THE INFLATIONARY IMPACT OF HIGHER ENERGY PRICES 1973-1975

Knut Anton Mork

Energy Laboratory Working Paper
No. MIT-EL 78-014WP August 1978

The research underlying this paper has been supported by the Center for Energy Policy Research at MIT.
I. Introduction

The 1973-1975 period brought unprecedented high inflation to the United States and most of the Western world. This surge in inflation was associated with several serious shocks to the economy. Increased demand for food and suddenly dwindling supplies caused farm prices to rise by 40% from 1973 to 75. The quadrupling of crude oil prices by the OPEC cartel caused the energy price shock, concentrated in the first months of 1974. About the same time came the removal of what was left of the general price controls imposed by the Nixon administration in an attempt to halt inflation.

How much of inflation in the U.S. was really caused by the energy price increase? The present paper assesses the impact in the first three quarters of 1974 as 5 percentage points of inflation at an annual rate. This is about one-half of inflation above trend, or a little more than one-third of total inflation in these three quarters. For the whole 1973-75 period, the contribution is down to one-third of above-trend inflation.

Estimates of this impact in the existing literature lie on both sides of these figures, and the variation is large. Gordon's "energy adjustment" of the private nonfarm GNP deflator gives figures as low as 1.5 percentage point in 1974 (Gordon (1975)). The other extreme is represented by Fair (1978), whose estimate is 8 percentage points. Other estimates fall in between.

One of the reasons for this discrepancy is the lack of a standard methodology for estimating the effect of energy price changes on the
general price level. The methodological problems are related to two fairly standard features of econometric models. One is the use of the GNP deflator as a measure of the overall price level; the other is the fact that the price of energy is not a standard variable in any of the traditional price equations. The disadvantage of using the GNP deflator is mainly that it is the deflator of a value-added concept and thus ill-suited for measurement of the inflationary effects of a price increase for a primary resource like energy. The absence of the price of energy from the price equation is sometimes remedied by including import prices.¹ This concept is, however, too broad for explicit studies of the effects of energy price changes; furthermore, the theoretical relationship between the GNP deflator and import prices is somewhat unclear.

The present paper claims to have solved this problem at least partially, by using a model of the aggregate technology in which energy is treated explicitly as an input factor. The model is presented in Mork (1987b) and used for a study of price behavior in Mork (1978c). A new price level index comes naturally out of the model as the price of macro gross output; and this index depends in a well defined way on the price of energy. This solves the two problems of traditional models discussed above.

The model, slightly revised to incorporate price controls, is presented in sections II and III of this paper. Section IV shows the

results of simulations that give estimates of the contribution of higher energy prices to inflation in the 1973-75 period. Two comments about the nature of these estimates are in order. First, since the long-term trend of inflation is not the concern of this paper, only the contribution of above-trend energy price increase to above-trend inflation is studied. Secondly, the estimates are partial in the sense that other factor prices are treated as predetermined variables in the simulations. This means that monetary factors are not discussed as explanations of inflation. This should not be taken as an indication that the author regards them as inessential. The approach has the advantage, however, that no assumption needs to be made about the response of wages to the higher price level. Given the lack of consensus on this issue, this seems a reasonable procedure. Needless to say, a non-monetary explanation of inflation is highly incomplete if applied to anything but the short run.
II. **Price Level Index and Empirical Structure**

The choice of price level index is crucial for the present study. The problem is to define a price level concept that depends on energy prices in a natural way and at the same time is a meaningful measure of the overall price level.

One common measure is the GNP deflator for the private nonfarm economy. The strength of this measure is that it is broad-based in the sense that it covers both consumption and investment goods. Its weakness is that, as a value-added deflator, it does not reflect properly the inflationary effects of changes in the prices of primary resources such as energy. For domestic resources this will show up indirectly via rents, which are counted as capital income and thus a part of GNP. Import price changes, on the other hand, have no direct effect on the GNP deflator. Thus, the only impact on the GNP deflator of the OPEC oil price increase in 1973-74 comes via the effect on domestic energy prices.

An alternative class of price level measures are price indices of consumer goods such as the CPI and the GNP deflator for consumption expenditures. These give satisfactory weight to imports but have the unfortunate limitation of not covering investment goods.

The solution chosen here is to construct a new price index for gross output of the nonfarm, non-primary energy sector of the private U.S. economy. It is gross in the sense that inputs of primary energy and farm products are not subtracted off in the computation of output, as they

---

2This has been pointed out, e.g. by Pierce and Enzler (op. cit.).
would have been for a value added concept of output. This makes the price level index depend on farm and energy prices in a way that fits into the neoclassical theory of the firm. At the same time, the index covers investment as well as consumer goods.

The index comes out of a three-sector model of the private U.S. economy. The three sectors are Energy (primary energy), Agriculture (farming), and the nonfarm, non-primary energy sector, also referred to as the Goods and Service sector. The output of the former two is considered input to the goods and service sector. The cornerstone of the present model is a cost function describing the technology of this sector.

The energy sector is defined as Coal Mining and Oil and Gas Extraction. These industries produce crude petroleum, natural gas, natural gas liquids, and coal. In computing energy input to the goods and service sector, imports are added to the output of the domestic energy sector and exports of energy subtracted off. For completeness, the import figures contain refined petroleum products. The definition of the energy sector excludes refining, conversion into electricity, and distribution. The motivation is to let the price of energy in the model contain as little as possible of labor and capital cost and to let the overall price level index include finished energy goods in final demand, such as gasoline and electricity. Hydroelectric and nuclear power are included in primary energy but evaluated at the equivalent fossil fuel cost for production of the same amount of electricity. The price of energy is defined as a divisia combination of the wholesale price indices
for coal and crude petroleum.\textsuperscript{3,4}

The exclusion of the price of natural gas from the price index of energy is based on the following argument. It is assumed that the macro technology is separable and that there exists a linear homogeneous energy subfunction

\[ E = (O, C, G), \]

where O is oil, C is coal and G natural gas.\textsuperscript{5} Since price controls caused an effective rationing of gas for an important part of the sampling period, the relevant dual of this function will be the restricted cost function

\[ C_E = C_E(p_0, p_C, G, E). \]

The correct measure of the price of energy is then

\[ p_E = \frac{\partial C_E}{\partial E} = f(p_0, p_C, E/G), \]

where \( f \) is homogeneous of degree one in \( p_0 \), \( p_C \) and increasing in all its variables. The price of energy is then computed on the basis of this formula with \( E/G \) as an omitted variable. Omitting \( E/G \), which decreased during the sampling period, means omitting a downward trend in \( p_E \). However, the error in the rate of change in \( p_E \) is likely to be small.

If gas were a perfect substitute for some other fuel, \( E/G \) would of course not be an argument of \( f \).

\textsuperscript{3}The latter is adjusted upwards from 1973 to include imports.

\textsuperscript{4}In doing this, the movements in the prices of natural gas liquids and refined petroleum imports are assumed to follow that of crude oil; and the prices of hydro and nuclear power are assumed to follow the coal price.

\textsuperscript{5}Natural gas liquids and refined petroleum imports, and hydro and nuclear power are suppressed in this discussion.
The agricultural sector is defined as farming. Imports, including processed food, are added to domestic farm output for computation of inputs to the goods and service sector, and exports of unprocessed farm products are subtracted off. The wholesale price index for farm products is used as the price of inputs from agriculture.

These two inputs are combined with labor and capital to produce gross output. Labor is measured as hours of all persons engaged in the goods and service sector. The wage rate is defined as compensation per man-hour for all persons engaged in the sector, corrected for overtime in manufacturing and for inter-industry shifts in employment. Capital data are constructed by the perpetual inventory method from data on real investment in structures and equipment. Since capital is treated as fixed in the short run, there is no price of capital in the model.

Data for gross output are not directly available. In value terms, they are constructed by adding the value of inputs from energy and agriculture to value added. (Data for value added of the goods and service sector are computed as the sum of GNP of the business, nonfarm sector and the household sector minus GNP of the energy sector.) This gives gross output in current dollars. Output in constant dollars is defined analogously, and the price level index used is obtained by

---

6For the purpose of computing nominal gross output, natural gas is valued at the Bureau of Mines price of gas at the wellhead, which is used by the Bureau of Economic Analysis for construction of constant dollar industry GNP. The apparent conflict with the energy price index discussed above comes about because the purpose here is adding back what has been subtracted in the national income and product account rather than improving the price index.
division of the two. Alternative measures of inflation, 1971-75, based on this price index, the consumer price index, and the business nonfarm GNP deflator, respectively, are presented in table 1. As expected, the new index shows the highest, and the GNP deflator the lowest impact of higher energy and farm prices. The data base is documented in Mork, Flavin, and Pauls (1978).

<table>
<thead>
<tr>
<th>Year</th>
<th>Price of Gross Output</th>
<th>Consumer Price Index</th>
<th>Business Nonfarm GNP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>4.0</td>
<td>4.3</td>
<td>4.6</td>
</tr>
<tr>
<td>1972</td>
<td>3.7</td>
<td>3.3</td>
<td>3.1</td>
</tr>
<tr>
<td>1973</td>
<td>7.8</td>
<td>6.2</td>
<td>4.1</td>
</tr>
<tr>
<td>1974</td>
<td>13.1</td>
<td>11.0</td>
<td>10.6</td>
</tr>
<tr>
<td>1975</td>
<td>6.4</td>
<td>9.1</td>
<td>9.7</td>
</tr>
</tbody>
</table>
III. The Model

The technology of the goods and service sector is estimated in the form of a homothetic restricted cost function with a generalized Leontief functional form and biased technical progress, defined as

\[ C = f(p)K(Q/K)^{\beta + (\theta/2)}\ln(Q/K)e^{T(p,Q,K,t)}, \]

where

\[ f(p) = \sum_i \sum_j b_{ij}p_i^{1/2}p_j^{1/2}, \quad i,j = L,A,E; \quad b_{ij} = b_{ji}, \]

\[ T(p,Q,K,t) = (\tau + \tau_Q \ln(Q/K) + \sum_i \tau_i \ln p_i)t, \quad i = L,A,E; \quad \sum_i \tau_i = 0. \]

Here Q, K, L, A, and E stand for output, capital stock, labor, and inputs from agriculture and energy, respectively; p_L, p_A, p_E are the prices of the three latter, and t is time. Capital is treated as a fixed factor. Cost is defined as variable cost:

\[ C = p_L^L + p_A^A + p_E^E. \]

The parameters were estimated by nonlinear three-stage least squares on the following system of equations:

\[ \begin{align*}
(2a) \quad & \ln(C/K) = \ln f(p) + \beta \ln(Q/K) + (\theta/2)(\ln(Q/K))^2 + T(p,Q,K,t) + \varepsilon_c \\
(2b) \quad & S_A = p_A^A/C = (f(p))^{-1} \sum_j b_{Aj}p_A^{1/2}p_j^{1/2} + \tau_A t + \varepsilon_A \\
(2c) \quad & S_E = p_E^E/C = (f(p))^{-1} \sum_j b_{Ej}p_E^{1/2}p_j^{1/2} + \tau_E t + \varepsilon_E \\
(2d) \quad & PQ/C = \beta + \theta \ln(Q/K) + \tau_Q t + \varepsilon_r,
\end{align*} \]
where \( P \) is the price level index. Equation (2d), which is referred to as the revenue-cost equation, is included for identification of the cyclical productivity parameter \( h \), which is defined by the expression

\[
P_L = w(Q/K)^h,
\]

where \( p_L \) is the price of labor in efficiency units and \( w \) is compensation per man-hour. The error term of this equation causes some problems if marginal cost pricing cannot be assumed.\(^7\) One possible violation of marginal cost pricing is price controls. This problem is avoided by estimating the cost function on quarterly data on the sample 1954:1-71:2, 74:3-75:4, for which no general price controls were in effect.\(^8\)

In the absence of price controls the author believes that marginal cost pricing is a good approximation to reality even though the price level appears to be quite rigid because, when cyclical productivity movements are taken into account, the cyclical fluctuation of marginal cost is practically zero (cf. Mork (1978c)). However, demand pressure in the very short run may cause the price level to deviate from the marginal cost schedule implied by (1) because it may not be optimal to adjust the variable factors fully. Since a complete modeling of this would be quite complicated, the following simplified procedure is adopted here. It can be shown that (cf. Mork (1978a)), when there is a short-run deviation of price from marginal cost, \( \epsilon_r \) is well behaved when its distribution

\(^7\)Cf. the discussion in Mork (1978a).

\(^8\)The wage-price guideposts of the sixties are disregarded here.
is defined conditionally on information available at the time the physical capacity was planned. This is used as a justification for the claim that the system (2) can be estimated consistently with instruments that are lagged eight quarters. The system was also corrected for serial correlation and heteroskedasticity in the same way as in Mork (1978b). The thus estimated parameters of the cost function are presented in table 2. The parameters $b_{AE}$ and $b_{EL}$ are constrained to be zero because the unconstrained estimates represented an (insignificant) violation of concavity in variable input prices.

These results give the following estimate of short-run marginal cost:

\[
\ln \text{SMRC} = \ln (\beta + \theta \ln (Q/K) + \tau Q_t) + \ln \hat{C} - \ln Q,
\]

where $\ln \hat{C}$ is computed from the fitted values of (2a). This estimated series is used in the additional equation (4) below, which estimates the effects of price controls and of short-run fluctuations in demand pressure other than what is measured by output variations.

The Nixon price controls have been widely discussed in the literature. Their impact has been estimated with a variety of results. Their impact is important to the present study because it

---

9Simulation of price equations or wage-price submodels estimated with pre-controls data have been used by Gordon (1972, 1973, 1975) and de Menil (1975). Gordon (1977) and Kraft, Kraft, and Roberts (1975) use dummy variables in similar models; Guy, Kraft, and Roberts (1975) do the same for industry price equations. A quantity theory model is used by Darby (1976); Feige and Pearce (1976) use a time-series model, whereas McGuire (1976) uses still another, innovative model of the inflationary process. Kraft, Kraft, and Roberts get a dummy coefficient with a perverse sign; most of the other authors agree that the price level was lowered by one to three percentage points early in the control period with no or the opposite effect later.
Table 2

Parameter Estimates of Cost Function

Elements of the matrix $b_{ij}$

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>E</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-0.0068 (0.0282)</td>
<td>0.0</td>
<td>0.0607 (0.0275)</td>
</tr>
<tr>
<td>E</td>
<td>0.0271 (0.0499)</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td>0.5476 (0.0263)</td>
</tr>
</tbody>
</table>

h: 0.9800 (0.0941)  $\beta$: 1.4913 (0.0060)  $\theta$: 0.6218 (0.0973)  $\tau$: -0.0053 (0.0002)

t A: -0.00029 (0.00030)  $\tau E$: 0.00029 (0.00002)  $\tau L$: -0.00000 (0.00030)  $\tau Q$: 0.00012 (0.00015)
can be claimed that much of the 1974 price increase can be attributed to the removal of the controls rather than to the energy price increase. Thus, Gordon, in his 1975 paper, concludes from post-sample simulation of his model that the lifting of controls can explain 4.6 percentage points of the total change of 13.3 in the business nofarm deflator for 1973:3-75:1. Most authors find, however, a much more modest effect. One of the most recent estimates is Gordon's 1977 paper which, by a dummy variable technique, gets a total of two percentage points of suppressed inflation to be released in 1974.

Although a detailed study of the effect of price controls is outside the scope of the present paper, it is necessary for a complete explanation of inflation in 1974 to get at least a crude measure of this effect. For this purpose, and for estimation of the effect of demand pressure, the following regression was run

\[(4) \ln P - \ln SMRC = \alpha CD + \beta \ln UFK - \gamma CD \cdot \Delta \ln UFK,\]

where SMRC is defined as in (3), UFK is unfilled orders divided by the stock of capital, and CD is a control dummy. After some experimentation on the exact timing for this variable, it was taken to be one for 1971:3-74.1 and zero otherwise. In order to avoid the presumably irregular catching-up period after the removal of controls, 1974:2 and 74:3 were removed from the sample. The last term is included to

\[10\text{This is about three times as large as his estimate of the impact of energy prices, i.e. his energy adjustment.}\]

\[11\text{The total sample was the same as for the cost function plus the period of controls, with the exception given in the text.}\]
reflect the character of the control program, namely a limitation of price increases relative to cost increases. This formulation is consistent with Oi's proposition that the control program must, if anything, have changed the parameters of the model (Oi (1976)).

The estimated parameter values are:

\[
\begin{align*}
\alpha &: -0.0015 \\
& (0.0022) \\
\beta  &: 0.0171 \\
& (0.0167) \\
\gamma &: 0.0227 \\
& (0.0525)
\end{align*}
\]

The hypothesis that \( \beta = \gamma \), i.e. that the control program removed the demand effect, could not be rejected. Imposing it gave

\[
\begin{align*}
\alpha &: -0.0017 \\
& (0.0016) \\
\beta  &: 0.0171 \\
& (0.0166)
\end{align*}
\]

This gives a total of suppressed inflation at the end of 1974:1 of 2.4 percentage points, which corresponds closely to Gordon's latest results.\(^{13}\)

---

\(^{12}\)The results were obtained by OLS. Serial correlation was corrected for, but was as close to zero as -0.007 even though the Durbin-Watson statistic was as high as 2.6.

\(^{13}\)Unlike most other authors, I was unable to detect a stronger effect for 71:3-72:4 than for the rest of the period. This was mainly due to a large negative value of the left-hand side of (4) in 73:1.
IV. **Simulations**

The model was used for an analysis of inflation in the period 1973:2-75:4. This period is chosen because the price of energy started to accelerate already in the second quarter of 1973. Simulation of the model permits a decomposition of inflation into parts that can be attributed to energy prices, farm prices, labor cost, the removal of general price controls, and the dampening effect of the recession. Since this study is concerned only with factors that were specific for this period, the analysis is confined to inflation above its past trend. Trend inflation is defined as the price level increase that is implied by the model under the assumption that variable factor prices followed their past trends, that no recession occurred, and that no general price controls were effective over any part of the period. The "no recession" alternative was defined as keeping the output-capital ratio and UFK constant from the dates they started to decline, which were 1973:3 and 1974:3, respectively. Trends were estimated on the sample 1968:4-73:1 for energy prices, 1964:2-71:4 for farm prices, and 1971:3-73:4 for wages. The annual trend rates are 6.5% for energy prices and wages, and 2.3% for farm prices. Actual and trend values of the price level and variable factor prices are presented in table 3. All price indices are normalized to 100 for 1973:1.

The effects of the variables on inflation above trend were quantified by counterfactual simulations, in which one or more factor prices were restricted to follow their past trends, and under various assumptions about price controls and the recession. The results of
Table 3
Actual and Trend Values of the Price Level and Variable Factor Prices 1973-75

<table>
<thead>
<tr>
<th></th>
<th>Price Level</th>
<th>Price of Energy</th>
<th>Farm Price</th>
<th>Compensation per Man-Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual</td>
<td>Trend</td>
<td>Actual</td>
<td>Trend</td>
</tr>
<tr>
<td>1973:1</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>2</td>
<td>101.9</td>
<td>101.0</td>
<td>107.5</td>
<td>101.6</td>
</tr>
<tr>
<td>3</td>
<td>103.9</td>
<td>102.1</td>
<td>118.4</td>
<td>103.3</td>
</tr>
<tr>
<td>4</td>
<td>106.0</td>
<td>103.3</td>
<td>125.9</td>
<td>105.0</td>
</tr>
<tr>
<td>1974:1</td>
<td>110.2</td>
<td>104.4</td>
<td>184.5</td>
<td>106.7</td>
</tr>
<tr>
<td>2</td>
<td>113.4</td>
<td>105.6</td>
<td>211.7</td>
<td>108.5</td>
</tr>
<tr>
<td>3</td>
<td>117.4</td>
<td>106.7</td>
<td>235.1</td>
<td>110.3</td>
</tr>
<tr>
<td>4</td>
<td>121.0</td>
<td>107.8</td>
<td>238.9</td>
<td>112.1</td>
</tr>
<tr>
<td>1975:1</td>
<td>123.4</td>
<td>108.9</td>
<td>239.5</td>
<td>113.9</td>
</tr>
<tr>
<td>2</td>
<td>124.4</td>
<td>110.0</td>
<td>239.0</td>
<td>115.8</td>
</tr>
<tr>
<td>3</td>
<td>126.9</td>
<td>111.1</td>
<td>260.4</td>
<td>117.7</td>
</tr>
<tr>
<td>4</td>
<td>128.6</td>
<td>112.3</td>
<td>263.9</td>
<td>119.6</td>
</tr>
</tbody>
</table>
selected simulations are shown in table 4.\textsuperscript{14}

The results of table 4 suggest that the inflation of 1973:2-75:4 has taken place in three stages for which different sources dominated. The first stage took place in the three last quarters of 1973 and was dominated by farm prices, which accounted for almost two-thirds of the total above-trend price level increase. The influence of accelerating energy prices was starting to make itself felt, but its contribution was only half of that of farm prices. Wage increase\textsuperscript{15} was below its trend, and price controls were also holding prices down somewhat.

The second stage covered the first three quarters of 1974 and was dominated by the doubling of energy prices, which contributed one-half to total price level increase above trend. The removal of price controls early in the year added another jump. Wages started also to accelerate, but the effect of this acceleration was weaker than that of energy

\textsuperscript{14}The effect of, say energy prices, can obviously be measured as the difference between the price levels of any two simulations, where one uses the actual price of energy, and the other its trend path. However, since the model is nonlinear, it makes a slight difference whether the other variables are assumed to follow actual or trend paths. The differences are small, though, and do not affect the main conclusions. Thus, the effect of energy prices varies between 5.1 and 5.6 percentage points. The largest relative variation is found for the effect of the recession, which decreases by 0.4 percentage points in absolute value when the price of energy is changed from its actual to its trend value. The simulations underlying table 4 were organized in the following way. First, all variables followed their trend paths. Then actual values were used, starting with the price control dummy and adding, in the following order, actual values of the farm price index, the energy price index, the demand variables, and the wage rate. As a result, the contributions of each of the variables sum to total explained inflation above trend.

\textsuperscript{15}Wage increase is measured as increase in compensation per man-hour, not the efficiency price of labor corrected for cyclical productivity.
Table 4

Decomposition of Inflation Above Trend
1973:2-75:4
Percentage Points, 1973:1 = 100

<table>
<thead>
<tr>
<th></th>
<th>Price Controls and Removal</th>
<th>Farm Prices</th>
<th>Energy Prices</th>
<th>Recession</th>
<th>Wage Inflation</th>
<th>Residual</th>
<th>Price Level in Excess of Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973:1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2</td>
<td>-0.3</td>
<td>0.9</td>
<td>0.2</td>
<td>0.0</td>
<td>-0.7</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>3</td>
<td>-0.6</td>
<td>2.1</td>
<td>0.6</td>
<td>-0.0</td>
<td>-1.0</td>
<td>0.8</td>
<td>1.8</td>
</tr>
<tr>
<td>4</td>
<td>-0.8</td>
<td>1.6</td>
<td>0.8</td>
<td>-0.1</td>
<td>-0.3</td>
<td>1.5</td>
<td>2.7</td>
</tr>
<tr>
<td>1974:1</td>
<td>-1.1</td>
<td>2.3</td>
<td>3.0</td>
<td>-0.2</td>
<td>0.6</td>
<td>1.2</td>
<td>5.8</td>
</tr>
<tr>
<td>2</td>
<td>1.4</td>
<td>1.2</td>
<td>4.0</td>
<td>-0.3</td>
<td>1.6</td>
<td>-0.1</td>
<td>7.8</td>
</tr>
<tr>
<td>3</td>
<td>1.4</td>
<td>1.4</td>
<td>4.9</td>
<td>-0.4</td>
<td>2.5</td>
<td>0.8</td>
<td>10.6</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
<td>1.4</td>
<td>4.9</td>
<td>-0.5</td>
<td>4.0</td>
<td>1.7</td>
<td>13.1</td>
</tr>
<tr>
<td>1975:1</td>
<td>1.5</td>
<td>1.1</td>
<td>4.9</td>
<td>-0.5</td>
<td>5.9</td>
<td>1.7</td>
<td>14.5</td>
</tr>
<tr>
<td>2</td>
<td>1.5</td>
<td>1.1</td>
<td>4.8</td>
<td>-0.6</td>
<td>5.9</td>
<td>1.7</td>
<td>14.3</td>
</tr>
<tr>
<td>3</td>
<td>1.5</td>
<td>1.4</td>
<td>5.5</td>
<td>-0.7</td>
<td>6.0</td>
<td>2.0</td>
<td>15.8</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
<td>1.3</td>
<td>5.6</td>
<td>-0.7</td>
<td>6.3</td>
<td>2.3</td>
<td>16.3</td>
</tr>
</tbody>
</table>
prices. Farm prices stagnated and made no contribution. The recession was still in its beginning and did little, given the wage level, to slow down inflation.

The third stage started in the fourth quarter of 1974 and lasted throughout 1975. This stage represents a return to normal in the sense that wage inflation is the dominant source of above-trend inflation. There is a positive contribution of energy prices and some, but limited, slowdown due to the low demand of the recession.16

The results of the whole period are summarized in the first three columns of table 5. The impact of farm prices was moderate as these stagnated in the middle of the period. The effect of the lifting of price controls was not trivial; but since it was a one-time effect, it explained no more than one-tenth of above-trend inflation over the whole period.17 The contribution of the energy price increase was much larger, explaining one-third of the total. But to some extent this was also a one-time event concentrated in early 1974. And the energy price increase failed to reach the same level of impact over the whole period as the acceleration of wages. In this sense, even this unusual period was dominated by traditional inflationary forces.

16The high residual is somewhat disturbing. Its persistent positive sign corresponds to the heavy serial correlation in the whole model. Its high value late in 1975 is partly due to the fact that the figures shown are in level form while the model was estimated in logarithmic form. This also explains the increase in the effect of the removal of price controls.

17Another reason for the somewhat low figure is the dampening of inflation by price controls during the first four quarters of the period considered.
### Table 5

**Contributions to Inflation Above Trend**


<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>Increase</td>
<td>Percent</td>
</tr>
<tr>
<td></td>
<td>Above</td>
<td>of Total</td>
</tr>
<tr>
<td></td>
<td>Trend</td>
<td>Rate Above</td>
</tr>
<tr>
<td>Removal of Price</td>
<td>1.52</td>
<td>0.55</td>
</tr>
<tr>
<td>Controls</td>
<td>1.31</td>
<td>0.48</td>
</tr>
<tr>
<td>Farm Prices</td>
<td>5.60</td>
<td>2.04</td>
</tr>
<tr>
<td>Energy Prices</td>
<td>-0.75</td>
<td>-0.27</td>
</tr>
<tr>
<td>Recession</td>
<td>6.27</td>
<td>2.28</td>
</tr>
<tr>
<td>Wages</td>
<td>2.35</td>
<td>0.85</td>
</tr>
<tr>
<td>Residual</td>
<td>16.30</td>
<td>5.93</td>
</tr>
</tbody>
</table>
It is outside the scope of this paper to give a rigorous analysis of indirect inflationary effects of higher energy prices through wage adjustments. But it ought to be mentioned that, contrary to the popular belief, it is not completely clear that nominal wages rose as a consequence of higher energy prices. Workers and unions may have attempted to maintain their real wage by demanding nominal raises, but it is not sure that this was successful. Thus, Gordon (1977) reports findings that the wage rate in this period responded to a price level index adjusted to exclude energy prices. From a general equilibrium point of view it may be argued that higher energy prices would force the nominal wage to fall in the long run relative to what it would have been otherwise. Nevertheless, it is a fact that the wage level started to accelerate after the oil shock, with prices following, at a higher rate than indicated by the acceleration of the money supply. The explanation of this happening will have to await further research.

Another type of indirect effect is more straightforward. It seems clear that a major part of the 1974-75 recession can be explained as a consequence of the oil shock. Thus, it may be appropriate to

---

18There may also have been indirect effects through energy use in the farm sector, which is not covered by the present model, but this is likely to have been modest given the low total effect of farm prices.

19As an example, consider a log-linear price equation with only labor and energy:

\[ \Delta \ln p = \alpha_0 + \alpha \Delta \ln w + (1-\alpha) \Delta \ln p_E. \]

If \( p_E \) is increased exogenously and \( p \) fixed in the long run by the monetary authorities, \( w \) will have to fall.

subtract the slight dampening effect of the recession from the total impact of energy prices. This would lower the latter to 4.85 percentage points, which is 30% of the total.

Table 6 gives a blown-up picture of inflation in the first three quarters of 1974, which was the critical period for the energy price increase. The results are also summarized in the last three columns of table 5. There seems little doubt that inflation in this period was dominated by the energy price increase, explaining one-half of the total inflation above trend over the three quarters. The only caveat to this conclusion is the high negative residual in the second quarter. This is, however, reduced in the third quarter and zero in the fourth, which seems to indicate that the model misses slightly only on the timing of the impact.

The removal of price controls was another important factor in this period although it did not overshadow the effect of higher energy prices. Taken together, the two events explained most of the accelerated inflation in this period.
Table 6
Decomposition of Inflation Above Trend
1974:1-74:3
Percentage points, 1973:4 = 100

<table>
<thead>
<tr>
<th></th>
<th>Cumulative Price Level Increase Above Trend Attributed to:</th>
<th>Price Level in Excess of Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price Controls and Removal</td>
<td>Farm Prices</td>
</tr>
<tr>
<td>1973:4</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1974:1</td>
<td>-0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>2</td>
<td>2.2</td>
<td>-0.5</td>
</tr>
<tr>
<td>3</td>
<td>2.3</td>
<td>-0.3</td>
</tr>
</tbody>
</table>
V. Summary and Conclusions

A model has been constructed that is suitable for the analysis of the effect of energy price changes on the price level. The model is based on a division of the private U.S. economy into three sectors: The Energy sector, Agriculture, and Goods and Services. A short-run cost function is estimated for the technology of the Goods and Service sector. Energy imports are included along with inputs from the domestic energy sector. With some additional assumptions about pricing behavior, and estimates of the effect of price controls, the model is used to analyze the impact of energy price changes on the price index for gross output of the Goods and Services sector.

Simulations for the first three quarters of 1974 show that the energy price increase explains half of the annual inflation rate of 9.8% above trend. Another third is explained by another unusual event, namely the removal of general price controls.

When inflation is studied over the slightly longer period 1973:2-75:4, traditional wage inflation is the largest contributing factor, even though the price of energy increased faster than its past trend throughout the period. It is also uncertain whether this wage inflation can be explained by the energy price increase. Thus, it does not seem justified to put the blame on the oil cartel for a major part of the accelerated inflation in this period. Furthermore, since it took more than a doubling of energy prices to get an inflationary impact of the magnitude actually found, one can hardly expect energy prices to be a major inflationary force over reasonably long periods in the future.
References


