Energy Prices and State Economic Performance

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In this article, we use simulations based on input–output analysis to examine how declines in the prominence of the industries most sensitive to oil prices have affected and are likely to affect the response of state economies to changes in oil prices.

Over the past two decades, interregional divisiveness has been an integral part of the debate over U.S. energy policy. Energy-producing regions have tended to favor policies that would boost domestic energy prices, while energy-consuming regions have tended to favor policies that would lower domestic energy prices.

In fact, fluctuations in energy prices have been frequently cited as a major reason for differences in regional economic performance during the late 1970s and early 1980s. Rising oil prices stimulated economic growth in energy-exporting states and retarded economic growth in energy-importing states. Falling oil prices retarded economic growth in energy-exporting states and stimulated economic growth in energy-importing states.

In the past decade, however, economic fluctuations have become increasingly correlated across states, and fluctuating energy prices have played a smaller role in the differences in economic performance across states (Sherwood-Call 1988). Increased homogeneity in the composition of state economies likely accounts for much of the increasing similarity in economic fluctuations across regions (Barro and Sala-I-Martin 1991, Carlino and Mills 1993). By our estimates, however, shrinkage of the industries most sensitive to energy prices has also contributed to the declining role of energy price fluctuations in the differences in economic performance across states. This trend is likely to continue throughout the 1990s.

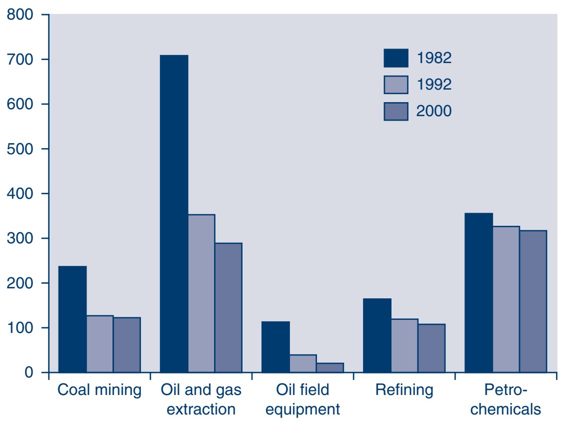
In this article, we use simulations based on input–output analysis to examine how declines in the prominence of the industries most sensitive to oil prices have affected and are likely to affect the response of state economies to changes in oil prices. We find that the decreased prominence of these industries in nearly every state's economy has reduced the differences in the states' responses to changes in oil prices. Given forecasts that the industries most sensitive to oil prices will further decline in prominence during the 1990s, we expect the differences in the states' responses to oil price changes to decline further throughout the decade.

These findings have important implications for economic activity and national energy policy. The role of energy price fluctuations in the variation in economic activity across states should continue to diminish, as it has done in the past decade. In addition, the regional flavor of national debates over energy policy should diminish.

Diversification of state economies

Since 1982, state economies have diversified away from both energy-intensive industries

Figure 1
U.S. Energy-Related Employment



SOURCES: Bureau of Labor Statistics, U.S. Department of Labor; U.S. Department of Energy.

and energy-producing industries. Projections made by the U.S. Department of Energy (DOE) and DRI/McGraw–Hill (DRI) indicate this trend will continue through 2000, albeit at a slower rate.

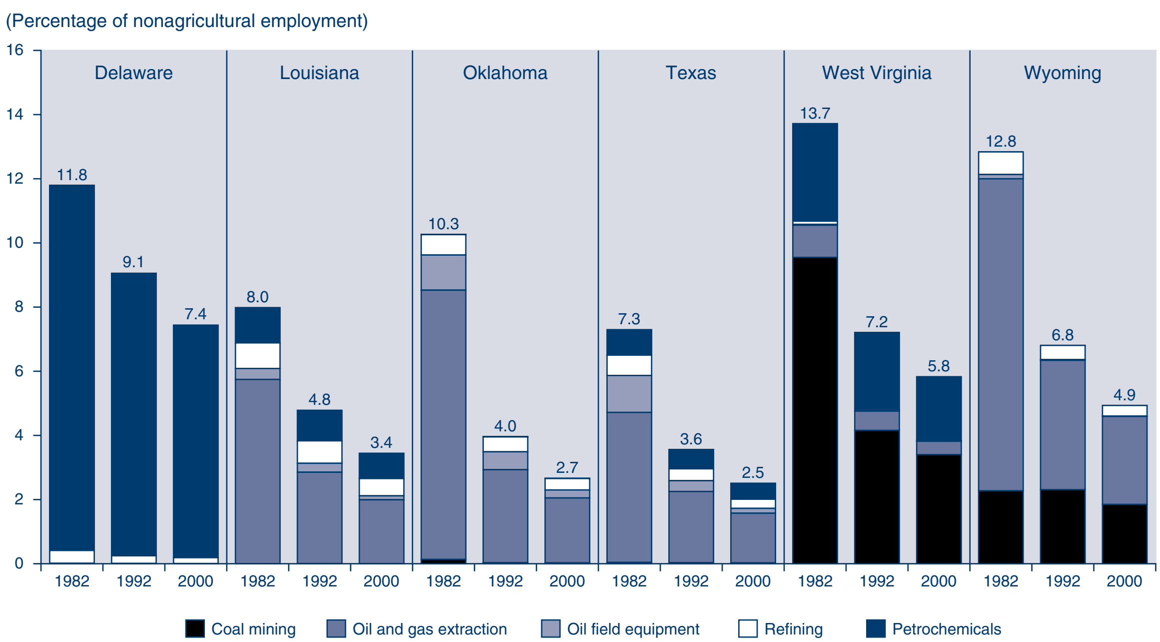
A shrinking energy industry. In 1982, the five industries most sensitive to oil prices—coal mining, oil and gas extraction, oil field machinery, petroleum refining, and petrochemicals—accounted for 1.6 million jobs (1.8 percent of total U.S. nonagricultural employment). Of these five key energy industries, oil and gas extraction accounted for the largest share of total nonagricultural employment at 0.79 percent (*Figure 1*), followed by petrochemicals with an employment share of 0.40 percent and coal mining with a 0.26 percent share. Refining accounted for 0.18 percent employment, and oil field machinery accounted for 0.13 percent.

The decade from 1982 to 1992 brought wild swings in oil prices and a severe downsizing in the oil and gas industry. Oil prices were at an all-time high in the first quarter of 1981 at $36 per barrel. They remained relatively high in 1982 but began a slow decline that continued until July 1986, when they collapsed to $11 per barrel.

Lower oil prices brought about a drastic downsizing in oil and gas extraction and related service industries. Coal prices also fell, and coal mining was reduced. Falling consumption of refined products and petrochemicals—a lagged response to the higher prices in the late 1970s and early 1980s—also led to a decline of the refining and petrochemical industries.

From 1982 to 1992, employment in the five key energy industries declined a total of 39 percent, while total U.S. nonagricultural employment increased by 23 percent. By 1992, the five industries accounted for only 1 million jobs (0.9 percent of total U.S. nonagricultural employment). Oil and gas extraction accounted for 0.32 percent of total nonagricultural employment. Petrochemicals claimed an employment share of 0.30 percent, coal mining 0.12 percent, refining 0.11 percent, and oil field machinery 0.04 percent.

Figure 2
Energy-Related Employment for Select States



SOURCES: Bureau of Labor Statistics, U.S. Department of Labor; U.S. Department of Energy; Independent Petroleum Association of America.

Table 1

Employment-Weighted Variances In Energy-Industry Employment Across States

	Coal mining	Oil and gas extraction	Oil field machinery	Refining	Petro-chemicals	Sum energy
1982	.8646	2.9653	.0973	.0390	.5302	6.6927
1992	.1548	.5405	.0110	.0180	.3188	1.6354
2000	.1091	.2700	.0022	.0111	.2250	.9251

Employment-Weighted Coefficients of Variation In Energy-Industry Employment Across States

	Coal mining	Oil and gas extraction	Oil field machinery	Refining	Petro-chemicals	Sum energy
1982	354.10	221.25	247.97	108.43	184.79	148.44
1992	346.89	227.02	272.62	122.86	191.13	145.27
2000	343.28	222.82	267.90	121.52	188.06	140.19

The DOE/DRI projections suggest an employment decline of 11 percent in the five key energy industries between 1992 and 2000, while total U.S. nonagricultural employment increases by 15 percent. In oil and gas extraction, resource depletion and productivity gains are projected to reduce employment. In oil field machinery, productivity gains and a declining domestic market are projected to lead to reduced employment. In coal, refining, and petrochemicals, productivity gains and growth slower than that of the national economy are projected to translate into slight employment losses from 1992 to 2000.

By 2000, the five key energy industries are projected to account for 0.9 million jobs (0.7 percent of total U.S. nonagricultural employment). Oil and gas extraction is projected to account for 0.23 percent of total nonagricultural employment, petrochemicals 0.25 percent, coal mining 0.10 percent, refining 0.09 percent, and oil field machinery 0.02 percent.

Increasing diversification of state economies. At the same time that energy industries have been shrinking, individual state economies have increasingly diversified away from energy-intensive and energy-producing industries. Since the early 1980s, nearly every state has become less dependent on the five key energy industries. This trend is likely to continue throughout the remainder of the 1990s.

For example, in 1982 the five key energy industries accounted for 7.3 percent to 13.7 percent of nonagricultural employment in the six states with the highest concentrations of energy-industry employment—Delaware, Louisiana, Oklahoma, Texas, West Virginia, and Wyoming (*Figure 2*). By 1992, the same five industries accounted for 3.6 percent to 9.1 percent of nonagricultural employment in the six states. The most dramatic effects occurred in the oil- and gas-producing states. By 1992, the combined employment shares of oil and gas extraction and oil field machinery in Louisiana, Oklahoma, Texas, and Wyoming were less than 50 percent of the 1982 levels. Data for all 50 states and the District of Columbia indicate that declines in the size of the energy industry reduced the variance of employment in the five key energy industries across the states from 1982 to 1992 (*Table 1*).[1]

From 1992 to 2000, the energy industry is likely to continue to lose prominence in individual state economies, but less dramatically than during the 1980s. Our reading of the DOE/DRI projections indicates that the five industries will account for 2.5 percent to 7.4 percent of nonagricultural employment in the six states with the highest concentrations of energy-industry employment. Continued declines in the size of the energy industry will further reduce the variance of employment in the five key energy industries across states from 1992 to 2000.

Analytical framework

To analyze how the composition of each state's economy affects its response to changing oil prices, we use a computational model developed by Brown and Hill (1988). In this model, differences in state concentrations of energy-producing and energy-consuming industries are the principal factors accounting for the variation across states of the employment response to changing oil prices. The model also allows for differences in multiplier effects across states while remaining computationally tractable.

In this framework, employment in each state is decomposed into two parts. One part captures the abundance or scarcity of key energy-producing and energy-consuming industries in the state relative to the nation. The other part, which contains both key and non-key industries, has the same composition of employment as the national economy.[2] For the former part, the effects of changing oil prices are modeled as a combination of the direct effects on key industries and indirect multiplier effects. For the latter part, the effect of changing oil prices is modeled as identical to those occurring at the national level. The total effect of changing oil prices on state employment is the sum of the effects on the two parts.

In the model, let E^*_{ij} denote the margin by which employment in industry i is overrepresented (+) or underrepresented (–) in state j. Estimates of the E^*_{ij} are developed by hypothetically withdrawing workers from, or adding workers to, a set of key energy-producing and energy-consuming industries—and the non-key workers they support through multiplier effects—until the remaining industry composition of each state is identical to that of the nation. Formally, E^*_{ij} is represented by the expression

(1) $$E^*_{ij} = E_{ij} - s_i \bullet (N_j - N^*_j)$$

for every key industry i. In equation 1, E_{ij} represents actual employment in key industry i for state j, N_j actual state employment in non-key industries, s_i the ratio of national employment in industry i to national employment in non-key industries, and N^*_j the employment in non-key industries in state j that can be attributed to multiplier effects associated with the overrepresentation or underrepresentation of the key industries, E^*_{ij}.

Formally, N^*_j can be expressed as

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

where summation is over i, and m_{ij} is the multiplier effect from key industry i into the non-key industries but not other key industries. The m_{ij} accounts for the intermediate demands that each key industry makes on the non-key industries and the indirect effects operating through personal income.

With some manipulation, equations 1 and 2 can be combined to obtain a computable expression for the E^*_{ij} as follows:

(3) $$E^*_{ij} = E_{ij} - s_i \bullet N_j \frac{1 - \sum m_{ij} \frac{E_{ij}}{N_j}}{1 - \sum m_{ij} s_i}.$$

By construction, all the E^*_{ij} are zero if $E_{ij}/N_j = s_i$ for all i in state j. Such a case would arise if employment in the key industries represented the same proportions in the state as the nation. Otherwise, the E^*_{ij} will tend to be positive when $E_{ij}/N_j > s_i$ and negative when $E_{ij}/N_j < s_i$.

Once the nonrepresentative portions of the state economy are defined, the remaining state employment, T^*_j, is identical in composition to the national economy at some degree of aggregation:

(4) $$T^*_j = N_j - N^*_j + \sum \left(E_{ij} - E^*_{ij} \right).$$

With each state's economy divided into two parts, the total response of each state's employment to a change in oil prices, ΔT_j, can be represented as a combination of the national response, the responses of key industries, and multiplier effects as follows:

(5) $$\Delta T_j = T^*_j \frac{\Delta T}{T} + \sum E^*_{ij} \left(1 + m_{ij} \right) \frac{\Delta E_i}{E_i},$$

where summation is over i, $\Delta T/T$ represents the percentage change in total national employment resulting from a change in oil prices, and $\Delta E_i/E_i$ the percentage change in national employment in key industry i resulting from a change in oil prices.

Data and parameter values

Key industries. Although the procedure allows the use of any number of key industries, we follow Brown and Hill and limit the key industries to five. These include oil and gas extraction (Standard Industrial Classification code 13), coal extraction (code 12), oil field machinery (code 3533), petroleum refining (code 2911), and petrochemicals (codes 282 and 286). Employment in the remaining, non-key industries is assumed to respond uniformly to a change in oil prices.

The list of key industries does not include a number of industries that are directly affected by changing oil prices. Some of those ignored—such as pulp and paper; stone, clay, and glass; food processing; primary metals; electric utilities; and transportation—are important energy-using industries. Nevertheless, the list of key industries should be sufficiently complete to provide a good estimate of the effects that changing oil prices have on state employment. Empirically, the omitted industries are substantially less sensitive to oil prices than the included industries. In addition, many of the omitted industries are distributed more evenly across the states than are the key industries.

Employment data. We use the employment and earnings series produced by the Bureau of Labor Statistics, U.S. Department of Labor, as the basic data source for 1982 and 1992. Where this series lacks sufficient detail for the analysis, we supplement it with the annual employment and wages series produced by the Bureau of Labor Statistics and data obtained from the Independent Petroleum Association of America.

Employment data for 2000 are based on a DOE/DRI forecast.[3] We chose the DOE/DRI forecast because it provides sufficient detail for our analysis, is generally consistent with the consensus outlook for energy markets, and is often taken as a standard reference for analysis. The forecast shows U.S. employment increasing by almost 15 percent from 1992 to 2000, while employment in the key industries declines.

We follow the DOE forecast and allow for differences in employment growth across the nine U.S. census regions (as shown in *Table 2*).[4] The DOE projects that three regions—Mountain, South Atlantic, and West South Central—will grow more rapidly than the nation between 1992 and 2000. For the same time period, the DOE also projects, the Pacific region will grow at the same rate as the nation, and five regions—West North Central, East South Central, East North Central, New England, and Mid-Atlantic, will grow more slowly than the nation.

Table 2
Projected Employment Growth by Census Region, 1992–2000
(Percent)

United States	14.64
New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont)	10.08
Mid-Atlantic (New Jersey, New York, Pennsylvania)	10.08
East North Central (Illinois, Indiana, Michigan, Ohio, Wisconsin)	10.98
West North Central (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota)	14.33
South Atlantic (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia)	17.96
East South Central (Alabama, Kentucky, Mississippi, Tennessee)	11.14
West South Central (Arkansas, Louisiana, Oklahoma, Texas)	17.32
Mountain (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming)	20.44
Pacific (Alaska, California, Hawaii, Oregon, Washington)	14.64

SOURCE: U.S. Department of Energy.

Response of key industries

Brown and Hill estimated the long-run oil-price elasticities of employment in each key industry. They found elasticities of +1.01 for oil and gas extraction, +1.23 for oil field machinery, +0.45 for coal extraction, –0.56 for petroleum refining, and –0.32 for petrochemicals. We use these estimates to calculate the effects of changing oil prices on employment in the key industries nationwide.

Employment multipliers. The multipliers used in evaluating the employment effects are nonstandard. The multiplier for each key industry expresses the effect of a unit change in employment in the key industry on state employment in non-key industries while holding the output of other key industries constant. These multipliers allow us to treat the output from each of the key industries as exogenous while avoiding a double-counting of purchases that key industries make from each other.

We adapted the work of Brown and Hill to develop the requisite employment multipliers for each of the five key industries in each state (and the District of Columbia) for each of the three analysis years.[5] They used a special inversion of a 1979 Texas input–output table to obtain special private output multipliers as described in Appendix A. They converted these multipliers to special private employment multipliers for Texas by using the associated employment coefficients.

Following Brown and Hill, we develop total special employment multipliers for each state and the District of Columbia for each of the analysis years by adjusting the special private employment multipliers Brown and Hill developed for Texas. To do so, we use information on 1982 state input–output multipliers supplied by the Bureau of Economic Analysis (BEA) (1986) and employment in state and local government as follows:[6]

$$(6) \qquad m_{ij} = \left((M_i - 1)\left(\frac{r_{ij}}{r_{itx}}\right) + 1 \right) \frac{1}{1 - g_j} - 1,$$

where m_{ij} is the multiplier effect from key industry i into the non-key industries but not other key industries in state j, M_i is the special private employment multiplier for Texas, r_{ij} is the BEA's private employment multiplier for industry i in state j, r_{itx} is the BEA's private employment multiplier for industry i in Texas, and g_j is the share of total employment in state j accounted for by state and local government in the analysis year.

National employment response. Brown and Hill surveyed the major forecasting services to obtain a consensus estimate of the response of national employment to changing energy prices. They concluded that a drop in the price of oil from \$26.50 to \$21.50 per barrel would increase national employment by 0.4 percent. They implemented this relationship through a point elasticity between oil prices and national employment equal to –0.0193.

We adopt Brown and Hill's estimate of the oil price elasticity of national employment for 1982. Since that year, however, both energy prices and the energy-to-GDP ratio have declined. The likely consequence is that the U.S. economy has become somewhat less sensitive to changes in energy prices. Although we are unaware of any formal research that shows how the oil price sensitivity of the U.S. economy may have varied over time, discussions with a number of experts supports the view that U.S. economy has become less sensitive to oil price changes.

In the absence of formal estimates, we use a CES production function with parameter values drawn from the economics literature and information about energy prices and the energy-to-GDP ratio to calculate oil price elasticities of national employment for 1992 and 2000. We calibrated the function to reproduce the Brown–Hill estimate for 1982. We then input new prices and energy-to-GDP ratios to obtain estimates for 1992 and 2000. For 1992, we estimate the oil price elasticity of national employment to equal –0.0125. For 2000, the DOE/DRI forecast we have adopted yields an estimated oil price elasticity of national employment equal to –0.0120.[7]

Using the elasticities described above, we estimate that a permanent 10-percent increase in real oil prices would have resulted in a nationwide net employment loss of 165,000 jobs (0.18 percent) in 1982 and 129,000 jobs (0.12 percent) in 1992. In 2000, a permanent 10-percent increase in real oil prices is projected to result in a nationwide net employment loss of 142,000 jobs (0.11 percent).[8]

Oil prices shocks and state employment

We use the model and parameters described above to assess how diversification away from the key energy industries has and will affect each state's response to a change in oil prices. To do so, we simulate the employment consequences of a hypothetical 10-percent increase in oil prices in each of three years: 1982, 1992, and 2000.[9] Our simulations show that since 1982 the variance across states in the response of economic activity to oil price changes has declined. Our simulations further show that the narrowing is likely to continue through the end of the decade but at a slower rate.

State employment effects, 1982. In 1982, oil prices were $48.40 per barrel (in 1992 dollars). In that year, a 10-percent increase in the price of oil would have amounted to $4.84 per barrel. Such an increase would have led to employment losses of 165,000 nationwide (0.18 percent). Nonetheless, thirteen states would have gained employment for a combined total of 166,000 jobs (*Table 3*). The remaining thirty-seven states and the District of Columbia would have lost a combined employment of 331,000 jobs.

The estimated effects of higher oil prices vary considerably for 1982. The states most adversely affected by higher oil prices have high concentrations of employment in refining or petrochemicals (industries hurt by rising oil prices) and low concentrations of employment in coal, oil and gas extraction, and oil field machinery (industries helped by rising oil prices). The states helped by rising oil prices have high concentrations of employment in oil and gas extraction and oil field machinery. Many of these states also have relatively high concentrations of refining and petrochemicals, which partially offset the effects operating through the oil and gas extraction sector.

Coal mining is less important in driving the estimates because coal is not as sensitive to oil price changes as oil and gas extraction or oil field machinery and has smaller multipliers than refining or petrochemicals. Nonetheless, the extremely high concentrations of coal mining lead to estimated employment gains in West Virginia. Relatively high concentrations of coal mining also contribute to estimated employment gains in Wyoming.

Table 3
Estimated Effects of a 10-Percent Increase in Oil Prices On 1982 Nonagricultural Employment
(Percent)

United States	–.18		
Delaware	–2.51	South Dakota	–.38
South Carolina	–.85	Connecticut	–.38
New Jersey	–.73	Arizona	–.38
Tennessee	–.67	Ohio	–.37
North Carolina	–.61	Maine	–.36
Missouri	–.53	Alabama	–.35
Virginia	–.50	Maryland	–.34
New Hampshire	–.49	Nevada	–.33
Hawaii	–.47	California	–.33
Massachusetts	–.45	Nebraska	–.32
New York	–.44	District of Columbia	–.31
Pennsylvania	–.43	Arkansas	–.23
Minnesota	–.43	Kentucky	–.07
Washington	–.43	Utah	.02
Wisconsin	–.42	Mississippi	.03
Iowa	–.42	Kansas	.16
Indiana	–.42	North Dakota	.30
Oregon	–.42	West Virginia	.31
Rhode Island	–.42	Montana	.32
Illinois	–.41	Colorado	.44
Michigan	–.40	Alaska	.56
Florida	–.39	New Mexico	.83
Idaho	–.39	Louisiana	1.35
Georgia	–.39	Texas	1.37
Vermont	–.39	Oklahoma	2.91
		Wyoming	3.03

States between the extremes tend to have more balanced concentrations of all industries. Those states in which the five key industries have smaller shares than the national average but appear in the same proportions to each other as they do in the nation are hurt more by rising oil prices than the nation as a whole. Conversely, those states in which the five key industries have larger shares than the national average but appear in the same proportions to each other as they do in the nation are hurt less by rising oil prices than the nation as a whole.

State employment effects, 1992. In 1992, oil prices were $18.20 per barrel (in 1992 dollars). In that year, a 10-percent increase in the price of oil would have amounted to $1.82 per barrel. Such an increase would have led to employment losses of 129,000 nationwide (0.12 percent). Nine states would have gained 68,000 jobs (*Table 4*).[10] The remaining forty-one states and the District of Columbia would have lost a combined employment of 197,000 jobs.

By 1992, Montana, Utah, Mississippi, and West Virginia would no longer have gained employment from higher oil prices. Between 1982 and 1992, employment in coal mining, oil and gas extraction, and oil field machinery declined enough in these states such that the prospective gains in these industries resulting from higher oil prices could no longer offset the losses in other sectors of the states' economies.

A comparison of estimates for 1982 and 1992 indicates that states became increasingly similar in the response to a change in oil prices. At the extremes, 10-percent higher oil prices would have reduced employment by 2.51 percent in Delaware and increased employment by 2.91 percent in Oklahoma and 3.03 percent in Wyoming in 1982. In 1992, the same increase would have yielded extremes of –1.86 percent in Delaware, 0.95 percent in Oklahoma, and 1.40 percent in Wyoming. We find the employment-weighted variance of the response across states to be 0.4598 in 1982 and 0.0749 in 1992.[11]

Alaska is one state that countered the pattern of convergence. Higher oil prices would have meant a 0.56-percent increase in employment during 1982 and a 0.66-percent increase in 1992. With new finds in Alaska in the 1980s, Alaskan oil production peaked in 1988, and the oil industry continued to thrive in the 1980s despite lower oil prices.

State employment effects, 2000. For 2000, DOE projects oil prices will be $20.70 per barrel (in 1992 dollars). In 2000, a 10-percent increase in the price of oil would amount to $2.07 per barrel. Such an increase would lead to employment losses of 142,000 nationwide (0.11 percent). Eight states would gain 46,000 jobs (*Table 5*).[12] The remaining forty-two states and the District of Columbia would lose a combined employment of 197,000 jobs.

Table 4
Estimated Effects of a 10-Percent Increase in Oil Prices On 1992 Nonagricultural Employment
(Percent)

United States	–.12		
Delaware	–1.86	Florida	–.16
South Carolina	–.47	Oregon	–.16
Tennessee	–.37	Idaho	–.15
New Jersey	–.36	Nevada	–.15
North Carolina	–.28	Alabama	–.14
Virginia	–.24	Wisconsin	–.14
Pennsylvania	–.22	Arizona	–.14
Illinois	–.22	South Dakota	–.14
Ohio	–.22	Maine	–.13
Missouri	–.22	Maryland	–.12
Hawaii	–.22	Kentucky	–.12
Minnesota	–.21	Nebraska	–.11
Rhode Island	–.21	Mississippi	–.10
New Hampshire	–.19	Montana	–.06
Indiana	–.19	West Virginia	–.06
Massachusetts	–.19	Arkansas	–.05
Michigan	–.19	Utah	–.05
New York	–.18	Kansas	.03
Washington	–.18	Colorado	.09
Connecticut	–.17	North Dakota	.14
Vermont	–.17	New Mexico	.44
Georgia	–.16	Louisiana	.53
California	–.16	Texas	.53
Iowa	–.16	Alaska	.72
District of Columbia	–.16	Oklahoma	.95
		Wyoming	1.40

The pattern of diminished oil price effects and variance across states is repeated in 2000. In 1992, 10-percent higher oil prices would have reduced employment by 1.86 percent in Delaware and increased employment by 0.95 percent in Oklahoma and 1.40 percent in Wyoming. By 2000, the same increase is projected to yield extremes of –1.54 percent in Delaware, 0.58 percent in Oklahoma, and 0.94 percent in Wyoming. We find the employment-weighted variance of the response across states to be 0.0749 in 1992 and 0.0360 in 2000.[13]

Converging state employment effects, 1982 to 2000. Although the variance in the response to oil prices across states is projected to diminish from 1992 and 2000, the rate of convergence is less than that from 1982 to 1992. In 1982, oil prices were near record highs and the domestic oil and gas industry was at its peak. In the early 1980s, the energy-consuming states diversified away from energy-intensive industries and

Table 5
Estimated Effects of a 10-Percent Increase in Oil Prices On 2000 Nonagricultural Employment
(Percent)

United States	–.11		
Delaware	–1.54	Florida	–.13
South Carolina	–.39	Nevada	–.13
New Jersey	–.32	Oregon	–.12
Tennessee	–.31	Idaho	–.12
North Carolina	–.23	Alabama	–.12
Virginia	–.20	Wisconsin	–.12
Pennsylvania	–.19	Arizona	–.11
Ohio	–.19	South Dakota	–.11
Illinois	–.19	Maryland	–.10
Missouri	–.18	Maine	–.10
Hawaii	–.18	Mississippi	–.10
Rhode Island	–.17	Kentucky	–.09
Minnesota	–.17	Nebraska	–.09
Michigan	–.16	West Virginia	–.08
Massachusetts	–.16	Montana	–.07
Indiana	–.16	Arkansas	–.06
New Hampshire	–.16	Utah	–.06
New York	–.16	Kansas	–.00
Washington	–.16	Colorado	.04
Connecticut	–.15	North Dakota	.08
California	–.14	New Mexico	.27
Vermont	–.14	Louisiana	.28
District of Columbia	–.14	Texas	.30
Georgia	–.13	Alaska	.49
Iowa	–.13	Oklahoma	.58
		Wyoming	.94

learned to conserve. As consumption fell, oil prices slipped and then crashed. Falling oil prices encouraged the energy-producing states to diversify away from energy industries. By 1992, the variance across states in response to changing oil prices had narrowed substantially.

For the 1990s, DOE projects less dramatic price changes than occurred in the 1980s. The implied impetus for diversification away from energy-related industries is thus weaker. It follows that the projected convergence will be less in the 1990s than it was in the 1980s.

Summary and conclusions

Changes in energy prices have had sizable but different effects on economic activity across states. The industrial composition of a state's economy determines the employment response to a change in energy prices. Our simulations show that as the states diversify away from energy-intensive and energy-producing industries, the variation across states in the response of economic activity to oil price changes is lessening.

During the 1980s, volatile oil prices helped erode the prominence of energy-intensive and energy-producing industries in nearly every state's economy. The consequence was reduced sensitivity to oil price changes and less variation across states in the response to changing oil prices. Without further impetus from volatile oil prices, industries sensitive to oil prices are likely to become only slightly less prominent during the remainder of the 1990s. Therefore, the rate at which states are becoming similar in their response to oil price changes is likely to moderate.

Nonetheless, the variance of energy-sensitive industries across states is projected to continue falling in the 1990s. This continuing convergence is likely to further reduce the differences in states' response to changing energy prices. In doing so, it could also further lessen the interregional divisiveness that has characterized past debate on national energy policy.

Notes

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1 For all but one of the industries, the decline in variance is a size effect. Only the data for coal mining show a decline in the coefficient of variation from 1982 to 1992. Of these measures, variance more closely represents the range of influence across states.

2 The composition of the state's economy is identical to that of the nation at a degree of aggregation that is inversely related to the number of key industries.

3 See Energy Information Administration (1994a and 1994b) and DRI/McGraw–Hill (1994).

4 See Energy Information Administration (1994b).

5 Multiplier effects arise because industries purchase inputs from one another and consumers use their income to purchase goods and services. States with less diverse economies generally have lower multiplier effects because subsequent purchases quickly leak out to other states. Use of state-specific multipliers accounts for the differences in leakages across states but does not account for the corresponding injections that the exporting states enjoy. The exporting states are likely to be substantially larger than the nondiverse states; therefore, a total accounting may not be crucial to the analysis.

6 A 1986 input–output table is available for Texas. We use a 1979 input–output table for Texas because it is most consistent with the 1982 input–output multipliers provided by the BEA.

7 Because this procedure to estimate elasticities is ad hoc, we also consider cases in which the oil price elasticity of U.S. employment remains constant at –0.0193. We find that the assumed value of the national elasticity affects the level of each state's

response to oil prices but does not substantially alter the variance across states. See Appendix B.

8 Under the assumption that the oil price elasticity of U.S. employment is maintained at –0.0193 for 1992 and 2000, we estimate a 10-percent increase in real oil prices would have resulted in a nationwide employment loss of 200,000 jobs in 1992 and would result in a nationwide employment loss of 228,000 jobs in 2000.

9 Because the model operates on constant price elasticities, a constant percentage increase in prices maintains comparability across years.

10 Only eight states would benefit from higher oil prices if we assume that the national economy remained as sensitive to oil prices in 1992 as it was in 1982. See Appendix B.

11 The variation across states is not simply a size effect. The coefficients of variation for 1982 and 1992 are –378.04 and –241.95, respectively.

12 Only seven states would benefit from higher oil prices if we assume that the national economy remains as sensitive to oil prices in 2000 as it was in 1982. See Appendix B.

13 The coefficients of variation are –241.95 for 1992 and –172.27 for 2000.

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Appendix A

Developing Special Output Multipliers

The analysis presented in the body of the article requires special output multipliers. Each special multiplier represents the effect of a unit change in the output of a key energy industry on the output in non-key industries while holding the output of other key energy industries constant. These multipliers allow us to treat the output from each of the key industries as exogenous while avoiding the double-counting of purchases that key industries make from each other.

Each industry i must produce enough output to satisfy both final demand and meet the input requirements of all industries as follows:

(A.1) $$x_i = d_i + \sum_{j=1}^{n} a_{ij} x_j \qquad i = 1,2,\ldots,n.$$

In the above equation, x_i is the output of industry i, d_i is the final demand for goods produced in industry i, a_{ij} indicates how much of industry i's output is used to produce each unit of industry j's output, and n is the number of industries.

If we treat the first g industries as the key energy industries for which output is exogenous, the equations described in A.1 can be divided into two groups by placing all endogenous variables on the left-hand side and all exogenous variables on the right-hand side of each equation as follows:

(A.2) $$-d_i - \sum_{j=g+1}^{n} a_{ij} x_j = x_i + \sum_{j=1}^{g} a_{ij} x_j \qquad i = 1,2,\ldots,g, \text{ and}$$

(A.3) $$x_i - \sum_{j=g+1}^{n} a_{ij} x_j = d_i + \sum_{j=1}^{g} a_{ij} x_j \qquad i = g+1,\ldots,n.$$

In matrix notation, equations A.2 and A.3 are rewritten as

(A.4) $$-\boldsymbol{D_g} - \boldsymbol{A_{g,n-g}} \boldsymbol{X_{n-g}} = -\left[\boldsymbol{I_g} - \boldsymbol{A_g}\right]\boldsymbol{X_g}, \text{ and}$$

(A.5) $$\left[\boldsymbol{I_{n-g}} - \boldsymbol{A_{n-g}}\right]\boldsymbol{X_{n-g}} = \boldsymbol{D_{n-g}} + \boldsymbol{A_{n-g,g}}\boldsymbol{X_g}.$$

In the above equations, $\boldsymbol{D_g}$ and $\boldsymbol{D_{n-g}}$ are vectors of the final demands for output from the key energy industries and non-key industries respectively, $\boldsymbol{A_{g,n-g}}$ and $\boldsymbol{A_{n-g}}$ are arrays of input coefficients relating the outputs of the non-key industries to the inputs required from the key industries and the non-key industries, respectively, $\boldsymbol{X_g}$ and $\boldsymbol{X_{n-g}}$ are vectors of the output from the key and non-key industries, respectively, $\boldsymbol{I_g}$ and $\boldsymbol{I_{n-g}}$ are identity matrices, and $\boldsymbol{A_g}$ and $\boldsymbol{A_{n-g,g}}$ are arrays of input coefficients relating the output of key industries to the inputs required from the key industries and the non-key industries, respectively.

Combining A.4 and A.5 yields:

(A.6) $$\begin{bmatrix} -\boldsymbol{I_g} & -\boldsymbol{A_{g,n-g}} \\ \boldsymbol{0_{n-g,g}} & \boldsymbol{I_{n-g}} - \boldsymbol{A_{n-g}} \end{bmatrix} \begin{bmatrix} \boldsymbol{D_g} \\ \boldsymbol{X_{n-g}} \end{bmatrix} = \begin{bmatrix} -\boldsymbol{I_g} + \boldsymbol{A_g} & \boldsymbol{0_{g,n-g}} \\ \boldsymbol{A_{n-g,g}} & \boldsymbol{I_{n-g}} \end{bmatrix} \begin{bmatrix} \boldsymbol{X_g} \\ \boldsymbol{D_{n-g}} \end{bmatrix}.$$

In the equation A.6, $\boldsymbol{0_{n-g,g}}$ and $\boldsymbol{0_{g,n-g}}$ are arrays of zeros.

Equation A.6 can be rewritten to express the endogenous variables as a function of the exogenous variables and the input coefficients as follows:

(A.7) $$\begin{bmatrix} \boldsymbol{D_g} \\ \boldsymbol{X_{n-g}} \end{bmatrix} = \begin{bmatrix} -\boldsymbol{I_g} & -\boldsymbol{A_{g,n-g}} \\ \boldsymbol{0_{n-g,g}} & \boldsymbol{I_{n-g}} - \boldsymbol{A_{n-g}} \end{bmatrix}^{-1} \begin{bmatrix} -\boldsymbol{I_g} + \boldsymbol{A_g} & \boldsymbol{0_{g,n-g}} \\ \boldsymbol{A_{n-g,g}} & \boldsymbol{I_{n-g}} \end{bmatrix} \begin{bmatrix} \boldsymbol{X_g} \\ \boldsymbol{D_{n-g}} \end{bmatrix}.$$

An alternative approach is to recognize that equation A.5 shows the output vector of non-key industries, $\boldsymbol{X_{n-g}}$, strictly as a function of exogenous variables and parameters. Equation A.5 can be rewritten to express the output of the non-key industries as a function of the exogenous variables and the input coefficients as follows:

(A.8) $$\boldsymbol{X_{n-g}} = \left[\boldsymbol{I_{n-g}} - \boldsymbol{A_{n-g}}\right]^{-1}\left[\boldsymbol{D_{n-g}} + \boldsymbol{A_{n-g,g}}\boldsymbol{X_g}\right].$$

Combining equations A.8 and A.4 yields the following expression for the final demand for output from the key energy industries:

(A.9) $$\boldsymbol{D_g} = \left[\boldsymbol{I_g} - \boldsymbol{A_g}\right]\boldsymbol{X_g} - \boldsymbol{A_{g,n-g}}\left[\left[\boldsymbol{I_{n-g}} - \boldsymbol{A_{n-g}}\right]^{-1}\left[\boldsymbol{D_{n-g}} + \boldsymbol{A_{n-g,g}}\boldsymbol{X_g}\right]\right].$$

The special output multipliers associated with each key energy industry (i=1, 2,..., g) can be obtained from A.7 or A.8. Take total derivatives of either expression with respect to x_i and combine as follows:

(A.10) $$M_i = 1 + \sum_{j=g+1}^{n} \partial x_j / \partial x_i \qquad i = 2,\ldots,g.$$

Throughout the analysis, g determines the number of key industries—those for which output is treated as exogenous. For all values of g, output multipliers for each of the key energy industries include purchases from non-key industries but exclude purchases from other key industries. For g=1, the procedures outlined above yield a standard output multiplier that includes purchases from all other industries.

Appendix B

Estimated Effects of Oil Price Increases with a Constant National Response

Tables B1 and B2 present alternate estimates of the effects of a 10-percent increase in oil prices for 1992 and 2000. These estimates are made under the assumption that the national employment response remains at the 1982 value of 0.18 percent.

Table B1

Estimated Effects of a 10-Percent Increase in Oil Prices On 1992 Nonagricultural Employment

(Percent)

United States	**–.18**				
Delaware	–1.89	New York	–.25	Maryland	–.19
South Carolina	–.53	Washington	–.25	Nebraska	–.18
Tennessee	–.43	Connecticut	–.24	Kentucky	–.18
New Jersey	–.43	Vermont	–.24	Mississippi	–.17
North Carolina	–.35	Georgia	–.23	Montana	–.12
Virginia	–.30	California	–.23	Arkansas	–.12
Pennsylvania	–.29	Iowa	–.23	Utah	–.12
Illinois	–.29	Oregon	–.22	West Virginia	–.11
Ohio	–.29	Florida	–.22	Kansas	–.04
Missouri	–.28	District of Columbia	–.22	Colorado	.02
Hawaii	–.28	Idaho	–.22	North Dakota	.07
Minnesota	–.28	Nevada	–.22	New Mexico	.38
Rhode Island	–.27	Wisconsin	–.21	Louisiana	.47
New Hampshire	–.26	Alabama	–.21	Texas	.48
Indiana	–.26	Arizona	–.21	Alaska	.66
Massachusetts	–.26	South Dakota	–.20	Oklahoma	.90
Michigan	–.25	Maine	–.20	Wyoming	1.34

Table B2

Estimated Effects of a 10-Percent Increase in Oil Prices On 2000 Nonagricultural Employment

(Percent)

United States	**–.18**				
Delaware	–1.57	Washington	–.23	Maryland	–.18
South Carolina	–.45	New York	–.23	Mississippi	–.17
New Jersey	–.39	Connecticut	–.22	Nebraska	–.17
Tennessee	–.38	California	–.21	Kentucky	–.16
North Carolina	–.30	Vermont	–.22	Montana	–.14
Virginia	–.26	District of Columbia	–.21	West Virginia	–.14
Pennsylvania	–.26	Georgia	–.21	Arkansas	–.13
Ohio	–.26	Iowa	–.20	Utah	–.13
Illinois	–.26	Florida	–.20	Kansas	–.07
Missouri	–.25	Nevada	–.20	Colorado	–.03
Hawaii	–.25	Oregon	–.20	North Dakota	.01
Rhode Island	–.24	Idaho	–.20	New Mexico	.20
Minnesota	–.24	Alabama	–.19	Louisiana	.22
Michigan	–.23	Wisconsin	–.19	Texas	.24
Massachusetts	–.23	Arizona	–.18	Alaska	.43
New Hampshire	–.23	South Dakota	–.18	Oklahoma	.52
Indiana	–.23	Maine	–.18	Wyoming	.88