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EMPLOYMENT EFFECTS OF THE FEDERAL MINIMUM WAGE

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SUMMARY

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This paper describes an empirical study of the effects of federal minimum wage policy on aggregate employment, on the employment of various demographic groups, and on employment in low-wage industries. The analytical framework permits separate testing both for direct employment effects of the level and coverage of the minimum wage and for indirect employment effects resulting from a possible role for the minimum wage as a cause of monetary nonneutrality. Another innovation in this study is the inclusion of rational expectations of expected future relative minimum wages as determinants of the demands and supplies of labor services.

The study finds that minimum-wage policy seems not to affect aggregate employment or average wages either directly or indirectly. Minimum-wage policy, however, has large and statistically significant effects on the industrial and demographic composition of employment, with employment decreasing in certain low-wage industries and for teenagers and for young men but increasing for young women and for adults. A major part of these effects are associated with anticipated future changes in the level of the minimum wage.

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This paper describes an empirical study of the effects of federal minimum wage policy on aggregate employment, on the employment of various demographic groups, and on employment in low-wage industries. The analytical framework permits separate testing both for direct employment effects of the level and coverage of the minimum wage and for indirect employment effects resulting from a possible role for the minimum wage as a cause of monetary nonneutrality. The implementation of these tests involves the estimation of reduced form equations that use monetary variables, in contrast to the usual reliance on endogenous variables such as aggregate output, to distinguish the employment effects of minimum wage variables from the employment effects of macroeconomic disturbances. Another innovation in this study is the inclusion of expected relative minimum wages in the near and distant future, in addition to the current relative minimum wage, as determinants of the demands and supplies of labor services, together with the assumption that the expectations of both workers and employers about future relative minimum wages are "rational."

To summarize briefly the main results, the study finds that minimum wage policy seems <u>not</u> to affect aggregate employment or average wages either directly or indirectly. Minimum-wage policy, however, has significant effects on the industrial and demographic composition of employment, with employment decreasing in certain low-wage industries and for teenagers and for young men but increasing for young women and for adults. A major part of these effects are associated with anticipated future changes in the level of the minimum wage.

An earlier paper published by the Minimum Wage Study Commission--see Boschen and Grossman (1981)--reported preliminary results that were consistent with these findings, but were ambiguous in some respects. The present study uses a full-information maximum-likelihood estimation procedure and analyses a comprehensive set of equations for employment of demographic groups. These improvements provide a more complete picture and firmer conclusions about the effects of minimum-wage policy. In what follows, Section 1 sets up the theoretical model, Section 2 solves the model, Section 3 describes the data used in the empirical analysis, Sections 4, 5, and 6 describe the estimation of the aggregate wage and employment equations, the employment equations for demographic groups, and the employment equations for low-wage industries, and Section 7 presents conclusions.

I. 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 framework 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 rational expectations of the 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. The assumption that expectations are rational means that workers and employers 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. 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, although 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.

$$(1)\qquad N_t^s - L_t^s = n_0^s(N_{t-1}-L_{t-1}) - n_1^s(W_t-\Omega_t) - n_2^s\, E_t(W_{t+1}-\Omega_{t+1}) - n_3^s\, E_t(W_{t+2}-\Omega_{t+2}) + n_4^s\, C_t + n_5^s t + \beta_t \quad \text{and}$$

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

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 assumed to be normally distributed and 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.

Theoretical considerations suggest that the elasticity coefficients in equations (1) and (2) 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 supposition, however, is that the sum of n_1^d and n_1^s is positive. Another plausible quantitative supposition is that n_4^s is larger than n_4^d, because, when the subset of constrained markets expands due to an increase in coverage, the newly constrained markets add more to supply than to demand. For simplicity, the analysis assumes that n_0^s is equal to n_0^d and that n_5^s is equal to n_5^d. The empirical analysis treats the elasticity coefficients as constants.

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) $\quad N_t = N_t^d$ and

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

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 nonparticipation in the labor force and, hence, does not attempt to explain measured unemployment.

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

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 result in increased effective supply in the unconstrained labor markets. Specifically, we assume the log-linear form,

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

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 present analysis treats α as a constant.

The plausible range for α is from zero to $\exp(N_t - L_t)$. A value of α of $\exp(N_t - L_t)$ would mean that effective supply in unconstrained markets is independent of excess supply in the subset of constrained markets. The opposite extreme, a value of α of zero, would mean that effective supply in unconstrained labor markets increases one-for-one in response to excess supply in the subset of constrained labor markets. This response could involve either decisions by affected low-productivity workers in constrained markets to seek alternative employment in unconstrained markets or decisions by other individuals, who otherwise would not choose to be employed, to seek employment. The existing literature has not emphasized the second type of response, the replacement in the labor force of individuals for whom the minimum wage is an effective constraint by other individuals. Such a replacement could reflect either an income effect resulting from the inability of certain family members to obtain employment or a substitution effect resulting from higher demand and higher relative wages for workers who can substitute for low-productivity workers.

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.

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. Thus, in this model, although the minimum wage depresses employment in the subset of constrained markets, any effect of minimum-wage policy on aggregate employment depends on α being positive--that is, on the effect that inability to obtain employment in the subset of constrained markets has on aggregate effective labor supply. In addition, this aggregate market-clearing assumption implies, as is verified by the calculations below, that any effect of monetary policy on aggregate employment also depends on α being positive. Thus, this model generates the testable hypothesis that 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 the level and the coverage of 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% and 56% of the average manufacturing wage rate and have steadily removed coverage exemptions. (d) Between amendments, the relative minimum wage has declined to between 40% and 47% of the average manufacturing wage rate.

These observations suggest that a policy objective has been to avoid large variation in the relative minimum wage and to expand coverage, but that policy execution has not been precise. In light of these observations, it would seem appropriate to characterize minimum-wage policy as allowing, at least implicitly, periodic review and possible adjustment of future nominal minimum wages and coverage, with the objective being to equate on average the expected relative minimum wage and coverage to given target levels. We suppose that the expectations on which this policy is based are "rational," but not necessarily always correct. The failure to achieve the policy objectives precisely results, in this formulation, from imperfect foresight and from random factors that influence the carrying out of policy.

This representation of minimum-wage policy assumes that current and near-future policy variables--Ω_t, Ω_{t+1}, C_t, and C_{t+1}--are currently predetermined and known exactly. The distant future level of the minimum wage is determined according to

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

where y is the constant 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. The policy target, y, does not represent necessarily the level at which the relative minimum wage is set when the Fair Labor Standards Act is amended. Rather, it is the desired mean over time of the level of the nominal minimum wage relative to expectations of the average wage. The random policy 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. In incorporating the rational expectations of the future average wage, equation (9) attributes the same form of rationality to minimum-wage policy as to labor supply and demand behavior. The distant future coverage of the minimum wage is determined according to

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

where c is the constant long-run target growth rate for coverage and θ is a random variable with zero mean.

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

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

Taking expectations of equation (10) yields

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

These expressions imply that for the distant future, which in this 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 at a constant rate.

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, an assumption that contrasts sharply with the assumption of incomplete monetary information made in many macroeconomic models that incorporate rational expectations. With regard to the prediction of the future money stock, extensive experiments with a variety of models suggest that a parsimoniously specified univariate time series is not unrealistic. In particular, we specify an AR(1,1) process,

$$m_{t+1} = z + gm_t + \mu_{t+1}, \tag{11}$$

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

$$E_t m_{t+1} = z + gm_t. \tag{11.1}$$

Note also that

$$E_t M_{t+1} = M_t + E_t m_{t+1}. \tag{11.2}$$

These expressions imply that rational expectations of future monetary policy involve an autoregression on current and past monetary policy.

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:

$$\text{(iii)}\qquad W_t = \Pi_0 + \Pi_1\Omega_t + \Pi_2(E_tW_{t+1}-\Omega_{t+1}) + \Pi_3 C_t + \Pi_4 C_{t+1} + \Pi_5 M_t + \Pi_6 m_t + \Pi_7 t + \Pi_8(\phi_t-\lambda_t) + \Pi_9(\beta_t-\gamma_t),$$

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

$$\text{(iv)}\qquad W_{t+1} = \Pi_0 + \Pi_1\Omega_{t+1} + \Pi_2(E_{t+1}W_{t+2}-\Omega_{t+2}) + \Pi_3 C_{t+1} + \Pi_4 C_{t+2} + \Pi_5 M_{t+1} + \Pi_6 m_{t+1} + \Pi_7(t+1) + \Pi_8(\phi_{t+1}-\lambda_{t+1}) + \Pi_9(\beta_{t+1}-\gamma_{t+1}).$$

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

$$\text{(v)}\qquad E_tW_{t+1} = \Pi_0 + \Pi_1\Omega_{t+1} + \Pi_2 y + \Pi_3 C_{t+1} + \Pi_4(C_{t+1} + c) + \Pi_5(M_t + z + gm_t) + \Pi_6(z + gm_t) + \Pi_7(t+1).$$

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 equations:

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

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

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

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

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

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

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

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

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

Although this system of equations is not linear in $\Pi_0 \ldots \Pi_9$, its structure permits a recursive solution that eliminates these undetermined coefficients and yields uniquely 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.

Inspection of these expressions reveals that, 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. Alternatively, 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 generally ambiguous, because this coefficient involves offsetting effects of trends in supply and demand. The final term, $\varepsilon(W)_t$, is stochastic and, being a linear combination of the random variables in the structural equations, has mean zero.

To obtain the solution for L_t, we substitute into equation (7) the values of W_t from equation (vi) and E_tW_{t+1} from equation (v) and substitute into equation (8) the value of L_t from equation (7). Referring to the expressions for the coefficients $A_1 \ldots A_7$ yields the following equation 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,

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

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

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

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

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

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

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

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

The coefficients, $B_1 \ldots B_7$, of equation (vii) are all linear functions of the coefficients of equation (vi). The stochastic term, $\varepsilon(L)_t$, is a linear function of $\varepsilon(W)_t$, and also has mean zero. These cross-equation relations result from the form of the aggregate demand equation and from the assumptions of aggregate market clearing and rational expectations.

With regard to the signs of $B_1 \ldots B_7$, 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 expressions for the coefficients $A_1 \ldots A_7$ yields the following equation 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 $\varepsilon(N)_t = n_1^d \varepsilon(W)_t + \gamma_t$.

The coefficients, $D_1 \ldots D_7$, of equation (viii) are also linear functions of the coefficients of equation (vi) and the stochastic term, $\varepsilon(N)_t$, is also a linear function of $\varepsilon(W)_t$ with mean zero. With regard to the signs of $D_1 \ldots D_7$, 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) show how the model focuses attention on the behavioral parameter α. 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 excess supply in the subset of constrained markets causes a one-for-one increase in 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.

A related observation about the theoretical results is that regardless of the value of α, the 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. These summations mean 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 M_t. These implications about the interaction between monetary policy and minimum-wage policy reflect the property of the present model, which is tested empirically below, that the setting of the minimum wage as an effective constraint in a subset of markets is the only source of monetary nonneutrality. This property results directly from the assumed equality of aggregate demand and aggregate effective supply, as specified by equation (8).

Equations (vi), (vii), and (viii) provide a basis for testing of derived hypotheses, for quantification of empirical relations, and for the interpretation of empirical observations. Most importantly, the econometric results discussed below indicate that the data do not reject the hypothesis that the effects of minimum wage variables reflect a value of α equal to zero, but that the data reject the hypothesis that the effects of monetary policy on employment result from the existence of the minimum wage.

3. Data

The econometric analysis requires the development of empirical proxies 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 average hourly earnings of production or nonsupervisory workers on private payrolls in manufacturing, calculated by the Bureau of Labor Statistics from its establishment survey. 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, minimum-wage policy appears to be targeted in relation to the average manufacturing wage rate. Experiments carried out with other wage series, such as average wages adjusted for nonpecuniary benefits, did not substantially alter the results.

As an empirical proxy for L_t, we use the total number of civilians employed, calculated by the BLS from its household survey. This measure of employment conforms most closely to the data that we use to estimate the effects of minimum wage policy on demographic groups, thereby allowing a comparison between disaggregated estimates and the estimates for aggregate employment. Experiments with other measures of total employment, such as total hours worked, did not yield substantially different empirical conclusions.

The most difficult data problem is that no time series are available that correspond to the theoretical concept N_t. Our strategy, therefore, is to focus on measures that appear to involve a high incidence of minimum-wage employment. (See Welsh (1978) for a discussion of wage distributions.) One such measure is the number of teenagers (16-19 years old) employed, calculated from the BLS household survey. Teenagers are the demographic group reporting the highest incidence of minimum-wage employment. In addition, in order to obtain a complete picture of the effects of minimum-wage policy on the distribution of employment among demographic groups, we also use as dependent variables measures of the numbers of young persons (20-24 years old) employed and adults (over age 24) employed. In order to consider the possibility of male-female or white-nonwhite differences in the effects of minimum-wage policy, we divide teenagers and young persons by sex, and we divide adults and the sum of teenagers and young persons by sex and race. Tests using finer demographic divisions were not productive, a result that may be attributable to small sample sizes and large measurement errors for these groups.

Another measure possibly involving a high incidence of minimum-wage employment is the number of production or non-supervisory workers on private payrolls in those SIC two digit industries that report relatively low average wages. These data are calculated from the BLS establishment survey and, thus, are not directly comparable to the data on aggregate employment and employment of demographic groups from the household survey. Nevertheless, the industry data enhance our picture of the effects of the minimum wage.

We consider nine low-wage industries: 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.

One problem with using these data series to infer the effects of minimum-wage policy on minimum-wage employment is that only a fraction of employment in any demographic group or industry, including teenagers or low-wage industries, is at the minimum wage. Consequently, estimated elasticities of employment in these categories with respect to minimum-wage variables would tend to understate the effects of minimum-wage policy on minimum-wage employment.

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, increases in the coverage of the minimum wage can depress employment as measured by these data even though increases in coverage presumably increase total minimum wage employment.

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 level and rate of change of the money stock, M_t and m_t. 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}, from unpublished ESA data, 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. Almost all of the legal coverage changes over the sample periods were in these industries. The measure of the money stock is M1B per working person.

As indicated above, each of the employment variables is measured as a logarithm of a fraction of the working-aged population. All of the data employed are annual averages. In the estimated equations for employment of demographic groups, available data on the dependent variables limits the sample period to 1954 through 1981. For consistency the estimated equations for average wages and aggregate employment use the same sample period. The inclusion of Ω_{t+1} and C_{t+1} among the independent variables and allowance for a possible first-order autoregressive structure on the residuals mean that all of these equations are fitted to observations of the dependent variable from 1955 through 1980. In the estimated equations for employment in low-wage industries, the sample period is from 1947 to 1980.

4. Estimation of Average Wage and Aggregate Employment Equations

We estimate the equations for W_t and L_t jointly using the full-information maximum-likelihood procedure in the RESIMUL program. This program selects coefficient values by employing the Newton-Raphson iterative method to find the maximum of the concentrated likelihood function. See Wymer (1978) for a full description of this estimation procedure.

To test the various hypotheses associated with the equations for W_t and L_t, we use a likelihood-ratio statistic calculated as follows: Let θ_u be the maximized value of the likelihood function under unconstrained estimation and let θ_c be the maximized value of the likelihood function when k parameters are constrained during estimation. The test statistic $\psi_k = -2 \log_e(\theta_c/\theta_u)$ is χ^2-distributed with k degrees of freedom.

Because of the possibility of multiple local maxima in the likelihood function, we used three different sets of initial guesses for the parameters to start the estimation. The guesses were a vector of zeros, a vector of unit values, and the single equation OLS estimates of the parameters. Because the estimates were essentially invariant to these different initial guesses, we report only the estimates associated with the zero vector of starting values.

To deal with first-order serial correlation in the residuals, we estimated the coefficient of the autoregressive disturbance term, denoted as ρ, simultaneously with the rest of the parameters. The sample residuals did not show significant evidence of higher-order serial correlation in either equation.

The estimated equation for the average wage rate is

$$\text{(I)}\qquad \underset{}{W_t} = \underset{(-2.6)}{-1.7} + \underset{(1.1)}{.04\Omega_t} + \underset{(1.0)}{.06\Omega_{t+1}} - \underset{(-0.4)}{.00C_t} - \underset{(-1.4)}{.01C_{t+1}}$$

$$+ \underset{(6.9)}{1.2M_t} - \underset{(-6.5)}{.90m_t} + \underset{(1.6)}{.01t.}$$

$$R^2 = .99 \qquad \underset{(9.9)}{\rho = .78}$$

Hypothesis: $A_1 + A_2 = 0$, $\quad \psi_1 = 2.0$, $\Pr(\psi > \psi_1) = .16$

Hypothesis: $A_1 = A_2 = A_3 = A_4 = 0$, $\quad \psi_4 = 4.2$, $\Pr(\psi > \psi_4) = .38$

Hypothesis: $A_1 + A_2 + A_5 = 1$, $\quad \psi_1 = 12.6$, $\Pr(\psi > \psi_1) = .01$.

The numbers in parentheses under the coefficients are the t-ratios. The statistics reported after each indicated null hypothesis are the computed value of the test statistic, ψ_k, and the probability of finding under the null hypothesis a value of ψ_k greater than the computed value.

One clear implication of equation (I) is that minimum-wage variables do not have a statistically significant effect on average wages. The estimated coefficients on Ω_t and Ω_{t+1} are positive, but the t-values indicate that neither of these coefficients is significantly different from zero. In addition, the likelihood-ratio test of the hypotheses $A_1 + A_2 = 0$ indicates that the total effect of current and near-future minimum wages is not significant at either the 5% or 10% level.

Similarly, although the estimated coefficients of C_t and C_{t+1} are negative, the associated t values indicate that neither of these coefficients is significantly different from zero at the 5% level. (The coefficient of C_{t+1}, however, is significant at the 10% level, a result that foreshadows a puzzling finding about C_{t+1} in the equation for aggregate employment.) Finally, the likelihood ratio test for $A_1 = A_2 = A_3 = A_4 = 0$ confirms that the date do not reject the null hypothesis that the minimum-wage variables all have no effect on the average wage rate. All of these results have in common the implication 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 zero.

The estimated coefficient of M_t in equation (I) and the associated t-value indicate that the current money stock has a significant positive effect on the average wage rate. Moreover, although the point estimate and estimated standard error seem consistent with the hypothesis that this coefficient equals unity, the likelihood ratio test for $A_1 + A_2 + A_5 = 1$ indicates that the data reject this null hypothesis at the 1% level. This implication that the effects of Ω_t, Ω_{t+1}, and M_t do not sum to unity is inconsistent with the theoretical model specified above. Specifically, this finding means that monetary policy is not neutral. However, the conclusion drawn above that the data do not show that α differs from zero suggests 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.

The estimated coefficient on m_t in equation (II) indicates that current monetary growth has a significantly negative effect on the average wage rate. This result provides an additional reason for rejecting the implication of the model that a value of α close to zero would produce monetary neutrality.

The estimated equation for aggregate employment is

$$\text{(II)} \quad L_t = \underset{(-5.2)}{-1.6} + \underset{(1.3)}{.05\Omega_t} + \underset{(0.3)}{.01\Omega_{t+1}} - \underset{(-0.4)}{.00C_t} + \underset{(1.9)}{.01C_{t+1}}$$

$$+ \underset{(3.7)}{.17M_t} - \underset{(-0.4)}{.07m_t} - \underset{(-4.6)}{.01t.}$$

$$R^2 = .99 \qquad \rho = \underset{(0.4)}{.05}$$

Hypothesis: $B_1 = B_2 = B_3 = B_4 = 0, \quad \psi_4 = 8.8, \; Pr(\psi > \psi_4) = .08$

Hypothesis: $B_1 = B_2 = B_3 = 0, \quad \psi_3 = 3.2, \; Pr(\psi > \psi_3) = .34$

Hypothesis: $B_1 + B_2 + B_5 = 0, \quad \psi_1 = 20.5, \; Pr(\psi > \psi_1) = .01.$

The general impression from equation (II) is that minimum wage variables do <u>not</u> have a statistically significant effect on aggregate employment. The estimated coefficients on Ω_t and Ω_{t+1} are positive, contrary to what the theory implies, but the t-values indicate that neither of these coefficients are significantly different from zero. The estimated coefficient on C_t is negative, but also not significantly different from zero. Similarly, the likelihood-ratio test for $B_1 = B_2 = B_3 = 0$ confirms that the data do not reject the hypotheses that Ω_t, Ω_{t+1}, and C_t all have no effect on aggregate employment. These findings are consistent with the results in equation (I). The implication again is that we cannot reject the hypothesis that α is zero.

A problematical aspect of equation (II), for which we have no obvious explanation, is that the estimated coefficient of C_{t+1} is positive and, according to the t-value, is significant at the 5% level. Associated with this result, the likelihood-ratio test value for $B_1 = B_2 = B_3 = B_4 = 0$, is significant at the 8% level. These findings are not consistent with the conclusions drawn above, because the theoretical analysis implies that, if α is zero, the coefficient of C_{t+1}, like the coefficients of the other minimum-wage variables in equations (I) and (II), should be zero. Note also that the point estimate for the coefficient of C_{t+1} in equation (II) is consistent with the point estimate for the coefficient of C_{t+1} in equation (I), given that the other coefficients are zero.

The estimated coefficient of M_t in equation (II) and the associated t-value indicate that the currency money stock has a significantly positive effect on aggregate employment. The likelihood ratio test for $B_1 + B_2 + B_5 = 0$, which rejects this hypothesis at the 1% level, is consistent with this finding of monetary nonneutrality. This result is also consistent with the effect of M_t on W_t found in equation (I).

We also performed likelihood-ratio tests of the relations, implied by the theoretical analysis, between the coefficients $B_1 \ldots B_6$ of the aggregate-employment equation and the coefficients A_1, A_2, and A_5 of the average-wage equation. The data do not reject any of the individual relations at the 5% significance level, but they reject the relations associated with B_2, B_4, and B_5 at least the 10% level, and they reject the null hypothesis that all of these relations hold at the 1% significance level. These results are not surprising in light of the findings from the econometric analysis of the two individual equations and do not seem to have any important implications beyond those already drawn.

For example, given that the unconstrained estimate of B_4, the coefficient of C_{t+1} in equation (II), is inconsistent with the unconstrained estimates of the coefficients of the other minimum-wage variables in equation (II) we should expect the data to reject the cross-equation relation between A_2, A_3, and B_4. Also, given that the data reject the within-equation relations between A_1, A_2, and A_5 implied by the theory we should expect that they would reject the implied relation between A_1, A_2, and B_5.

5. Estimation of Employment Equations for Demographic Groups

Table 1 reports the estimates of the equations for the employment of the various demographic groups relative to aggregate employment. We estimate these equations individually, but for consistency with the estimated aggregate employment equation we use the same maximum-likelihood procedure in the RESIMUL program. The only evidence of first-order serial correlation was in the equation for employment of female nonwhite adults. The estimates reported in this case use $\rho = -.56$ as a correction. In the equation for employment of nonwhite males, the value of R^2 is .83. In all of the other equations, the value of R^2 is .97 or higher.

In Table 1, the columns headed by each independent variable report the estimated coefficients of this variable and the t-statistics in parentheses. In all of the equations, Wald tests of the null hypotheses $D_1 = D_2 = 0$ and $D_3 = D_4 = 0$, not reported in the table, confirmed the implications about statistical significance drawn from the t-statistics. The columns headed by $D_1 + D_2 = 0$, $D_3 + D_4 = 0$, and $D_1 + D_2 + D_5 = 0$ report the values of the Wald test for each of these null hypotheses with an asterisk indicating that the test value is significant at the 5% criterion level.

The Wald test statistic is specified as follows: Let $\Delta(\hat{D})$ be the maximum likelihood estimate of the covariance matrix of the estimated coefficients, $\hat{D}$, and let Z be a transformation matrix containing the k coefficient relations to be tested. The test statistic, $\zeta_k = (Z\hat{D}-ZD)'(Z\Delta(\hat{D})Z')^{-1}(Z\hat{D}-ZD)$, is χ^2-distributed with k degrees of freedom. The Wald test statistic eases the computational problem involved in testing multiple hypotheses because it does not require recalculation of the constrained residual covariance matrix. See Berndt and Savin (1977) for a comparison of the Wald and the likelihood-ratio test statistics.

An immediate observation from Table 1 is that the estimated coefficients of Ω_t in the equations for young persons, teenagers, and the sums of young persons and teenagers are in the line with the estimates for employment effects of the current minimum wage reported in other studies. See, for example, Gramlich (1976), Ragan (1977), and Hamermesh (1981). A fuller examination of the results in Table 1, however, provides a more complete and somewhat different picture of these effects. The estimated coefficients of Ω_t and Ω_{t+1}, the associated t-values, and the Wald tests for $D_1 + D_2 = 0$ indicate that together the current and near-future levels of the minimum wage have negative employment effects that are statistically significant for males aged 20-24, for females and males aged 16-19, and for white males aged 16-24. For each of these male groups, the estimated coefficients indicate that a 10% increase in both Ω_t and Ω_{t+1} would cause about a 2.8% decrease in employment, a much larger effect than estimated in studies that have looked only at the current minimum wage, and also indicate that the bigger part of this effect is associated with Ω_{t+1}. A 2.8% decrease in employment represents about 138,000 males aged 20-24, 85,000 males aged 16-19, and 198,000 white males aged 16-24. For females aged 16-19, the estimated coefficients

Table 1

Employment Equations for Demographic Groups

	Constant	Ω_t	Ω_{t+1}	C_t	C_{t+1}	M_t	m_t	t	$N_{t-1}-L_{t-1}$	$D_1+D_2=0$	$D_3+D_4=0$	$D_1+D_2+D_5=0$
(1) Females 20-24	3.0	-.06	.18	.01	-.00	-.45	.14	.01	.97	7.9*	0.8	115.1*
	(5.9)	(-1.9)	(4.3)	(1.1)	(-0.1)	(-8.6)	(0.8)	(4.5)	(17.9)			
(2) Males 20-24	-2.0	-.13	-.15	.01	-.02	.09	.21	.02	.62	22.5*	1.4	7.8*
	(-3.4)	(-2.0)	(-2.2)	(1.3)	(-2.3)	(1.1)	(0.7)	(3.1)	(4.4)			
(3) Females 16-19	-1.5	-.13	-.11	-.03	.05	.02	-.27	.02	.65	8.8*	1.0	7.3*
	(-1.7)	(-1.5)	(-1.1)	(-2.0)	(3.9)	(0.2)	(-0.6)	(3.1)	(3.2)			
(4) Males 16-19	-.81	-.07	-.21	-.04	.02	.05	1.3	.01	.93	12.6*	2.4	28.8*
	(-1.2)	(-0.7)	(-2.3)	(-3.3)	(1.2)	(0.4)	(3.0)	(2.6)	(5.5)			
(5) White Females 16-24	1.3	-.08	.03	-.02	.02	-.22	-.00	.01	.95	0.8	0.2	54.8*
	(2.4)	(-1.9)	(0.8)	(-2.5)	(3.2)	(-4.0)	(-0.0)	(4.0)	(11.9)			
(6) White Males 16-24	-1.2	-.09	-.19	-.01	-.00	.09	.63	.01	.83	28.8*	2.3	8.7*
	(-2.6)	(-1.6)	(-3.1)	(-0.9)	(-0.5)	(1.3)	(2.3)	(2.7)	(6.5)			
(7) Nonwhite Females 16-24	-1.0	-.06	.05	.02	.02	-.24	.47	.01	.45	0.0	5.7*	5.9*
	(-0.7)	(-0.5)	(0.4)	(1.4)	(1.5)	(-1.7)	(0.8)	(2.6)	(2.9)			
(8) Nonwhite Males 16-24	-2.1	-.19	-.07	.00	.01	-.16	.50	.02	.33	5.0	0.6	7.2*
	(-2.0)	(-1.5)	(-0.5)	(0.1)	(0.7)	(-0.9)	(0.8)	(2.8)	(1.6)			
(9) White Females over 24	-.57	.02	.05	.00	.00	.04	-.10	-.002	.77	18.1*	0.8	
	(-3.6)	(0.9)	(2.8)	(0.3)	(0.5)	(2.3)	(-1.3)	(-3.5)	(9.4)			
(10) Nonwhite Females over 24	-1.8	.06	-.00	-.01	.00	.08	-.10	-.002	.84	7.5*	13.4*	
	(-5.7)	(3.2)	(-0.7)	(-3.4)	(0.6)	(4.5)	(-3.6)	(-2.5)	(14.7)			
(11) White Males over 24	.04	.03	.00	.00	-.01	-.07	.07	-.01	.16	5.0*	4.1	
	(0.3)	(2.0)	(0.2)	(2.0)	(-2.4)	(-3.0)	(0.8)	(-3.9)	(0.7)			
(12) Nonwhite Males over 24	-.91	-.01	.12	-.00	-.01	-.14	.17	-.004	.37	8.8*	5.9*	
	(-2.5)	(-0.2)	(3.2)	(-0.7)	(-1.3)	(-3.0)	(1.1)	(-2.3)	(2.3)			

indicate about a 2.4% decrease in employment, which represents about 59,000 persons in this group.

The statistics relating to the effect of Ω_t and Ω_{t+1} on the employment of nonwhite males aged 16-24 are somewhat puzzling. The estimated coefficients for this group are negative and imply that a 10% increase in both Ω_t and Ω_{t+1} would decrease employment by about 2.4%, which corresponds to about 23,000 persons in this group. This number equals within the margin of rounding errors the number implied by the estimated effects for the other male groups. However, both the t-values and the Wald test of $D_1 + D_2 = 0$ for the equations for nonwhite males aged 16-24 indicate that the data do not reject the hypotheses that the coefficients of Ω_t and Ω_{t+1} are zero.

The results in Table 1 indicate that the effects of the level of the minimum wage on employment differ markedly by sex within each age group except teenagers. For employment of females aged 20-24, the negative coefficient of Ω_t is significant, but the positive coefficient of Ω_{t+1} is larger and is also significant, and the Wald test implies rejection of the null hypotheses $D_1 + D_2 = 0$. The estimated coefficients for this group indicate that a 10% increase in Ω_t and Ω_{t+1} would increase employment by 1.2%, corresponding to about 45,000 persons. This finding is consistent with the suggestion of Gramlich (1976) and Grant and Hamermesh (1981), also supported by the results in Table 1 on females over age 24, that employment of older females replaces at least in part the employment of younger males. For the employment of both white and nonwhite females aged 16-24, the Wald tests indicate that the data do not reject the null hypotheses $D_1 + D_2 = 0$. This finding suggests that the increased employment of young women roughly balances any decreased employment of female teenagers.

These results for the effects of the level of the minimum wage lead to three novel conclusions: First, the relatively clear findings for the male groups and mixed findings for the female groups suggest that the disemployment effects are concentrated on young males. Second, the relative importance of the coefficients of Ω_{t+1} suggest that these effects involve significant changes in labor demand in anticipation of future changes in the level of the minimum wage. Third, the combined effect of current and near-future levels of the minimum wage on the employment of teenagers and young men is much larger than the effect of the current minimum wage alone estimated in other studies.

Turning to the effect of current and near-future levels of the minimum wage on the employment of persons over age 24, the results in Table 1 indicate that the coefficients on Ω_t are positive and significant for nonwhite females and white males and that the coefficients on Ω_{t+1} are positive and significant for white females and nonwhite males. Moreover, the Wald tests indicate that for all four groups the data reject the null hypotheses $D_1 + D_2 = 0$. For the groups over age 24, the estimated coefficients indicate that a 10% increase in both Ω_t and Ω_{t+1} would cause approximate increases in employment of 0.7% (about 130,000 persons) for white females, 0.6% (about 17,000) for nonwhite females, 0.3% (about 110,000 persons) for white males, and 1.1% (about 41,000 persons) for nonwhite males.

If the minimum wage is an effective constraint on employment in some markets, the finding, from the estimation of equations (I) and (II), that the level of the minimum wage has no apparent effect on aggregate employment suggests either that affected workers take alternative employment in other, unconstrained markets or that a sufficient number of other individuals, who otherwise would not choose to be employed, respond by taking employment. The findings in Table 1 for the effect of the level of the minimum wage on the employment of various demographic groups indicate both that many constrained workers do not take alternative employment and that 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 is quantitatively important. Specifically, females over age 19 and males over age 24 apparently enter the workforce to replace females aged 16-19 and males aged 16-24.

The results in Table 1 for the effects of minimum-wage coverage show that estimated coefficients of C_t and C_{t+1} are significant for many of the demographic groups. In most cases, however, the coefficients of C_t and C_{t+1} have opposite signs and their effects on employment are offsetting. The Wald tests of $D_3 + D_4 = 0$ indicate that the data reject this null hypothesis for only three demographic groups. Specifically, an increase in both current and near-future coverage would seem to decrease employment of nonwhite females and males over age 24 and would seem to increase employment of nonwhite females aged 16-24.

The statistics in Table 1 relating to the effects of M_t and m_t are consistent with the conclusions drawn from equations (I) and (II) that monetary policy is not neutral, but that this nonneutrality does not result from minimum-wage policy. Equation (viii) derived from the theoretical model indicates that relative employment in the subset of markets in which the minimum wage is an effective constraint should be positively related to M_t. In the equations for employment of males aged 20-24, females and males aged 16-19, and white males aged 16-24, which are the demographic groups for which there is a significantly negative relation between employment and the level of the minimum wage, the positive coefficients of M_t and m_t are consistent with the theory, although only the coefficients of m_t for males aged 16-19 and white males aged 16-24 are statistically significant. In the equations for employment of females aged 20-24 and nonwhite females, white males, and nonwhite males over age 24, which are demographic groups for which there is a significantly positive relation between employment and the level of the minimum wage, the negative coefficients of M_t and m_t are also consistent with the theory. However, the statistically significant coefficients of M_t for other demographic groups, negative for white females aged 16-24 and positive for white and nonwhite females over age 24 suggests that monetary policy affects the composition of employment at least partly for reasons not associated with minimum wage policy. The Wald tests for $D_1 + D_2 + D_5 = 0$ confirm this conclusion by rejecting this null hypothesis in every case.

6. Estimation of Employment Equations for Low-Wage Industries

Table 2 reports the estimated equations for employment in the nine low-wage industries. 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

Table 2

Employment Equations for Low-Wage Industries

	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	$D_1=D_2=0$	$D_1+D_2=0$	$D_3+D_4=($
Lumber and Wood Products	-7.1 (-6.5)	-.21 (-3.2)	.02 (0.3)	-.00 (-0.1)	-.01 (-0.9)	.50 (5.1)	2.5 (6.7)	-.02 (-5.3)	.20 (1.8)	-.49 (-3.2)	-.43 (-3.0)	5.4 (.01)	9.6 (.01)	2.1 (.16
Furniture and Fixtures	-1.8 (-1.9)	.03 (0.4)	-.12 (-1.7)	-.00 (-0.2)	.03 (1.4)	-.33 (-2.6)	1.6 (3.0)	.00 (1.0)	.23 (1.4)			1.5 (.25)	1.7 (.21)	0.7 (.42
Miscellaneous Manufacturing Industries	-1.3 (-2.8)	-.11 (-2.7)	-.01 (-0.2)	-.02 (-2.7)	.01 (0.7)	-.06 (-1.6)	1.4 (6.0)	.00 (0.8)	.68 (7.2)	-.88 (-5.9)	-.55 (-3.7)	6.9 (.01)	10.7 (.003)	4.0 (.07
Food and Kindred Products	-.84 (-1.5)	.03 (1.5)	.00 (0.1)	.00 (0.0)	.01 (1.7)	-.04 (-1.2)	-.13 (-0.9)	-.01 (-2.6)	.69 (4.5)			1.5 (.24)	2.2 (.15)	4.6 (.04
Tobacco Manufactures	-4.4 (-3.3)	-.08 (-1.4)	-.08 (-1.2)	.02 (1.3)	-.02 (-1.7)	-.19 (-1.2)	-.37 (-0.9)	-.02 (-2.9)	.10 (0.5)	.45 (2.8)		1.1 (.35)	2.3 (.14)	1.2 (.27
Textile Mill Products	-.09 (-0.1)	-.15 (-3.2)	.05 (0.9)	-.00 (-0.2)	.02 (1.7)	-.14 (-2.8)	1.1 (3.9)	-.00 (-0.7)	.73 (7.1)	-.74 (-5.0)	-.50 (-3.4)	4.8 (.02)	3.9 (.06)	1.9 (.18
Apparel and Other Textile Products	.68 (3.5)	-.05 (-1.9)	-.04 (-1.3)	-.01 (-2.9)	.01 (2.1)	-.36 (-6.7)	1.0 (6.2)	.005 (5.2)	.56 (8.4)	-.79 (-4.6)	0.62 (-3.6)	5.4 (.01)	10.8 (.003)	0.5 (.48
Leather and Leather Products	.25 (0.4)	.05 (0.9)	-.01 (-0.1)	-.03 (-2.1)	.01 (1.0)	-.21 (-1.1)	.38 (1.1)	-.00 (-1.5)	.77 (5.3)	-.34 (-2.0)		0.9 (.41)	0.4 (.52)	1.4 (.25
Retail Trade	-1.1 (-2.4)	.00 (0.2)	-.03 (-2.2)	.00 (0.2)	.00 (1.3)	.06 (1.9)	.15 (1.5)	.002 (2.2)	.68 (5.7)			3.1 (.06)	4.2 (.05)	2.0 (.17

than the computed F-values under the null hypotheses. In the equation for Furniture and Fixtures, the value of R^2 is .71. In all of the other equations, the value of R^2 is .98 or higher.

The regressions reported in Table 2 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.

The results reported in Table 2 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, and Leather and Leather Products, 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.

7. Conclusions

The main conclusions from this study are the following: (1) Neither the level nor the coverage of the federal minimum wage seems to have a direct effect on aggregate employment or average wages. (2) The level of the minimum wage, however, has significant and pervasive effects on the demographic composition of employment. Specifically, increase in the current or near-future minimum wage cause the employment of teenagers and young men to decrease and cause the employment of young women and adults to increase. The empirical analysis of both aggregate employment and employment of demographic groups indicates that this replacement of teenagers and young men in employment by young women and adults is approximately one-for-one. (3) A major part of these effects is associated with the anticipation of future changes on the level of the minimum wage. The effect of combined increases in current and near-future levels of the minimum wage is much larger than the effect of the current minimum wage estimated in previous studies. A ten percent increase in the level of both the current and near-future minimum wage would decrease employment of teenage males and young men by about 2.8% and teenage women by about 2.4% and involve a turnover of about 300,000 workers. (4) The employment reductions associated with the level of the minimum wage are concentrated in certain industries that apparently have a high proportion of minimum-wage workers.
(5) Changes in the effective coverage of the federal minimum wage, as estimated by the Employment Standards Administration, have effects on the demographic and industrial composition

of employment that are significant, but limited to nonwhite demographic groups and a couple of industries. Specifically, an increase in both current and near-future coverage decreases employment of nonwhite adult women and men, but increases employment of the sum of nonwhite female teenagers and young women. (6) 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 policy also apparently affects the composition of employment, but there is also no clear association of this relation with minimum-wage policy. Monetary nonneutrality results from other, undetermined factors.

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