Labor Regulation and the (In)efficient (Re)allocation of Resources: Using Energy Shocks to Measure Growth Opportunities*

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Abstract

We study the responsiveness of firms to growth opportunities as a function of state-level labor regulation. We identify growth opportunities using a new approach, utilizing changes in energy prices during the 1970s and 1980s interacted with an industry's intensity of use of energy as an input. First, we show that the interaction of energy intensity and energy price is highly predictive of sales and employment growth, as well as investment, suggesting that this interaction is a credible proxy for growth opportunities. Based on this result, we then examine the effect of Right to Work laws on industry responsiveness to growth opportunities. Consistent with Right to Work legislation reducing labor market frictions, we find that employment growth responds more to growth opportunities in Right to Work states; the opposite pattern holds for capital investment, as predicted by a model with substitutability between capital and labor.

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INSTITUTIONS AND THE EFFICIENT (RE)ALLOCATION OF RESOURCES

1. Introduction

There is increasing consensus that institutions are an important determinant of economic growth (see, for example, Djankov, La Porta, Lopes-de-Silanes, and Shleifer (2003a,b)). One often emphasized mechanism by which the institutional environment is conjectured to affect economic development is through the role of institutions in resource allocation. This function has been emphasized, in particular, in the finance literature (See, for example, Rajan and Zingales (1998) and Fisman and Love (2003a)). A constant difficulty, however, is assessing what constitutes 'efficient allocation.' Rather than considering static allocations, one potential approach is to consider the response to growth opportunities: If an economy reallocates resources appropriately in reaction to such shocks, these opportunities should translate into actual growth. Hence, one wishes to examine the extent to which growth opportunities translated in *actual* growth, as a function of the institutional environment, and also the form (e.g., investment in new capital versus the hiring of new workers) that firms use to increase output. While actual growth is directly observable, growth opportunities are not. In this paper, we propose a methodology for measuring *differences* in growth opportunities across sectors, and apply this methodology to examine how states within the U.S. respond to these differential growth opportunities as a function of labor institutions. Thus, we make two contributions: We generate a plausible, exogenous, and observable measure of growth opportunities, and we utilize this measure in examining the role of labor institutions in the resource allocation process.

Our approach stems from the observation that while an increase in factor prices will be a shock to the cost structure of manufacturing firms in general, the effect will be particularly acute for firms with a high degree of dependence on that factor. In our case, we focus on energy costs, a specific factor that is a large cost component of many industries, and where the degree of industry specificity is high (as a function of the 'heaviness' of the industry; see Davis and Haltiwanger 2001)). Thus, we observe that the growth opportunities of energy-dependent industries should be *relatively* severely affected by high energy prices. This allows us to credibly identify differences in growth opportunities across industries, based on the interaction of energy prices and industry-level energy dependency: the growth opportunities of energy dependent industries will be *relatively* lower when energy prices are higher. Therefore, in an environment where resource (re)allocations are made efficiently, we should see relatively fewer resources devoted to these sectors. The first contribution of our paper is to show that the interaction of energy prices and energy dependency is a very strong predictor of cross-industry sales growth during 1972 – 1992, a period of large shifts in energy prices.

We then illustrate the application of this measure of growth opportunities to study how labor institutions influence the resource allocation process. Our findings on the effects of Right to Work laws suggest a distortion in the way in which firms respond to growth opportunities: Institutions that make labor reallocation difficult (such as the absence of Right to Work laws) lead to a lower response in employment to growth opportunities generated by energy price shifts. Furthermore, we find the *opposite* effect on capital investment: In states with high labor regulation, there is a larger effect on capital formation in response to growth opportunities.

Our approach draws from a couple of earlier literatures. The methodology we employ is motivated by earlier work on the impact of oil shocks on economic activity. We build most directly upon Davis and Haltiwanger (2001) who document the differential responses of different types of industries to oil shocks. Rather than documenting the determinants of these differential responses, however, we *utilize* these differences to uncover differential growth opportunities. Balke, Brown, and Yucel (2002) use a vector-autoregressive process to investigate the asymmetric response of the macro economy to oil price shocks.

We also contribute to the literature on the role of institutions in the economic development process. There are a number of cross-country studies that correlate various institutional characteristics, such as regulation or legal origin, with social outcome variables such as the level of corruption or economic growth (see, for example, Djankov, La Porta, Lopes-de-Silanes, and Shleifer (2003a,b)). We share with this literature an interest in the impact of institutions on economic outcomes, but our approach is less vulnerable to problems of unobserved heterogeneity that affect such cross-country correlations. The work of Rajan and Zingales (1998) and the many related papers that have followed are closer to our approach, in taking advantage of variation both across industries and across countries to identify the role of institutions in shaping the composition of economic activity. However, this literature has largely looked at variation across countries, and has grappled with the difficulty of measuring growth opportunities in a credible manner (See Fisman and Love, 2003a and 2003b, for two approaches).

The rest of this paper will proceed as follows: in Section 2, we describe the data; Section 3 will lays out our econometric and theoretical framework; Section 4 presents our results; and we conclude in Section 5.

2. Data

In this section, we provide an overview of our data sources. Appendix A lists the variables and their sources in greater detail.

2.1 Energy Costs and Growth Opportunities

In order to measure growth opportunities using energy prices, we require data on both energy prices faced by firms, as well as a measure of the relative importance of energy as an input. Our energy data come from the U.S. Department of Energy[1], and represent the price for industrial customers in dollars per million BTU's (in current dollars), taken over all sources of energy. The average price level by state is listed in Table 1 Note that there is a high degree of heterogeneity across states in energy prices, and this variation may to a large extent be attributable to a state's physical endowment rather than price regulation. For example, coal-producing states, such as West Virginia and Wyoming, have energy prices that are consistently lower than the national average (ranking fifth and sixth respectively in average energy price), owing to the high cost of transporting coal. We observe similar patterns for states naturally endowed with gas, oil, and hydro electricity. Our data on manufacturing activity cover the years 1972-92. (Although data is available for 1997, the discontinuity caused by the Census Bureau's transition from SIC industry coding to NAICS industry coding in that year rendered the 1997 data incompatible with those of previous years.), and in Figure 1 we show average energy prices over those years. Since these years cover the oil crisis and the subsequent recovery, this period offers a particularly rich testing ground for our approach.

To assess individual industries' relative reliance on energy as an input, we utilize the Compustat dataset, which contains information on firms' expenditures on electricity and fuel consumption. We deflate these expenditures by value added, and take the median ratio over all firms in a given 3-digit SIC classification, using data from 1996.[2] In Table 2 we list energy intensity, collapsed to the 2-digit SIC level of aggregation. The ordering appears sensible, with

[1] See http://www.eia.doe.gov/emeu/states/_price_multistate.html.

[2] As an alternative measure of energy intensity, we deflate by total costs of production; we find that this leads to nearly identical results, in terms of both the statistical significance and magnitudes of the coefficients.

Printing and Publishing (SIC 27) and Instruments (SIC 38) as the industries with the lowest energy requirements, and Pulp and Paper (SIC 26), Stone, Clay, and Glass Products (SIC 32), and Basic Metals (SIC 36) as the industries with the highest rates of energy usage.

2.2 Industry Production and Output

Our data on industry production and output are derived from data reported in the U.S. Census of Manufactures. We will be primarily interested in measuring sectoral growth, in terms of output, as well as the input choices that drive this growth. We use the value of shipments as our measure of sector size, and consider capital and labor as the two primary inputs into production.[3] Since we are using census data, we are limited to quintennial data; we do not view this as a significant limitation, since we are more interested in longer-term adjustments to growth opportunities; furthermore, as Figure 1 illustrates, the quintennial observations are in years such that they pick up much of the variation in energy prices generated by the oil shock of the 1970s. Our outcome measures for labor and value of shipments are 5-year growth rates for each of these variables, at the state-year level, at the 3-digit SIC level of aggregation. For growth in capital, since we do not have a measure of capital stock by industry, it is not possible to construct a precisely analogous series for capital. Instead, we calculate the proportion of new capital (gross fixed capital, or GFC) in a state that is created in a given industry. Thus, our measure of growth in capital stock is given by:

$$Gr(K_{sit}) = \frac{GFC_{sit}}{\sum_{i \in I} GFC_{sit}}$$

For growth in labor and employment, we have four observations per state-industry (1972, 77, 82, and 87). Since GFC is an inherently forward-looking flow variable, we do not lose 1992 as an observation; thus, there are five observations per state-industry for this variable.[4]

[3] See Appendix A for details on variable construction.
[4] For the purposes of consistency, we could omit observations on GFC for 1992; this approach marginally increases the magnitude and significance of the coefficients reported below.

2.3 Labor Market Institutions: Right to Work Laws

A labor market institution that has been used as a measure of labor market flexibility is the existence of Right to Work laws. Right to Work laws, discussed in greater detail in Holmes (1998), a Right to Work law gives employees the right to decide individually whether or not to join or financially support a union. That is, it bans a workplace where all employees are required to join a union. Our Right to Work variable is a dummy variable reflecting whether a state had a Right to Work law in place in that year. There are only two states that adopt Right to Work laws during our sample period, so our variation in this variable is primarily cross-sectional.

3. Methodology

3.1 The Basic Econometric Framework

We are interested in estimating the effect of energy prices (E) on a range of industry-level outcomes (Y), such as investment, employment, and wage growth. In particular, we will consider the effect of these prices on outcomes in energy-intensive sectors relative to less energy-intensive sectors, which correspond to the extent and means by which a state responds to growth opportunities. The simplest specification one could imagine measures the correlation between energy prices and the outcome of interest, and allows this effect to vary with the energy intensity of the sector:

$$Y_{sit} = a + bE_{it} + gE_{it}I_s + dI_s + e_{sit} \qquad (1)$$

where the indices are industry (s), state (i), and year (t), E_{it} measures energy prices by state and year, I_s measures the energy intensity of each sector, and e_{sit} is an error term. The coefficient of interest in this specification is g, which measures the differential response of energy-intensive sectors to energy prices, and in this sense measures the extent to which a sector efficiently responds to changes in its growth opportunities. If growth opportunities in energy intensive sectors are more affected by energy prices, then g should be negative in an economy that efficiently reallocates resources in response to differential opportunities across sectors.

The chief difficulty in interpreting specification (1) is the possibility of other variables that could be spuriously correlated with either energy prices or energy intensity. For example, if less energy intensive sectors tend to be located in the South, and Southern states also experienced other shocks coincident with energy prices in this period (e.g., migration) then we would be misinterpreting g. To address this concern, we introduce a series of industry, state, and year fixed effects into the specification. In particular, we consider:

$$Y_{sit} = a_{1s} + a_{2i} + a_{3t} + bE_{it} + gE_{it}I_s + e_{sit}, \qquad (2)$$

and

$$Y_{sit} = a_{1st} + a_{2i} + gE_{it}I_s + e_{sit}. \qquad (3)$$

Specification (2) allows us to control for unobserved state (time-invariant) shocks, time-varying national-level shocks, and industry shocks that could confound our interpretation of g. A limitation of this specification, that keeps the OLS specification (1) a natural starting point, is that the direct effect of energy intensity is absorbed by the industry fixed effects. However, given that our coefficient of interest is g, we are interested in confirming that it is robust to additional controls. Specification (3) is even more powerful in controlling for other unobserved factors that could be concatenated in our interpretation of g. In (3) we control not only for industry-specific differences, but also for all shocks at the state-year level. Except for within state-year shocks that vary by industry, we may conclude that g indeed measures the differential response of energy intensive industries to energy prices. It is worth noting that even if there were sector-variant, within state-year shocks that were ignored, these would need to be correlated with the energy price-energy intensity interaction within a state-year cell to bias our interpretation of g.

Our substantive interest in this paper is to examine how state-level labor market institutions affect industry response to changes in growth opportunities. Consequently, we are interested in how the energy price-energy intensity gradient varies across states with changes in the regulatory environment. In particular, we consider the following two specifications:

$$Y_{sit} = a_{1s} + a_{2i} + a_{3t} + bE_{it} + g_1E_{it}I_s + g_2E_{it}I_sR_{it} + e_{sit} \qquad (2')$$

and

$$Y_{sit} = a_{1s} + a_{2it} + g_1E_{it}I_s + g_2E_{it}I_sR_{it} + e_{sit}, \qquad (3')$$

where R_{it} measures some element of labor market institutions within a state that impacts the ability of firms to respond to growth opportunities. The interest at this point is in learning whether states with, for example, strong unions respond more or less (or indeed even in the same direction) as states with weak unions in terms of investment, employment, wages, etc. Hence we are primarily interested in g_2.

Again, in keeping with our discussion above, the use of fixed effects in these two specifications insulates us against a range of other variables that could confound our interpretation of g_2. Indeed, with our interest in the triple interaction, any omitted variable would have to be correlated with the energy price-energy intensity- regulatory gradient within state-year cells. Though we are confident that our fixed effects strategy controls for most alternative interpretations, we discuss this issue further below.

Finally, we do not believe that serial correlation is a significant problem for the outcomes we are examining. Investment, growth of wages and growth of employment are inherently forward-looking or flow variables. Heteroskedasticity is, however, a more serious concern. We address this concern, and also potential serial correlation, by allowing for an arbitrary variance-covariance structure to e_{sit} within states.

To generate predictions on the effects of energy prices on inputs into production, we consider a three-factor framework. We think of energy-intense sectors being those that have a high degree of complementarity between energy and the two other inputs, labor and capital. In these sectors, we anticipate a lower rate of investment and growth of employment in response to a change in energy prices, relative to energy non-intensive sectors. In other words, we anticipate that $g<0$.

Within this framework, consider a measure of labor market rigidity, R_{st}, which increases the cost of adjusting output through changing the supply of labor. In terms of the data that we utilize here, we will use (the inverse of) Right to Work laws as our proxy for R_{st}. The simplest way to think of the labor market rigidity is increasing the effective wage rate and consequently the price of labor relative to capital. Consequently we anticipate that, in response to changes in growth opportunities, the change in labor demand is weaker if R_{st} is high; the opposite pattern is predicted for the demand for capital. The intuition is straightforward: If labor institutions differentially increase the cost of adjustment to shocks for employment relative to capital, we expect more sensitivity in capital expenditures than employment in high labor regulation environments. Finally, since regulation in general is adding friction to the industry adjustment process, we expect a lesser overall sectoral response to changes in growth opportunities. This suggests the following set of regressions:

$$Gr(L)_{sit} = a_{1s} + a_{2i} + a_{3t} + bE_{it} + g_1 E_{it} I_s + g_2 E_{it} I_s R_{it} + e_{sit} \quad (4)$$

$$Gr(K)_{sit} = a_{1s} + a_{2i} + a_{3t} + bE_{it} + g_1 E_{it} I_s + g_2 E_{it} I_s R_{it} + esi \quad (5)$$

$$Gr(S)_{sit} = a_{1s} + a_{2i} + a_{3t} + bE_{it} + g_1 E_{it} I_s + g_2 E_{it} I_s R_{it} + esi \quad (6)$$

In these regressions, K represents the industry capital stock, L total industry employment, and S total industry sales, each in state s at time t. We thus conjecture that $g_2 > 0$ in (4) and (6), and $g_2 < 0$ in (5). As discussed in the data section, since we do not have capital stock data by industry, we use the proportion of investment in a given sector as a fraction of total investment across all sectors in a state-year, as a measure of $Gr(K)_{sit}$.

4. Results

4.1Does Energy Intensity Interacted with Energy Price Proxy For Growth Opportunities?

We begin by considering whether the response of energy-intensive firms to changes in energy prices reasonably proxies for changes in growth opportunities. In particular, we estimate specifications (1) – (3), for two measures of realized growth, growth of employment, growth of shipments, as well as an investment-based measure of reaction to growth opportunities, the rate of new capital expenditure.[5]

Our results are presented in Tables 3a-3d. For the growth of employment (Table 3a), in the OLS specification we find that energy intensity and energy prices are negatively associated with employment growth; neither effect is significant. The coefficient of interest, the interaction of energy prices and energy intensity, is negative and significant at the 10 percent level. In column (2), when we allow for state, year, and SIC fixed effects the magnitude of interaction term increases and is now significant at the 5 percent level. This suggests that employment growth among energy-intensive firms slows in response to energy prices shocks (relative to less energy-intensive firms).

[5] Growth in value added would also be a useful variable to consider. However, the expenses that are subtracted from the value of shipments in order to calculate value added includes energy costs, which pollutes the interpretation of changes in sector size. Regressions with value added as the dependent variable, similar to those in 3a and 3b, also yielded negative coefficients on the interaction term, but the standard errors were very large, and the coefficients were not significant at conventional levels.

In Table 3b we examine the response of the value of shipments. For growth in the value of shipments, the direct effect of energy intensity is positive, and the direct effect of energy prices is negative; both effects are significant, the latter at the one percent level. The interaction effect is negative, and significant at the one percent level. When we include state, year, and SIC fixed effects the sign, significance, and magnitude of the interaction effect remain robust. By contrast, the direct effect of energy prices switches signs, and is now positive and significant. This suggests that state and year fixed effects in the dependent variable are positively correlated with movement in energy prices; once we have controlled for these, the partial effect of energy prices changes substantially. In terms of magnitudes, for a sector at the 75th percentile of energy intensity (Textile Mill Products, SIC 22), value of shipments grew 5 percent more slowly than for a firm at the median level of energy intensity. The interaction term is robust to the inclusion of state-year fixed effects in both magnitude and significance, and to the exclusion of outliers.

In Table 3c, we present our results for the rate of new capital expenditure. To the extent that investment is a forward-looking activity, we are examining the extent to which energy-intensive firms respond to reduced growth opportunities by scaling back capital expenditures (or conversely, scaling up investment when growth opportunities increase). In column (1) we see that the direct effect of energy intensity is positive: energy-intensive sectors account for a larger share of capital investments; the interaction term in negative and significant at the one percent level. In column (2), when we allow for state, year, and SIC fixed effects, the interaction term is still negative and significant at the one percent level. The direct effect of energy prices is positive, and significant at the one percent level, which in conjunction with the interaction terms indicates that energy non-intensive firms respond to increased energy prices by increasing their level of investment. Energy intensive firms instead reduce their level of new investment; the switching point comes at the 75th percentile of the energy intensity distribution (Textile Mill Products).

We look at one additional dimension of adjustment in Table 3d: growth in wages. If labor markets were perfectly integrated across sectors, we would not expect to see any differential adjustment in response to growth opportunities: workers would migrate across sectors to equalize wages. However, if labor markets are segmented, then wages will be differentially bid up in energy intensive sectors during energy price declines, and bid down during energy price increases. Once again, this implies a negative coefficient on g in specifications (1) – (3). The results reported in the first three columns are consistent with this prediction premised on segmented labor markets (see, for example, Lang and Dickens (1993) and Katz and Summers (1989)).

Armed with these results that confer some validity of our use of the interaction term in (2) and (3) as an observable measure of differential growth opportunities, we proceed to our main interest, the responsiveness of states to these differential opportunities, based on labor market institutions.

4.2 How Do Institutions Affect the Reallocation of Resources?

Table 4 presents our results of specifications (4) to (6), in which we interact energy prices and energy intensity with Right to Work laws. Recall from Section 2 that the absence of Right to Work laws implies added costs and rigidities in hiring labor. As such we anticipate that employment should respond more to growth opportunities, and new capital expenditure less, relative to states without Right to Work laws. Our results are consistent with these predictions.

The triple interaction of Right to Work laws is negative (and significant at the 5 percent level) for the growth of employment. Hence, the adjustment of employment to growth opportunities is more sluggish in states without Right to Work laws. In particular, in states without Right to Work laws a one standard deviation increase in energy prices at the mean level of energy intensity leads to a 1.5 percent reduction in the growth of employment, relative to its standard deviation, and a six percent decline relative to its mean. In contrast, in states with Right to Work laws, the reduction in growth of employment is almost double: 3 percent and 6 percent respectively. The magnitude of the effect is robust to the inclusion of state-year fixed effects, and it becomes significant at the one percent level (Table 4, column (1)).

In column (4) of Table 4, we consider the effect of Right to Work laws on the responsiveness of wage growth to growth opportunities. If organized labor protects wages (possibly at the expense of employment), wages will be less responsive to shifts in growth opportunities in states without Right to Work laws. We do not find support for this in the data: the coefficient on the triple interaction is positive (i.e., less responsiveness to growth opportunities in states with Right to Work laws), but not significant at conventional levels.

For new capital expenditures (Table 4, column (3)), we find a contrasting set of results: the triple interaction is positive (and significant at the 5 percent level). This is consistent with the second prediction of the effects of labor market rigidities: In states with rigid labor institutions, there is relatively *more* adjustment in capital expenditures in response to growth opportunities, due to the substitutability of labor and capital. The magnitude of the effect is substantial. In states without Right to Work laws a one standard deviation increase in energy prices for the mean level of energy intensity leads to 4 percent (12 percent) decrease in the rate of new capital expenditure relative to the mean (standard deviation). In states with Right to Work laws, new capital investment contracts at rate of 2.5 percent (8 percent) relative to the mean (standard deviation). In percentage terms, the rate of contraction of capital expenditure is one third slower with Right to Work laws. The magnitude and significance of the effect is robust to the inclusion of state-year fixed effects, and a control for state income.

Finally, we estimate (6), in column (2), and find that sales growth is also less responsive to growth opportunities in states with labor market rigidities, consistent with the hypothesis that these rigidities affect the *extent* of adjustment, in addition to the composition (i.e., labor versus capital) of adjustment. In states without Right to Work laws, a one standard deviation increase in energy prices at the mean level of energy intensity leads to a 2.4 percent (6 percent) decrease in the growth in the value of shipments, relative to the standard deviation (mean). In states with Right to Work laws the contrast is almost more than double: 4 percent (10 percent) relative to the standard deviation (mean). Thus, our results suggest that energy-intensive firms in states with Right to Work laws perceive an even greater reduction in their growth opportunities than those in states without Right to Work laws.

4.3 Asymmetric Response

Since our data cover a period that includes both negative shocks (energy price increases) and positive shocks (energy price decreases), there is some scope for studying asymmetries in the responses of wages and employment to changes in energy prices and how the presence of unions contribute to these asymmetries. To implement this, in Table 5, we split the sample into the years 1972-77 (negative shocks), 1977-1982 (negative shocks), and 1982-87 (positive shocks). Our specifications allow for SIC and state-year fixed effects, and we focus first the coefficient of the double interaction of energy price and energy intensity.

Looking across panels (A) to (C), we note that the estimated coefficients are uniformly of the same sign across the three time periods. While there are qualitative differences, we cannot reject the hypothesis that all coefficients are equal. Similarly, we do not find any strong asymmetric effects in the impact of Right to Work laws for positive versus negative shocks (see panels (D) to (E).

5. Conclusions

In this paper, we have shown that firms in energy intensive industries are more sensitive to shifts in energy prices than industries that rely less on energy as an input. This allows us to identify a differential effect on the growth opportunities of firms in response to changes in energy prices. While we use this measure of growth opportunities to study the effects of labor market institutions on resource allocation, the same approach may be applied to any set of institutional variables that may be thought to impact resource allocation. In particular, there is a potential link to the finance literature, in considering the role of financial market institutions in resource allocation. Thus, in addition to the direct contribution of this paper to our understanding of how labor market rigidities impact the resource allocation process, we make the broader contribution of providing a new technique for studying resource allocation generally.

Furthermore, while we have chosen to examine institutions within the United States, the same approach could, in theory, be applied to study the implications of institutional differences on the allocative efficiency of economies internationally. Although generating a higher degree of unobserved heterogeneity across observations, this would also provide many additional dimensions of institutional variation that might be examined. We leave this for future work.

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Appendix A: Data Appendix

Variable	Description	Source
Year		
State	State FIPS code.	http://www.bls.gov/cew/cewedr10.htm
SIC code	Industries grouped at the three-digit SIC level.	Census of Manufactures, 1972-1992 Geographic Area Series (Bureau of the Census)
Capital expenditure	New capital expenditures (millions of dollars)	Census of Manufactures, 1972-1992 Geographic Area Series (Bureau of the Census)
Value added	Total value added by manufacture (millions of dollars)	Census of Manufactures, 1972-1992 Geographic Area Series (Bureau of the Census)
Wages	Payroll for production workers (millions of dollars)	Census of Manufactures, 1972-1992 Geographic Area Series (Bureau of the Census)
Employment	Number of employees (1000's)	Census of Manufactures, 1972-1992 Geographic Area Series (Bureau of the Census)
Energy prices	Real energy price (US$ per million btu)	Annual Energy Review http://www.energy.gov/dataandprices/
Energy intensity	Cost of electric and fuels (millions of dollars) / total value added (millions of dollars)	Compustat
Right to work	Did state have a right-to-work law in 1975? (0-no, 1=yes)	Holmes (1998)

Figure 1. Average real energy price, across all states (vertical lines indicate census years)

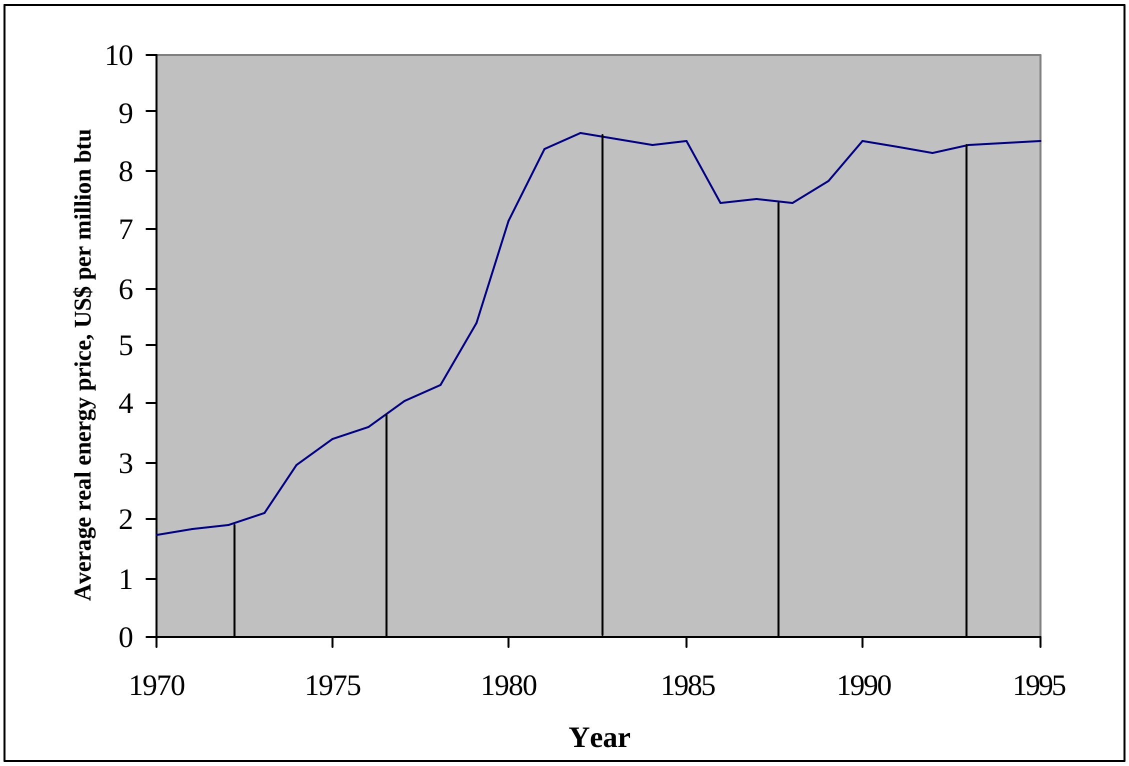

Table 1. Average energy price by state, 1972-92

State	Average real energy price (US$ per million btu)
Alabama	4.84
Alaska	5.82
Arizona	6.14
Arkansas	8.16
California	7.03
Colorado	6.21
Connecticut	8.69
Delaware	8.83
District of Columbia	7.01
Florida	8.06
Georgia	6.54
Hawaii	8.25
Idaho	6.09
Illinois	5.98
Indiana	6.52
Iowa	5.31
Kansas	5.89
Kentucky	5.99
Louisiana	4.38
Maine	7.91
Maryland	7.33
Massachusetts	6.52
Michigan	6.26
Minnesota	6.25
Mississippi	6.60
Missouri	6.33
Montana	5.80
Nebraska	7.39
Nevada	5.54
New Hampshire	6.13
New Jersey	8.23
New Mexico	7.22
New York	6.74
North Carolina	7.01
North Dakota	7.94
Ohio	6.29
Oklahoma	5.83
Oregon	6.29
Pennsylvania	6.46
Rhode Island	7.28
South Carolina	6.78
South Dakota	6.66
Tennessee	6.49
Texas	5.22
Utah	6.40
Vermont	5.51
Virginia	6.85
Washington	8.30
West Virginia	5.51
Wisconsin	6.32
Wyoming	5.33

Table 2. Energy intensity, by two-digit SIC

SIC	Industry description	Cost of electric and fuels (weighted by total value added)
38	Instruments and Related Products	.0118
27	Printing and Publishing	.0129
35	Industrial Machinery and Equipment	.0162
31	Leather and Leather Products	.0165
37	Transportation Equipment	.0165
36	Electronic & Other Electric Equipment	.0166
39	Misc. Manufacturing Industries	.0181
23	Apparel and Other Textile Products	.0199
25	Furniture and Fixtures	.0213
21	Tobacco Products	.0224
34	Fabricated Metal Products	.0326
30	Rubber and Misc. Plastics Products	.0377
20	Food and Kindred Products	.0382
24	Lumber and Wood Products	.0437
22	Textile Mill Products	.0718
28	Chemicals and Allied Products	.0746
26	Paper and Allied Products	.0784
32	Stone, Clay and Glass Products	.0843
29	Petroleum and Coal Products	.0912
33	Primary Metal Industries	.1262

Energy intensity is the median ratio of energy costs to value added for 1996 for all firms in the Compustat database. See text for details

Table 3a: Growth of Employment

	(1) OLS	(2) State. year, SIC FE	(3) State-year and SIC FE
Energy intensity	-1.666e-01		
	(4.538e-01)		
Energy intensity x Energy price	-1.211e-01*	-1.455e-01**	-1.535e-01**
	(6.702e-02)	(6.069e-02)	(6.091e-02)
Energy price	-3.975e-03	5.910e-02**	
	(8.298e-03)	(2.311e-02)	
Observations	10760	10760	10760
R-squared	0.01	0.15	0.19

Notes: Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3b: Growth in Value of Shipments

	(1) OLS	(2) State. year, SIC FE	(3) State-year and SIC FE
Energy intensity	1.629e+00*		
	(8.456e-01)		
Energy intensity x Energy price	-4.329e-01***	-4.099e-01***	-4.196e-01***
	(1.137e-01)	(1.179e-01)	(1.227e-01)
Energy price	-8.355e-02***	1.432e-01***	
	(1.451e-02)	(3.842e-02)	
Observations	9967	9967	9967
R-squared	0.04	0.15	0.18

Notes: Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3c: Rate of New Capital Expenditure

	(1) OLS	(2) State. year, SIC FE	(3) State-year and SIC FE
Energy intensity	1.668e-01***		
	(4.571e-02)		
Energy intensity x Energy price	-2.043e-02***	-2.086e-02***	-2.064e-02***
	(5.881e-03)	(5.758e-03)	(5.852e-03)
Energy price	7.084e-04	1.453e-03***	
	(4.489e-04)	(5.288e-04)	
Observations	18448	18448	18448
R-squared	0.00	0.14	0.14

Notes: Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3d: Growth in Wages

	(1) OLS	(2) State. year, SIC FE	(3) State-year and SIC FE
Energy intensity	8.839e-01***		
	(1.405e-01)		
Energy intensity x Energy price	-1.188e-01***	-1.081e-01***	-1.050e-01***
	(2.249e-02)	(2.367e-02)	(2.438e-02)
Energy price	1.784e-02***	5.644e-03	
	(1.530e-03)	(8.846e-03)	
Observations	8740	8740	8740
R-squared	0.03	0.16	0.20

Notes: Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: The Effect of Right to Work Laws (State, Year, SIC Fixed Effects)

	(1) Growth of employment	(2) Growth of value of shipments	(3) Rate of new capital expenditures	(4) Growth of wages
Real energy prices	5.896e-02**	1.404e-01***	1.477e-03***	5.335e-03
	(2.312e-02)	(3.832e-02)	(5.214e-04)	(8.837e-03)
Energy intensity x energy prices	-1.084e-01	-3.274e-01***	-2.398e-02***	-1.139e-01***
	(6.674e-02)	(1.067e-01)	(6.511e-03)	(2.379e-02)
Right to work	6.434e-02	-8.360e-02	-3.360e-03**	-5.850e-02**
	(6.850e-02)	(5.887e-02)	(1.638e-03)	(2.369e-02)
Right to work x Eint x Eprice	-1.088e-01**	-2.236e-01***	7.875e-03**	1.815e-02
	(4.232e-02)	(4.103e-02)	(3.261e-03)	(1.234e-02)
Observations	10760	9967	18448	8740
R-squared	0.15	0.15	0.14	0.16

Notes: Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Asymmetric Effects

	(1) Growth of employment	(2) Growth of value of shipments	(3) Rate of new capital expenditures	(4) Growth of wages
(A) 1972-1977				
Energy intensity x energy prices	-1.192e-01	-3.731e-01	-7.462e-03	-1.409e-01***
	(1.186e-01)	(4.048e-01)	(9.909e-03)	(4.381e-02)
Observations	5597	4777	6491	4332
R-squared	0.19	0.16	0.14	0.18
(B) 1977-1982				
Energy intensity x energy prices	-2.654e-01**	-1.230e-01	-3.904e-02***	-7.369e-02
	(1.082e-01)	(3.097e-01)	(9.028e-03)	(5.544e-02)
Observations	5141	5187	6623	4316
R-squared	0.24	0.20	0.15	0.28
(C) 1982-1987				
Energy intensity x energy prices	-4.620e-01***	-6.464e-01***	-2.097e-02**	-3.508e-02
	(8.580e-02)	(1.517e-01)	(1.056e-02)	(4.026e-02)
Observations	5163	5190	7523	4408
R-squared	0.25	0.20	0.15	0.19
(D) 1972-77 with Right to Work				
Energy intensity x energy prices	-6.061e-02	-2.225e-01	-1.627e-02	-1.361e-01***
	(1.153e-01)	(4.354e-01)	(1.008e-02)	(4.377e-02)
Energy intensity x energy prices	-1.377e-01**	-3.372e-01**	2.046e-02**	-9.561e-03
x Right to work	(5.715e-02)	(1.529e-01)	(8.647e-03)	(1.532e-02)
Observations	5597	4777	6491	4332
R-squared	0.19	0.16	0.15	0.18
(E) 1977-82 with Right to Work				
Energy intensity x energy prices	-2.390e-01**	-7.195e-02	-4.224e-02***	-7.452e-02
	(9.956e-02)	(2.888e-01)	(8.889e-03)	(5.549e-02)
Energy intensity x energy prices	-9.343e-02**	-1.862e-01**	8.508e-03**	3.880e-03
x Right to work	(4.139e-02)	(7.735e-02)	(3.923e-03)	(1.462e-02)
Observations	5141	5187	6623	4316
R-squared	0.25	0.20	0.16	0.28
(F) 1977-82 with Right to Work				
Energy intensity x energy prices	-4.288e-01***	-5.845e-01***	-2.276e-02**	-4.224e-02
	(8.776e-02)	(1.292e-01)	(1.057e-02)	(4.109e-02)
Energy intensity x energy prices	-8.545e-02**	-1.637e-01**	4.389e-03	2.359e-02
x Right to work	(4.338e-02)	(6.509e-02)	(2.706e-03)	(1.457e-02)
Observations	5163	5190	7523	4408
R-squared	0.25	0.20	0.15	0.19

Notes: Specifications include sic and state-year fixed effects. Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%