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LOWER OIL PRICES AND STATE EMPLOYMENT

S. P. A. Brown and John K. Hill

It is apparent even after one year of adjustment that the sharp drop in oil prices that occurred in late 1985 and early 1986 will have a profound effect on the regional distribution of employment in the United States. This paper develops and implements a procedure for quantifying the long-term consequences of lower oil prices on employment in each of the fifty states. The estimates developed are used to determine how much of the variation in state employment growth during 1986 can be attributed to the oil-price decline. We also use the estimates to gauge the feasibility of political action, such as an oil import tariff, that would reverse the decline in oil prices.

I. INTRODUCTION

In mid-November 1985, West Texas intermediate crude oil was selling for $31 per barrel. By the end of March 1986, its price had tumbled to $11.50 per barrel. That amounts to a 63-percent decline in less that five months. Rarely in the history of markets has the price of such an important and widely traded commodity changed so much in such a short period of time. Market fundamentals did not allow oil prices to remain this low for very long. But it is clear that expectations have changed and that, at least for the foreseeable future, oil prices will be substantially lower than previously thought.

This article attempts to determine how much of an effect lower oil prices will have on employment in each of the fifty states. Such an analysis is essential to a proper identification of the sources of regional economic growth and decline in coming years. The estimates also allow us to gauge the political support for policies such as an oil import tariff that would reverse the effects of the oil-price decline.

The paper is organized as follows. Sections II and III describe a computational model used to estimate the long-run employment effects of a change in oil prices. Estimates of the employment effects resulting from a \$5 decline in oil prices are presented in Section IV. In Section V, these estimates are used to evaluate the importance of the oil-price shock in explaining state economic performance during 1986. In Section VI, the estimates are used to assess the political viability of an oil import tariff. The main points of the paper are summarized in Section VII.

II. CONCEPTUAL FRAMEWORK

The basic computational model emphasizes differences in state endowments of energy-producing and energy-consuming industries as the principal determinant of interstate differences in the employment effects of lower oil prices. Employment in each state is written as the sum of two parts--one that derives from a relative abundance or scarcity of energy industries and another that is, by construction, identical to the national economy in its industry composition. The effect of lower oil prices on the first part depends both on the responsiveness of energy employment to changing oil prices and on the extent to which the state deviates from the national average in its endowment of energy industries. The second part of the state economy is assumed to respond to oil prices in the same way that the nation does.

To develop the model formally, let E^*_{ij} denote the margin by which employment in energy industry _i_ is overrepresented (+) or underrepresented

(-) in state _j_. The E^*_{ij} are defined by hypothetically withdrawing workers from (or adding workers to) a set of key energy industries, along with the nonenergy workers they directly or indirectly support, until the employment that remains (or is so built up) is identical to the nation's in its industry composition. This is accomplished by imposing the following conditions:

(1) $$E_{ij}-E^*_{ij} = s_i(N_j-N^*_j) \qquad \text{for every } \underline{i}\text{th energy industry.}$$

In the above equations, E_{ij} denotes actual state employment in energy industry _i_, N_j actual state nonenergy employment, and s_i the ratio of national employment in energy industry _i_ to national nonenergy employment. The term N^*_j denotes the nonenergy employment in state _j_ that is directly or indirectly attributable to the E^*_{ij}. It can be expressed as

(2) $$N^*_j = \sum_i m_i E^*_{ij},$$

where m_i is the nonenergy multiplier for energy industry _i_. The m_i are defined to account not only for the intermediate demands that key industries make on other industries, but also for the indirect effects that operate through induced changes in personal income.

In order to solve for the E^*_{ij}, first multiply (1) by m_i and sum over all of the key energy industries. Then combine the resulting expression with eq.(2) to obtain N^*_j. By substituting the result into (1), we have

(3) $$E^*_{ij} = N_j[(E_{ij}/N_j) - s_iA],$$

where $$A = [1 - \sum_i m_i(E_{ij}/N_j)]/[1 - \sum_i m_is_i].$$

By construction, all of the E^*_{ij} will be zero if $E_{ij}/N_j = s_i$ for all _i_. This would be the case if energy industries were represented in the state in the same proportions as they are in the nation. Otherwise, E^*_{ij} will tend to be positive when $E_{ij}/N_j > s_i$ and negative when $E_{ij}/N_j < s_i$.

By representing the state economy in this way, we can express the response in total state employment to changing oil prices as

(4) $$\Delta T_j/T_j = \sum_i (\Delta E_i/E_i)(E^*_{ij}/T_j)(1+m_i) + (\Delta T/T)\{[\sum_i(E_{ij}-E^*_{ij}) + (N_j-N^*_j)]/T_j\}.$$

The percentage change in state employment is a linear combination of the percentage changes in national energy employment (denoted $\Delta E_i/E_i$) and aggregate national employment (denoted $\Delta T/T$). The weights in the sum reflect the extent to which the state's endowment of energy industries deviates from the national average. If energy industries account for the same shares of employment in the state as they do in the nation, $\Delta T_j/T_j$ reduces to $\Delta T/T$. On the other hand, if the state is relatively well-endowed with energy-producing industries (so that $E^*_{ij} > 0$ whenever $\Delta E_i < 0$) and poorly endowed with energy-consuming industries (so that $E^*_{ij} < 0$ whenever $\Delta E_i > 0$), then $\Delta T_j/T_j$ is less than $\Delta T/T$ and may be negative.

III. DATA AND PARAMETER VALUES

The model outlined in the previous section was used to estimate the long-run effects on state employment of a $5 decline in the price of oil. The base period for the calculations was the year 1985. All of the employment data are for that year. The average price of oil in 1985 was $26.75 per barrel, as measured by U.S. refiners' acquisition cost. Thus the range of oil prices considered in the analysis is from $26.75 to $21.75. The remaining information used in the calculations is summarized below.

A. The Key Energy Industries

The list of key energy industries was limited to three energy-producing industries--oil and gas extraction (SIC code 13), coal extraction (12), and oil field machinery manufacturing (3533)--and two energy-consuming industries--petroleum refining (2911) and petrochemicals (282 and 286). This is certainly not an exhaustive list of industries that will be affected significantly by the decline in oil prices. Ignored, for example, are airlines, trucking, public utilities, steel, and food processing--all important users of energy. To the extent that these industries are unevenly distributed across states, our estimates will be subject to error. Nevertheless, it is hoped that the list of key energy industries is sufficiently complete to establish at least the sign, if not the order of magnitude, of the effect that cheaper oil will have on state employment.

B. Response of Energy Employment to Lower Oil Prices.

To determine the effects of lower oil prices on employment in the key energy industries, multiple regression techniques were used to estimate long-run oil-price elasticities of national energy employment. An appendix provides information on the nature of these regressions. The point estimates obtained for the elasticities are as follows: +1.01 for oil and gas extraction, +1.23 for oil field machinery manufacturing, +0.45 for coal extraction, -0.56 for petroleum refining, and -0.32 for petrochemicals. The functional forms used in the regressions constrain the elasticities to be constant with respect to the price of oil. To calculate changes in employment over the oil price interval from \$26.75 to \$21.75, we used the formula

$$(5) \qquad \Delta E_i/E_i = (21.75/26.75)^{\eta_i} - 1$$

where η_i is the oil-price elasticity of employment in energy industry *i*.

C. Energy Employment Multipliers

In developing eq.(4), states were assumed to be identical except for differences in their relative endowments of the key energy industries. In this case, there was no need to differentiate the energy employment multipliers by state. In practice, of course, states are not identical; nor do they have the same energy multipliers. Particularly troublesome are cases in which a state lacks a diverse nonenergy sector. A portion of the multiplier effects that stem from changes in energy employment are then lost to other states. To deal with this problem, we used state-specific multipliers when evaluating eq.(4). This procedure reduces the computational error for states with an unusually large amount of leakage. But it fails to acknowledge and adjust for the corresponding injections enjoyed by exporting states. Presumably, however, the exporting states are large in relation to the nondiverse states, so that a total accounting may not be as crucial in their case.

The theory requires that each multiplier express the effect on total state employment of a unit change in employment in energy industry $\underline{i}$ holding constant the level of output in all other key industries and the level of autonomous demand in all non-key industries. This is a nonstandard type of multiplier, and to obtain it requires a special inversion of an input-output matrix. To develop a set of these multipliers for all states, we first used a 1979 Texas input-output table to compute the relevant multipliers for the state of Texas. Multipliers for all other states were then estimated by adjusting the Texas multipliers with information on state input-output multipliers available from the Bureau of Economic Analysis.

D. Response of National Employment to Lower Oil Prices

Most large-scale econometric models provide for a positive response in aggregate employment to falling oil prices. Unfortunately, most of the forecasting services have not widely disseminated their estimates of these effects, confining their published figures to induced changes in gross national product (GNP). However, by combining the GNP estimates with those few employment estimates we could obtain, we were able to establish a consensus estimate of the effect of lower oil prices on aggregate employment.

The Forecasting Section of the U.S. Chamber of Commerce estimates that a $5 drop in the price of oil will raise national employment by .45 percent after two years. Estimates from the Board of Governors of the Federal Reserve System indicate that employment will be .7 percent higher as a result of a $5 decline in oil prices. In comparison to other macroeconomic forecasters, these two sources are optimistic in their assessment of the expansionary effects of lower oil prices on GNP. Combining the relationship between GNP growth and employment growth found in these two sources with the consensus estimate of effect of lower oil prices on GNP, we inferred that a $5 decline in the price of oil would be expected to raise national employment by .4 percent.

IV. NUMERICAL ESTIMATES OF THE EFFECTS OF LOWER OIL PRICES ON STATE EMPLOYMENT

Shown in Table 1 are our estimates of the percentage changes in state employment expected after long-run adjustment to a $5 decline in the price of oil. As can be seen from the table, most states gain employment. But for the few states that lose, the losses are substantial.

Ten states stand to lose employment as a result of the oil-price decline. They are Alaska, Colorado, Kansas, Louisiana, New Mexico, North Dakota, Oklahoma, Texas, West Virginia, and Wyoming. For a $5 drop in oil prices, their combined loss is 216 thousand jobs, or about 1.6 percent of their total employment. Each of the ten losing states has a concentration of energy-producing industries that is well above the national average.

Four of them--Louisiana, Oklahoma, Texas, and West Virginia--also have large shares of energy-processing employment. But the positive effects from these industries are outweighed by the losses originating in energy extraction. This is partly because energy extraction accounts for a larger share of employment in these states than does energy processing. It is also the case that the oil-price elasticity of extraction employment exceeds the elasticity for employment in energy processing.

For the other forty states and the District of Columbia, lower oil prices mean expanding employment. A $5 decline in the price of oil results in an additional 606 thousand jobs, about .7 percent of their total employment. Thirty-five of these states (and the District of Columbia) have relatively small endowments of energy extraction. The other five benefit from lower oil prices, but their percentage gains are less than the national average. Of the eight states with the highest percentage employment gains, six have among the largest concentrations of energy-processing employment.

V. LOWER OIL PRICES AND 1986 ECONOMIC PERFORMANCE

The sharp decline in oil prices that began in late 1985 undoubtedly constitutes one of the single most important economic events to shape state economic activity in 1986. Recognizing that our estimates represent long-run gains and losses, we nonetheless found the estimates to be useful in explaining state employment growth during 1986.

Of the ten states for which the model shows a loss in employment, eight suffered employment declines from 1985.IV to 1986.IV. The other two states grew at rates below the national average. Of the six states for which the model indicates employment gains below the national percentage, one suffered an employment decline, three grew at rates below the national average, and two grew at rates higher than the national average. Of the thirty-five states (including the District of Columbia) for which the model indicates employment gains higher than the national percentage, none suffered an employment loss, eleven grew at rates below the national average, and twenty-four grew faster than the nation.

To more precisely measure the degree of correspondence between our estimates of long-run adjustments to lower oil prices and state economic growth in 1986, we regressed the actual percentage changes in state nonagricultural employment from 1985.IV to 1986.IV (ACT_j) on the percentage changes in employment projected by our model for a one dollar decline in the price of oil ($MODEL_j$). The results are shown below, with t-statistics in parenthesis.

$$ACT_j = \underset{(5.34)}{1.18} + \underset{(9.00)}{8.12}\, MODEL_j; \qquad R^2 = .62$$

The coefficient on $MODEL_j$ represents the product of the decline in long-run oil price expectations during 1986 and the proportion of the long-run adjustment to occur within a year. As such, the regression assumes that the ratio of short-run adjustment to long-run adjustment is the same for every state. It is likely, however, that employment in oil and gas extraction adjusts more quickly to an oil-price change than does employment in coal extraction, refining, and petrochemicals. This limits the ability of the regression to explain the observed variation in state employment growth. Nevertheless, even the simple regression indicates that lower oil prices may account for as much as 62 percent of the variation in employment growth across states during 1986.

VI. THE POLITICAL ECONOMY OF AN OIL IMPORT TARIFF

The oil-price decline and subsequent economic downturns in energy-producing states have led to renewed debate over an oil import tariff. Apart from the tariff revenue, the effects on state employment of a tariff that achieves a $5 increase in domestic oil prices should be opposite in sign, but equal in absolute value to the figures presented in Table 1. Thus, it is possible to use these figures to assess the political climate for an oil import tariff. Lacking information on economic effects at the sub-state level, we will assume that individual congressmen vote in their state's interest on this issue, unless otherwise persuaded through logrolling.

If senators and congressmen vote in their own state's interest, an oil import tariff will lose in both houses of Congress. The vote would be 20 to 80 in the Senate and 62 to 373 in the House of Representatives. Is it possible that a different outcome could be reached through logrolling? Assuming no defectors from the camp favoring the tariff, 31 votes would have to be swung in the Senate and 156 votes in the House of Representatives for the measure to succeed.

As indicated by the figures in Table 1, representatives from Pennsylvania would seem to have the lowest political cost for switching their votes to support an oil import tariff. From there, the political cost of acquiring votes would rise, with senators and congressmen from Delaware having the highest political cost. This line of thinking suggests that it will prove extremely difficult to obtain enough votes to pass an oil import tariff of much consequence. The marginal senator would come from Arizona or Georgia and the marginal congressman from California, Iowa, or Wisconsin. Both marginal voters, and most of the inframarginal ones, represent states that would suffer an employment loss in excess of 1 percent were a tariff adopted that was sufficient to raise the domestic price of oil by $10.

VII. SUMMARY

The sharp decline in oil prices that occurred late in 1985 and early in 1986 will serve to redistribute employment throughout the United States. Evidence of such a redistribution can already be found in the relative growth rates of state employment in 1986. As much as 62 percent of the variation in state employment growth during that year can be attributed to lower oil prices.

A minority of states will suffer a loss of employment in the long run. These losses will be sizeable, but they would seem to be insufficient to generate political support for policies that would reverse the decline in domestic oil prices.

Appendix: Estimating Oil-Price Elasticities of Energy Employment

For oil and gas extraction and oil field machinery manufacturing, employment elasticities were estimated with a three-equation system using as dependent variables employment in the two energy industries and the number of rotary rigs in operation. The rig count was assumed to depend on the inflation-adjusted price of oil, as measured by U.S. refiners' acquisition cost of domestic crude oil. Employment in the two energy industries were assumed to depend both on the real price of oil and the rig count. A formal presentation of the model can be found in Schmidt (1986). For purposes of this paper, the model was re-estimated using national data.

For coal extraction, we first regressed coal employment on the real price of coal. The estimated elasticity was 1.86. The theoretical response in the price of coal to changes in oil prices can be expressed in terms of the own-price and cross-price elasticities of demand for coal and the own-price elasticity of coal supply. By using this relationship, together with existing estimates of the demand elasticities [see Bohi (1981)] and our estimate of the own-price elasticity of coal employment, we obtained a value of .24 for the elasticity of the price of coal with respect to the price of oil. Together the results imply the oil-price elasticity of coal employment cited in the text.

Elasticity estimates for petroleum refining and petrochemicals were made by regressing each industry's employment on the real price of oil and real GNP. The total effect of a change in the price of oil was defined to include both the direct effect and the indirect effect that operates through induced changes in real GNP. In conformity with the estimates of the major forecasting services, it was assumed that each 10 percent decline in the price of oil would raise real GNP by .25 percent.

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Table 1
ESTIMATED PERCENT CHANGE IN NONAGRICULTURAL EMPLOYMENT
RESULTING FROM A FIVE DOLLAR DECREASE IN OIL PRICES

United States	0.40		
Wyoming	-4.45	Arizona	.56
Oklahoma	-3.12	Georgia	.56
Louisiana	-1.90	California	.57
Texas	-1.66	Iowa	.57
West Virginia	-1.38	Wisconsin	.57
Alaska	-1.20	Idaho	.59
New Mexico	-1.10	Connecticut	.60
North Dakota	-.80	Ohio	.61
Colorado	-.59	Oregon	.61
Kansas	-.29	Vermont	.63
Pennsylvania	.08	Indiana	.64
Mississippi	.10	Illinois	.67
Utah	.17	Washington	.67
Kentucky	.24	New Hampshire	.68
Montana	.26	Massachusetts	.68
Arkansas	.32	Michigan	.68
Nebraska	.49	New York	.70
Rhode Island	.50	Hawaii	.72
Maryland	.51	Tennessee	.76
Alabama	.52	Missouri	.77
Maine	.52	Virginia	.81
Nevada	.53	North Carolina	.91
District of Columbia	.55	Minnesota	.97
		New Jersey	1.19
Florida	.55	South Carolina	1.19
South Dakota	.55	Delaware	4.36