A SIMULATION MODEL OF THE EFFECTS OF AN INCREASE IN THE MINIMUM WAGE ON EMPLOYMENT, OUTPUT AND THE PRICE LEVEL

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Introduction

Assessing the economic impact of changes in the minimum wage level and coverage has been a controversial public policy issue. A number of theoretical and empirical models have been formulated to trace the effects of changes in minimum wage legislation on the level of employment, the wage rate, and prices. A partial list of these studies and their major findings are reported in Table 1.

They concentrate on teenage employment which is likely to be affected most by changes in the minimum wage legislation and on estimating the direct impact of minimum wages on the aggregate level or for particular classes of workers.

The results of the studies differ somewhat because of the underlying assumptions about the existence of unemployment in the economy, presence and extent of the uncovered sectors, and risk attitudes of the workers. However, their general findings are: (1) that employment, especially that of teenage workers, is decreased in response to an increase in minimum wages; (2) the response of employment to such an increase differs substantially between low- and high-wage level industries; (3) workers benefit from the change if the elasticity of demand for their services is less than unity; and (4) changes in the level of minimum wages do trigger flow of workers between the covered and uncovered sectors of the economy, though the magnitude of this response is fairly uncertain.

Two recent studies of particular relevance to our present study deal with the impact of a change in the minimum wage floor on the price level. The first is by Gramlich (1976), who uses Phillips curves of the form estimated by Wachter (1976) to examine whether changes in the minimum wage help explain changes in overall wage rates. The impact of the percentage change of the former on the percentage change in the latter was found to be consistently in the area of 0.28, and no significant follow-on effects of a lagged minimum wage variable were found, suggesting that any emulation effects take place immediately. The advance notice of minimum wage increases lends support to this idea. Using CPS Wage distributions,
### Table 1

**Summary of Finding of Selected Empirical Studies on the Impact of Minimum Wages**

<table>
<thead>
<tr>
<th>Author/Date of Publication</th>
<th>Period Covered by Study</th>
<th>Dependent Variable</th>
<th>Effect of an Increase in the Minimum Wage and/or Coverage on Dep. Variable</th>
<th>Coverage Included?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaltz (1970)</td>
<td>1954-1968</td>
<td>Aggregate teenage employment and unemployment</td>
<td>Inconclusive</td>
<td>Yes</td>
</tr>
<tr>
<td>Moore (1971)</td>
<td>1958-1969</td>
<td>Aggregate teenage unemployment</td>
<td>Increases teenage unemployment</td>
<td>Yes</td>
</tr>
<tr>
<td>Kosters &amp; Welch (1972)</td>
<td>1954-1968</td>
<td>Aggregate employment shares for 8 age/sex/color groups</td>
<td>Increases adult shares of normal employment, decreases teenage share of normal employment</td>
<td>Yes</td>
</tr>
<tr>
<td>Lovell (1972)</td>
<td>1954-1969</td>
<td>Aggregate teenage unemployment</td>
<td>Inconclusive/no change</td>
<td>No</td>
</tr>
<tr>
<td>Gardner (1972)</td>
<td>1967-1970</td>
<td>Hired farm labor</td>
<td>Decreases employment</td>
<td>No</td>
</tr>
<tr>
<td>Llanos (1972)</td>
<td>1950-1969</td>
<td>Hired farm labor</td>
<td>Decreases employment</td>
<td>No</td>
</tr>
<tr>
<td>Adie (1973)</td>
<td>1954-1965</td>
<td>Aggregate teenage unemployment</td>
<td>Increases teenage unemployment</td>
<td>No</td>
</tr>
<tr>
<td>Welch (1974)</td>
<td>1954-1968</td>
<td>Teenage employment in manufacturing, retail trade and services sectors</td>
<td>Decreases teenage employment</td>
<td>Yes</td>
</tr>
<tr>
<td>King (1974)</td>
<td>1973</td>
<td>Aggregate teenage Unemployment</td>
<td>Increases teenage unemployment</td>
<td>No</td>
</tr>
<tr>
<td>Gramlich (1976)</td>
<td>1948-1975</td>
<td>Aggregate employment of teenagers, adult males, and adult females</td>
<td>Decreases teenage employment, possible increases in adult male employment, increases in female employment</td>
<td>Yes</td>
</tr>
<tr>
<td>Mincer (1976)</td>
<td>1954-1968</td>
<td>Aggregate employment/population and aggregate labor force/population for 10 age/color/sex groups</td>
<td>Decreases labor force participation and employment for most groups</td>
<td>Yes</td>
</tr>
<tr>
<td>Welch and Cunningham (1978)</td>
<td>1970</td>
<td>Teenage employment of 14-15 year olds, 16-17 year olds, 18-19 year olds</td>
<td>Decreases employment for all groups</td>
<td>No</td>
</tr>
<tr>
<td>Uri and Mx (1978)</td>
<td>1947-1975</td>
<td>Employment shares for 21 manufacturing industries</td>
<td>Stabilizes employment for high-wage industries, increases employment vulnerability for low-wage industries</td>
<td>No</td>
</tr>
</tbody>
</table>

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*a Study also concludes that the minimum wage increases wages in the covered sector and decreases wages in the uncovered sector.

*b Study also estimates the impact of an increase in the minimum wage on other wages above the new floor.

*c Study also concludes that the minimum wage serves to decrease wages in the covered sector if the outflow of labor from that sector is positive; if the outflow is negative, uncovered wages increase.
Gramlich found that the 25 percent minimum wage increase (from $1.60 to $2.00) of May 1, 1974, increased the total wage bill by 0.8 percent. After adjustment for incomplete coverage, noncompliance and 1974 underreporting, approximately half of the impact was estimated to be directly attributable to the change in the minimum, with the remainder due to emualition. Gramlich further notes that the minimum wage cannot have a substantial impact on the relative wage structure since the change in the minimum largely affects the bottom tail of the wage distribution where the weight is small in terms of dollars and numbers.

The second study is by Falconer (1978), who examines the impact of an increase in the minimum within the MIT-PENN-SSRC macro model. An increase in the minimum wage is seen to increase the wage floor, unit labor costs and the total wage bill for employers. Changes in the minimum can lead to increases in other wages if the entire pay structure of many firms is adjusted to the higher base pay. The higher labor costs work to exert pressure on firms to pass these on to the customer. The measurable direct and indirect effects of the 1978 minimum increase on the overall price level are estimated within the model to be 0.333 percent, from a 15 percent increase in the wage floor. The price pressure is seen to be greater in sectors which use larger quantities of low wage labor. Within the model, increases in the minimum affect inflation in another indirect way. As wage increases become written into laws and contracts, inflationary expectations with respect to wages become reinforced.

In our present study we use an augmented input-output model with substitution among factors of production and in components of household demand to trace the effects of a change in the minimum wage on employment, output, and the price level. Unlike the other studies cited above, this approach allows us to analyze both the direct and indirect effects of a change in the minimum wage on sectoral demand for labor, sectoral output, and sectoral prices. Table 2 shows the concentration of low-wage labor by sector. The immediate effect of raising the minimum wage level will be to raise prices most in those sectors with the highest concentration of low-wage workers. These price effects, however, are eventually transmitted to other sectors depending on the pattern of inter-industry demand. Moreover, household consumption will change from two effects. The first is the change in the distribution of income resulting from the change in the minimum wage and the second is the change in the composition of consumption depending on relative price movements and the price elasticity of demand for the output of each sector. The equilibrium solution will give us the new equilibrium level of final output. Finally, sectoral and total employment will be altered from two effects: the first is from the substitution of capital and material inputs for labor within production as a result of relative factor price movements, and the second is from the change in the composition of output.

Our model is a medium-term model in that we assume no technological change and no change in non-household final demand but do allow substitution in production and consumption. Moreover, our simulations are performed under the assumption of full coverage of and full compliance with the minimum wage law to estimate the maximum potential effects of a change in the wage floor. With these provisos in mind, we find, to anticipate our results, a positive impact on the price level and negative impact on aggregate employment of the same order as estimated in the studies cited above from an increase in the wage floor. More interestingly, we find a positive effect on aggregate output mainly from the income distribution effect.

1. The Accounting Framework

The basic model will be an inter-
The following table shows the percent of low wage workers earning less than $1.36, $1.60, and $1.80 per hour (1972 dollars) by industry in 1973:

<table>
<thead>
<tr>
<th>Industry</th>
<th>$1.36 or less</th>
<th>$1.60 or less</th>
<th>$1.80 or less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>10.6%</td>
<td>19.6%</td>
<td>30.4%</td>
</tr>
<tr>
<td>Mining</td>
<td>0.6%</td>
<td>0.9%</td>
<td>1.3%</td>
</tr>
<tr>
<td>Construction</td>
<td>0.4%</td>
<td>1.4%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.6%</td>
<td>2.8%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Transportation</td>
<td>0.8%</td>
<td>1.4%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Wholesale/Retail</td>
<td>4.7%</td>
<td>9.9%</td>
<td>16.2%</td>
</tr>
<tr>
<td>F.I.R.E.</td>
<td>1.1%</td>
<td>3.1%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Services</td>
<td>2.9%</td>
<td>6.6%</td>
<td>11.1%</td>
</tr>
<tr>
<td>Government</td>
<td>0.5%</td>
<td>1.3%</td>
<td>2.3%</td>
</tr>
<tr>
<td>OVERALL</td>
<td>2.5%</td>
<td>5.3%</td>
<td>8.7%</td>
</tr>
</tbody>
</table>


a: The minimum wage in 1972 and 1973 was $1.60 per hour for non-farm workers, $1.36 per hour for farm workers.
b: Figured by straight line interpolation between the first and third columns.

In the input-output framework, the occupational class framework has been augmented with occupational distributions and consumption patterns by income class. The components, all as of 1972 and in 1972 dollars, are as follows (see the Appendix for data sources and methods):

- $a$: an 85-order inter-industry coefficient matrix
- $i$: a 12 by 85 employee coefficient matrix, showing the employment of each work in income group $i$ in industry $j$ per dollar of output
- $w$: a 12 by 85 matrix showing mean annual earnings for each of the twelve income classes in each of the 85 sectors.
- $\pi$: an 85-order row vector showing the ratio of gross profits in each industry to total output, where gross profits are defined as the sum of business profits, net interest, rent, and other property income.
- $t$: an 85-order row vector showing the ratio of indirect business taxes to total output.
- $v$: an 85-order row vector of value added per dollar of output of each industry. Thus
\[ v = \sum_{i=1}^{n} e + \pi = t, \]
where \( e = w(x) \) and \( x \) is term by term multiplication.

- **C:** an 85 by 12 household consumption matrix showing total household consumption out of labor earnings of each sector's output by each income class.

- **Z:** an 85-order column vector of other final demand, including household consumption out of non-labor income.

- \( Y = Ec + Z \), showing the total final demand for each industry's output.

- **X:** an 85-order column vector showing gross output by sector, thus \( X = (I-a)^{-1} Y \)

- **p:** an 85-order row vector, showing the price of each sector's output. Thus \( p = v(I-a)^{-1} \)

- **Qm** and **Qf:** two matrices showing total employment for each of 441 occupations and 85 industries for males and females, respectively.

- **Sm** and **Sf:** two matrices showing mean hourly wage rates for each of 441 occupations and 85 industries for males and females, respectively.

- **Hm** and **Hf:** two vectors showing mean hours worked per year for each of 441 occupations for males and females, respectively.

- \( \varepsilon \): a vector of price elasticities of demand for the output of each of the 85 sectors.

- \( \sigma \): a vector of elasticities of substitution between capital and labor in each of the 85 sectors.

II. The Simulation Models

Three different simulation models were used. In the first, we assumed that both technology and consumption patterns by income class were fixed. In the second, we allowed the household consumption mix by income class to change depending on relative price movements and the price elasticity of demand for different products. In the third, we allowed both substitution in the consumption mix and substitution between intermediate inputs and labor in each sector depending on relative movements of prices and wages and the sector's elasticity of substitution. No attempt was made to introduce technological change into the model, so the third model is best understood as an intermediate-term model allowing substitution due to relative price movements but not from technological change.

The model works as follows. First, a change in the minimum wage law with regard to the level of the minimum wage and its coverage will raise the money wage of the covered workers in the non-exempt sectors earning below the new minimum. Though there is some evidence of an "emulation effect" whereby unions or other groups of workers will tie their wage demands in part to the minimum wage level, we will assume that the other wage levels remain constant. This will allow us to measure the direct effect of the change in the minimum wage on the price level, disregarding its effect on wage or price expectations. The resulting estimate of its effect on the price level will, as a result, be a lower-bound estimate, since we are assuming no other wage adjustment in response. The change in the minimum wage will result in a new matrix \( w \), showing the new mean labor earnings in each family income class in each sector. This effect will therefore be referred to as the income distribution effect.

Second, the change in matrix \( w \) will cause the value added in each sector to also assume that savings rates by family income class are fixed. In the first mod-
el, the household consumption patterns by income class are assumed fixed, while in the second and third models the household demand composition adjusts according to the price elasticity of demand (e) which is considered independent of family income level. In all three models, the income distribution effect causes a change in matrix C due to differences in both the "average propensity to consume" of each income class and in their consumption mixes. In models two and three, the change in relative prices generates an additional change in C, which can be called the consumption substitution effect.

Fourth, in model three the change in the ratio of the average wage to the average price of material inputs in each sector will cause a substitution between materials and labor. Since the ratio in wages to material prices will vary across sectors and since the elasticities of substitution also vary, the change in the ratio of material inputs to labor will differ across sectors. We will assume that there is no change in the mix of material inputs in each sector (alk/ak constant for each i,j,k) and no change in the mix of occupations in each sector (Qij/Qj constant for each i,j,k, except see footnote 2). The only change is the ratio of total material inputs to total labor. The change in matrices a and \( \ell \) will be referred to as the production substitution effect.

Fifth, the new final demand vector Y will result in a new gross output vector X, according to equation (x). The new gross output vector X will create a new total employment vector by occupation, and this in turn will affect C, total consumption by income group and commodity. Using an iterative technique, we will then determine the final equilibrium values for final demand and employment.

We will now formally specify each model.

Model 1. We assume that technology is fixed:

\[
\begin{align*}
1.1 & \quad a = \bar{a} \\
1.2 & \quad \ell = \bar{\ell}
\end{align*}
\]

We also assume that final demand other than household consumption out of labor earnings is fixed in 1972 dollars,

\[
1.3 \quad z = \bar{z}
\]

and the ratio of indirect business taxes to dollar value of output (less indirect business tax) is fixed:

\[
1.4 \quad t/(1-t) = \bar{t}
\]

A change in the minimum wage law will cause a change in matrices \( S_m \) and \( S_f \) (mean hourly wage rates by occupation and industry). Multiplying each row by \( H_m \) and \( H_f \), and term-multiplying each by \( Q_m \) and \( Q_f \), respectively, will give us two matrices of total earnings by 441 occupations and 85 industries. Third, aggregation over occupation will then produce a new matrix, w*, which we shall designate w*.

We will assume that firms adjust their prices to maintain the same profit margin on their costs, i.e., the profit margin \( \bar{r} \) is fixed:

\[
1.5 \quad \pi/(1 - t - \pi) = \bar{r}
\]

The new equilibrium price vector \( p^* \) corresponding to \( w^* \), is thus given by

\[
1.6 \quad (p^* a + e_s^*) (1 + \bar{r}) (1 + \bar{t}) = p^*
\]

where \( e_s^* = \Sigma e_i^* \).

Thus:

\[
1.7 \quad p^* = e_s^* (\bar{k} - \bar{a})^{-1}
\]

where

\[
1.8 \quad \bar{k} = \frac{1}{(1 + \bar{r})(1 + \bar{t})}
\]
Define for each income class $j$ the average propensity to consume

$$
\alpha_j = \frac{\sum_i C_{ij}}{(eX)_j}
$$

where the denominator of the expression is the total labor earnings of income class $j$. To ensure that the average propensities to consume remain constant after the change in wage rates and prices, set:

$$
(1.9) \quad C_{ij}^* = \frac{(p_i^*/p_i)C_{ij}}{\sum_i ((p_i^*/p_i)C_{ij})} \cdot \alpha_j(e^*X)_j
$$

Each cell of the new consumption matrix $C$ is thus adjusted to reflect the new price of each sector's output and the new total labor earnings of the income class. Moreover, in the new prices

$$
(1.10) \quad Z_i^* = \overline{Z}_i \quad (p_i^*/p_i)
$$

The solution is now iterative:

$$
(1.11) \quad Y^*_n = \sum_j C_j^* + \overline{Z}
$$

where the subscript $(n)$ refers to iteration $n$. Then

$$
(1.12) \quad X^*_n = (1 - \overline{a})^{-1} Y^*_n
$$

and

$$
(1.13) \quad C_{ij}^*(n) = \frac{(p_i^*/p_i) C_{ij}}{\sum_i ((p_i^*/p_i) C_{ij})} \cdot \alpha_j(e^*X)_j
$$

(2.1) \quad a = \overline{a}

(2.2) \quad \xi = \overline{\xi}

(2.3) \quad Z = \overline{Z}

(2.4) \quad t/(1 - t) = t

(2.5) \quad \pi/(1 - t - \pi) = \overline{r}

(2.6) \quad p^* = e^* (\overline{\kappa} I - \overline{a})^{-1}

Here too, relative prices are determined in the first iteration and are the same as in Model 1. We now assume that consumer demand adjusts according to the price elasticity of various components of household demand. The new household demand consumption matrix $C^*$ (in the new prices $p^*$) as given by

$$
(2.7) \quad C_{ij}^* = \frac{(p_i^*/p_i)}{(\epsilon_i + 1)} \cdot C_{ij}
$$

where $\alpha_j$ is defined as in equation (1.8), $\epsilon_i$ is the price elasticity of demand for commodity $i$, and the term $(\epsilon_i + 1)$ reflects both the change in prices and the demand adjustment. The solution algorithm is the same as in model 1, except that equation (1.13) is now replaced by the more complicated expression for $C^*$ indicated in equation (2.7).

Model 3. The simulation procedure for Model 3 is more complicated that that for the other two, because we are now
allowing the technical coefficients $\alpha$ and $\lambda$ to change. As a result, the equilibrium price vector $p^*$ cannot be solved for on the first iteration.

Let us define the following variables:

(3.1) $N = \sum (\lambda X)$ vector of total employment by sector.

(3.2) $M = \sum (\alpha X)$ vector of total material inputs by sector.

(3.3) $K = \text{vector of total capital stock by sector.}$

Suppose the output of each sector $j$ can be represented by a standard C.E.S. production function of its labor, material and capital inputs:

(3.4) $X_j = B_j [\delta_1 j N_j]^{-\rho_j} + (1 - \delta_j) M_j^{-\rho_j} -1/\rho_j$

where $B_j$, $\delta_1 j$, $\delta_2 j$, and $\rho_j$ are constants and $\delta_1 j$ and $\delta_2 j$ are factor shares of labor and material inputs in sector $j$. Because we have data only for the elasticity of substitution between labor and capital by sector (not between labor and material inputs), we assume that the material inputs remain proportional to the capital stock in each sector. Moreover, since we are free to choose our units for capital stock, we assume the unit is such that:

(3.5) $K_j = M_j$ for each sector $j$.

Therefore,

(3.6) $X_j = B_j [\delta_1 j N_j]^{-\rho_j} + (1 - \delta_j) M_j^{-\rho_j} -1/\rho_j$

where $\delta_j$ is the factor share of labor in sector $j$. Following Fishelson (1979), for example, we have as first order conditions for optimization (i.e., profit maximization or cost minimization) the following:

(3.7) $X_j/K_j = B_j (1 - \sigma) \delta_j p_{mj}^{-\sigma}$

(3.8) $X_j/N_j = B_j (1 - \sigma) (1 - \delta_j) w_j^{-\sigma}$

where $p_{mj}$ is the average price of materials in sector $j$, $w_j$ is the average wage in sector $j$, and

(3.9) $\sigma = 1/(1 + \rho_j)$

$\sigma_j$ is the elasticity of substitution between capital and labor in sector $j$.

As in Models 1 and 2, we assume that $Z, t,$ and $r$ are all fixed. As in Model II, we assume that the new consumption matrix $C$ changes from relative price movements and demand elasticities as specified in equation (2.7). Our iterative solution is then as follows. We assume as before an initial change in matrix $w$ from a change in the minimum wage floor. Then in iteration $(n)$:

(3.10) $p^*_n = e^*_s(n-1)$

(3.11) $e^*_n = w^*(n) \otimes (n-1)$

(3.12) $e^*_s(n) = e^*_i(n)$

(3.13) $\bar{w}_j(n) = e^*_s(n)/\sum_i e^*_i(n)$

(3.14) $\bar{p}_{mj}(n) = p^*_n a(n-1) j_i /\sum a(n-1)$

From equations (3.7) and (3.8), we have:
(3.15) \[ \frac{M_j(n)}{N_j(n)} = \left[ \delta_j / (1 - \delta_j) \right]^{\sigma_j} \left[ \frac{\bar{w}_j(n)}{\bar{p}_{m_j}(n)} \right]^{\sigma_j} \]

Then, from (3.4) we obtain:

(3.16) \[ \frac{M_j(n)}{X_j(n)} = B^{-1} \left[ \delta_j + (1 - \delta_j) \left[ \frac{N_j(n)}{M_j(n)} \right]^{\rho_j} \right]^{1/\rho_j} \]

and

(3.17) \[ \frac{N_j(n)}{X_j(n)} = B^{-1} \left[ \frac{M_j(n)}{N_j(n)} \right]^{\rho_j} + (1 - \delta_j) \right]^{1/\rho_j} \]

We can now adjust our technology matrices accordingly:

(3.18) \[ a_{ij}(n) = \frac{M_j(n)}{X_j(n)} \cdot \frac{a_{ij}(n-1)}{\sum_i a_{ij}(n-1)} \]

(3.19) \[ \ell_{ij}(n) = \frac{N_j(n)}{X_j(n)} \cdot \frac{\ell_{ij}(n-1)}{\sum_i \ell_{ij}(n-1)} \]

As in Model 2:

(3.20) \[ \dot{Y}^*(n) = \sum_j \dot{X}^*_j(n) + \dot{Z} \]

(3.21) \[ \dot{X}^*_j(n) = [I - a(n)]^{-1} \dot{Y}^*_j(n) \]

and

(3.22) \[ \dot{C}_{ij}(n+1) = \left[ \frac{p_i^*(n)/p_i}{(\varepsilon_j + 1)^{\sigma_j}} \right] \cdot \frac{(\varepsilon_j + 1)^{\sigma_j}}{\sum_i (p_i^*/p_i)} \cdot \alpha_j \dot{e}(n) \cdot \dot{X}^*_j(n) \]

Convergence will yield a solution.

Results. The following results can be computed from the models:

(4.1) The change in the CPI:
\[ \frac{\varepsilon_j}{\varepsilon_j} \cdot \frac{p_j^*/p_j}{p_j^*/p_j} \]

(4.2) The change in the GNP deflator:
\[ \frac{p_Y^*}{p_Y} \]

(4.3) Relative price changes by sector:
\[ \frac{p_i^*}{p_i} \]

(4.4) The change in gross domestic product:
\[ \frac{p_Y^*}{p_Y} \]

(4.5) The change in total employment:
\[ \frac{\sum_i \dot{X}_i^*}{\sum_i \dot{X}_i} \]

(4.6) The change in employment by occupation:
\[ \frac{(\dot{X}_i^*)}{(\dot{X}_i)} \]

(4.7) The change in employment by sector:
\[ \frac{\sum_i (\dot{X}_i^*)}{\sum_i (\dot{X}_i)} \]

where "hat" (\(^\hat{\cdot}\)) indicates a diagonal matrix.

It should be noted that in Models 1 and 2, \( \dot{\ell} = \dot{\ell}^* = \dot{\ell}^\hat{\cdot} \).

III. Simulation Results

The legislated minimum wage levels and our estimates of the coverage rates by sector are shown in appendix (Table A-8) for the years 1963, 1972, and
1979. Our simulations are run on the basis of full coverage and full compliance with the law. This is for two reasons. First, it is very difficult to determine exactly which occupations in the partially covered industries are the ones that are uncovered. Second, the assumption of full coverage and full compliance allows us to gauge the maximum potential impact of a change in the minimum wage floor on employment and output. Our first simulation run for each model assumes full coverage and full compliance at the 1972 (non-agricultural) wage floor of $1.60 per hour. In subsequent runs, we raised the minimum wage by 5 cents per hour up to $2.25 per hour. The first line of Table 3 shows the percentage of the labor force affected by the increase in the wage floor at selected levels.

The first set of our results are for Model 1, where no substitution is allowed. Let us first look at the change in the CPI. An increase in the wage floor by 25 percent from $1.60 to $2.00

<table>
<thead>
<tr>
<th>Wage Floor</th>
<th>$1.60</th>
<th>$1.65</th>
<th>$1.70</th>
<th>$1.75</th>
<th>$1.80</th>
<th>$1.90</th>
<th>$2.00</th>
<th>$2.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of Labor Force Earning Less than or Equal the Wage Floor</td>
<td>5.3%</td>
<td>6.3%</td>
<td>6.6%</td>
<td>8.9%</td>
<td>8.9%</td>
<td>10.9%</td>
<td>12.6%</td>
<td>15.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model 1</th>
<th>1. Employment</th>
<th>2. GNP (real terms)</th>
<th>3. CPI</th>
<th>4. GNP deflator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0010</td>
<td>1.0011</td>
<td>1.0012</td>
<td>1.0013</td>
<td>1.0014</td>
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<th>2. GNP (real terms)</th>
<th>3. CPI</th>
<th>4. GNP deflator</th>
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<th>2. GNP (real terms)</th>
<th>3. CPI</th>
<th>4. GNP deflator</th>
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All figures except the top line show the ratio of the new levels to the actual 1972 values.
increases the CPI by 0.7 percentage points, which is very close to Gramlich's (1976) estimate on the wage bill. Moreover, when an adjustment for coverage is made, the CPI increases by 0.32 percentage points, which is very close to Gramlich's adjusted estimate and a little less than Falconer's (1978) estimate. Without allowing for substitution, the increase in the wage floor has a positive impact on both employment and GNP. The 25 percent increase in the wage floor from $1.60 to $2.00 cause a 0.2 percentage point rise in employment and a 0.5 percentage point rise in GNP. This is from the income distribution effect, where the relative income distribution shifts to income classes with high average propensities to consume and different consumption patterns.6

In Model 2, we allow substitution in household consumption due to relative price movements and the price elasticity of demand for the output of different sectors. There is thus an effect on the mean consumption level per dollar of income from the change in the income distribution, and there is also a shift in the composition from two effects: (1) change in the income distribution and (2) shift in relative prices and the difference in price elasticities among commodities. The equilibrium levels of employment and GNP depend both on the increase in the average consumption rate and the shift in the composition of demand.

The combined effect of the change in income distribution and the substitution in consumption is to lower employment. An increase of coverage to full coverage at $1.60 per hour lowers overall employment by 0.32 percent. The full impact of an increase in the minimum wage by 25 percent from $1.60 to $2.00 per hour with full coverage is to lower employment by only another 0.08 percent. Since the income distribution effect by itself has a positive effect on employment (see Model 1), the decrease in employment is due entirely to the consumption substitution effect. Indeed, since the income distribution effect on employment increases with the wage floor, the negative impact on employment of the consumption substitution effect apparently also grows stronger as the wage floor increases. At $1.60 per hour (with full coverage), the consumption substitution effect is -.0042 (0.9968-1.0010); at $2.00 per hour the effect is -.0061; and at $2.25 per hour, the effect is -.0072. Moreover, as we shall see below, the employment displacement effect falls entirely on personal service workers. The reason for this, as we shall also see below, is the very large relative increase in the price of their services from the increase in the wage floor.

The combined income distribution and consumption substitution effects exert a net positive impact on GNP. At $1.60 per hour with full coverage, GNP increases by 0.35 percent, and as the wage floor increases, so does GNP. The GNP levels are lower in Model 2 than in Model 1, which indicates that consumption substitution has a negative effect on output. The floor levels, from -.0007 (1.0035-1.0042) at $1.60 per hour to -.0010 at $2.00 per hour and -.0012 at $2.25 per hour.

One last point of interest is that, in Model 2, employment starts to increase again after the wage floor rises above $2.00 per hour. At $2.25 per hour, employment is 0.05 percentage points higher than at $2.00 per hour. To understand this, let us note that in Model 1 not only does GNP increase with the wage floor but it increases at an increasing rate. With a 40 cent increase in the wage floor from $1.60 to $2.00, GNP increases by 0.12 percentage points; but with a 25 cent increase in the wage floor from $2.00 to $2.25, GNP increases by 0.17 percentage points. Thus, the income distribution effect on output on increase at an increasing rate. As a result, in Model 1, employment also rises at an increasing rate with the wage floor: 0.11 percent-
age points from $1.60 to $2.00 and 0.16 percentage points from $2.00 to $2.25. Thus, between the wage floors $2.00 and $2.25, the acceleration of the income distribution effect on output and thereby on employment dominates the deceleration effect of the consumption substitution effect on employment. The net result is that employment actually starts to rise again with an increase in the wage floor.

The price levels in Model 2 are, by construction, identical to those in Model 1 and no further discussion is required.

In Model 3, the production substitution effect is combined with the income distribution and consumption substitution effects. Firms are thus allowed to substitute capital and materials for labor and, conversely, in response to relative factor price changes to maximize profits. The results are almost identical to those of Model 2. Employment falls by 0.01 percentage points more at some wage floors, GNP rises by 0.01 percentage points less, and the price levels are about 0.01 percentage points less. The reason for the almost identical results is that there is very little change in the factor input prices except for the so-called "household industry" (see Table 4). This sector is a dummy industry consisting of household servants and has no material inputs. Thus, there is no substitution within this sector. Moreover, this sector sells only to final demand and therefore does not affect the material input (inter-industry) prices of the other sector. Thus, the factor proportions remain virtually unchanged in the sectors of production. Moreover, the only sector with a substantial change in its price is the household industry, whose price almost doubles at a wage floor of $2.00 per hour (Table 4). The next largest price increase is in agricultural goods, with a 0.33 percentage increase in its price.

Looking at employment by occupation and industry, we note that the only groups showing a substantial decline in employment is the private household occupation and the corresponding non-government services industry. The decline in this group's employment is due to the large increase in their relative price. All other groups show a not in-substantial rise in employment, except government services, and this is due to the shift in consumption away from household workers to other goods. Even agriculture and agricultural workers show an increase in employment, despite its second highest price increase. This is due to the very low price elasticity of demand for its product (see Table A-6).

IV. Conclusion

The surprising result of our simulation experiment is that raising the minimum wage floor, under the assumptions of full coverage and full compliance, will actually have a positive impact on output. The reason is that the income distribution effect will dominate the combined consumption and factor substitution effects. On the other hand, raising the minimum wage floor will have a decidedly negative impact on employment because the substitution effects dominate the income distribution effect. Moreover, both the positive income distribution effect and the negative consumption substitution effect on output and employment accelerate as the wage floor rises. However, the distribution effect accelerates more than the substitution effect, and above a wage floor of $2.00 per hour, employment actually begins to rise as the wage floor increase. Moreover, the increase in the wage floor has an expected positive effect on the price level. In addition, increasing the minimum wage has an accelerating impact on the price level, with the CPI increasing by only 0.32 percentage points when the wage floor increases from $1.60 to $2.00 per hour and by 0.41 percentage points when the wage floor increases from $2.00 to $2.25.

Of the two substitution effects,
the consumption substitution effect dominates by far the production substitution effect. Indeed, the effect on the average price of intermediate inputs and on the average wage, even in agriculture, is very tiny from an increase in the wage floor, except for the household industry where there are no intermediate inputs. Thus, the substitution induced among factors in production from an increase in the wage floor is very minimal. Thus, from the standpoint of production very few inefficiencies are created by raising the minimum wage.

What then of the costs and benefits of raising the minimum wage (in real terms)? On the cost side are its
negative impact on employment and its positive effect on the price level. On
the benefits side, besides its possible amelioration of poverty and reduction in
income inequality (effects that are not analyzed in this paper) is the increase
in GNP associated with the increase in the wage floor.

On the cost side, as far as em-
ployment is concerned, the negative ef-
fect of raising the minimum wage on
employment actually slows down as the
wage floor rises and after $2.00 per
hour employment in fact rises. More-
over, as we saw, the only group ad-
versely affected was private household
workers. Indeed, all other employees,
including agricultural workers, showed
an increase in employment as the wage
floor increased. One possible device to
ameliorate the negative impact in private
household workers is a two-tier system,
similar to the older minimum wage sys-
tems, where household workers are
either exempt or subject to a lower min-
imum wage. Moreover, on the price
side, the major reason for the increase
in CPI with an increasing wage floor
was the sharp rise in the price of
household services. The other prices
showed only moderate increases. Here,
again, a two-tier system would guard
against an excessive rise in the CPI.

However, it should be noted that
there are certain restrictive assumptions
built into our model which do not permit
answering some other policy questions.
For example, we have not taken explicit
account of the age distribution of the
work force and therefore could not say
what the precise effect of the current
minimum wage policy or a two-tier sys-
tem advocated recently will be on the
employment of teenagers and older
workers. Another issue is the impact of
technological change which is explicitly
excluded from our model. A more gen-
eral model that incorporates the effects
of technology and factor price rigidity
would have to be undertaken.

Footnotes

1Actually, the agricultural wage floor
increased by 20 percent from $2.20 to
$2.65 per hour, while the nonfarm sector
increased by 15 percent from $2.30 to
$2.65.

2A fourth model was also run, where, in
addition to substitution in consumption
and between intermediate inputs and la-
bor in production, we allowed sub-
titution between low-wage and high-wage la-
bor. In Hamermesh and Grant (1979),
various estimates of the elasticity of
substitution between "production" and
"non-production" workers are reported.
The range is enormous, from - .05 to 7.5.
We tried three values: 0.5, 1.0, and
2.0. However, the simulation results
were almost identical to the third model
and are, as a result, not reported here.

3Modeling such responses would require
making some fairly arbitrary assumptions
and estimates of elasticities which are,
as far as we are aware, unknown.

4We shall assume throughout that the
change in the minimum wage is suf-
ciently small so as not to change the
family income class of the wage recip-
ient.

5Empirically, this is not an unreason-
able assumption to make on the aggre-
gate. Our estimates of the ratio of to-
tal material inputs to total capital
stock in constant price terms for se-
lected years are as follows:

<table>
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<tr>
<td>1958</td>
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<td>1967</td>
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<td>1972</td>
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6Technically, we are assuming that the
marginal propensity to consume is equal
to the average propensity in each income
class.

7On the final demand consumption side,
there is very strong substitution of other consumer goods for this consumer service.

Model 3 was run with two sets of elasticities of substitution between capital and labor (see Table A-7). The first set was estimated using time-series data and represents short-term elasticities of substitution. The second set was estimated using cross-sectional data and represents long-term elasticities of substitution. The simulation results from these very different sets of substitution elasticities are almost identical for reasons indicated in the text. Tables 3 and 4 show the results using the time-series estimates.

One possible misinterpretation of our results is that raising the wage floor is a good policy mechanism to increase overall labor productivity, since output increases and employment falls. It is always possible to increase measured productivity by substituting high-skill ed workers for low-skilled workers or capital for labor or high-productivity output for low-productivity output. The cost, however, is increased unemploy-

References


