Wage Behavior
in the United States: 1907-80

By George A. Kahn

Inflation has declined sharply in the United States since 1979, but economic growth has slipped and unemployment has reached post-World War II highs. One explanation for this unsatisfactory economic performance may be that the postwar introduction of long-term labor contracts has prevented the growth of nominal wages from adjusting downward in response to declining inflation.[1] If nominal wage growth is sticky, the slowing of inflation causes a temporary increase in real wage growth—nominal wage growth adjusted for in-flation. The increase in real wage growth, in turn, causes a temporary reduction in production and employment.

This article examines the behavior of wages in the United States to determine whether the increased prevalence of long-term wage contracts since World War II has led to an increase in nominal wage stickiness. The first section defines wage stickiness and examines its theoretical implications. The article then looks for empirical evidence of changing patterns of wage adjustment, first by analyzing the basic data on wage behavior for 1907-80 and then by presenting estimates of an econometric model of wage adjustment. The findings confirm that nominal wage inertia increased as long-term wage contracts became more prevalent, thus suggesting that disinflationary macroeconomic policies are more likely than previously to be accompanied by increased unemployment.

WAGE STICKINESS AND THE EFFECTS OF DISINFLATIONARY MONETARY POLICY

The labor market is in equilibrium when the demand for labor is equal to the supply of labor. Firms' demand for labor varies inversely with the real wage—the nominal wage divided by the aggregate price level. Workers' supply of labor increases with the real wage. Equilibrium

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[1] Other explanations include a lack of credibility of Federal Reserve policy, backward-looking expectations, or price rigidity. In the intermediate term when agents learn about structural changes, however, lack of credibility and rationality become less acceptable explanations for a prolonged recession. Price and wage rigidity take on more significance. For evidence on price adjustment in the United States, see, for example, Robert J. Gordon, "A Consistent Characterization of a Near-Century of Price Behavior," *American Economic Review,* Vol. 70, No. 2, May 1980, pp. 243-49, and Robert J. Gordon, "Price Inertia and Policy Ineffectiveness in the United States, 1890-1980," *Journal of Political Economy,* Vol. 90, No. 6, December 1982, pp. 1087-117.

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occurs at the unique real wage that equates the supply of and demand for labor.

Market forces ensure that nominal wages adjust in the long run to yield this equilibrium real wage, the value of which depends on, among other things, labor productivity. However, various frictions can prevent the necessary adjustments from occurring in the short run to the extent that these frictions result in sticky wages. From a macroeconomic perspective, the degree of wage stickiness is a major factor determining the response of inflation and output to changes in the aggregate demand for goods and services as caused, for example, by changes in the rate of monetary growth.[2]

Nominal wage stickiness

Nominal wage stickiness results when nominal wages do not adjust sufficiently to changes in the aggregate price level, causing real wages to deviate from their equilibrium value.[3] One possible cause of nominal wage stickiness is long-term wage agreements.[4] Unless fully indexed to inflation, the nominal wages set by long-term contracts do not adjust completely to changes in the aggregate price level over the contract period.

If nominal wages are sticky, changes in the price level resulting from changes in aggregate demand cause short-run changes in output and employment. Consider, for example, the effects of a reduction in aggregate demand. The associated decline in the aggregate price level does not lead to a commensurate decline in nominal wages. Thus, real wages increase even though there is no corresponding increase in labor productivity. The resulting rise in unit labor costs leads firms to reduce employment and output below equilibrium levels in the short run.[5] In the long run, renegotiation of wage contracts will realign nominal wages with the aggregate price level. As a consequence, equilibrium values of real wages, employment, and output will prevail in the long run, despite temporary deviations caused by nominal wage stickiness.

Nominal wage flexibility and real wage stickiness

Nominal wages are flexible when they adjust immediately to changes in the aggregate price level. Nominal wage flexibility can result, for example, either from the absence of long-term wage contracts or from wage contracts that are fully indexed to inflation. Insofar as changes in the price level are caused by changes in aggregate demand, nominal wage flexibility ensures that nominal wages adjust to keep the real wage at its equilibrium value. As a result, a flexible nominal wage helps insulate output and employment from changes in aggregate demand.

Problems can arise, however, when nominal wage flexibility leads to real wage stickiness—the failure of real wages to adjust to changes in such real economic factors as labor productivity. As with nominal wage stickiness, real wage stickiness may cause real wages, employment, and output to diverge from

[2] William Branson and Julio Rotemberg present a formal open economy theory of nominal and real wage stickiness in "International Adjustment with Wage Rigidity," *European Economic Review,* Vol. 13, No. 3, May 1980, pp. 309-32. The analysis here is similar.

[3] For simplicity, this section discusses wage adjustment with variables defined as levels. Because in reality, wages, prices, and output all grow along a trend, it is preferable in empirical work to use detrended levels, rates of growth, or even detrended growth rates. Because this article analyzes cyclical wage adjustment rather than secular adjustment, detrending is not only desirable but also necessary.

[4] No effort is made here to explain the existence of long-term contracts, but transactions costs must play an important part in any explanation.

[5] Resulting unemployment will be involuntary *ex post* even though *ex ante,* workers and firms agree to a fixed nominal wage knowing full well its possible consequences.

equilibrium values. For example, suppose there is an increase in the relative price of an important input to the production process such as energy. For a given level of aggregate spending, the energy price increase causes both an increase in the aggregate price level and a reduction in the productivity of labor.[6] This type of supply shock will also lower the equilibrium real wage. However, if there is real wage stickiness—that is, if the increase in the price level is fully offset by an increase in nominal wages—real wages do not immediately decline to the lower equilibrium level associated with lower productivity. The delay in the adjustment of real wages to the drop in productivity will cause firms to reduce employment and output temporarily below equilibrium levels.

As sticky nominal wages prevent short-run adjustment to changes in aggregate demand, sticky real wages prevent short-run adjustment to changes in aggregate supply. Market forces ensure, however, that real wages adjust in the long run to the level consistent with labor market equilibrium.

Effects of disinflationary monetary policy

The impact of a disinflationary monetary policy that lowers monetary growth depends in part on whether wage adjustment is sticky.[7] Specifically, if nominal wages are sticky, a deceleration of monetary growth causes real output to decline and unemployment to increase. The reduction in monetary growth slows growth in aggregate demand, but the resulting

slowdown in inflation is not reflected initially by a commensurate slowing in the growth of nominal wages. Thus, real wages increase more rapidly than productivity, causing firms to reduce output and employment.

In contrast, a disinflationary monetary policy has no adverse effect on employment and output if nominal wages and prices are completely flexible. In this case, lower growth in nominal wages fully reflects declining inflation, leaving growth in real wages, employment, and output unaffected. Thus, nominal wage flexibility reduces the real economic cost of disinflationary monetary policy, even though it may lead to real wage stickiness, which magnifies the short-run impact of changes in factors that affect labor productivity.

AN OVERVIEW OF THE EVIDENCE OF WAGE STICKINESS

This section provides an overview of some evidence on wage stickiness in the United States during the period from 1907 to 1980. By breaking the sample into three subgroups—1907-28, 1929-53, and 1954-80—and calculating sample statistics, changing patterns of economic performance can be identified. Breaking points were selected to separate the Great Depression and World War II years from the rest of the sample because of the "well known perversities in the wage and price dynamics of the period."[8] The statistical properties analyzed in this section are the volatility of individual series and the correlation of differing series.

Table 1 presents the standard deviations of annual nominal wages, real wages, and prices for each subperiod and for the full sample period. These statistics measure the volatility and secular changes in the volatility of the

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[6] See Robert Rasche and John Tatom, "Energy Price Shocks, Aggregate Supply and Monetary Policy: The Theory and the International Evidence," *Carnegie-Rochester Conference Series on Public Policy*, Vol. 14, Spring 1981, pp. 10-94, for a discussion of the technical assumptions necessary for declining productivity.

[7] The appendix derives aggregate supply relationships and demonstrates the effects of changes in aggregate demand on prices and output under nominal and real wage stickiness.

[8] Jeffrey Sachs, "The Changing Cyclical Behavior of Wages and Prices," *American Economic Review*, Vol. 70, No. 1, March 1980, p. 79.

Table 1
STANDARD DEVIATIONS OF WAGES AND PRICES: 1907-80

Variables	1907-80	1907-28	1929-53	1954-80
Prices	0.64	1.71	1.19	0.26
Nominal Wages	0.74	2.04	1.33	0.26
Real Wages	0.39	1.04	0.73	0.15

Table 2
CORRELATION COEFFICIENTS: 1907-80

Variables	1907-80	1907-28	1929-53	1954-80
Nominal Wages and Prices	0.85*	0.86*	0.84*	0.84*
Real Wages and Prices	−0.02	0.04	−0.10	−0.29

*Significant at .05 level.

variables.[9] Real wages are measured as total compensation per hour for manufacturing workers in 1957 dollars and are inflated by the consumer price index to yield nominal wages. Prices, however, are measured by the implicit GNP deflator.

The most striking feature of Table 1 is the decline in the volatility of all variables, especially after 1953. For example, despite the recent high rate of inflation, inflationary volatility since 1954 has been remarkably low compared with the earlier periods. Volatility of nominal

and real wages has also declined substantially in the most recent period.

The volatility of individual wage and price variables reported in Table 1 does not provide conclusive evidence regarding the degree of wage stickiness. The decline in variability of real wages taken by itself seems to suggest a decline in nominal wage stickiness. If nominal wage growth fully reflected the rate of inflation, then real wages would vary only because of changes in productivity and other real factors. In this case, the relatively low volatility of real wages since 1954 would be indicative of little or no nominal wage stickiness. However, the observed decline in real wage volatility could also result from the accompanying decline in the volatility of inflation even if nominal wage flexibility had declined. For this reason, an analysis of the co-movement of wages and prices provides better information on the degree of wage stickiness.

One statistic for measuring the extent to which two variables move in the same direction is the correlation coefficient.[10] The value of this statistic varies from minus one to plus one, with one indicating perfect positive correlation between the two series, zero indicating no correlation, and negative one indicating perfect negative correlation. Table 2 presents correlation coefficients for nominal wages and prices and for real wages and prices for 1907-80, 1907-28, 1929-53, and 1954-80.

The statistics reported in Table 2 show that nominal wages were highly correlated with prices for the entire sample period and for each subperiod. Moreover, the correlation did not decline significantly over time. This high and

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[9] Before calculating standard deviations, each series was detrended by a regression of the natural logarithm of each variable on a constant and on linear and quadratic time trends. Natural logarithms are used to minimize problems with heteroscedasticity and to allow for log-linear relationships among variables. Residuals from these regressions became the data for the analysis. Because the means of the resulting detrended variables were zero, the standard deviation of series $X_t(t = 1, \ldots, N)$ is defined as:

$$\left\{ \frac{1}{(N-1)} \cdot \sum_{t=1}^{N} X_t^2 \right\}^{1/2}$$

[10] The correlation coefficient between a series X_t and a series $Y_t(t = 1, \ldots, N)$ is defined as:

$$\sum_{t=1}^{N} X_t Y_t (\Sigma X_t^2 \Sigma Y_t^2)^{-1/2}$$

where the mean of X_t and Y_t are both zero because of detrending.

stable correlation does not support the hypothesis of significant and increasing stickiness of nominal wages. The higher the correlation between nominal wages and prices, the more closely nominal wage growth reflects changes in the rate of inflation. Thus, the high and stable correlation between nominal wages and prices seems to indicate that nominal wage stickiness was not prevalent in any of the subperiods.

The correlation coefficients between real wages and prices, however, provide more support for the hypothesis of increased nominal wage stickiness. Negative correlation between real wages and prices indicates that higher inflation is associated with lower growth in real wages, perhaps because nominal wages are sticky. Thus, the increasingly negative correlation between real wages and prices over the sample period is consistent with the view that increasing nominal wage stickiness reduced the responsiveness of nominal wage growth to inflation. However, the correlation between real wages and prices was not significantly different from zero in a statistical sense for any of the subperiods. Therefore, the increasingly negative correlation between real wages and prices could be the result of random occurrences rather than the increased nominal wage stickiness associated with a fundamental change in wage-setting behavior.

While the nominal wage and price correlations point to the conclusion that nominal wages remained flexible, the real wage and price correlations hint at increased nominal wage stickiness. Neither result, however, decisively establishes whether there was a change in wage behavior. Simple correlations can be misleading in certain situations. For example, correlation coefficients are incapable of distinguishing between price changes resulting from changes in aggregate supply and those resulting from changes in aggregate demand, even though the source of price level changes

has important implications for the associated behavior of nominal and real wages. Thus, determining the degree of wage stickiness requires a more complete model of wage behavior that takes account of supply shocks and various other factors affecting nominal and real wages.

AN EMPIRICAL MODEL
OF WAGE ADJUSTMENT

Determining the type and extent of wage stickiness requires the estimation of a model of wage behavior. The model used in this article includes the factors affecting the target growth of real wages and the equilibrium growth of nominal wages. In the absence of wage stickiness, these factors would fully explain wage behavior. To allow for the possibility that stickiness also affects wages, however, the model is extended to include a description of how nominal wage growth adjusts to equilibrium.

A model of wage behavior

The model of wage behavior assumes that the demand for labor and the supply of labor depend on real rather than nominal wages. It further assumes that firms and workers decide on target real wage growth over the period covered by wage agreements, which are specified in terms of nominal wage growth. Determination of the target growth in real wages, $\tilde{w}$, is represented by equation 1 in Table 3. In the long run, trend growth of productivity—represented in the equation by the constant term, a, and the time trend variable, T—is a major determinant of real wage growth. However, anything that causes productivity to diverge from trend growth changes target real wage growth in the short run. For example, some analysts maintain that supply shocks in the 1970s reduced productivity and, thereby, lowered real wage growth. Government policies, such as wage and price controls, can

also change growth in real wages temporarily. These effects were captured by the inclusion of a variable, z, measuring oil and food price shocks and government policy intervention in the wage setting process. Finally, the degree of labor market tightness, as represented by $\dot{q}$, the deviation in the growth rate of real output from trend, can influence the increase in real wages firms must pay to attract or retain workers.[11]

The model then stipulates that equilibrium growth in nominal wages, W^*, is equal to target growth in real wages plus the expected rate of inflation, P^e. This is represented by equation 2. Equilibrium nominal wage growth can be interpreted as the nominal wage growth specified in recent wage agreements, which presumably reflect expectations of inflation and target real wage growth based on the information available when the agreement was reached. For

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[11] Equation 1 uses the rate of growth of real GNP at the time of contract negotiation to represent labor market tightness and a time trend to represent secular movements in the underlying economic variables. Inclusion of the trend allows estimation of the short-run response of wages to cyclical fluctuations. Inclusion of the trend also implies that wage growth will eventually reflect any change in the long-run, secular rate of inflation.

Policy and supply variables control for episodes of governmental invervention in the wage-setting process and changes in the relative price of food and energy. The government intervention variables represent price and wage control programs introduced during the 1930s under the National Recovery Act, during World War II, and during the Nixon Administration. They are represented as dummy variables. The values of these policy variables are based on the assumption that government intervention has, at most, a temporary effect on wages. Precise definitions of these variables are given in the notes to Table 4.

The variable representing food and energy prices is the difference between the rates of change of the U.S. National Income and Product Accounts deflators for personal consumption expenditures and for personal consumption net of expenditures on food and energy. Because these statistics were not compiled before 1947 and energy supply shocks were not important before then, the food and energy variable is set equal to zero for the 1907-46 period. Both the food and energy variable and the government intervention variables are defined as in Gordon, "A Consistent Characterization . . . ."

wage agreements that fully index nominal wages to inflation, there is no need to incorporate the expected rate of inflation into nominal wage growth to keep growth in real wages at the target rate. Fully indexed nominal wages adjust automatically to reflect actual inflation. Comparatively few wage agreements, however, provide for cost of living adjustments, and almost none are fully indexed.[12] Thus, it seems realistic to assume that equilibrium nominal wage growth is based on the rate of inflation expected over the term of wage agreements.

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[12] See Alan Blinder, "Indexing the Economy Through Financial Intermediation," Carnegie-Rochester Conference Series on Public Policy, Vol. 5, 1975, pp. 69-106, for a more complete discussion of indexation of wage and other contracts.

The model next recognizes that stickiness in nominal wages may keep actual nominal wage growth from adjusting immediately to equilibrium. This is represented by equation 3. In equation 3, the coefficient of adjustment, λ, measures the extent to which the change in nominal wage growth, $W_t - W_{t-1}$, reflects the change that would be required to achieve equilibrium nominal wage growth, $W_t^* - W_{t-1}$. If the coefficient of adjustment equals one, nominal wage growth equals equilibrium wage growth in each period, implying the absence of nominal wage stickiness. A coefficient of adjustment less than one, however, implies that nominal wages are sticky and that a portion of any discrepancy between actual and equilibrium growth in nominal wages may persist for several periods. Nominal wage stickiness is thus characterized as partial adjustment of actual growth in wages to equilibrium growth.

This type of nominal wage stickiness might result, for example, because the U.S. labor market includes a substantial unionized sector characterized by three-year overlapping wage contracts, which are typically not fully indexed to the rate of inflation, as well as a nonunion sector in which long-term wage contracts are less prevalent. Nominal wage growth over a year, therefore, depends both on wages determined by current labor market conditions and current expectations of inflation and on wages specified in long-term contracts negotiated in each of the two preceding years, when labor market conditions and inflationary expectations may have been substantially different. Thus, the rate of adjustment of nominal wage growth to equilibrium reflects both the prevalence and duration of long-term wage contracts.[13]

All these elements of wage behavior are summarized in equation 4, which combines the three previous equations. By incorporating partial adjustment to equilibrium nominal wage growth as well as the determinants of equilibrium nominal wage growth, the equation completely represents wage behavior.

Empirical estimates of the model

Equation 4, representing the adjustment of wages, was estimated for the 1907-80 period and two subperiods.[14] Division of the sample into two subperiods, the second beginning in 1945, allowed a test of whether the growing prevalence of long-term wage contracts after World War II fundamentally changed wage adjustment.

The estimates indicate that, for the period from 1907 to 1944, nominal wage growth adjusted to changes in expected inflation within a year. Thereafter, the adjustment took significantly longer. These results suggest that an important change in wage-setting behavior

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[13] Jeffrey Sachs introduced this interpretation of a partial adjustment model of wage behavior in "Wages, Profits, and Macroeconomic Adjustment: A Comparative Study," *Brookings Papers on Economic Activity,* 1979, pp. 269-332.

[14] Before the estimation can be carried out, a proxy must be found for expected inflation, which is not directly observable. Under the assumption that economic agents know how prices are determined (rational expectations), expected inflation will be an unbiased forecast of actual inflation. Thus, the actual inflation rate may be used as a proxy variable for expected inflation. Because the inflation forecast error may be correlated with other right-hand-side variables, however, an instrumental variables procedure is used for estimating equation 4. Instruments include all predetermined variables in the model, as well as lagged prices and lagged money. Bennett McCallum suggests this technique in "Rational Expectations and the Estimation of Econometric Models: An Alternative Procedure," *International Economic Review,* Vol. 17, No. 2, June 1976, pp. 484-90.

Other specifications of equation 4 were estimated. These specifications experimented with alternative detrending techniques and various labor market tightness proxies. Among the latter were the unemployment rate and the GNP gap. All the specifications tried suggested an increase in nominal wage stickiness after World War II.

did take place in the postwar period. The hypothesis of nominal wage stickiness in the 1907-44 subperiod can be rejected because the estimated value of the coefficient of adjustment, λ, is 0.916 and is insignificantly different from one (Table 4). Nominal wage growth closely shadowed equilibrium wage growth in that period. Data from the early half of the century, therefore, show no influence of

Table 4
REGRESSIONS RESULTS
FOR THE WAGE EQUATION

Dependent Variable = $W_t - W_{t-1}$

Variable	1907-80	1907-44	1945-80
Constant	0.101* (2.781)	−4.940 (11.686)	−15.760 (12.478)
$P_t^e - W_{t-1}$	0.908** (0.087)	0.916** (0.126)	0.592** (0.114)
q_{t-1}	0.063 (0.074)	0.134 (0.122)	−0.073 (0.062)
NRA†	7.587** (3.491)	8.466 (4.924)	— —
WWII‡	7.158 (4.020)	3.749 (9.267)	1.435 (3.348)
NIXON§	1.477 (2.954)	— —	0.862 (1.227)
Food and Energy	−0.655 (0.686)	— —	−0.260 (0.339)
T	0.086 (0.112)	0.340 (0.674)	0.458 (0.345)
Standard Error	3.043	4.248	1.193
Durbin-Watson	2.476	2.674	2.924

*Standard errors are in parentheses
**Significant at .05 level
†NRA Dummy: NRA = 0.4 for 1933, 0.6 for 1934, −0.4 for 1935, −0.6 for 1936, and 0 otherwise
‡WWII Dummy: WWII = 0.5 for 1943, 0.4 for 1944, 0.1 for 1945, −0.6 for 1946, −0.4 for 1947, 0 otherwise
§NIXON Control Dummy: NIXON = 0.5 for 1972, 0.5 for 1973, −0.3 for 1974, −0.7 for 1975, 0 otherwise

long-term contracts on nominal wages. In contrast, for the 1945-80 period, the estimate of the coefficient of partial adjustment of wages falls to 0.592, which is significantly less than one.[15] Thus, empirical estimates support the view that nominal wage stickiness increased in the postwar period. Nominal wage growth in that period did not respond quickly to changes in equilibrium wage growth, possibly because of the growing importance of long-term wage contracts after 1945.

Empirical evidence regarding real wage stickiness is less conclusive. Since nominal wage growth immediately reflected changes in the expected rate of inflation in the 1907-44 subperiod, the estimated equation can be interpreted as explaining real wage growth in that period. Consequently, the small and statistically insignificant coefficient on the labor market tightness variable, q_{t-1}, suggests that labor market conditions did not have an appreciable effect on real wage growth for the 1907-44 subperiod. This indicates that real wages were sticky in the first part of this century. In contrast, the empirical evidence is not conclusive regarding real wage stickiness in the postwar period. The finding that nominal wage growth did not respond immediately to changes in expected inflation after World War II means the estimated equation cannot be taken as explaining real wage growth in the second subperiod. As a result, the statistically insignificant coefficients on both the labor market variable and the food and energy supply shock variable do not necessarily imply real wage stickiness in the postwar period. The results show only that nominal wage growth was independent of these real influences. Thus, it cannot be determined from the empirical evidence presented whether the real wage stickiness from 1907-44 continued in the postwar period.

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[15] Equation 4, however, passes a Chow test for the stability of all the parameters together.

SUMMARY AND CONCLUSION

The degree of nominal wage stickiness increased in the United States after World War II. Because the timing of the increase coincided roughly with the introduction of three-year staggered wage contracts the finding is consistent with the view that long-term contracts cause nominal wage stickiness.

Regardless of the cause, the finding of nominal wage stickiness in the postwar period implies that the cost of disinflation has increased. A slowing of inflation brought on by a reduction in the rate of growth of the money supply causes an increase in real wage growth, which, in turn, slows growth of output and increases unemployment.

Thus, the evidence presented in this article helps to explain the recent U.S. economic experience. The progressively lower inflation accompanying reduced monetary growth since 1979 has been associated with increasing unemployment and sluggish growth in real output. A partial explanation for the adverse economic consequences of disinflationary monetary policy is the slow adjustment of wages to declining inflation.

APPENDIX

This appendix derives aggregate supply curves under nominal and real wage stickiness. It then illustrates the nominal and real consequences of a shift in aggregate demand under the two types of wage behavior. The symbols used in the appendix are not the same as those used in the text.

Figure 1 illustrates the special case of a fixed nominal wage. It is assumed that no contract is renegotiated in the short run. In panel a, labor
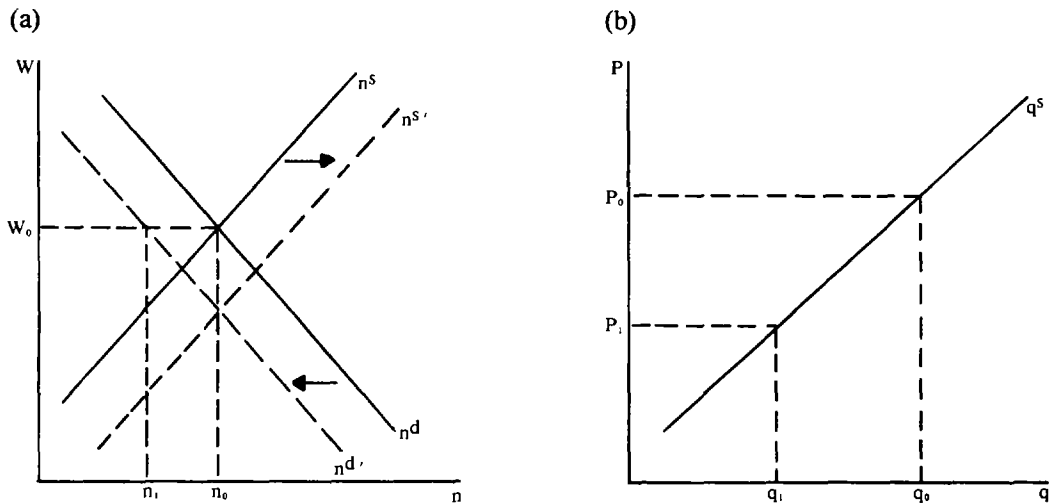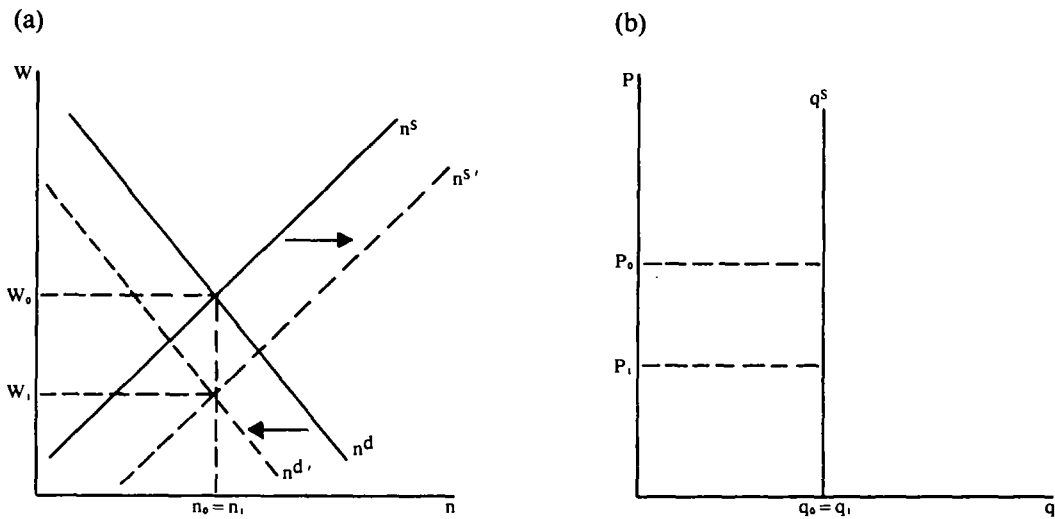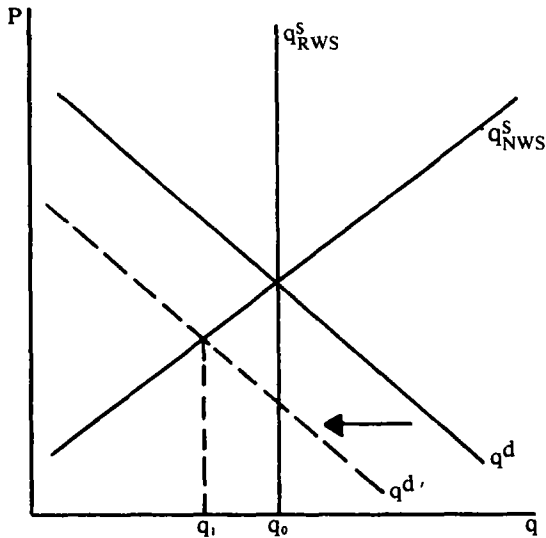
Figure 1

Figure 2

(a)

(b)

supply and demand curves are drawn as functions of the nominal wage rate. The nominal wage rate, w, is on the vertical axis, and labor supply and demand, n^s and n^d, are on the horizontal axis. With prices held constant, an increase in w increases real wages and causes workers to increase the hours they work. At the same time, an increase in real wages increases production costs and causes firms to hire fewer workers. Thus, for a particular price level, labor demand declines and labor supply increases as w increases. Under the assumption that the economy is initially at long-run equilibrium, the wage rate, w_0, and employment, n_0, are determined by the intersection of labor supply and demand. Long-run equilibrium corresponds to a situation where all contracts determine market-clearing wages.

If the price level declines in the short run, as a result of, say, a decline in the money supply, labor demand shifts down and to the left from n^d to $n^{d'}$. At any nominal wage rate, firms

want to hire fewer workers because the associated real wage has increased. Labor supply, on the other hand, shifts down and to the right, from n^s to $n^{s'}$. At any nominal wage rate, workers will supply more labor, because the associated real wage is higher. If w is fixed contractually at w_0, however, the labor market will no longer clear. The new level of employment, n_1, will be determined by the value of labor demanded at the wage, w_0. As long as w_0 remains above the new long-run equilibrium, employment will decline below its full-employment level.

Because declining employment means declining output, the hypothesized fall in the price level generates a reduction in output. Panel b of Figure 1 plots the initial output, q_0, associated with the initial price level, p_0, and plots the lower level of output, q_1, associated with lower prices, p_1. Carrying out the same experiment of altering the price level and tracing out the effect of the change through the labor market to the

Figure 3

supply, nominal wages quickly fall to maintain a constant real wage. As in Figure 1, the increase in real wages shifts n^d and n^s downward, but the nominal wage rate now falls from its initial level, w_0, to a new level, w_1. Because both labor demand and labor supply depend on real wages, which have not changed, employment remains the same. As panel b of Figure 2 indicates, constant employment in the labor market translates into constant output in the product market. The short-run aggregate supply curve, q^s, is vertical, implying that any price level is compatible with employment level, n_0, and output level, q_0.[16]

Figure 3 illustrates the effect of a fall in aggregate demand on prices and real output under different short-run aggregate supply curves. When short-run aggregate supply slopes upward as a result of nominal wage stickiness, as in curve q^s_{NWS}, a downward shift in aggregate demand causes both prices and output to fall. Any policy that shifts aggregate demand from q^d to $q^{d'}$ results in a drop in prices and a short-run output loss of $q_1 - q_0$. Under real wage stickiness and a vertical aggregate supply curve, q^s_{RWS}, however, declining aggregate demand causes only prices to fall. Output remains at its original level of q_0.

product market for all possible prices determines a short-run aggregate supply curve, q^s, that slopes upward. Nominal wage stickiness, therefore, causes a short-term decrease in production when the price level falls.

Panel a of Figure 2 depicts the same labor supply and demand curves as in Figure 1. However, the real wage, $r = w/p$, is now assumed fixed at its initial level, r_0. When prices fall as a result of, say, a decline in the money

16 While the real wage was initially assumed fixed at a level that clears the labor market, this assumption may not, in fact, be true. If the real wage is fixed at a level above long-run equilibrium, chronic unemployment will result. Only by chance would an inflexible real wage lead to full employment in the short run.

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