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THE FEDERAL MINIMUM WAGE, INFLATION, AND EMPLOYMENT

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ABSTRACT

The Federal Minimum Wage, Inflation, and Employment

This study investigates the effects of federal minimum-wage policy on minimum-wage employment, aggregate employment, and average wage rates. The theoretical analysis focuses on the possible effect of the federal minimum wage in constraining wages and employment in a subset of labor markets, on the possible responses of labor suppliers to these constraints, and on the possible role of the policy of presetting the nominal minimum wage in making monetary policy nonneutral. Among the elements of the theoretical framework that are both distinctive and important are the assumptions that both the demands and supplies of labor services in the subset of constrained markets depend on the expected relative minimum wage in the near and distant future, as well as on the current relative minimum wage and on past levels of employment, and that the relevant expectations of both workers and employers about relative minimum wages are "rational."

The main conclusions from this study are the following: (1) Increases in the current or near-future federal minimum wage appear to depress current employment in certain industries that probably have a high proportion of minimum-wage workers and among teenagers, the demographic group that has the highest incidence of minimum-wage workers.

(2) Neither the current nor the near-future federal minimum wage appear to affect either current aggregate employment or average wage rates. This finding suggests that the curtailment of employment opportunities in certain industries and for teenagers that apparently results from minimum-wage policy produces two types of response. First, to some extent affected workers possibly take employment in other industries. Second, to some extent other individuals, who are not teenagers and/or who work in other industries, apparently increase their employment.

(3) Federal minimum wage policy and, specifically, the role of monetary policy in determining the real value of the preset nominal minimum wage do not seem to account even in part for the relation between monetary policy and aggregate employment. Monetary nonneutrality apparently results from other, undetermined, factors.

(4) The effect of proposed indexation of the federal minimum wage on the average over time of employment of minimum-wage workers would depend inversely on the chosen relation between the federal minimum wage and recent-past average wage rates relative to the level and trend of the expected rate of average wage inflation. The effect of proposed indexation on the variability over time of employment of minimum-wage workers would depend directly on the amount of year-to-year variation in expected wage inflation relative to the amount of year-to-year variation in unexpected wage inflation.

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This study investigates the effects of federal minimum-wage policy on minimum-wage employment, aggregate employment, and average wage rates. The theoretical analysis focuses on the possible effect of the federal minimum wage in constraining wages and employment in a subset of labor markets, on the possible responses of labor suppliers to these constraints, and on the possible role of the policy of presetting the nominal minimum wage in making monetary policy nonneutral. The main components of the theoretical framework are stochastic specifications of the demands and supplies for labor services in aggregate as well as in the subset of constrained markets and stochastic specifications of minimum-wage policy and monetary policy. The elements of this theoretical framework that are both distinctive and important are the following:

(1) Both the demands and supplies of labor services in the subset of constrained markets depend on the expected relative minimum wage in the near and distant future, as well as on the current relative minimum wage and on past levels of employment.

(2) The relevant expectations of both workers and employers about relative minimum wages are "rational," which means that these agents behave as if their beliefs about future wages and policy actions are equal to the true mathematical expectations implied by the current and past levels of these variables and by the economy's stochastic structure.

(3) The federal minimum wage depresses employment in the subset of constrained markets, but, because the aggregate labor market clears, the effect of minimum-wage policy on average wages and aggregate employment depends on the effect that inability to obtain employment in the subset of constrained markets has on effective labor supply in unconstrained markets.

(4) The current and near-future federal minimum wage and coverage are currently predetermined, but for the distant future, which in the empirical analysis means after next year, it is rational to expect the minimum wage to be adjusted in line with average wages and for coverage to increase.

(5) Current monetary policy is known, an assumption that contrasts sharply with the assumption of incomplete monetary information made in many macroeconomic models that incorporate rational expectations, and it is rational to predict future monetary policy by an autoregression on current and past monetary policy.

The analysis of this theoretical framework provides a basis for testing of derived hypotheses, for quantification of empirical relations, and for interpretation of empirical results. In what follows, Section 1 sets up the theoretical model, Section 2 solves the model, Section 3 discusses the data used in the empirical analysis, Section 4 reports the results of estimating the wage and employment equations, Section 5 presents an empirical analysis of parameter stability over the business cycle, Section 6 analyzes the possible effects of indexing the minimum wage, and Section 7 discusses conclusions.

1. Analytical Framework

The point of departure for the theoretical analysis is the division of labor markets into one subset in which the minimum wage is an effective constraint on the wage rate and another subset in which the wage rate is free to adjust to equate quantities supplied and demanded. The presumption that since the establishment of the federal minimum wage the subset of constrained markets has not been empty is based on the observation that the wage distribution has continually exhibited a cluster at the level of the federal minimum wage.

The first part of the theoretical analysis specifies the supply and demand functions for labor services in the subset of constrained markets and the proximate determination of employment and excess supply in these markets. This specification involves the determination of behavior in the representative market in the subset of constrained markets and, also, the determination of the size of this subset. One basic assumption is that the ratios of supply and demand in the representative constrained market to aggregate supply and demand depend on the past ratio of employment in that market to aggregate employment, on the current ratio of the average wage rate to the minimum wage, on the expected ratio of the average wage rate to the minimum wage in the near and distant future, and on time trends. The importance of past employment and expected future relative wages reflects mobility costs for supply and technological adjustment costs for demand. Another basic assumption is that the number of constrained markets depends positively on the current ratio of the minimum wage to the average wage and on the current ratio of employment covered by the minimum wage to aggregate employment. For simplicity, this assumption treats this coverage ratio as strictly exogenous to the markets for labor services, even though it actually depends on the chosen distribution of employment and on the size distribution of firms in addition to depending on the legal designation of covered employment.

Incorporating these basic assumptions into log-linear supply and demand functions for the subset of constrained markets yields the structural equations.

$$(1)\qquad N_t^s - L_t^s = n_o^s(N_{t-1}-L_{t-1}) - n_1^s(W_t-\Omega_t) - n_2^s\, E_t(W_{t+1}-\Omega_{t+1}) - n_3^s\, E_t(W_{t+2}-\Omega_{t+2}) + n_4^s\, C_t + n_5^s t + \beta_t \quad \text{and}$$

$$(2)\qquad N_t^d - L_t^d = n_o^d(N_{t-1}-L_{t-1}) + n_1^d(W_t-\Omega_t) + n_2^d\, E_t(W_{t+1}-\Omega_{t+1}) + n_3^d\, E_t(W_{t+2}-\Omega_{t+2}) + n_4^d\, C_t + n_5^d t + \gamma_t,$$

where the variables are defined as follows:

N^s, N^d, and N are the logs of supply, demand, and actual employment, respectively, in the subset of constrained markets.

L^s, L^d, and L are the logs of aggregate supply, demand, and actual employment, respectively.

Each of these quantity variables is measured as a fraction of the working-aged population.

W is the log of the average wage rate.

Ω is the log of the minimum wage rate.

C is the log of the ratio of employment covered by the minimum wage to aggregate employment.

β and γ are random variables with zero means. All random variables in the model are normally distributed and are assumed to be uncorrelated with other random variables.

The subscripts date the variables. The empirical implementation of the model uses a periodicity of one year.

E_t is an operator that designates a currently formed rational expectation.

The analysis assumes that the elasticity coefficients in equations (1) and (2) are constant and are all unambiguously positive with the exception of n_1^d, n_5^d, and n_5^s. The ambiguity with regard to n_1^d arises because an increase in the current ratio of the average wage rate to the minimum wage rate increases demand in the representative constrained market but decreases the number of constrained markets. A plausible quantitative assumption, however, is that the sum of n_1^d and n_1^s is positive. Another plausible quantitative assumption is that n_4^s is larger than n_4^d. This assumption reflects the fact that, when the subset of constrained markets expands because of an increase in coverage, the newly constrained markets add more to supply than to demand. Other quantitative assumptions, which seem to be innocuous simplifications, are that n_0^s

is equal to n_o^d and that n_s^s is equal to n_s^d.

Actual employment in the subset of markets in which the minimum wage is an effective constraint is equal to demand and is less than supply. Thus, we have the structural equations,

(3) $N_t = N_t^d$ and

(4) $X_t = N_t^s - N_t$,

where X is the log of the ratio of supply to employment in the subset of constrained markets. The presumption that since the establishment of the federal minimum wage this subset has not been empty implies that X has been positive over this period.

Note that the variable, X, does not correspond to the measured concept of unemployment. The analysis does not consider the choice that persons who are not employed make between the alternatives of active search for acceptable employment and non-participation in the labor force and, hence, does not attempt to explain measured unemployment. In the empirical implementation of the model, employment is measured alternatively as the fraction of the working-aged population employed and as the number of hours worked per working-aged person.

The second part of the theoretical model specifies the aggregate supply and demand for labor services and the proximate determination of aggregate employment and average wages. The specification of aggregate supply involves a distinction between aggregate notional supply, already represented by L^s, and aggregate effective supply. Aggregate notional supply measures the level of employment that would be accepted by workers if they could obtain employment in the markets that they prefer, given the current and expected future structure of wage rates. The analysis assumes that aggregate notional supply is an exogenous variable that grows at an exogenous rate and is subject to random disturbances. Specifically,

$$(5) \qquad L_t^s = \Lambda + r^s t + \lambda_t$$

where Λ and r^s are constants
and λ is a random variable with zero mean.

In the present context, actual aggregate supply differs from aggregate notional supply because the minimum wage causes demand to be an effective constraint on employment in some markets. Aggregate effective supply equals aggregate notional supply less that part of excess notional supply in the subset of constrained labor markets that does not want alternative employment in the unconstrained labor markets. Specifically, we assume the log-linear form,

$$(6) \qquad L_t^{s'} = L_t^s - \alpha X_t,$$

where $L^{s'}$ is the log of aggregate effective supply and α is the elasticity of the ratio of aggregate effective supply to aggregate notional supply with respect to the ratio of supply to employment in the subset of constrained markets. The plausible range for α would be from zero to $\exp\,(N_t - L_t)$. Extreme values for α of zero or $\exp\,(N_t - L_t)$ would mean that all or none, respectively, of excess supply in the subset of constrained labor markets wants alternative employment in unconstrained labor markets. The present analysis treats α as a constant. The assumption, implicit in equation (6), that current aggregate effective supply does not depend on expected future values of X is based on the presumption that excess supply in the subset of constrained markets mainly affects new or recent entrants to the labor force.

The specification of aggregate demand involves the form of an equation of exchange with employment velocity depending positively on productivity growth, which the econometric analysis represents as a simple time trend, and on the expected rate of wage inflation and also subject to random disturbances. Specifically,

$$(7) \qquad L_t^d = M_t - W_t + V_t \quad \text{with} \quad V_t = r^d t + v(E_t W_{t+1} - W_t) + \phi_t,$$

where M is the log of the money stock,
V is the log of employment velocity,
r^d and v are constant coefficients,
and ϕ is a random variable with zero mean.
We assume that the parameter, v, is small enough to insure that the model has a unique solution.

The final assumption regarding the proximate determination of aggregate employment is that the average wage adjusts to equate aggregate demand with aggregate effective supply, i.e.,

$$(8) \qquad L_t = L_t^d = L_t^{s'}.$$

This aggregate market-clearing assumption means that any excess supply in the subset of constrained markets that wants alternative employment in unconstrained markets can obtain such employment. This assumption also implies, as is verified by the calculations below, that any effect of monetary policy on aggregate employment depends on α being positive. Thus, in this model, the setting of the minimum wage as an effective constraint provides the critical linkage between monetary variables and aggregate employment.

The third part of the theoretical model specifies minimum-wage policy and monetary policy. Minimum-wage policy includes the determination of coverage and the minimum wage in both the short run and the long run. The history of federal minimum-wage legislation suggests the following observations: (a) The law has specified future time paths for the nominal minimum wage and for coverage criteria. (b) The law has been amended at intervals ranging from four to seven years. (c) These amendments have raised the relative minimum wage to between 46.2% and 55.6% of the average manufacturing wage rate. (d) Between amendments, the relative minimum wage has declined to between 39.3% and 47.3% of the average manufacturing wage rate.

It is not clear why the law has specified the minimum wage in nominal terms rather than as a percentage of the average wage, but the above observations suggest, nevertheless, that a long-run policy objective has been to avoid large variation in the relative minimum wage. In light of these observations, the following structural assumptions about the relevant policy variables would seem to be realistic: First, current and near future policy variables--specifically, Ω_t, Ω_{t+1}, C_t, and C_{t+1} are currently predetermined and known exactly.

Second, in the longer run, the presetting of the nominal minimum wage on average equates the expected relative minimum wage to a target level. Specifically, the analysis assumes that

$$(9) \qquad \Omega_{t+i} = E_{t+i-1} W_{t+i} + y + \omega_{t+i} \quad \text{for all} \quad i = 2,3,4, \ldots,$$

where y is the long-run policy target for the log of ratio of the minimum wage to the average wage rate and ω is a random variable with zero mean. In incorporating the rational expectations of the future average wage, this specification attributes the same form of rationality to minimum-wage policy as to labor supply and demand behavior. The present analysis treats the target, y, as a constant. Taking expectations of equation (9) yields

$$E_t(\Omega_{t+i} - E_{t+i-1} W_{t+i}) = y \quad \text{for all} \quad i = 2,3,4, \ldots,$$

which implies

$$(9.1) \quad E_t(\Omega_{t+i} - W_{t+i}) = y \quad \text{for all} \quad i = 2,3,4, \ldots.$$

Third, in the longer run, coverage grows on average at a given target rate. Specifically, the analysis assumes that

(10) $\quad C_{t+i} = C_{t+i-1} + c + \theta_{t+i}$ for all $i = 2,3,4, \ldots,$

where c is the long-run target growth rate for coverage and θ is a random variable with zero mean. Taking expectations of equation (10) yields

(10.1) $\quad E_t C_{t+i} = C_{t+i-i} + c$ for all $i = 2,3,4, \ldots.$

Monetary policy includes the determination of the current money stock and of future increases in the money stock. Observation of the actual formulation and reporting of monetary policy suggests that a reasonable simplification is to treat the current money stock as predetermined and known exactly. With regard to prediction of the future money stock, we considered econometrically a variety of models relating future money growth to current and lagged values of a wide range of variables, including the wage and employment variables introduced in the theoretical model, minimum wage variables, demographic variables, and money growth itself. In models that included lagged money growth, the only other statistically significant coefficient was associated with a demographic variable , the growth in the ratio of working-aged population to total population. This variable, however, did not have a statistically significant effect when introduced into the estimated wage and employment equations discussed below. As a result of these experiments, we choose to model money growth as a parsimoniously specified univariate time series. In particular, we specify an AR(1,1) process,

(11) $\quad m_{t+1} = z + gm_t + \mu_{t+1},$

where m measures money growth, i.e., $m_{t+i} = M_{t+i} - M_{t-1+i}$, z and g are constants, and μ is a random variable with zero mean. An advantage of this model is that it explains a substantial portion of observed money growth with the addition of a minimum number of parameters to the analysis. Taking expectations of equation (11) gives

$$(11.1) \quad E_t m_{t+1} = z + g m_t.$$

Note also that

$$(11.2) \quad E_t M_{t+1} = M_t + E_t m_{t+1}.$$

2. Solution of the Model

Econometric analysis of the model given by equations (1) - (11) requires a solution that expresses the endogenous variables--the average wage rate, aggregate employment, and employment in the subset of constrained markets--as depending on minimum-wage policy, on monetary policy, and on any other relevant predetermined variables. The procedure followed is to obtain such a solution for W_t, and then to use this result to derive solutions for L_t and for $N_t - L_t$.

Combining equations (1) - (8) gives, after some algebraic manipulation, the following expression for W_t as a function of expected future values of the average wage rate, policy variables, and other exogenous variables:

$$\text{(i)} \quad W_t = K\,\{(1-\alpha)[M_t + (r^d - r^s)t + vE_tW_{t+1} + \phi_t - \Lambda - \lambda_t] + \alpha[(n_1^s + n_1^d)\Omega_t - (n_2^s + n_2^d)\;E_t(W_{t+1} - \Omega_{t+1}) - (n_3^s + n_3^d)\;E_t(W_{t+2} - \Omega_{t+2}) + (n_4^s - n_4^d)C_t + \beta_t - \gamma_t]\},$$

where $K = [(1-\alpha)(1+v) + \alpha(n_1^s + n_1^d)]^{-1}$.

Substituting the known values of near-future minimum-wage policy and the expected value of the distant-future relative minimum wage, from equation (9.1), into equation (i) gives

$$\text{(ii)} \quad W_t = K\,\{(1-\alpha)[M_t + (r^d - r^s)t + vE_tW_{t+1} + \phi_t - \Lambda - \lambda_t] + \alpha[(n_1^s + n_1^d)\Omega_t - (n_2^s + n_2^d)(E_tW_{t+1} - \Omega_{t+1}) + (n_3^s + n_3^d)y + (n_4^s - n_4^d)C_t + \beta_t - \gamma_t]\}.$$

In equations (i) and (ii), expectations of future average wage rates affect W_t through two channels. First, the term, vE_tW_{t+1}, reflects the effect of expected inflation on velocity. This term produces a positive effect on W_t. Second, the terms, $(n_2^s + n_2^d)\ E_t(W_{t+1}-\Omega_{t+1})$ and $(n_3^s + n_3^d)\ E_t(W_{t+2}-\Omega_{t+2})$, reflect the effects of expected future relative wages on supply and demand in the subset of constrained markets. If α is positive, these terms produce negative effects on W_t.

To obtain an expression for W_t that we can implement empirically, we use the method of undetermined coefficients to solve out for these effects of expected future average wage rates. To employ this method, we conjecture the following solution for W_t:

$$\text{(iii)} \qquad W_t = \Pi_0 + \Pi_1\Omega_t + \Pi_2(E_tW_{t+1}-\Omega_{t+1}) + \Pi_3C_t + \Pi_4C_{t+1} + \Pi_5M_t + \Pi_6m_t + \Pi_7t + \Pi_8(\phi_t-\lambda_t) + \Pi_9(\beta_t-\gamma_t),$$

where $\Pi_0, \ldots, \Pi_9$ are coefficients to be determined. The objective of solving out for E_tW_{t+1} suggests the inclusion of the variable, m_t, which according to equation (11.1) is a determinant of expected future money growth, as well as the variable, C_{t+1}. The other variables in equation (iii) either are carried over from equation (ii) or a captured in the constant term, Π_0.

Updating equation (iii) gives

$$\text{(iv)} \qquad W_{t+1} = \Pi_0 + \Pi_1\Omega_{t+1} + \Pi_2(E_{t+1}W_{t+2}-\Omega_{t+2}) + \Pi_3C_{t+1} + \Pi_4C_{t+2} + \Pi_5M_{t+1} + \Pi_6m_{t+1} + \Pi_7(t+1) + \Pi_8(\phi_{t+1}-\lambda_{t+1}) + \Pi_9(\beta_{t+1}-\gamma_{t+1}).$$

Taking a rational expectation of equation (iv) and using equations (9.1), (10.1), (11.1), and (11.2) gives

$$\text{(v)} \qquad E_tW_{t+1} = \Pi_0 + \Pi_1\Omega_{t+1} + \Pi_2y + \Pi_3C_{t+1} + \Pi_4(C_{t+1} + c) + \Pi_5(M_t + z + gm_t) + \Pi_6(z + gm_t) + \Pi_7(t+1).$$

This calculation of E_tW_{t+1} sets the current expectations of the future values of the stochastic variables equal to their zero means and relates current and future expectations according to the example, $E_t(E_{t+2}W_{t+2}) = E_tW_{t+2}$.

To obtain the solution for W_t, we substitute into equations (ii) and (iii) the value of E_tW_{t+1} given by equation (v). These substitutions give two equations for W_t that have the same form,

$$\text{(vi)} \qquad W_t = A_0 + A_1\Omega_t + A_2\Omega_{t+1} + A_3C_t + A_4C_{t+1} + A_5M_t + A_6m_t + A_7t + \varepsilon(W)_t.$$

Equating the coefficient of each variable in equation (ii) with the coefficient of the same variable in equation (iii) yields the following system of simultaneous equations:

$$\begin{aligned}
A_0 &= \Pi_0 + \Pi_2[\Pi_0+\Pi_2y + \Pi_4c + (\Pi_5+\Pi_6)z + \Pi_7] \\
&= K\{[\Pi_0+\Pi_2y+\Pi_4c+(\Pi_5+\Pi_6)z+\Pi_7][(1-\alpha)v - \alpha(n_2^s + n_2^d)] \\
&\qquad - (1-\alpha)\Lambda + \alpha(n_3^s+n_3^d)y\}
\end{aligned}$$

$$A_1 = \Pi_1 = K\alpha(n_1^s+n_1^d)$$

$$A_2 = \Pi_2(\Pi_1-1) = K[(1-\alpha)v\Pi_1 + \alpha(n_2^s+n_2^d)(1-\Pi_1)]$$

$$A_3 = \Pi_3 = K\alpha(n_4^s-n_4^d)$$

$$A_4 = \Pi_2(\Pi_3+\Pi_4) + \Pi_4 = K(\Pi_3+\Pi_4)[(1-\alpha)v - \alpha(n_2^s+n_2^d)]$$

$$A_5 = (1+\Pi_2)\Pi_5 = K[(1-\alpha)(1+v\Pi_5) - \alpha(n_2^s+n_2^d)\Pi_5]$$

$$A_6 = \Pi_2(\Pi_5+\Pi_6)g + \Pi_6 = K(\Pi_5+\Pi_6)g[(1-\alpha)v - \alpha(n_2^s+n_2^d)]$$

$$A_7 = (1+\Pi_2)\Pi_7 = K[(1-\alpha)(r^d-r^s+v\Pi_7) - \alpha(n_2^s+n_2^d)\Pi_7]$$

$$\varepsilon(W)_t = \Pi_8(\phi_t - \lambda_t) + \Pi_9(\beta_t - \gamma_t) = K[(1-\alpha)(\phi_t - \lambda_t) + \alpha(\beta_t - \gamma_t)].$$

Solving these equations simultaneously to eliminate $\Pi_0 \ldots \Pi_9$, we obtain the following expressions for the coefficients of equation (vi):

$$A_1 = K\alpha(n_1^s + n_1^d)$$

$$A_2 = K[(1-\alpha)vA_1 + \alpha(n_2^s + n_2^d)(1-A_1)]$$

$$A_3 = K\alpha(n_4^s - n_4^d)$$

$$A_4 = A_3(vA_5 - A_2)(1-A_1)^{-1}$$

$$A_5 = 1 - A_1 - A_2$$

$$A_6 = g(vA_5 - A_2)(1 + v - gv)^{-1}$$

$$A_7 = (r^d - r^s)A_5$$

$$\varepsilon(W)_t = K[(1-\alpha)(\phi_t - \lambda_t) + \alpha(\beta_t - \gamma_t)].$$

The constant term, A_0, is a linear combination of the constants Λ, y, c, and z. If α is positive, A_1 and A_5 are positive but less than unity, A_2 and A_3 are also positive, and the sign of A_4 and A_6 is the same, but is ambiguous. Although both C_{t+1} and m_t have positive effects on E_tW_{t+1}, A_4 and A_6 involve the net result of the positive effect of E_tW_{t+1} on aggregate labor demand, which has a positive effect on W_t, and the positive effect of E_tW_{t+1} on demand and employment in the subset of constrained markets, which has a negative effect on W_t. If α is zero, A_1, A_2, A_3, and A_4 are zero, A_5 equals unity, and A_6 is positive but less than the parameter, v. The sign of A_7 is ambiguous, because this coefficient involves possibly offsetting effects of trends in supply and demand.

To obtain the solution for L_t, we substitute into equation (7) the values of W_t from equation (vi) and $E_t W_{t+1}$ from equation (v) and substitute into equation (8) the value of L_t from equation (7). Referring to the system of simultaneous equations involving the coefficients $A_1 \ldots A_7$ yields the following expression for L_t:

$$\text{(vii)} \quad L_t = B_0 + B_1\Omega_t + B_2\Omega_{t+1} + B_3C_t + B_4C_{t+1} + B_5M_t + B_6m_t + B_7t + \varepsilon(L)_t,$$

where B_0 is a linear combination of the constants, Λ, y, c, and z,

$$B_1 = -(1+v)A_1$$

$$B_2 = -(1+v)A_2 + vA_1$$

$$B_3 = -(1+v)A_3$$

$$B_4 = (1+v)^2A_2A_3(1-A_1)^{-1}$$

$$B_5 = A_1 + (1+v)A_2$$

$$B_6 = (1+v)^2A_2(1 + v - gv)^{-1}$$

$$B_7 = (r^d-r^s)B_5 + r^s$$

$$\varepsilon(L)_t = -(1+v)\varepsilon(W)_t + \phi_t$$

and $\quad v = (A_2+A_6)[A_5 - (1-g)A_6]^{-1}.$

The coefficients, $B_1 \ldots B_7$, are all combinations of the coefficients of equation (vi). With regard to the signs of these coefficients, if α is positive, B_1 and B_3 are negative, B_4, B_5, and B_6 are positive, and B_2 and B_7 are ambiguous. If α is zero, all of these coefficients, except B_7, are zero.

To obtain the solution for $N_t - L_t$, we substitute into equation (2) the values of N_t^d from equation (3), L_t^d from equation (8), W_t from equation (vi), $E_t W_{t+1}$ from equation (v), and $E_t(W_{t+2} - \Omega_{t+2})$ from equation (9.1). Referring to the coefficients $A_1 \ldots A_7$ yields the following expression for $N_t - L_t$:

$$\text{(viii)} \quad N_t - L_t = D_0 + D_1\Omega_t + D_2\Omega_{t+1} + D_3 C_t + D_4 C_{t+1} + D_5 M_t + D_6 m_t + D_7 t + D_8(N_{t-1} - L_{t-1}) + \varepsilon(W)_t,$$

where D_0 is a linear combination of the constants, Ω, y, c, and z,

$$D_1 = n_1^d(A_1 - 1)$$

$$D_2 = n_1^d A_2 + n_2^d(A_1 - 1)$$

$$D_3 = n_1^d A_3 + n_4^d$$

$$D_4 = n_1^d A_4 + n_2^d(1+v)A_3$$

$$D_5 = n_1^d A_5 + n_2^d(1 - A_1)$$

$$D_6 = n_1^d A_6 + n_2^d\, g(A_5 + A_6)$$

$$D_7 = (r^d - r^s)D_5 + n_5^d$$

$$D_8 = n_0^d$$

and $\varepsilon(N)_t = n_1^d \varepsilon(W)_t + \gamma_t$.

With regard to the signs of these coefficients, regardless of the value of α, D_1 is negative, D_3, D_5, and D_8 are positive, and D_7 is ambiguous. If α is positive, D_2, D_4, and D_6 are ambiguous. If α is zero, D_2 is negative, D_4 is zero, and D_6 is positive.

The solutions given by equations (vi), (vii), and (viii) reveal that key properties of the model depend on the amount by which the behavioral parameter, α, exceeds zero. This parameter, introduced in equation (6), measures the effect that excess supply in the subset of markets in which the minimum wage is an effective constraint has on aggregate labor supply. First, the size of α determines the extent to which the minimum wage variables--Ω_t, Ω_{t+1}, C_t, C_{t+1}--have a positive effect on the average wage rate and an associated negative effect on aggregate employment. If α were equal to zero, a value that would mean that all excess supply in the subset of constrained markets takes alternative employment in unconstrained markets, the average wage rate and aggregate employment would be independent of minimum-wage policy. In this case, the sole effect of minimum-wage policy would be to reduce the proportion of aggregate employment that occurs in the subset of markets in which the minimum wage is an effective constraint.

Second, the size of α determines the extent to which the monetary variables--M_t and m_t--are not fully absorbed in the average wage rate and, hence, have a positive effect on aggregate employment. If α were equal to zero, the elasticity of W_t with respect to M_t would be equal to unity, the elasticity of W_t with respect to m_t would be positive but less than the parameter, v, and L_t would be independent of both M_t and m_t. In this case, the sole real effect of expansionary monetary policy would be to increase the proportion of aggregate employment that occurs in the subset of markets in which the minimum wage is an effective constraint. These implications reflect the property of the present model that the setting of the minimum wage as an effective constraint in a subset of markets is the only source of monetary non-neutrality. This property results directly from the assumed equality of aggregate demand and aggregate effective supply, as specified by equation (8).

A related property of equations (vi), (vii), and (viii) is that sum of coefficients, $A_1 + A_2 + A_5$, is unity and that the sums of coefficients, $B_1 + B_2 + B_5$ and $D_1 + D_2 + D_5$ are zero. This property implies that equiproportionate increases in Ω_t, Ω_{t+1}, and M_t would produce an equiproportionate increase in W_t and no changes in L_t and N_t. An important aspect of the econometric results presented below is that the estimated equations for aggregate employment suggest that effects of minimum wage policy and monetary policy do not conform to the relations implied by the model.

3. Data

The econometric analysis requires the development of empirical proxies for the variables in the model that conform as closely as possible to the theoretical constructs. The endogenous variables are the average wage rate, W_t, total employment, L_t, and minimum-wage employment, N_t. As an empirical proxy for W_t we use the time series, calculated by the Bureau of Labor Statistics from its Establishment Data, on average hourly earnings of production or nonsupervisory workers on private payrolls in manufacturing. This series is the most inclusive average wage measure that excludes the effects both of fluctuations in overtime premiums and of changes in the proportion of workers in high-wage and low-wage industries. This series also seems appropriate as the measure of average wages because, as noted above, the minimum wage appears to maintain a fairly stable long-run relation to the average manufacturing wage rate.

As empirical proxies for L_t, we experimented both with the time series on gross hours worked of production and nonsupervisory workers on private nonagricultural payrolls from BLS Establishment Data and with the time series on the total number of civilians employed from BLS Household Data. In estimated employment equations, the effects of the minimum-wage policy variables did not differ substantially between the two proxies for L_t, but equations using the series on number of civilians employed were more successful in controlling for the effects of monetary variables and time trend. This result indicates that the estimates of the effects of minimum-wage policy variables are more reliable for this employment series, and, consequently, the discussion focuses on this proxy for L_t.

As empirical proxies for N_t, we use the time series from BLS Household Data on the number of teenagers employed and time series from BLS Establishment Data for the number of production or nonsupervisory workers on private payrolls in nine different SIC two-digit industries that report relatively low average wages. Teenagers are the demographic group reporting the highest incidence of minimum-wage employment. The nine industries, in which low wages suggest a high incidence of minimum-wage employment, are Lumber and Wood Products, Furniture and Fixtures, Miscellaneous Manufacturing Industries (which include jewelry), Food and Kindred Products, Tobacco Manufactures, Textile Mill Products, Apparel and Other Textile Products, Leather and Leather Products, and Retail Trade. With the exception of Apparel and Other Textile Products and Retail Trade, these industries represent the two-digit industries that reported average wage rates below $1.10 in 1947. We included Apparel and Other Textile Products because the average wage rate in this industry was low relative to the above industries throughout the latter part of the sample period. We included Retail Trade because of the large coverage increases that occurred in retail employment and the relatively low average wage rate in this industry during the latter part of the sample period.

A serious problem with using these data series to measure N_t is that only a fraction of employment of teenagers or employment in these industries is at the minimum wage. This problem would tend to bias downward the estimated elasticity of employment with respect to the minimum wage. If there are intra-industry spillover effects, the bias would be even more severe.

Another problem is that each one of these industries, as well as the demographic group of teenagers, accounts for only a small fraction of total minimum-wage employment. Consequently, it seems appropriate to interpret these data to be measures of employment in individual markets in the subset of constrained markets, rather than total employment in this subset. Thus, we should expect increases in the coverage of the minimum wage to depress employment as measured by these data, although increases in coverage presumably would increase total minimum wage employment.

As indicated above, each of the employment variables is measured as a fraction of the working-aged population. The data on L and N in the regression equations are logs of these ratios.

The exogenous variables in the model are the current and near-future level of the minimum wage, Ω_t and Ω_{t+1}, the current and near-future minimum-wage coverage ratio, C_t and C_{t+1}, and current and lagged values of the money stock. The measure of Ω_t and Ω_{t+1} is the log of the federal minimum wage from published data of the Employment Standards Administration. The measure of C_t and C_{t+1} is the log of the average of the estimated ratios of covered workers to total employment of production and nonsupervising personnel in the following industries: Construction, Transportation and Public Utilities, Wholesale Trade, Retail Trade, and Services. These industries are the ones in which coverage ratios increased during the sample period. The estimated coverage ratios are from unpublished data of the Employment Standards Administration. The measure of the money stock is M1B.

4. Estimation of Wage and Employment Equations

The estimation of equations (vi), (vii), and (viii) uses annual data for the 34-year period, 1947 to 1980. All of the reported estimates are ordinary least-squares regressions.

Average Wage Rate

Our initial estimated equation for the average wage rate is the following:

$$\text{(I)} \quad W_t = \underset{(-14.4)}{-7.0} + \underset{(1.5)}{.05\Omega_t} + \underset{(3.0)}{.13\Omega_{t+1}} - \underset{(-3.1)}{.02C_t} - \underset{(-3.2)}{.02C_{t+1}} + \underset{(15.8)}{1.00M_t} - \underset{(-5.2)}{.87m_t} + \underset{(6.8)}{.02t}$$

$$\rho_1 = \underset{(5.4)}{.80} \qquad \rho_2 = \underset{(-3.2)}{-.50} \qquad R^2 = .99 \qquad DW = 1.8$$

Hypothesis: $A_1 = A_2 = 0$, $F^2_{20} = 0.3$, $Pr(F > F^2_{20}) = .77$

Hypothesis: $A_1 + A_2 + A_5 = 1$, $F^1_{20} = 4.0$, $Pr(F > F^1_{20}) = .06$

The numbers in parentheses under the coefficients are t-statistics. Equation (I) uses a second-order Cochrane-Orcutt procedure to reduce serial correlation in the residuals. The reported statistics, ρ_1 and ρ_2, are the estimated values of the autoregressive parameters. This procedure and the inclusion among the independent variables of m_t and Ω_{t+1} use up four data points, with the result that equation I involves 30 remaining observations of W_t from 1950 to 1979. The reported statistics, F^2_{20} and F^1_{20}, are the values of F-tests for the following indicated null hypotheses: (1) $A_1 = A_2 = 0$, which means that both Ω_t and Ω_{t+1} have no effect on W_t. (2) $A_1 + A_2 + A_5 = 1$, which means that an equiproportionate increase in Ω_t, Ω_{t+1}, and M_t produces an equiproportionate increase in W_t. The numbers, $Pr(F > F^2_{20})$ and $Pr(F > F^1_{20})$, are the probabilities of finding F-values greater than the computed F-values under the null hypothesis.

Equation I gives a confusing impression of the effects of the current minimum wage and the near-future minimum wage on the average wage rate. The coefficients and associated t-statistics on Ω_t and, especially, on Ω_{t+1} suggest that these minimum-wage-policy variables raise W_t. However, the result that $\Pr(F > F^2_{18})$ equals .77 indicates that according to this F-test it is highly likely that the sample data were drawn from a population in which W_t depends on neither Ω_t and Ω_{t+1}.

Another troublesome aspect of equation (I) is the significantly negative coefficient on C_t, a result that is clearly inconsistent both with the theoretical model formulated above and with any obvious and theoretically plausible alternative to that model. The significantly negative coefficient on C_{t+1} is also problematical, but it could mean that the positive effect of the expected future average wage rate on current demand and employment in the subset of constrained markets, which has a negative effect on W_t, outweighs the positive effect of the expected future average wage rate on aggregate labor demand.

It is possible that the average manufacturing wage rate as a proxy for W_t does not capture adequately changes in average wage rates in other industries, such as Retail Trade, in which coverage ratios increased greatly over the sample period. Because of such misspecification of the dependent variable, the negative coefficients on the coverage variables in equation I could be measuring the effect on the average manufacturing wage of increases in labor supply in manufacturing induced by increased coverage in other industries. The evidence, however, does not support this possibility. In particular, we re-estimated the equation for the average wage rate using as the dependent variable average hourly earnings of production or nonsupervising workers on total private nonagricultural payrolls, rather than only private manufacturing payrolls, and obtained results substantially the same as the results reported in equation I.

The most likely possibilities seem to be that the troublesome results for the coverage variable reflect either the fact that there were only three large changes in the time series for C_t during the sample period or the crudeness of this time series as a measure of the coverage of the minimum wage. For example, these data make no apparent attempt to allow for the avoidance and evasion of the minimum wage, practices that some studies suggest may be widespread.

Because of these problems, we estimated the following alternative equation for the average wage rate omitting the variables, C_t and C_{t+1}:

$$\text{(II)} \quad W_t = \underset{(-5.6)}{-5.9} - \underset{(-0.2)}{.00\Omega_t} - \underset{(-0.0)}{.00\Omega_{t+1}} + \underset{(5.7)}{.89M_t} - \underset{(-4.6)}{.62m_t} + \underset{(5.2)}{.03t}$$

$$\rho_1 = \underset{(8.8)}{1.40} \quad \rho_2 = \underset{(-3.8)}{-.58} \quad R^2 = .99 \quad DW = 2.0$$

$$\text{Hypothesis:} \quad A_1 = A_2 = 0, \quad F^2_{22} = 0.0, \ \Pr(F > F^2_{22}) = .99$$

$$\text{Hypothesis:} \quad A_1 + A_2 + A_5 = 1, F^1_{22} = 3.9, \ \Pr(F > F^1_{20}) = .06$$

Equation II, like equation I, uses remaining observations on W_t from 1950 to 1979.

Equation II seems to clear up the ambiguity regarding the effects of minimum wage policy on average wages. Both the t-statistics on Ω_t and Ω_{t+1} and the F-test for $A_1 = A_2 = 0$ indicate that we cannot reject the hypothesis that neither Ω_t nor Ω_{t+1} affect W_t. This result implies, in turn, that we cannot reject the hypothesis that α, the parameter that measures the effect of excess supply in the subset of constrained markets on aggregate employment, is not positive.

Equation II indicates that the current money stock has a significantly positive effect on the average wage rate. Although the estimated standard error associated with this coefficient suggests that we cannot reject the hypothesis that this coefficient equals unity, the relevant F-test indicates that the probability that the sample data were drawn from a population in which the effects of Ω_t, Ω_{t+1}, and M_t sum to unity is only six percent. This result is inconsistent with the theoretical model specified above. Together with the implication that α is not positive, it suggests that monetary policy is not neutral, but that minimum wage policy and the role of monetary policy in determining the real value of the preset nominal minimum wage do not account even in part for this nonneutrality.

Equation II indicates further that current monetary growth has a significantly negative effect on the average wage rate. This result is also inconsistent with the theoretical model specified above, and it provides an additional reason for rejecting the implication of the model that an apparent value of α close to zero produces monetary neutrality.

Aggregate Employment

Our estimated equations for aggregate employment are the following:

$$\text{(III)}\quad \begin{array}{llllllll} L_t = & -1.4 & + .02\Omega_t & + .00\Omega_{t+1} & + .00C_t & + .01C_{t+1} & + .12M_t \\ & (-5.5) & (0.9) & (0.0) & (0.2) & (1.4) & (3.5) \\ & & + .07m_t & - .004t \\ & & (0.4) & (-2.9) \end{array}$$

$R^2 = .77 \quad \text{D.W.} = 1.5$

Hypothesis: $B_1 = B_2 = 0, \quad F^2_{24} = 0.05 \quad Pr(F > F^2_{24}) = .59$

Hypothesis: $B_1 + B_2 + B_5 = 0, \quad F^1_{24} = 13.9 \quad Pr(F > F^2_{24}) = .001$

$$\text{(IV)}\quad \begin{array}{lllllll} L_t = & -1.3 & + .03\Omega_t & + .03\Omega_{t+1} & + .11M_t & + .18m_t & - .004t \\ & (-4.6) & (1.1) & (0.9) & (2.8) & (1.1) & (-2.6) \end{array}$$

$$\begin{array}{ll} \rho_1 = .34 & \rho_2 = -.25 \\ (1.7) & (-1.6) \end{array} \qquad R^2 = .80 \qquad \text{D.W.} = 1.9$$

Hypothesis: $B_1 = B_2 = 0, \quad F^2_{22} = .92 \quad Pr(F > F^2_{22}) = .41$

Hypothesis: $B_1 + B_2 + B_5 = 0, \quad F^1_{22} = 14.2 \quad Pr(F > F^1_{22}) = .001$

The proxy for L_t in both of these equations is total civilians employed. Equation III includes the coverage variables, whereas equation IV omits these variables. After examining preliminary regressions for serial correlation in the residuals, we used a second-order Cochrane-Orcutt procedure to obtain the final form of equation IV. Equation III involves observations of L_t from 1948 to 1979, whereas equation IV, because of the Cochrane-Orcutt procedure, involves observations of L_t from 1950 to 1979. The F-tests reported below each equation relate to the null hypotheses that $B_1 = B_2 = 0$, which means that both Ω_t and Ω_{t+1} have no effect on L_t, and that $B_1 + B_2 + B_5 = 0$, which means that an equiproportionate increase in Ω_t, Ω_{t+1}, and M_t has no effect on L_t. Next to each computed F-value is the probability of observing an F-value greater than the computed F-value under the null hypotheses.

The coefficients on the coverage variables in equation III again are difficult to interpret. The coefficient on C_t is close to zero and the coefficient on C_{t+1}, although not highly significant, is positive, a result that makes no apparent sense. As in the case of the equations for the average wage rate, the omission of the coverage variables in equation IV makes it useful to employ a second-order Cochrane-Orcutt procedure, but seems otherwise inconsequential.

The most interesting aspect of the equations III and IV is that in no case, using either t-statistics or F-tests, can we reject the hypothesis that neither Ω_t nor Ω_{t+1} affect L_t. For example, the relevant F-test for equation IV indicates that the probability that the sample data were drawn from a population in which the effects of Ω_t and Ω_{t+1} are both zero is 41 percent. This result is consistent with the findings of no significant effect of Ω_t and Ω_{t+1} on W_t in equation II. The implication again is that we cannot reject the hypothesis that α is not positive. Excess supply in the subset of constrained is apparently not reflected as a decline in aggregate employment.

Each of the aggregate employment equations also indicates that the current money stock has a positive effect on aggregate employment, and that this effect is statistically significant using either t-statistics or F-tests. For example, the relevant F-tests for equations III and IV both indicate that the probability that the sample data were drawn from a population in which the effects of Ω_t, Ω_{t+1}, and M_t sum to zero is only one-tenth of one percent. This result is consistent with the findings for the effects of M_t on W_t in equation II. The implication again is that monetary policy is not neutral, but that, because α does not seem to be positive, this nonneutrality does not result from minimum-wage policy. The positive effects of m_t on L_t, although not statistically significant, are consistent with the negative effect of m_t on W_t found in equation II and with the above conclusions about monetary nonneutrality.

We tested both the aggregate wage employment and the aggregate employment equation extensively for the effects of introducing additional independent variables, such as federal expenditures, long-term and short-term interest rates, the ratio of working-aged to total population, and measures of monetary velocity. In all cases, the coefficients of these additional variables were not significantly different from zero and the introduction of these additional variables did not affect substantially the coefficients of the variables included in equations I-IV.

Minimum Wage Employment

Table 1 reports the estimated equations for the industry and demographic proxies for minimum-wage employment. The columns headed by each independent variable report the estimated coefficients of this variable and the t-statistics in parentheses. We examined preliminary regressions for serial correlation in the residuals using χ^2-tests of the null hypotheses that the residuals are serially independent. Where necessary, we used a first-order or a second-order Cochrane-Orcutt procedure to obtain the final estimated equations. The columns headed by ρ_1 and ρ_2 report the estimated values of the autoregressive parameters used to correct for serial correlation in the residuals. The columns headed by $D_1 = D_2 = 0$, $D_1 + D_2 = 0$, and $D_3 + D_4 = 0$ report the values of F-tests for these null hypothesis and, in parentheses, the probabilities of finding F-values greater than the computed F-values under the null hypotheses.

The regressions reported in Table 1 indicate that either the current minimum wage or the near-future minimum wage have a significantly negative effect on employment in seven of these nine industries. Based on computed t-statistics less than -1.4, which corresponds to significance at the ten percent level, we can conclude that an increase in the current minimum wage depresses current employment in Lumber and Wood Products, in Miscellaneous Manufacturing Industries, in Tobacco Manufactures, in Textile Mill Products, and in Apparel and Other Textile Products, and that an increase in the near-future minimum wage depresses current employment in Furniture and Fixtures and in Retail Trade. The F-tests for the joint importance of Ω_t and Ω_{t+1} and for the total effects of Ω_t and Ω_{t+1} indicate that depressing effects on employment are significant at the six percent level in five industries: Lumber and Wood Products, Miscellaneous Manufacturing, Textile Mill Products, Apparel and Other Textile Products, and Retail Trade. In these five industries, the sums of the estimated coefficients on Ω_t and Ω_{t+1} range from -.03 to -.19. It is worth noting that in no industry did the F-tests indicate a significantly positive effect of Ω_t and Ω_{t+1} on employment.

For teenagers, the estimated coefficients on Ω_t and Ω_{t+1} are negative, and the computed t-statistic indicates that the coefficient of Ω_{t+1} is significantly different from zero at the five percent level. The F-test for the total effect of Ω_t and Ω_{t+1} on Teenage Employment indicates that this effect is significant at the one percent level.

The sum of these estimated coefficients on Ω_t and Ω_{t+1} is -.15. Over the sample period, the average number of teenagers employed was about 5.2 million. The estimated coefficients, thus, imply an estimated average decrease in teenage employment of about 78,000 persons in response to a ten percent increase in both the current and near-future minimum wage. The estimated standard errors of the coefficients indicate, of course, that this point estimate falls within a substantial confidence interval.

Table 1

	Constant	Ω_t	Ω_{t+1}	C_t	C_{t+1}	M_t	m_t	t	$N_{t-1}-L_{t-1}$	ρ_1	ρ_2	R^2	$D_1=D_2=0$	$D_1+D_2=0$	$D_3+D_4=0$
Lumber and	-7.1	-.21	.02	-.00	-.01	.50	2.5	-.02	.20	-.49	-.43	.99	5.4	9.6	2.1
Wood Products	(-6.5)	(-3.2)	(0.3)	(-0.1)	(-0.9)	(5.1)	(6.7)	(-5.3)	(1.8)	(-3.2)	(-3.0)		(.01)	(.01)	(.16)
Furniture and	-1.8	.03	-.12	-.00	.03	-.33	1.6	.00	.23			.71	1.5	1.7	0.7
Fixtures	(-1.9)	(0.4)	(-1.7)	(-0.2)	(1.4)	(-2.6)	(3.0)	(1.0)	(1.4)				(.25)	(.21)	(.42)
Miscellaneous	-1.3	-.11	-.01	-.02	.01	-.06	1.4	.00	.68	-.88	-.55	.98	6.9	10.7	4.0
Manufacturing	(-2.8)	(-2.7)	(-0.2)	(-2.7)	(0.7)	(-1.6)	(6.0)	(0.8)	(7.2)	(-5.9)	(-3.7)		(.01)	(.003)	(.07)
Industries															
Food and	-.84	.03	.00	.00	.01	-.04	-.13	-.01	.69			.99	1.5	2.2	4.6
Kindred Products	(-1.5)	(1.5)	(0.1)	(0.0)	(1.7)	(-1.2)	(-0.9)	(-2.6)	(4.5)				(.24)	(.15)	(.04)
Tobacco	-4.4	-.08	-.08	.02	-.02	-.19	-.37	-.02	.10	.45		.99	1.1	2.3	1.2
Manufactures	(-3.3)	(-1.4)	(-1.2)	(1.3)	(-1.7)	(-1.2)	(-0.9)	(-2.9)	(0.5)	(2.8)			(.35)	(.14)	(.27)
Textile Mill	-.09	-.15	.05	-.00	.02	-.14	1.1	-.00	.73	-.74	-.50	.99	4.8	3.9	1.9
Products	(-0.1)	(-3.2)	(0.9)	(-0.2)	(1.7)	(-2.8)	(3.9)	(-0.7)	(7.1)	(-5.0)	(-3.4)		(.02)	(.06)	(.18)
Apparel and Other Textile	.68	-.05	-.04	-.01	.01	-.36	1.0	.005	.56	-.79	-.62	.99	5.4	10.8	0.5
Products	(3.5)	(-1.9)	(-1.3)	(-2.9)	(2.1)	(-6.7)	(6.2)	(5.2)	(8.4)	(-4.6)	(-3.6)		(.01)	(.003)	(.48)
Leather and	.25	.05	-.01	-.03	.01	-.21	.38	-.00	.77	-.34		.99	0.9	0.4	1.4
Leather Products	(0.4)	(0.9)	(-0.1)	(-2.1)	(1.0)	(-1.1)	(1.1)	(-1.5)	(5.3)	(-2.0)			(.41)	(.52)	(.25)
Retail	-1.1	.00	-.03	.00	.00	.06	.15	.002	.68			.99	3.1	4.2	2.0
Trade	(-2.4)	(0.2)	(-2.2)	(0.2)	(1.3)	(1.9)	(1.5)	(2.2)	(5.7)				(.06)	(.05)	(.17)
Teenage	-.31	-.05	-.10	-.04	.03	-.05	.78	.01	.82			.99	4.6	8.4	0.8
Employment	(-0.5)	(-0.9)	(-2.1)	(-2.8)	(2.0)	(-0.7)	(2.1)	(4.0)	(6.8)				(.02)	(.01)	(.37)

The results reported in Table 1 for the effects on employment of current or near-future minimum wage coverage are less clear. We estimated significantly negative coefficients on C_t for Miscellaneous Manufacturing Industries, Apparel and Other Textile Products, Leather and Leather Products, and Teenage Employment and a significantly negative coefficient on C_{t+1} for Tobacco Manufactures, but we estimated significantly positive coefficients on C_{t+1} for Furniture and Fixtures, Food and Kindred Products, Textile Mill Products, Apparel and Other Textile Products, and Teenage Employment. The F-test for the total effect of C_t and C_{t+1} indicates that the sum of the coefficients is significantly negative in Miscellaneous Manufacturing and significantly positive in Food and Kindred Products, As indicated above, the data on coverage are crude and these effects on employment proxies that account for only a fraction of minimum-wage employment are especially difficult to interpret.

The curtailment of employment opportunities in certain industries and for teenagers that apparently results from the federal minimum wage is especially interesting in light of the findings from equations III and IV that the current and near-future minimum wage do not affect current aggregate employment. Taken together, the results from these equations and from Table 1 suggest that the effects of the federal minimum wage indicated in Table 1 produce two types of responses. First, to some extent, affected workers possibly take alternative employment in other industries. Second, to some extent, other individuals, who are not teenagers and/or who work in other industries, apparently increase their employment.

Previous discussions of the effects of minimum wages have focussed mainly on the first type of response, the shift of employment from the subset of constrained markets to the subset of unconstrained markets. The literature has given less attention to the second type of response, the replacement in the workforce of individuals for whom the minimum wage is an effective constraint to employment by other individuals for whom the minimum wage is not a constraint to employment. The empirical result that the minimum wage does not seem to affect the average wage rate implies that the decision by the replacers to take employment does not result from a shift in the demand for their services. Rather, this replacement phenomenon involves a shift in the effective supply of labor services by the replacers, which is reflected in the inferred low value of the parameter, α. The replacers are individuals who would not choose to take employment if the minimum wage were not preventing employment of other individuals.

Given the finding that teenagers experience a significant amount of displacement, and assuming that to a large extent effective labor supply decisions are made with family or household income in mind, it seems reasonable to conjecture that many of these replacers are adult women. Although they have employable skills, these adult women would prefer to be housepersons, reflecting their comparative advantage, but the inability of teenage family members to obtain employment and provide family income prompts them to take employment.

To test this conjecture empirically, we estimated a regression equation for employment of adult women that corresponds to the regression equation for teenage employment:

$$G_t - L_t = H_0 + H_1\Omega_t + H_2\Omega_{t+1} + H_3C_t + H_4C_{t+1} + H_5M_t$$
$$+ H_6m_t + H_7t + H_8(G_{t-1}-L_{t-1}) + \varepsilon(G)_t.$$

The new dependent variable, denoted by G_t, is the number of employed women aged 25 years or older from BLS Household Data.

The estimated equation for employment of adult women is the following:

$$\text{(V)} \qquad G_t - L_t = \underset{(-2.0)}{-.31} + \underset{(0.3)}{.01\Omega_t} + \underset{(3.0)}{.06\Omega_{t+1}} - \underset{(-0.1)}{.00C_t} - \underset{(-0.0)}{.00C_{t+1}}$$

$$+ \underset{(0.9)}{.02M_t} - \underset{(-0.2)}{.02m_t} - \underset{(-2.2)}{.002t} + \underset{(13.4)}{.84(G_{t-1}-L_{t-1})}$$

$R^2 = .99$

Hypothesis: $H_1 = H_2 = 0$, $F^2_{21} = 8.2$ $Pr(F > F^2_{21}) = .003$

Hypothesis: $H_1 + H_2 = 0$, $F^1_{21} = 13.1$ $Pr(F > F^1_{21}) = .002$

The data series for G_t extends from 1948 to 1980, so that equation V uses observations on the dependent variable from 1949 to 1979. We examined equation V for serial correlation using a χ^2-test that did not reject the null hypothesis that the residuals are serially independent. The F-tests reported below each equation relate to the indicated null hypothesis with the probabilities of finding F-values greater than the computed F-values as indicated.

Equation V indicates that both Ω_t and Ω_{t+1} have a positive effect on employment of adult women. The estimated t-statistics indicate that the effect of Ω_{t+1} is significantly different from zero. The F-tests imply rejection of both null hypotheses of no effect of Ω_t and Ω_{t+1} individually and in sum at less than the one percent level. The sum of the coefficients on Ω_t and Ω_{t+1} is .07. Over the sample period, the average number of adult women employed was about 19.9 million. The estimated coefficients, thus, imply an estimated average increase of employment of adult women of about 139,000 persons in response to a ten percent increase in both the current and near-future minimum wage. At least on the basis of these rough point estimates, the increased employment of adult women easily offsets the effect on total employment of the decreased employment of teenagers.

5. Parameter Stability over the Business Cycle

The model developed in Sections 1 and 2 expresses the relations between aggregate employment and minimum wage policy and between average wages and minimum wage policy as functions of the relevant supply and demand elasticities and the parameter, α. The hypothesis that these underlying parameters are constant and the fact that the reduced form coefficients relating L_t and W_t to Ω_t, Ω_{t+1}, C_t and C_{t+1} do not depend on monetary variables imply that these estimated relations are independent of the business cycle. We can test this implication of the theory empirically by estimating the change in the coefficients, A_1, A_2, A_3, A_4, B_1, B_2, B_3, and B_4, over the business cycle.

The test method is to re-estimate equations I-IV for average wages and aggregate employment including an additional variable that takes on the value of the minimum wage policy variable during periods of average and above average employment and is zero otherwise. The estimated coefficient associated with this variable measures the change in the relevant minimum wage policy variable coefficient from periods of low aggregate employment to periods of high aggregate employment. We define periods of low employment to be those designated by the National Bureau of Economic Research as recessions. On an annual basis these recessions covered 1953-1954, 1957-58, 1960-61, 1969-70, and 1974-75.

Table 2 reports the estimated movement in the coefficients of Ω_t, Ω_{t+1}, C_t and C_{t+1} that is associated with the business cycle.

Table 2

	$A_1^H - A_1^L$	$A_2^H - A_2^L$	$A_3^H - A_3^L$	$A_4^H - A_4^L$
Equation I'	.010	.010	.002	.003
	(1.0)	(1.0)	(1.0)	(1.0)
Equation II'	.002	.002		
	(0.3)	(0.2)		

	$B_1^H - B_1^L$	$B_2^H - B_2^L$	$B_3^H - B_3^L$	$B_4^H - B_4^L$
Equation III'	.002	.003	-.003	-.003
	(0.2)	(0.3)	(-1.1)	(-1.1)
Equation IV'	.000	.001		
	(0.0)	(0.1)		

Equation I' corresponds to equation I, and so forth. The number reported under the heading $A_1^H - A_1^L$, etc., measures the difference between the size of the coefficient in periods of high employment and the size of the coefficient during recessions as estimated in the equation listed on the left-hand side of the table. In parenthesis below the estimated difference is the associated t-statistic.

These t-statistics indicate that there are no statistically significant shifts in these coefficients over the business cycle. This evidence of parameter stability gives additional credence to the conclusions drawn above about the insignificant effects of minimum-wage policy on average wages and aggregate employment.

6. Indexation of the Minimum Wage

This section considers the possible effects of reforming minimum-wage policy to incorporate indexation of the nominal minimum wage. A feasible indexation scheme would involve periodic adjustment in the minimum wage in accord with a wage or price index. The specification of an indexation scheme would require designation of the periodicity of adjustment, of the relevant index, and of the factor of indexation that determines the quantitative relation between the minimum wage and the designated index. As a relevant example, the Congress has recently considered an indexation scheme that would specify annual adjustments of the minimum wage to make it a fixed fraction of the average wage rate of the preceding year. The theoretical model developed above together with the results of our empirical implementation of this model enable us to analyze the factors that would determine how, if at all, the effects of a minimum-wage policy involving such an indexation scheme would differ from the effects of the existing minimum wage policy. Although the framework developed in this study does not enable us to analyze explicitly the alternative policy of indexing the minimum wage to average prices, the choice between a wage index and a price index would be consequential only if the behavior of average wages differed substantially over time from the behavior of average prices.

From the econometric analysis reported above, we concluded that the data do not reject the hypotheses that the parameter, α, is zero. The main implication of this hypothesis is that the form of minimum-wage policy does not affect either average wage rates or aggregate employment and that, in the context of the present study, the only important effect of minimum-wage policy is on the amount of employment in the subset of markets in which the minimum wage is an effective constraint. Consequently, in considering the possible effects of indexing the minimum wage, we focus on the amount of employment in the subset of constrained markets relative to aggregate employment, taking actual and expected changes in average wages as well as in aggregate employment to be givens determined by other factors. Combining equations (2) and (3) implies that this fraction representing relative employment in the subset of constrained markets is given by

$$(a)\qquad N_t - L_t = n_0^d(N_{t-1} - L_{t-1}) + n_1^d(W_t - \Omega_t) + n_2^d E_t(W_{t+1} - \Omega_{t+1}) + n_3^d E_t(W_{t+2} - \Omega_{t+2}) + n_4^d C_t + n_5^d t + \gamma_t.$$

Based on the history of federal minimum-wage legislation, the analysis developed above represents the existing form of policy for determining the level of the minimum wage in the following way: First, the current and near future minimum wage, Ω_t and Ω_{t+1}, are currently predetermined. Second, in the longer run, amendments to the Fair Labor Standards Act preset the nominal minimum wage to equate on average the expected relative minimum wage to a target level, y, which we treat as a constant. The expectations on which this policy is based are "rational," but the carrying out of policy is subject to a random error, ω.

The variable, y, does not represent the level at which the relative minimum wage is set when the Fair Labor Standards Act is amended. Rather, it is the mean over time of the level of the nominal minimum wage relative to expectations of the average wage. It also turns out to be, as we see in equation (c) below, the expected long-run value of the minimum wage relative to the average wage. The random error, ω, results from stochastic factors that affect either the timing of amendments to the law or the level at which the minimum wage is set when the law is amended.

This representation of minimum-wage policy implies, from equation (9), that

$$(b)\qquad \Omega_{t+2} = E_{t+1}W_{t+2} + y + \omega_{t+2}.$$

Taking expectations of equation (b) yields

(c) $\quad E_t(W_{t+2}-\Omega_{t+2}) = -y.$

Backdating equation (b) yields

(d) $\quad \Omega_{t+1} = E_t W_{t+1} + y + \omega_{t+1}$ and

(e) $\quad \Omega_t = E_{t-1} W_t + y + \omega_t.$

An implicit assumption involved in the use of the expectations operator, E, in equations (a-e) is that employers and policymakers have the same (rational) expectations about average wages.

Substituting equations (b-e) into equation (a) yields the following solution for relative employment in the subset of constrained markets in terms of minimum-wage policy variables, unexpected wage inflation, and other variables:

(f)
$$N_t-L_t = -(n_1^d + n_2^d + n_3^d)y - n_1^d\omega_t + n_1^d(w_t - E_{t-1}w_t) + n_4^dC_t + n_5^dt + n_0^d(N_{t-1}-L_{t-1}) + \gamma_t,$$

where $w_t \equiv W_t - W_{t-1}$ measures current wage inflation and $E_{t-1}w_t \equiv E_{t-1}W_t - W_{t-1}$ measures last year's expectation of this year's wage inflation. For present purposes, the important implications of equation (f) are that relative employment in the subset of constrained markets is negatively related to the target level for the relative minimum wage, given by y, and to the amount, given by ω_t, by which the setting of the current relative minimum wage exceeds this target level, and is positively related to the amount, given by $w_t - E_{t-1}w_t$, by which current wage inflation exceeds last year's expectation.

This difference measures the amount by which unexpected inflation erodes the relative minimum wage.

The indexation scheme considered here would differ in two important ways from existing minimum-wage policy: First, with indexation, adjustment of the minimum wage would be an automatic response to changes in average wages rather than depending on a revision of expectations about average wages on the part of policymakers. Second, with indexation, the setting of the minimum wage would be a backward looking reaction to last year's average wages rather than a forward looking anticipation of next year's average wages.

We can specify this indexation scheme as

$$\text{(g)} \qquad \Omega_t = W_{t-1} + x,$$

where x is the factor of indexation. Updating equation (g) and taking expectations yields

$$\text{(h)} \qquad E_t\Omega_{t+1} = W_t + x \quad \text{and}$$

$$\text{(i)} \qquad E_t\Omega_{t+2} = E_tW_{t+1} + x.$$

Substituting equations (g-i) into equation (a) yields the following solution for relative employment in the subset of constrained markets in terms of the revised minimum-wage policy variables, expected wage inflation for the near and distant future, and other variables:

$$\begin{aligned}\text{(j)} \qquad N_t - L_t = & -(n_1^d + n_2^d + n_3^d)(x - E_tw_{t+2}) + n_1^d(w_t - E_tw_{t+2}) \\ & + n_2^d(E_tw_{t+1} - E_tw_{t+2}) + n_4^dC_t + n_5^dt \\ & + n_0^d(N_{t-1} - L_{t-1}) + \gamma_t,\end{aligned}$$

where $E_tw_{t+2} = E_tW_{t+2} - E_tW_{t+1}$ measures currently expected long-run wage inflation and $E_tw_{t+1} = E_tW_{t+1} - W_t$ measures currently expected near future wage inflation. For present purposes, the important implications of equation (j) are that relative employment in the subset of constrained markets is negatively related to the factor of indexation minus currently expected long-run wage inflation, a difference given by $x - E_t w_{t+2}$, and is positively related to the amount, given by $w_t - E_t w_{t+2}$, by which current wage inflation exceeds expected long-run wage inflation and to the amount, given by $E_t w_{t+1} - E_t w_{t+2}$, by which expected near-future wage inflation exceeds expected long-run wage inflation. Expected long-run wage inflation plays a critical role in this case because it determines the extent of the expected future erosion of the relative minimum wage that results from the backward-looking nature of the indexation scheme.

Comparison of equations (f) and (j) indicates that with an indexed minimum wage the selection of the factor of indexation, x, relative to the expected long-run rate of wage inflation, $E_t w_{t+2}$, would have the same effect on relative employment in the subset of constrained markets that the selection of the relative minimum-wage target, y, has under present policy. However, the nature of the factors that either erode or reinforce the effects of these key policy variables differs drastically in the two cases. Under present policy, which we characterize as forward looking, these other relevant factors include the unexpected part of the current rate of wage inflation and randomness in the carrying out of policy. In any particular year, these factors can have a significant effect, but, given that expectations and policy execution are accurate on average, the average effect of these factors over time is zero. In the long run, the effect of present minimum-wage policy depends on the level of y.

With an indexed minimum wage, which by its nature would be backward looking, the other relevant factors would include deviations of the current and expected near-future rates of wage inflation from the expected long-run rate of wage inflation. In any particular year, these deviations could have a significant effect. Moreover, if, for example, the expected rate of wage inflation were trending upward, these deviations would be chronically negative, and their effect would be to depress relative employment further in the subset of constrained markets. If, however, the expected rate of wage inflation had no trend, the average effect of these deviations over time would be zero. In this case, the long-run effect of an indexed minimum wage would depend only on the level of the factor of indexation relative to expected long-run wage inflation.

Suppose that minimum-wage policy were changed to incorporate this indexation scheme with the factor of indexation, x, set equal to the sum of the present relative minimum-wage target, y, and the expected long-run rate of wage inflation, $E_t w_{t+2}$. The preceding discussion implies that, if the expected rate of wage inflation has no trend, the average effect over time of this indexed minimum-wage policy on relative employment in the subset of constrained markets would be the same as the average effect over time of present policy. These effects, however, would not necessarily be the same in each and every year because of the influence of the other relevant factors--unexpected wage inflation and policy randomness in the present case and variations in expected wage inflation in the indexation case. Moreover, if, for example, the expected rate of wage inflation were trending upward, x would have to be less than the sum of y and $E_t w_{t+2}$ to make the average effect over time of an indexed minimum wage the same as the average effect over time of present policy.

An important general implication of this analysis is that we cannot draw any a priori conclusions about how, if at all, the effects of an indexed minimum wage would differ from the effects of existing minimum-wage policy. How, if at all, the average level over time of employment in the subset of constrained markets would change with the adoption of indexation would depend on the size of the chosen factor of indexation relative to the present relative minimum-wage target and the expected pattern of the rate of average wage inflation. How, if at all, the amount of year-to-year variation in employment in the subset of constrained markets would change with the adoption of indexation would depend on the amount of year-to-year variation in expected wage inflation relative to the amount of year-to-year variation in unexpected wage inflation and in policy execution.

7. Conclusions

The main conclusions from this study are the following:

(1) Increases in the current or near-future federal minimum wage appear to depress current employment in certain industries that probably have a high proportion of minimum-wage workers and among teenagers, the demographic group that has the highest incidence of minimum-wage workers.

(2) Neither the current nor the near-future minimum wage appear to affect either current aggregate employment or average wage rates. This finding suggests that the curtailment of employment opportunities in certain industries and for teenagers that apparently results from minimum-wage policy produces two types of response. First, to some extent affected workers possibly take employment in other industries. Second, to some extent other individuals, who are not teenagers and/or who work in other industries, apparently increase their employment.

(3) Although monetary policy affects average wage rates, this relation does not seem to be equiproportionate. In line with this finding, monetary expansion appears to have a positive effect on aggregate employment. However, federal minimum wage policy and, specifically, the role of monetary policy in determining the real value of the preset nominal minimum wage do not seem to account even in part for the relation between monetary policy and aggregate employment. Monetary nonneutrality apparently results from other, undetermined, factors.

(4) The effects of proposed indexation of the federal minimum wage on the average over time of employment of minimum-wage workers would depend inversely on the chosen relation between the federal minimum wage and recent-past average wage rates relative to the level and trend of the expected rate of average wage inflation. The effect of proposed indexation on the variability over time of employment of minimum-wage workers would depend directly on the amount of year-to-year variation in expected wage inflation relative to the amount of year-to-year variation in unexpected wage inflation.