages became more rigid in the postwar period can still point to the evidence in Section II on wage growth in moderate expansions and severe contractions. More adventurous thinkers who are willing to contemplate the possibility that postwar wages are actually less rigid can find some signals along those lines in the exercises in disaggregation reported in Section VI.

Until a few years ago the prevailing wisdom within the economics profession was that output, wages, and prices have all been less volatile in the postwar period. Romer's work has seriously challenged the part of that wisdom relating to output. This study raises the same sort of questions about wages.

One might still ask whether a one percentage point increase in unemployment today is truly comparable to the same change 100 years ago in terms of its impact on the labor market and the personal well-being of the unemployed. This issue hinges on a number of poorly understood characteristics of the prewar period, including the average duration of unemployment, the ability of workers to transfer skills across occupations and industries, and the amount of support available from families, churches, and communities. More work by economists and historians (perhaps along the lines of Keyssar (1986)) will be needed to come to grips with this issue.

The cost of focusing on how wages react to output and employment in this study has been the cursory attention paid to price behavior. This is clearly a subject that needs to be addressed more carefully in future work, in terms of both extending the econometric analysis in Sections IV through VI and carefully studying the price data in their own right. If the reaction of wages to unemployment is the same in the prewar and postwar periods and the variability of output and employment in the two periods is roughly the same, then the greater univariate volatility of wages in the prewar period presumably must come from some combination of (1) measurement error, (2) sectoral shifts, and (3) the reaction of wages to prices. The analysis in Sections V and VI has indicated that the first two factors have clearly been important. The role of the third factor needs to be evaluated.

Based on the belief that wages in the postwar economy have become more rigid and that wage rigidity reduces economic welfare, a number of proposals have been made in recent years to impose costs on the use of particular types of payment schemes for labor services that are believed to make wages less sensitive to economic conditions (e.g. bans on multiyear collective bargaining agreements, tax incentives for profit sharing or bonus systems). Given the changes in labor market structure and countercyclical policy that have taken place over the last 100 years and the absence of any evidence of changes in wage flexibility over that period, it would seem that these proposals are based mainly on theory rather than evidence.

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DATA APPENDIX

1. Average hourly earnings. The variable used in the analysis of the 1891-1941 sample period comes from Rees (1961), Table 1, p. 4, col. 1, for 1890 through 1914 and from Rees (1960), Table 1, p. 3, col. 1, for 1915 through 1941. The source for the 1890-1914 sample period is also Rees (1961). The analysis of the Douglas (1930) data for 1891-1926 is based on the variable reported in Table 24, p. 108. The results for the 1921-1936 sample period are derived from June to June changes in average hourly earnings in Beney (1936), Table 2, pp. 44-47. June 1922 values are assumed to be the same as those reported for July 1922. This assumption is based on Creamer's (1950) finding that there was no change in average hourly earnings in manufacturing between those months. The results for the Conference Board annual average data for 1921-1941 are derived from Conference Board (1946), p. 178. Averages for 1920 and 1922 were derived from Beney (1936), Table 2, using the same technique as in Rees (1960), p. 15. The postwar data on average hourly earnings were derived from CITIBASE. Monthly estimates of average hourly earnings (LE6HM) are aggregated into annual averages using production worker employment (LPWM) and average weekly hours (LPHRM) as weights. The ratio of total compensation to wage and salary compensation from the national income accounts was derived from the 1989 Economic Report of the President, Table B-24, p. 334. Average hourly earnings for total private nonagricultural sector also comes from the 1989 ERP, Table B-44, p. 358.

2. Output gap. Two output series were used in the analysis: the Nutter (1962) series, reported in Long Run Economic Growth, series A15, pp. 184-185 and the Federal Reserve Board's industrial production index. Values of the latter for 1919 through 1946 are taken from LREG, series A16, pp. 184-185, whereas values for 1947 through 1987 are estimated using variable IP in CITIBASE. Each year's monthly values of IP are converted into annual values by summing them and dividing by 12. The FRB materials production index comes from ERP, Table B-49, p. 363. All of the prewar regression analysis using industrial production is based on the Nutter index. The output gap estimates based on GNP were based on the series developed by Romer (1989) and Balke and Gordon (1989) for 1890-1928 and on the figures in the national income accounts, as reported in the Survey of Current Business, September 1986 Supplement, Table 1.2 for 1929-41 and in ERP, Table B-2, p. 310 for 1947-87.

3. Unemployment rate. The prewar series is a combination of the Lebergott's estimates for 1890-1929, as reported in Romer (1986a), and values for 1930-1941 from LREG, series B2, pp. 212-213. The postwar series was derived from seasonally adjusted monthly data from CITIBASE for 1948-1987. Annual average unemployment is the simple average of monthly rates, estimated as the ratio of unemployed persons (LHUEM) to the civilian labor force (LHC). The estimate for 1947 comes from LREG, series B2.

4. Price index. The prewar series values for 1886-1889 and 1914-1941 come from LREG, series B69, pp. 222-223. Values for 1890-1913 from Rees (1961), p. 4 were spliced onto this series by multiplying the data from Rees by the ratio of the 1914 values of series B69 (30.1) to the 1914 value of Rees' series (100). The postwar annual series for 1947-1987 is the simple average of the monthly values of CPI-U from CITIBASE (series PUNEW). Values for 1943-1946 from series B69 of LREG (where 1967=100) were spliced onto this series using the 1967 value of the 1982-1984 benchmark series from ERP, Table B-58, p. 373.

Appendix Table 1. Means and standard deviations of variables in regression analysis

Sample Period	Dw_t	Dp_t	U_t	G_t
1891-1941	3.44 (7.91)	1.09 (5.70)	8.78 (6.38)	-0.16 (18.27)
1948-1987	5.41 (2.36)	4.21 (3.48)	5.67 (1.69)	3.36 (6.60)
1891-1914	1.85 (3.70)	0.48 (2.23)	7.22 (4.49)	-2.14 (8.64)
1891-1926	3.54 (6.95)	2.06 (6.02)	6.40 (4.20)	-0.04 (9.97)
1921-1936	0.62 (10.52)	-2.17 (4.69)	10.96 (8.52)	-10.57 (24.48)
1921-1941	1.78 (7.22)	-1.35 (4.53)	11.82 (7.64)	-12.18 (22.69)

Note: The variables used in the regression analysis were multiplied by 100 here to make the table easier to read.

Appendix Table 2. Phillips curve estimates with current unemployment rate, 1891-1987

	1891-1941	1948-1987	1891-1914	1891-1926	1921-1936	1921-1941
Constant	.081 (.050)	.071 (.012)	.050 (.017)	.067 (.031)	.007 (.057)	.011 (.036)
Trend	.002 (.002)	.0005 (.0004)	.001 (.001)	-.0004 (.0011)	.006 (.010)	.007 (.003)
Dp _{t-1}	.049 (.194)	.436 (.094)	-.379 (.280)	.640 (.197)	.272 (.489)	.037 (.226)
Dp _{t-2}	-.637 (.192)	-.054 (.092)	-.747 (.274)	-.151 (.225)	-.948 (.477)	-.636 (.226)
Dp _{t-3}	.040 (.197)	.254 (.099)	.353 (.296)	.162 (.198)	.152 (.469)	.065 (.208)
U _t	-1.129 (.254)	-.987 (.246)	-.543 (.144)	-.604 (.259)	-.429 (.433)	-.538 (.256)
AR1	.679 (.135)	.540 (.182)	-.116 (.262)	.012 (.408)	-.180 (.359)	.263 (.271)
R ²	.464	.722	.643	.461	.444	.569
D.W.	2.139	2.184	1.987	1.959	2.042	1.909
SEE	.062	.014	.026	.056	.101	.057

Appendix Table 3. Phillips curve estimates with current and lagged unemployment rates, 1891-1987

	1891-1941	1948-1987	1891-1914	1891-1926	1921-1936	1921-1941
Constant	.024 (.018)	.060 (.014)	.044 (.016)	.025 (.021)	.005 (.035)	.007 (.018)
Trend	.001 (.001)	.0002 (.0005)	.001 (.001)	-.0002 (.0007)	.003 (.006)	.002 (.002)
Dp _{t-1}	1.012 (.195)	.448 (.095)	-.116 (.339)	1.287 (.186)	.536 (.418)	.396 (.207)
Dp _{t-2}	-.676 (.219)	-.066 (.091)	-.748 (.279)	-.610 (.233)	-.981 (.390)	-.697 (.200)
Dp _{t-3}	.186 (.186)	.219 (.101)	.465 (.313)	.319 (.176)	.182 (.359)	.072 (.163)
U _t	-1.181 (.242)	-.982 (.244)	-.649 (.175)	-.902 (.254)	-1.336 (.432)	-1.076 (.241)
U _{t-1}	1.084 (.255)	.294 (.224)	.215 (.198)	.805 (.262)	1.223 (.394)	.993 (.268)
AR1	.006 (.241)	.557 (.193)	-.276 (.270)	-.517 (.263)	-.509 (.305)	-.164 (.292)
R ²	.547	.736	.662	.582	.732	.760
D.W.	2.000	2.263	2.114	2.157	2.590	2.171
SEE	.057	.013	.026	.050	.074	.044

Appendix Table 4. Phillips curve estimates with current output gap, 1891-1987

	1891-1941	1948-1987	1891-1914	1891-1926	1921-1936	1921-1941
Constant	-.008 (.035)	.021 (.006)	.011 (.011)	.036 (.022)	-.023 (.061)	-.021 (.030)
Trend	.002 (.001)	-.0002 (.0002)	.001 (.001)	-.001 (.001)	.006 (.009)	.006 (.003)
Dp _{t-1}	.267 (.192)	.517 (.076)	-.227 (.303)	.598 (.176)	.284 (.489)	.078 (.225)
Dp _{t-2}	-.576 (.194)	-.090 (.090)	-.737 (.306)	.008 (.188)	-.958 (.472)	-.641 (.225)
Dp _{t-3}	.082 (.194)	.239 (.076)	.264 (.351)	.186 (.176)	.176 (.454)	.071 (.202)
G _t	.314 (.072)	.208 (.036)	.247 (.084)	.411 (.101)	.162 (.128)	.161 (.068)
AR1	.538 (.167)	.224 (.190)	-.155 (.250)	.210 (.274)	-.244 (.346)	.172 (.278)
R ²	.482	.788	.562	.573	.478	.595
D.W.	2.037	2.082	2.064	1.891	2.085	1.939
SEE	.061	.012	.028	.050	.098	.055

Appendix Table 5. Phillips curve estimates with current and lagged output gap, 1891-1987

	1891-1941	1948-1987	1891-1914	1891-1926	1921-1936	1921-1941
Constant	.008 (.020)	.021 (.006)	.011 (.014)	.026 (.016)	.005 (.046)	-.004 (.023)
Trend	.001 (.001)	-.0002 (.0002)	.002 (.001)	-.001 (.001)	.002 (.007)	.003 (.002)
Dp _{t-1}	.912 (.226)	.529 (.082)	-.526 (.398)	1.084 (.243)	.699 (.493)	.433 (.272)
Dp _{t-2}	-.672 (.223)	-.098 (.093)	-.702 (.311)	-.274 (.227)	-1.060 (.442)	-.726 (.243)
Dp _{t-3}	.142 (.196)	.236 (.078)	.195 (.377)	.178 (.176)	.216 (.402)	.117 (.197)
G _t	.316 (.076)	.215 (.040)	.210 (.093)	.421 (.109)	.332 (.130)	.234 (.076)
G _{t-1}	-.205 (.088)	-.016 (.042)	.102 (.106)	-.234 (.140)	-.296 (.130)	-.176 (.094)
AR1	.128 (.256)	.218 (.195)	.034 (.266)	-.130 (.386)	-.563 (.293)	-.168 (.295)
R ²	.498	.789	.572	.598	.661	.648
D.W.	1.990	2.083	1.972	1.972	2.626	2.115
SEE	.060	.012	.029	.049	.084	.053

Appendix Table 6. Residuals of estimates for 1891-1941
from Appendix Tables 3 and 5.

Year	Unemployment	Output Gap
1891	-.275270E-02	-.116398E-01
1892	-.402154E-01	-.162892E-01
1893	.121657	.743553E-01
1894	-.392404E-02	-.571499E-01
1895	-.337557E-01	.208936E-03
1896	.345544E-01	.665232E-01
1897	-.477255E-01	-.500934E-01
1898	-.445833E-01	-.249632E-01
1899	-.272703E-01	.366706E-01
1900	-.437434E-02	.214834E-01
1901	-.933288E-03	-.456432E-02
1902	.865313E-02	-.221371E-02
1903	-.263570E-03	-.267038E-02
1904	-.341220E-01	-.234027E-01
1905	-.199469E-01	-.378291E-01
1906	.258364E-01	.429591E-01
1907	-.142163E-01	-.323001E-01
1908	-.338518E-01	-.310861E-01
1909	-.226155E-02	.289288E-02
1910	.315197E-01	.133488E-01
1911	-.476231E-01	-.389417E-01
1912	.225606E-02	.130545E-02
1913	.196256E-02	-.705647E-02
1914	-.202582E-02	-.223901E-01
1915	.375987E-02	-.390870E-01
1916	.811238E-01	.683621E-01
1917	.938078E-01	.809771E-01
1918	.118106	.150692
1919	.312908E-01	.647866E-01
1920	.991122E-01	.475099E-01
1921	-.169730	-.162749
1922	.225140E-01	.447947E-01
1923	-.187038E-01	-.797294E-02
1924	-.182389E-01	-.377983E-01
1925	-.435564E-01	-.501479E-01
1926	-.785693E-01	-.733342E-01
1927	-.842051E-02	-.220030E-01
1928	-.109968E-01	-.345368E-01
1929	-.393955E-01	-.567793E-01
1930	.738808E-02	.134124E-02
1931	.280733E-01	.952078E-02
1932	.804388E-02	.167822E-01
1933	.294516E-01	-.114532E-02
1934	.131867	.173770
1935	-.716316E-01	-.828423E-01
1936	-.524742E-01	-.365342E-01
1937	.533453E-01	.797187E-01
1938	-.226634E-01	.794829E-02
1939	-.139680E-01	-.223784E-01
1940	-.207935E-01	-.358466E-02
1941	-.531788E-02	-.108657E-01

Appendix Table 7. Residuals of estimates for 1948-1987
from Appendix Tables 3 and 5.

Year	Unemployment	Output Gap
1948	-.712074E-02	-.694355E-02
1949	-.129785E-01	-.954032E-02
1950	.508995E-02	-.587006E-03
1951	.221157E-01	.283101E-01
1952	-.318504E-01	-.231002E-01
1953	.201256E-01	.144366E-01
1954	-.173213E-01	-.185593E-01
1955	.663573E-02	.228838E-02
1956	.188719E-01	.189194E-01
1957	-.395916E-02	.470075E-02
1958	.299723E-02	.508569E-02
1959	-.393139E-02	.363658E-02
1960	-.258102E-02	.291553E-02
1961	-.198844E-03	.120417E-03
1962	-.486302E-02	.327120E-02
1963	-.104223E-03	-.240059E-02
1964	-.580119E-02	-.513126E-02
1965	-.570878E-02	-.124858E-01
1966	-.503335E-02	-.147136E-01
1967	-.669804E-02	-.144978E-01
1968	.158862E-01	.770478E-02
1969	-.988775E-02	-.134963E-01
1970	-.689141E-03	-.734419E-02
1971	.130810E-01	.609861E-02
1972	.808757E-02	.199658E-02
1973	.227805E-02	-.265238E-02
1974	.157794E-01	.102487E-01
1975	.267403E-01	.236342E-01
1976	-.494867E-02	.423353E-02
1977	.140129E-01	.125619E-01
1978	.209536E-03	.325760E-02
1979	.670747E-02	.531437E-02
1980	.434179E-02	-.686026E-03
1981	.747274E-02	.390356E-02
1982	-.226337E-02	.168018E-02
1983	-.171684E-01	-.144503E-01
1984	-.788347E-02	-.547609E-02
1985	-.440825E-02	-.347212E-02
1986	-.139412E-01	-.460849E-02
1987	-.148560E-01	-.245259E-02

