AN ANALYSIS OF IMPACT OF THE 1974 AND 1979 ENERGY PRICE SHOCKS ON THE COMPETITIVE SHIFT OF INDUSTRIAL EMPLOYMENT FOR INDIANA AND TEXAS

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Introduction

Indiana is both a Rustbelt and a Snowbelt state. During the 1970s and early 1980s, these two descriptive titles provided a rough and ready mental model for explaining past and predicting future industrial decline. In contrast, Texas is a Sunbelt state that, until the recent slump in oil prices, epitomized dynamic regional growth. There is a general belief, reflected in political and journalistic circles and given some credence in professional writings (Tabb [16], Lakshmanan [9], and Sandoval [15]), that industry migrated from the Snowbelt to the South and Southwest from 1972 to 1982 at least in part because of geographic differentials in energy costs.

The Sandoval model, developed for the U.S. Department of Energy, indicated that the manufacturing sector was the most sensitive to higher energy prices. Therefore, the Midwest region, containing the manufacturing states of Ohio, Michigan, Indiana, and Illinois, should demonstrate the greatest sensitivity to different energy price levels. The DOE model forecast a decline in the total earnings share of the Midwest and, given its definite price advantage in energy, continued high rates of growth in the earnings share for the Southwest. Pfister [13, p.15] criticizes the Sandoval approach both on the narrow technical ground that changes in earnings shares are not the same as changes in regional location patterns (although they may be correlated) and the more general ground that the rise in energy prices would not have much impact upon regional location patterns because of previous adjustments to regional differences in energy costs and potential declines in differences among regions in these costs. There is at least one more *ex ante* reason to believe that the increase in energy costs may not have a pronounced effect on locational patterns. In most manufacturing activities labor costs are a larger share of total costs than are energy costs; changes in locational patterns based on labor

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cost differences may dominate changes in response to energy costs especially in data aggregated to three digit SIC codes.

This paper readdresses the issue of the impact of changing energy prices on industry location through a shift-share analysis of changes in employment in the manufacturing sectors of Indiana and Texas between 1972 and 1982. This research also attempts to determine if energy cost-related variables can be used to forecast the differential shifts of industry in these two states. The three censuses used (1972, 1977 and 1982) bracket both the first and second oil shocks (1974 and 1979). The current research differs from prior research, as most prior research has examined highly aggregated sectors. Pfister began with 45 manufacturing industries identified by Miernyk [11] as most energy-intensive and calculated national employment growth rates for them, but had to aggregate to five two digit manufacturing sectors to compare state data. Only raw state growth rates were examined; thus, the impact of relative energy price changes and interstate energy price differences were mixed with all other factors that could cause state growth rates to differ. In contrast, this paper analyzes the employment growth patterns of 57 manufacturing industries for Indiana and 47 manufacturing industries for Texas from 1972 to 1982. A shift-share accounting of employment changes is possible for 110 mostly four digit SIC categories in Indiana and for 81 categories in Texas. Disclosure problems in some of the explanatory variables used in the econometric analysis required aggregating the employment data into a smaller number of categories. This left the level of aggregation at the three digit SIC level for most industries. The sample of aggregated industries shows substantial variance in the ratio of energy costs to value added, so this variable can be examined for explanatory power in predicting the location shifts of industry. A test of the hypothesis that changes in energy costs have been important in causing changes in manufacturing location is provided using the differential (competitive) shift component of the shift-share framework. The explanatory variables used in the study are constructed to reflect expected savings to changing geographic location based on cost differentials per BTU used for power and heat and differentials in labor costs.

Measuring the Migration of Industry

When industrial employment is dropping absolutely in one location and increasing in another, it may seem obvious that industry is migrating. The obvious, however, may be misleading. Local employment losses may be associated with an industry that is declining nationally, and gains may come from an advantageous mix of industries that are growing nationwide. The mix of industries inherited from the past may influence regional employment growth patterns more than migration does. Shift-share accounting makes clear that if local employment in an industry is growing at less than its national growth rate, an adverse shift is occurring from the local point of view. This accounting framework is one means of measuring employment change that separates the impact of the inherited mix of local industries from changes based on divergences from this mix. This method was chosen for this study because the dependent variable of interest is the divergence of employment from historic trends. There are several versions of the shift-share accounting framework in the literature. The one selected for this study is that developed by Perloff, *et al.* [12].[1] For each industry, the components of this framework are defined as:

$N_{ij} = E_{ij}\{E^*_{oo}/E_{oo} - 1\}$ (national effect);
$I_{ij} = E_{ij}\{E^*_{io}/E_{io} - E^*_{oo}/E_{oo}\}$ (industry effect); and
$C_{ij} = E_{ij}\{E^*_{ij}/E_{ij} - E^*_{io}/E_{io}\}$ (differential effect).

where:

E^*_{oo} and E_{oo} = end year and base year national manufacturing employment, respectively;
E^*_{io} and E_{io} = national employment levels in the ith industry; and
E^*_{ij} and E_{ij} = employment levels in the ith industry in the jth region.

For the region under study, summing the national effect over all industries ($N_{oj} = \Sigma_i N_{ij}$) yields the amount that local employment would have grown had the locality maintained its share of national employment (began and remained totally homothetic to the national economy). Summing the industry effect ($I_{oj} = \Sigma_i I_{ij}$) gives the additional change, positive or negative, that the local region would have had if it had maintained a constant share of its base year industries. Finally, summing the differential effect ($C_{oj} = \Sigma_i C_{ij}$) yields the amount that employment has changed due to changes in the region's shares of national manufacturing activities. A major advantage of the shift-share

[1]The foregone alternatives are those that define an *allocative effect* that accounts for prior specialization based on comparative advantage, as in Esteban-Marquillas [10], Klaasen and Paelinck [7], and Arcelus [1]. According to Houston [6], the purged differential shift also is alleged to be more stable under disaggregation. The Esteban-Marquillas formulation has been criticized by Beaudry and Martin [2], however, because it implies a nonzero competitive effect at the national level. As neither prior specialization nor disaggregation instability was thought to be a problem in this study, the Perloff formulation was used.

framework is that the term C_{oj} is freed from the influence of national growth and particular industry growth patterns that also influence local employment changes. Thus, this term should reflect changes in comparative advantage over time. Prior research has shown that behavioral meaning can be given to this term despite its derivation from an accounting identity. (See Chalmers and Beckhelm [4], Hellman [5], and Keil [8].)

Tables 1 and 2 present shift-share accounts for Indiana and Texas employment for the two *Census of Manufacturing*-defined periods (1972-1977 and 1977-1982) used in this study. The industrial categories shown were determined by the differing industrial structures of the states which results in different industry categories being suppressed by disclosure rules. Although detail is lost, the data are sufficiently detailed to provide the necessary degrees of freedoms for the statistical procedures used. For Indiana the census-measured change in the whole manufacturing sector was a gain of approximately 2,000 jobs between 1972 and 1977 and a loss of 120,000 jobs between 1977 and 1982. Cumulative rounding errors and missing data result in constructed employment changes during the two periods of losses of 2,800 and 116,600 jobs for 1972-1977 and 1977-1982, respectively. The Indiana table highlights an important difference between the two periods. Most important is that the 1982 census occurred during the trough of a business cycle which overemphasizes the decline of manufacturing in the national effect. It is nonetheless instructive to examine the pattern by which the decline in manufacturing in Indiana occurred. As shown in Table 1, Indiana employment should have added 19,976 jobs from 1972 to 1977 simply to maintain its 1972 share of national manufacturing employment. In addition, Indiana's 1972 industrial mix grew faster than the national average mix during the period up to 1977. Thus, had Indiana maintained its shares of each industry, it would have gained another 4,637 jobs. The rather counterintuitive implication (especially given the strongly held media perception) is that Indiana began the 1972-1977 period with a favorable industry mix and that, if Indiana had held onto its 1972 shares of that industry mix, employment would have increased 24,613 workers. That measured employment in Indiana fell 2,800 jobs in the period indicates that approximately 27,414 manufacturing jobs shifted from Indiana to other regions of the country. Two industries in particular highlight the problems that the Indiana economy had during the mid-1970s: the electrical motor and generator industry and the other-electronic-components industry (SIC code 367 except 3677). Both of these would have experienced substantial employment growth had Indiana maintained its shares, but both lost employment due to overwhelmingly adverse differential shifts. The loss of 116,600 manufacturing jobs between 1977 and 1982 was brought in large part by a loss of 60,996 through the national decline in manufacturing employment. Indiana still had an industrial mix that was declining slower than the national average (the industry mix effect was positive), however, and would have lost only 45,446 jobs (60,996 - 15,550) despite the national slump if it had not suffered a substantial adverse differential shift of 71,154 jobs. Indeed, Indiana increased its share of the basic steel industry, despite losing 10,300 jobs in steel.

The shift-share accounts for manufacturing employment growth in Texas from 1972 to 1982 tell a different story. A total increase of 128,300 manufacturing jobs between 1972 and 1977 was accounted for by a share effect of 22,179 jobs and a favorable differential shift of 106,421 jobs. The 1977-1982 period saw Texas benefit from an even larger differential shift of 163,874 jobs. The gains posted by Texas were often counter to national trends, i.e., in industries that were losing jobs nationally. The gains in Texas also were distributed broadly across industrial categories.

Table 3 presents a summary of the shift-share analysis in two parts. Part A shows the total share effects and competitive effects for the two states for each period. The share effect is the employment growth each state would have had if it had maintained its share of each industry during each period. Part B summarizes the pattern of the differential shifts for both periods. Table 3 shows that for the 110 industries in Indiana, only 15 had positive competitive shifts for both periods. Thirty-seven industries had negative competitive shifts in both periods. For Indiana, gainers and losers match from 1972 to 1977, but losers clearly dominated from 1977 to 1982. In sum, Indiana began the study period with an advantageous industrial mix in terms of growth potential and cyclic sensitivity compared to most states (surprisingly, given its image as an automobile state) and suffered a differential shift or outmigration of approximately 98,500 jobs. Texas, although not saddled with an adverse industrial mix, did not begin with as strong an industrial mix as did Indiana. Thus, a large percent of Texas's economic growth of approximately 287,500 jobs came from competitive shifts that totalled 270,295. As one would expect, a Kolomogorov-Smirnov test of the null hypothesis that the pattern of gains and losses in Table 3 for the two states is the same leads to its rejection (KS = 0.2756, significance = 0.001).

In addition to employment data, establishment data were examined. To a limited extent, established data help reduce the impact of the 1982 recession, as some establishments would lay off part of their workforce but remain in existence. Business failures accelerate in a recession, however, so the problem is not completely overcome. The results of a shift-share analysis of establishment data reveal patterns similar to those of the employment data. In particular, the data showed again that Indiana had a favorable mix of industries in 1972. Thus, Indiana's actual loss of establishments hides a much larger competitive loss (111 versus 170 between 1977 and 1982).

In contrast, Texas saw a net increase of 2,181 manufacturing establishments between 1977 and 1982. A shift- share analysis of Texas manufacturing indicated that Texas needed to gain 247 establishments to maintain its share. Thus, Texas benefited from a differential shift of 1865 establishments.

A detailed summary of the establishment shift-share analysis is available from the author. Both the employment data and establishment data imply that the experience of Indiana and Texas were radically different from 1972 to 1982.

An Energy-Based Model of the Competitive Shift

There are two strains of theoretical and empirical work pertinent to the differential shift of industry from the Midwest to the Southwest. One deals with the effect of changes in energy costs on location choice. The second line of research concerns with the relationship of energy and capital. In the latter literature, the issue is whether energy has a substitute or complement relationship with capital. (See, for example, the collection of articles in Berndt and Fields [2].) If energy and capital are complements in production, an increase in energy prices would increase the importance of relative wage differentials in making location decisions.

To see the implications of the first strain of theoretical work, consider a two firm, two product model in which one firm uses an imported raw material to produce an intermediate input and the other uses the intermediate input to produce a finished good sold in a market some distance from the port of entry for the raw material. Both firms use ubiquitous labor supplied at a geographically invariant wage. Both firms could locate in the port, at the market site, or at intermediate sites. Sakashita [14] demonstrated that if the price function of the finished product is strictly concave, an increase in the price of the imported raw material increases the likelihood that both firms would locate at the port of entry of the raw material. If the raw material is used in the transportation process (e.g., fossil fuels), however, the attractiveness of the port location depends on the relative impact of the increased price on the relative transportation rates of the raw material, the intermediate good, and the finished good. Sakashita argues that under a wide variety of changes in relative transportation rates, both firms will locate either at the market or at the port. That is, the likelihood of separate locations (intermediate good production at or nearer the port and finished product production at or nearer the market) is diminished both by the direct impact of the increase in the price of the raw material and by the indirect impact of the increase in its price on transportation costs. These results imply that the shift of manufacturing from the Midwest toward the South and Southwest would have been reinforced by both a shift toward ports of entry for energy producing raw materials and shifts toward growing markets. In either case, cumulative causation seems to be suggested.

The implications of a change in energy prices for location decisions may be explored further with a generalized model of the profit function of the firm when location is a variable. For a firm that produces a single product with homogeneous capital and labor, one non-energy raw material, and energy, profits can be expressed as:[2]

$$(1)\quad \Pi(u) = [P - D_o(t) - D_e(t)]Q - \{P_L(r)L + P_K K + [A_o(s) + A_e(s)]N + P_e(v)E\}$$

where:

$\Pi(u)$	=	profit at location u;
P	=	output price;
D_o and D_e	=	distribution costs independent of and dependent on energy use, respectively (so that $P-D_o-D_e$ is the net price of output);
Q	=	output quantity;
P_L, P_K, and P_e	=	prices for labor, capital, and a price index for energy, respectively;
A_o and A_e	=	costs of acquiring and assembling the raw material, N, at the firm's location independent and dependent on energy use, respectively;
L, K, N, and E	=	levels of input use where energy use, E, is measured in millions of British thermal units (BTUs) and is assumed to be the amount generated by the most economic mix of fuels possible in each industry in each location.

It follows from the definition of E that P_e is the lowest possible value that the energy price index can take at a given location. The variables t, r, v, and s are indices of location variation in the costs of distribution, labor, energy, and input assembly, respectively. Each

[2]The equation easily is generalized by considering each of the variables to be a vector. For example, P_L would be either a wage vector or a wage index for all types of labor, and N would be a vector of raw materials and semiprocessed inputs.

t, r, v, and s are indices of location variation in the costs of distribution, labor, energy, and input assembly, respectively. Each location, u, is associated with a unique vector of t, r, v, and s. Given the geographic distribution of prices, the firm chooses the vector of t,r,v, and s that maximizes profit. What is of interest is the inverse function of equation (1) or

(2) $u = \pi'(t,r,v,s)$.

A change in energy prices is likely to change each of these indices in different ways. Thus, the change in optimal location, u, with a change in the energy price index is given by the total derivative of equation (2) with respect to P_e, or

$$(3)\ \frac{du}{dP_e} = f\{\frac{\partial \pi'}{\partial t}\frac{dt}{dP_e}, \frac{\partial \pi'}{\partial s}\frac{ds}{dP_e}, \frac{\partial \pi'}{\partial r}\frac{dr}{dP_e}, \frac{\partial \pi'}{\partial v}\frac{dv}{dP_e}\}$$

In the Sakashita model,

$$\frac{\partial \pi'}{\partial t}\frac{dt}{dP_e} \text{ and } \frac{\partial \pi'}{\partial s}\frac{ds}{dP_e}$$

dominate the other changes. In terms of the shift-share framework, C_{ij} is analogous to du/dP_e: thus, C_{ij} is substituted on the left side of equation (3) in the empirical model developed in the next section.

The Empirical Model

Translating the above model into an empirical statement of the hypothesis that energy price differentials are significantly responsible for the outmigration of industrial employment from Indiana required several assumptions conditioned on data availability. It is likely that a firm moving to a new location by means of building a new plant would incorporate the latest technology which would alter the ratios of capital to labor to raw materials as optimal substitutions are made, etc. It is also likely that a relocation will make substantial changes in a firm's networks and modes for gathering inputs and distributing outputs. It is the expected *ex post* level of profits given all of these simultaneous changes that determines whether a firm will relocate some or all of its activities in response to a change in any one variable such as energy prices. Detailed data for most of these potentially important variables are difficult to obtain for three and four digit levels of disaggregation. It was assumed that this difficulty could be partially overcome with measures of the importance of energy costs in the production process.

Energy costs as a percentage of value added provides an *ex ante* measure of this importance. The amount of total energy used in production multiplied by the difference in energy costs between two sites provides an *ex ante* measure of savings resulting from a move, assuming that energy use remains the same after the move. Neither of these assumptions may be valid *ex post*. Larger differences in the importance of energy costs and larger geographic price differentials, however, should be associated with greater profit differentials and, therefore, larger competitive shifts of industry.

A similar argument holds for labor cost differentials. The labor market variable used here is the ratio of payroll per employee in Indiana to payroll per employee in Texas. This ratio is significantly greater than one on average (t=5.136, df=55). An arguably better measure of relative labor cost would take into account simultaneously wage differences and differences in productivity. Data were not available to calculate such a measure in 1972. For data available in 1977 and 1982, a measure calculable from the available data, value added per dollar of payroll, would be a good proxy. An interesting relationship arises when this variable is examined. In 1977 the mean of this variable was $2.49 for Texas and $2.46 for Indiana. (The difference is not statistically significant (t=0.194, df = 198).) This was likely the case for 1972 as well. Value added per employee was larger in Indiana than in Texas in both 1972 ($20.78 versus $18.93) and 1977 ($32.98 versus $30.76). By 1982 the situation had reversed. Both value added per employee and value added per dollar of payroll were significantly higher in Texas than in Indiana in 1982. The value added per dollar of payroll was $2.48 for Texas and $2.20 in Indiana. (The difference is statistically significant (t=2.249, df=192).) Because 1982 was a recession year and layoffs seldom match declines in output, the statistical significance of the difference in 1982 is suspect. Given that the simple ratio of payroll per employee clearly favored Texas, showed greater overall variance across industries, and was available for 1972 as well as 1977, this variable was used to proxy the difference in labor costs.

If a firm's markets are not changing significantly in size or geographic distribution, a move from a current location is likely to increase transportation costs above the initial increase in energy costs. *Ceteris paribus*, potentially significant increases in transportation costs would act to inhibit the movement of economic activity—there must be some threshold energy cost differential before a move will occur. In terms of the regression equations used this gives rise to *a priori* expectations about the constant term.

Perhaps the most important missing variables for measuring the relative growth of manufacturing in Texas and its relative decline in Indiana are those corresponding to the relative market shares for finished and semi-finished manufactures and those relating to backward linkages. Growth of a market sparks a process of import substitution that works through backward linkages to bring a host of related manufacturing nearer to the market. This process is accelerated by an increase in the cost of distributing semi-finished and finished goods due to an increase in energy prices. There is no simple way to correct this problem for 1972. For this reason the coefficients of the 1972 regressions suffer from a missing variable bias. The residuals from the regressions from 1972 to 1977 include the influence of the missing market shares. The residuals were added to the regressions for 1977 to 1982 to remove the missing variable bias.

The basic empirical model used is of the form:

$$(4)\ C_{ij} = F\left(\frac{dP_e}{du}, \frac{EP_e}{V}, \frac{EdP_e}{du}, \frac{dP_L}{du}, MS\right)$$

where:

$\frac{dP_e}{du}$ = geographic variance in energy costs;

$\frac{EP_e}{V}$ = total energy expenditure as a fraction of value added ;

$\frac{EdP_e}{du}$ = potential energy cost saving from a change in location;

$\frac{dP_L}{du}$ = geographic variance in labor costs; and

MS = market share variable used for 1977 to 1982 only.

The data used are a mixture of three and four digit SIC code industries and, as such, aggregate over firms of a wide variety of sizes. The resulting industries are also of widely differing sizes. Therefore, absolute levels of employment and energy are used. For this reason, three dependent variables were used: the actual differential shift (C_{ij}); the shift relative to the size of the industry in the state in the base year (C_{ij}/E_{ij}); and the log of the odds of the probability of a negative differential shift for Indiana or the probability of a positive differential shift for Texas. The use of the log of the odds (log(P/(1-P))) provides a variable that runs continuously from negative infinity to positive infinity as P moves from zero to one. This makes it possible to use the maximum likelihood technique logit to obtain regression coefficients for the variables likely to affect that probability. Use of the log-odds dependent variables also sets the weakest condition for finding significant explanatory power. The latter two models provide a means of compensating for differences in the absolute sizes of shifts caused by differences in industry size.

The 1972-1977 and 1977-1982 periods were treated separately for part of the empirical work because beginning and end period categories for data on relative labor and energy costs by industry differed for the two periods. In addition, Texas and Indiana have radically different manufacturing sectors—data available for an industry in one state would be suppressed or bracketed for disclosure reasons in the other. For example, the ratio of costs per BTU in power and heat used for explaining the 1977 to 1982 differential shifts were derived from the 1977 *Census of Manufacturing*. These ratios could be defined for 57 industry categories for Indiana, but for only 48 categories for Texas and Indiana simultaneously. The number of observations for each of the tested equations is determined by the variables used and is noted separately for each equation.

The following models were tested for the period 1977 to 1982:

(5) $C_{ij} = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{5i} + \beta_5 X_{6i}$

(6) $C_{ij} = \beta_6 + \beta_7 X_{2i} + \beta_8 X_{3i} + \beta_9 X_{4i} + \beta_{10} X_{5i} + \beta_{11} X_{6i}$

(7) $C_{ij}/E_{ij} = \beta_{12} + \beta_{13} X_{1i} + \beta_{14} X_{2i} + \beta_{15} X_{3i} + \beta_{16} X_{5i} + \beta_{17} X_{6i}$

(8) $C_{ij}/E_{ij} = \beta_{18} + \beta_{19} X_{2i} + \beta_{20} X_{3i} + \beta_{21} X_{4i} + \beta_{22} X_{5i} + \beta_{23} X_{6i}$

(9) $\ln(\frac{P_i}{1-P_i}) = \beta_{24} + \beta_{25} X_{1i} + \beta_{26} X_{2i} + \beta_{27} X_{3i} + \beta_{28} X_{5i} + \beta_{29} X_{6i}$

(10) $\ln(\frac{P_i}{1-P_i}) = \beta_{30} + \beta_{31} X_{2i} + \beta_{32} X_{3i} + \beta_{33} X_{4i} + \beta_{35} X_{5i} + \beta_{36} X_{6i}$

where:

P_i = probability that $C_{ij} < 0$;

X_{1i} = Indiana cost per BTU divided by the U.S. average cost per BTU for the ith industry (P_{iIN}/P_{iUS}) ;

X_{2i} = Fuel costs as a fraction of value added in Indiana ((P_{iIN} * B_{iIN})/VA_{iIN});

X_{3i} = the ratio of Indiana payroll costs per employee to Texas payroll costs (L_{iIN} /L_{iTEX});

X_{4i} = Indiana cost per BTU divided by the Texas cost per BTU (P_{iIN} / P_{iTEX});

X_{5i} = $((P_{iIN} * B_{iIN}) * (PC_{enc}/PC_{wnc} - 1))$, an index of potential energy cost saving to the ith industry of moving from Indiana to Texas. PC_{enc} and PC_{wnc} are the East North Central and West South Central prices for a kilowatt of commercial power in January 1971; and

X_{6i} = the residuals from the corresponding regression from 1972 to 1977 used as a proxy variable for relative market shares in the regressions from 1977 to 1982.

The expected signs of the constant terms, β_0, β_6, and β_{12}, which represent inertia are positive. The expected signs of the regression coefficients are positive for β_{13}, β_{25}, β_{26}, β_{27}, β_{28}, β_{31}, β_{32}, β_{33} and β_{34}; ambiguous for the coefficients of X_{6i}; and negative for the remaining coefficients. A weak argument can be made that the coefficients for X_{6i} are positive for equations (5), (6), (7), and (8) and negative for equations (9) and (10). These residuals, if positive, may be capturing the effect of locational factors favorable to Indiana. If those conditions remain favorable, positive values of the residual should correlate positively with the competitive shift.

With some modifications, the same models were used to study the differential shift of industry into Texas. The variables used for Texas were X_7 = ratio of cost per BTU in Texas to the U.S. average cost (coefficients expected to be negative), X_8 = the average U.S. ratio of energy expenditures to value added (coefficients expected to be positive), X_9 = the U.S. average cost per BTU (coefficients expected to be positive), and X_{10} = the ratio of Texas payroll cost per employee to the U.S. average payroll cost per employee (coefficients expected to be negative). X_6 is the residual from 1972 to 1977 used as an independent variable from 1977 to 1982 to remove missing variable bias. Energy prices and expenditures and labor costs for Texas were measured against U.S. averages, as firms could move to Texas from any location. Because most of the competitive shifts for Texas were positive, the logit models used $Prob(C_{ij} > 0)$ as the dependent variable.

The models that yielded significant results are shown in Table 4. Models that included both X_2 and X_5 were characterized by extreme multicollinearity (condition indices greater than 1000). When X_2 is excluded from the model ,multicollinearity is lessened but still in the moderate range (condition indices between 100 and 250).

Results

In the models tested, energy cost and labor cost differentials do not appear to explain much of the shift of manufacturing from Indiana. If one accepts the argument that the residuals for the 1972 to 1977 regressions capture location pulls not represented in the other variables, then these residuals (represented in each equation as X_6) consistently enter with the correct sign and significance at the 0.10 level or better. Thus, the presence of this variable should significantly reduce any bias due to missing variables. With few exceptions, all of the other significant coefficients for the Indiana equations in Table 4 have the wrong sign. One of the exceptions is of interest, however. In the variant of equation (6) with X_4 omitted, the potential savings variable (X_5) has both the correct sign and is significant at the 0.01 level.

The logit models (equations (9) and (10)) constitute the least stringent test of the hypotheses that industry shifts were occurring in response to relative energy prices and were concentrated among energy-intensive firms. These models require only that the log odds of an adverse differential shift be positively correlated with higher relative energy prices or energy intensities, i.e., that β_{25} and β_{26} (in equation (9)) or β_{31} and β_{33} (in equation (10)) be positive. In these equations, the signs of the coefficients for X_6 are expected to be negative; this is confirmed in both logit models. The only other variable that has the expected sign is the ratio of energy costs in Indiana to costs in Texas (X_4), and its coefficient is not statistically significant. These results indicate that neither energy costs nor energy's relative share of value added played a large role in the adverse differential shifts of industry from Indiana in the period studied.

An examination of Tables 2 and 5 gives some insight into these results. First, Indiana's energy costs are not particularly high relative to either the United States average or to Texas. Few industries with negative shifts in Indiana had higher costs per BTU used than did the corresponding industry in Texas. Second, from 1972 to 1977, the average manufacturing industry suffered a negative differential shift of 480 jobs. Those industries with higher than average labor and energy costs, however, suffered relatively small losses and, in the case of basic steel and several other energy-intensive activities, saw significant positive shifts.

The results for Texas are intriguing. The amount of variance explained was consistently higher than the variance explained for the equivalent model for Indiana, but the signs were also frequently wrong. In the OLS regressions, relative energy costs per BTU (X_7), relative labor costs (X_{10}), and energy costs as a fraction of value added (X_8) always enter with the wrong sign, regardless of whether the prior residuals are included in the regressions. Although not significant, relative labor costs enter with the correct sign in logit equations. The national average cost per BTU enters correctly and significantly in OLS models, however, suggesting that higher energy cost manufacturing activities found Texas attractive relative to the nation as a whole.

Rerunning all of the models with either total employment changes or the probability of a negative (for Indiana) or positive change (for Texas) in total employment rather than a positive differential shift as the dependent variable did not change the results (for either state).

The results in this paper are, as indicated earlier, subject to the limitations imposed by the nature of the data available through public sources. Suppression of data under disclosure rules meant the loss of much detail in creating a consistent set of industries for Indiana and Texas. Some of the unique features of their economies were lost. Nonetheless, it seems clear from these data that there is little evidence that energy price differentials accounted for much of the adverse differential shift in manufacturing employment experienced by Indiana between 1972 and 1977. The data in Table 5 suggest that Indiana was not an unambiguously high energy cost state compared with either the U.S. or with Texas. Nor does it appear that Texas was attracting manufacturing plants that were seeking only to lower energy costs. The fact that the relative labor costs consistently entered with the wrong sign is mysterious. Texas was clearly a lower labor cost state compared to Indiana and to the U.S. average. It may be that these lower labor costs were attracting manufacturing, but that the relative degrees of labor cheapness were not important. This would be the case if manufacturing industries with relatively higher labor costs were also the most mobile.

Perhaps the most important missing variables for measuring the relative growth of manufacturing in Texas are those corresponding to the growth of Texas as a market for finished and semi-finished manufactures and those relating to backward linkages. Inclusion of the residual variables for 1977 through 1982 can only partially compensate for these variables by reducing missing variable bias. That the coefficients of these residuals were often significant with the expected sign indicates that a historical process with some momentum before the oil shocks accounts for a significant proportion of both the adverse shifts suffered by Indiana and gains of Texas. This study makes clear that energy cost and labor cost differentials by themselves did not have the explanatory power for employment shifts presupposed by the public or by the impressionistic studies of the Snowbelt-to-Sunbelt shift of economic activity that dominated earlier discussion of regional manufacturing policy. These results reinforce the findings of Pfister [13] and suggest that most movement of industry based on regional differentials in energy costs had occurred prior to the increase in the level of energy prices in 1973.

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Table 1
Employment Shift-Share Accounts for Indiana

Industry	----------Shifts for 1972-1977----------				----------Shifts for 1977-1982----------			
	Total	National	Industry	Competitive	Total	National	Industry	Competitive
Food & kindred products	-800	1,092	-2,254	362	-3,300	-3,275	2,505	-2,531
Men's & boys furnishings	-700	159	-143	-716	-1,500	-425	549	-1,624
Women & misses outerwear	-900	71	12	-983	-700	-136	40	-604
All other clothing	200	65	-344	479	-1,100	-217	-603	-280
Misc. textiles	1,200	83	-98	1,215	-1,400	-362	120	-1,158
Logging camps	200	3	1	196	0	-27	18	9
Saw & planing mills	400	56	8	336	-400	-208	-374	182
Millwork, plywood, structural	700	266	37	398	-3,000	-877	-688	-1,435
Wood containers	200	27	-2	176	0	-100	44	55
Mobile homes	-2,500	180	-1,996	-684	-600	-326	-223	-51
Wood buildings	-400	59	243	-702	-1,000	-145	-528	-327
Misc. wood products	100	56	-24	68	-300	-181	30	-149
Household furniture	-1,700	513	-935	-1,278	-3,800	-1,420	-947	-1,433
Office furniture	800	71	277	452	700	-289	1,271	-281
Public building furniture	-100	24	-76	-48	0	-63	21	42
Partitions & fixtures	0	47	-47	0	300	-145	209	236
Misc. furniture & fixtures	1,100	6	33	1,061	600	-118	286	432
Paper coating & glazing	200	18	23	160	200	-72	141	131
Bags, excluding textile	600	32	-30	598	-200	-154	206	-252
Misc. converted paper products	200	86	336	-221	-200	-280	325	-245
Folding paper board boxes	-200	47	-68	-179	100	-127	95	131
Corrugated & solid boxes	-100	118	-355	137	-700	-353	80	-427
Sanitary food containers	0	15	-106	91	-200	-45	-26	-129
Other paper board containers	-200	27	-184	-42	-200	-63	-45	-92

Table 1 (continued)
Employment Shift-Share Accounts for Indiana

Industry	Shifts for 1972-1977				Shifts for 1977-1982			
	Total	National	Industry	Competitive	Total	National	Industry	Competitive
Periodicals	100	15	11	74	200	-54	261	-7
Books	-400	148	276	-823	-1,100	-416	650	-1,333
Commercial printing	-400	236	38	-674	2,000	-687	2,731	-43
Manifold business forms	100	21	101	-22	900	-72	147	826
All other publishing	-200	375	-237	-337	200	-1,131	2,836	-1,505
Industrial inorganic chemicals	100	27	68	5	300	-90	70	320
Drugs	700	425	2,513	-2,238	1,100	-1,366	2,264	202
Soaps & cleaners	100	89	-89	100	-200	-28	717	-636
Paint	0	38	-127	89	100	-118	-37	55
Agricultural chemicals	-200	56	182	-438	100	-154	62	191
Plastics & other chemicals	-100	97	-52	-145	-200	-289	122	-33
Petroleum & coal products	-200	183	142	-2,324	-400	-380	517	-537
Rubber & misc. plastics	2,000	915	4,285	-3,199	-3,100	-2,985	1,173	-1,288
Blown & pressed glass products	-1,300	263	-204	-1,358	-1,000	-687	8,978	-9,291
Purchased glass products	100	27	40	33	500	-90	231	359
Cement	400	18	-62	444	-300	-90	-25	-185
Structural clay products	-300	35	-193	-142	-600	-81	-221	-298
Other misc. nonmetal	200	369	-458	-289	-3,300	-1,149	-2,158	7
Blast furnaces & steel	700	1,847	-5,477	4,330	-10,300	-5,726	-15,202	10,628
Steel wire	400	30	6	364	-600	-127	-293	-180
Other basic steel	300	86	73	142	-600	-289	-190	-121
Gray iron foundries	0	274	-247	-27	-3,000	-841	-1,939	-219
Other iron & steel foundries	-1,400	136	42	-1,577	-300	-289	-603	593
Aluminum extruded products	100	77	-189	213	-500	-244	132	-388

Table 1 (continued)
Employment Shift-Share Accounts for Indiana

Industry	Shifts for 1972-1977 Total	National	Industry	Competitive	Shifts for 1977-1982 Total	National	Industry	Competitive
Nonferrous wire	100	174	-388	314	-700	-543	660	-818
Other nonferrous rolling	-300	171	-626	155	800	-498	-218	1,515
Nonferrous foundries	200	118	-84	166	-1,300	-380	37	-957
All other primary & secondary metal	-300	112	-86	-326	200	-317	-136	652
Cans & shipping containers	300	59	-219	460	-600	-208	-218	-174
Cutlery, hand tools	600	136	136	328	-900	-470	-384	-46
Plumbing & heating goods	-3,800	227	-1,179	-2,849	-1,400	-353	-36	-1,011
Fabricated structural metal	-1,000	118	-310	-808	-700	-271	401	-830
Metal doors & sashes	-700	77	-257	-520	700	-172	186	686
Fabricated plate work	500	91	925	-517	-400	-326	-275	200
Sheet plate work	400	68	38	294	-300	-244	373	-429
Misc. metal work	-100	53	182	-335	0	-154	387	-233
All forging & stamping	500	475	1,022	-997	-4,500	-1,502	-1,484	-1,514
Plating & polishing	100	59	183	-142	100	-190	214	76
Metal coating	600	32	155	413	-200	-154	296	-342
Steel springs excluding wire	1,100	18	-39	1,121	-1,000	-154	-468	-378
Valves & pipe fittings	700	91	382	227	-900	-344	571	-1,127
Fabricated pipe & fittings	-100	18	349	-467	1,000	-45	198	848
Scrap machinery, misc. fabricated metal & ord.	3,600	440	-1,542	-2,498	-1,700	-1,022	679	-1,356
Farm & garden machinery	0	159	944	-1,103	-2,000	-488	-836	-676
Construction machinery	-600	127	564	-1,291	-1,200	-335	-614	-252
Misc. construction machinery	700	62	473	165	200	-253	769	-315

Table 1 (continued)
Employment Shift-Share Accounts for Indiana

Industry	Total (Shifts for 1972-1977)	National (Shifts for 1972-1977)	Industry (Shifts for 1972-1977)	Competitive (Shifts for 1972-1977)	Total (Shifts for 1977-1982)	National (Shifts for 1977-1982)	Industry (Shifts for 1977-1982)	Competitive (Shifts for 1977-1982)
Machine tools, metal cutting	500	27	93	380	-100	-127	98	-72
Special dies, tools, & jigs	600	174	296	129	-700	-588	422	-534
Machine tool accessories	200	21	90	89	100	-81	98	83
Misc. metal working machinery	700	24	61	616	200	-136	-88	423
Pumps & pumping equipment	-300	41	148	-489	300	-100	194	206
Blowers & fans	300	53	292	-45	-300	-190	325	-435
Power transmission equipment	1,200	136	661	403	-3,100	-525	-475	-2,101
Other general industry equipment	1,100	307	2,002	-1,209	-1,700	-1,040	943	-1,603
Refrigeration & heating equipment	500	139	-519	880	-700	-470	-209	-21
Other service industry equipment	-400	65	206	-671	-400	-163	105	-342
All other nonelectric machinery	600	690	2,584	-2,674	-200	-2,171	7,711	-5,740
Electric motors & generators	-2,000	319	471	-2,789	-3,200	-796	-357	-2,047
Other electric industrial apparatus	0	103	33	-136	500	-317	517	300
Current carrying devices	200	47	-254	406	-100	-163	187	-125
Other electric wiring & lighting	-300	209	-523	14	-1,200	-615	267	-852
Communication equipment	-2,400	481	-305	-2,576	-800	-1,257	5,565	-5,108
Electronic coils & transformers	-500	62	-366	-196	600	-145	377	368
Other electronic components	-3,900	398	1,387	-5,685	-1,700	-868	4,659	-5,490
Household. appliances, radio & TV,misc. electric	-400	1,814	747	-2,961	-17,800	-5,527	-3,794	-8,479
All motor vehicles, excluding cycles	6,000	410	239	5,350	-8,200	-1,800	-4,344	-2,056
Motor vehicle parts & accessories	900	1,425	4,575	-5,100	-22,600	-4,451	-9,664	-8,485

Table 1 (continued)
Employment Shift-Share Accounts for Indiana

Industry	----------Shifts for 1972-1977----------				----------Shifts for 1977-1982----------			
	Total	National	Industry	Competitive	Total	National	Industry	Competitive
Shipbuilding	1,000	53	287	660	-700	-253	60	-507
All other transportation	-1,600	915	-3,245	730	-1,600	-2,659	7,194	-6,135
Measuring & control devices	1,500	94	896	509	-200	-425	3,180	-2,955
Jewelry, silverware	0	27	110	-137	-300	-81	-82	-137
Toys & sporting goods	500	35	-156	620	-300	-154	-138	-8
Pens, pencils, office supplies	-100	12	-11	-101	0	-27	30	-3
Signs & advertising display	-100	27	-28	-98	-100	-72	122	-150
Burial caskets	0	68	-503	435	0	-208	-118	326
Other misc. manufactures	800	15	-3	788	-500	-118	-70	-312
Totals calculated	-2,800	19,976	4,637	-2,7414	-116,600	-60,996	15,550	-71,154
Totals - census given	2,000				-120,800			

Table 2

Employment Shift-Share Data for Texas*

Industry	1972-1977 Actual Change	1972-1977 Share Growth	1972-1977 Competitive Shift	1977-1982 Actual Change	1977-1982 Share Growth	1977-1982 Competitive Shift
Food & kindred products	7,300	-2,435	9,735	5,100	-1,802	6,902
Men & boys furnishings	-2,900	101	-3,001	-4,200	-5,489	1,289
Women & misses outerwear	2,400	623	1,777	300	-1,306	1,606
All other clothing	4,900	-1,282	6,182	-1,700	-1,780	80
Misc. textiles	2,000	-29	2,029	-1,100	-448	-652
Logging camps	600	66	534	-100	-66	-34
Saw & planing mills	-1,300	246	-1,546	-2,700	-1,519	-1,181
Millwork, plywood, structural	2,100	356	1,744	1,400	-2,049	3,449
Wood containers	-100	65	-165	-400	-116	-284
Mobile homes	-100	-1,786	1,686	900	-900	1,800
Wood buildings	800	90	710	300	-589	889
Misc. wood products	200	41	159	900	-196	1,096
Household furniture	400	-252	652	-2,500	-1,629	-871
Public building furniture	-300	na	na	-100	-114	14
Partitions & fixtures	200	0	200	200	96	104
Misc. furniture & fixtures	900	215	685	800	513	287
Bags, excluding textile	200	5	195	600	83	517
Corrugated & solid boxes	600	-255	855	-300	-343	43
Sanitary food containers	-100	-182	82	700	-129	829
Other paper board containers	-100	-126	26	-100	-104	4
All other allied paper	1,600	340	1,260	200	-208	408
Books	700	186	514	900	147	753
Commercial printing	1,800	422	1,378	8,100	3,790	4,310

Table 2 (continued)
Employment Shift-Share Data for Texas

Industry	1972-1977 Actual Change	1972-1977 Share Growth	1972-1977 Competitive Shift	1977-1982 Actual Change	1977-1982 Share Growth	1977-1982 Competitive Shift
Manifold business forms	900	590	310	-400	399	-799
All other publishing	3,400	351	3,049	9,700	4,211	5,489
Industrial inorganic chemicals	800	591	209	-200	-128	-72
Drugs	1,200	286	914	700	155	545
Soaps & cleaners	-100	0	-100	2,900	309	2,591
Paint	-100	-246	146	0	-416	416
Agricultural chemicals	1,300	388	912	-600	-237	-363
Plastics & other chemicals	7,900	554	7,346	3,800	-2,537	6,337
Petroleum & coal products	2,600	1,711	889	4,100	1,154	2,946
Rubber & misc. plastics	9,500	2,684	6,816	4,400	-1,400	5,800
Blown & pressed glass prod.	400	16	384	600	3,055	-2,455
Cement	200	-205	405	300	-345	-645
Structural clay products	200	-564	764	-1,100	-1,510	410
Flat glass & misc. nonmetal	5,500	-32	5,532	4,300	-5,846	10,146
Gray iron foundries	0	16	-16	-300	-1,615	1,315
Other iron & steel foundries	700	96	604	400	-893	1,293
Nonferrous wire	100	-51	151	900	29	871
Other nonferrous rolling	-800	-110	-690	-100	-78	-22
Nonferrous foundries	1,000	8	992	900	-155	1,055
All other primary & secondary metal	4,500	-747	5,247	-1,200	-7,042	5,842
Cans & shipping containers	600	-321	921	-1,100	-853	-247
Cutlery, hand tools	1,000	35	965	500	-263	763
Fabricated structural metal	1,800	-388	2,188	3,000	429	2,571

Table 2 (continued)
Employment Shift-Share Data for Texas

Industry	1972-1977 Actual Change	1972-1977 Share Growth	1972-1977 Competitive Shift	1977-1982 Actual Change	1977-1982 Share Growth	1977-1982 Competitive Shift
Fabricated plate work	3,000	2,624	376	1,200	-1,835	3,035
Sheet plate work	500	179	321	2,000	210	1,790
Architectural metal products	700	-5	705	700	163	537
Misc. metal work	1,400	168	1,232	3,000	614	2,386
Screw machine products	100	24	76	100	-18	118
Metal forging & stamping	1,500	232	1,268	400	-719	1,119
Metal services	500	591	-91	1,400	175	1,225
Valves & pipe fittings	1,300	1,115	185	3,500	514	2,986
Fabricated pipe & fittings	2,400	1,529	871	4,100	1,494	2,606
Misc. fabricated metal & ord.	-5,600	-1,817	-3,783	2,200	-615	2,815
Farm & garden machinery	1,500	388	1,112	-600	-834	234
Construction machinery	-400	771	-1,171	-600	-1,128	528
Conveyors	600	293	307	200	225	-25
Misc. construction machinery	17,300	6,723	10,577	24,700	8,532	16,168
Special dies, tools, & jigs	500	48	452	300	-28	328
Pumps & pumping equipment	700	405	295	5,100	317	4,783
Misc. general industry equipment	0	1,441	-1,441	800	235	565
Refrigeration & heating equipment	2,000	-720	2,720	-1,000	-1,423	423
Other service industry equipment	1,000	209	791	-800	-87	-713
All other nonelectrical machinery	22,000	2,836	19,164	25,600	5,818	19,782
Household appliances	-100	-6	-94	500	-264	764
Electrical wiring & lighting	-800	-212	-588	1,200	-78	1278
Storage batteries	100	292	-192	100	-208	308

Table 2 (continued)
Employment Shift-Share Data for Texas

Industry	1972-1977 Actual Change	1972-1977 Share Growth	1972-1977 Competitive Shift	1977-1982 Actual Change	1977-1982 Share Growth	1977-1982 Competitive Shift
Other electric machinery, including radios	14,000	2,646	11,354	29,700	10,609	19,091
Motor vehicles parts & accessories	600	385	215	1,800	-1,061	2,861
All other motor vehicle	2,000	369	1,631	-1,000	-3,057	2,057
Shipbuilding	-1,600	2,381	-3,981	300	-759	1,059
Travel trailers & campers	-1,100	-699	-401	-600	-618	18
All other transportation	-6,200	-2,631	-3,569	11,400	6,332	5,068
Instruments to measure electricity	-100	280	-380	300	419	-119
Other measurement & control instruments	1,400	543	857	2,300	2,043	257
Other scientific & photographic equipment	4,200	1,131	3,069	1,500	-1,471	2,971
Toys & sporting goods	200	-311	511	-200	-567	367
Pens, pencils, office supplies	400	1	399	-100	8	-108
Signs & advertising	100	-5	105	1,000	162	838
Burial caskets	-200	-95	-105	0	-42	42
Totals	128,300	22,179	106,421	159,200	-4,674	163,874

*Share growth is the sum of the national effect and the industry effects

Table 3
A. Summaries of Shift-Share Results

	1972 to 1977	1977 to 1982
Indiana		
Share Growth	24,613	-45,446
Competitive Shift	-27,414	-71,154
Texas		
Share Growth	22,179	-4,674
Competitive Shift	106,421	163,874

Share Growth = National Effect + Industrial Mix Effect

B. Competitive Shift Patterns for Manufacturing Employment*

Indiana

		1972 to 1977			
		Positive	Negative	Zero	Total
1977	Positive	15	17	1	33
to	Negative	40	37	0	77
1982	Zero	0	0	0	0
	Total	55	54	1	110

Texas

		1972 to 1977			
		Positive	Negative	Zero	Total
1977	Positive	52	14	0	68
to	Negative	11	4	0	15
1982	Zero	0	0	0	0
	Total	63	18	0	81

*Entries are counts of industries with each sign combination for the competitive shift

Table 4
Results of Regression Analyses

Indiana

$$C_{72} = -5.108 + 3.762X_2 + 3.276X_3 + 0.794X_4$$
$$(1.651) \quad (2.075)^{**} \quad (0.795)$$
$$\bar{R}^2 = 0.0833 \quad F(3,44) = 2.424^{*} \quad (N=48)$$

$$C_{77} = -5.360 + 8.621X_2 + 2.941X_3 + 0.065X_4 + 0.755X_6$$
$$(2.141)^{**} \quad (1.054) \quad (0.036) \quad (2.832)^{**}$$
$$\bar{R}^2 = .1703 \quad F(4,43) = 3.413^{**} \quad (N=48)$$

$$C_{77} = -4.07 + 5.487X_2 + 1.79X_3 - 0.015X_5 + 0.535X_6$$
$$(1.42) \quad (0.699) \quad (-3.284)^{**} \quad (2.036)$$
$$\bar{R}^2 = 0.269 \quad F(4,43) = 5.33^{**} \quad (N = 48)$$

$$LO(C_{77} < 0) = 3.726 - 6.347X_2 - 1.580X_3 + 0.258X_4 - 0.752X_6$$
$$(1.783) \quad (0.507) \quad (0.142) \quad (1.887)^{*}$$
$M\text{-}R^2 = 0.1574$ (N=48)
Likelihood Ratio Test = 8.222* 4 degrees of freedom

$$C_{72} = -2.663 - 0.510X_1 + 4.086X_2 + 2.169X_3$$
$$(0.424) \quad (1.877)^{*} \quad (1.550)$$
$$\bar{R}^2 = 0.0484 \quad F(3,53) = 1.950 \quad (N=57)$$

$$C_{77} = -4.263 - 0.671X_1 + 8.182X_2 + 2.786X_3 + 0.736X_6$$
$$(0.326) \quad (2.195)^{**} \quad (1.166) \quad (3.128)^{**}$$
$$\bar{R}^2 = 0.1742 \quad F(4,52) = 3.953^{**} \quad (N=57)$$

$$LO(C_{77} < 0) = 3.833 - 0.514X_1 - 4.791X_2 - 1.639X_3 - 0.550X_6$$
$$(-0.251) \quad (-1.504)^{*} \quad (-0.682) \quad (-1.861)$$
$M\text{-}R^2 = 0.112$ (N=57)
Likelihood Ratio Test = 6.738* 4 degrees of freedom

Table 4 (continued)

Results of Regression Analyses

Texas

$$C_{72} = -19.542 + 11.298X_7 - 7.615X_8 + 11.777X_{10}$$
$$\qquad\quad (3.096)^{**} \quad (1.211) \quad (1.899)^{*}$$
$$\bar{R}^2 = .1471 \quad F(3,43) = 3.644^{**} \quad (N=47)$$

$$C_{77} = -19.542 + 10.147X_7 - 14.178X_8 + 14.287X_{10}$$
$$\qquad\quad (2.562)^{**} \quad (2.078)^{**} \quad (2.122)^{**}$$
$$\bar{R}^2 = 0.1348 \quad F(3,43) = 3.388^{**} \quad (N=47)$$

$$C_{77} = -19.542 + 10.147X_7 - 14.178X_8 + 14.287X_{10} + 0.819X_6$$
$$\qquad\quad (3.861)^{**} \quad (3.133)^{**} \quad (3.198)^{**} \quad (7.461)^{**}$$
$$\bar{R}^2 = 0.6191 \quad F(3,43) = 19.69^{**} \quad (N=47)$$

$$C_{77} = -7.508 + 1.862X_8 + 0.8139X_9 + 7.342X_{10} + 0.9031X_6$$
$$\qquad\quad (0.490) \quad (2.857)^{**} \quad (3.137)^{**} \quad (11.971)^{**}$$
$$\bar{R}^2 = 0.6676 \quad F(4,76) = 41.18^{**} \quad (N=81)$$

$$LO(C77 > 0) = 6.606 + 0.209X_7 - 3.762X_8 - 5.044X_{10} + 0.208X_6$$
$$\qquad\quad (0.063) \quad (0.911) \quad (1.070) \quad (1.218)$$
$$M - R^2 = 0.113 \quad (N=47)$$

Likelihood Ratio Test = 5.626 4 degrees of freedom

* denotes t-statistics significant at the 10 percent level
** denotes t-statistics significant at the 5 percent level
C_{72} and C_{77} are the differential shifts for 1972 through 1977 and 1977 to 1982, respectively, measured in thousands, $LO(C_{77} < 0)$ is the log of the odds that the 1977 to 1982 differential shift is negative, etc., reported R^2s are adjusted for degrees of freedom and $M\text{-}R^2$ is the Maddala measure of prediction success for the LOGIT models

Table 5
Variables Used in the Regressions

Industry	'72-'77 Indiana Competitive Shift	'77-'82 Indiana Competitive Shift	Indiana/ Texas Price/BTU	Indiana/ USA Price/BTU	Energy/ Value Added IN 1977	Energy/ Value Added US 1977	Labor Cost IN/TEX 1977	Gross Potential Savings**
Food & kindred products	0.362	-2.531	0.841	0.883	0.044	0.045	1.144	17.87
Men & boys furnishings	-0.716	-1.624	0.889	0.880	0.011	0.013	1.212	0.21
Women & misses outwear	-0.983	-0.604	0.450	0.407	0.010	0.013	0.986	0.05
All other clothing	0.479	-0.280	1.200	0.899	0.014	0.015	1.096	0.10
Misc. textiles	1.215	-1.158	0.825	0.827	0.019	0.020	1.147	0.31
Saw & planing mills	0.336	0.182	*	0.872	0.055	0.050	1.111	0.57
Millwork, plywood, structural	0.398	-1.435	0.944	1.008	0.026	0.036	1.066	1.37
Wood containers	0.176	0.055	0.667	0.783	0.036	0.038	1.022	0.15
Wood buildings & mobile homes	-1.432	-0.298	0.792	0.881	0.006	0.012	1.364	0.49
Misc. wood products	0.242	-0.179	1.196	1.157	0.041	0.064	0.889	0.52
Household furniture	-1.278	-1.433	0.856	0.799	0.037	0.023	1.234	2.35
Public building furniture	-0.048	0.042	*	0.608	0.021	0.025	1.097	0.05
Partitions & fixtures	0.000	0.236	*	0.853	0.026	0.022	0.873	0.23
Misc. furniture & fixtures	1.469	0.250	0.686	0.797	0.023	0.019	1.040	0.52
Misc. converted paper products	0.572	-0.379	0.777	0.825	0.036	0.030	0.986	1.50
Paper board containers	0.113	-0.468	*	0.915	0.032	0.036	1.048	1.39
Commercial printing	-0.674	-0.043	0.848	0.875	0.020	0.023	1.096	1.03
Manifold business forms	-0.022	0.826	1.111	0.979	0.016	0.016	1.131	0.13
All other publishing	-0.965	-3.254	0.888	0.880	0.012	0.009	1.137	1.47
Industrial inorganic chemicals	0.005	0.320	1.574	1.363	0.471	0.290	0.944	11.36
Drugs	-2.238	0.202	*	0.854	0.029	0.023	1.344	7.23

Table 5 (continued)
Variables Used in the Regressions

Industry	'72-'77 Indiana Competitive Shift	'77-'82 Indiana Competitive Shift	Indiana/ Texas Price/BTU	Indiana/ USA Price/BTU	Energy/ Value Added IN 1977	Energy/ Value Added US 1977	Labor Cost IN/TEX 1977	Gross Potential Savings**
Paint	0.089	0.055	0.750	0.724	0.019	0.021	1.075	0.23
Plastics & other chemicals	-0.370	-0.193	1.073	1.055	0.051	0.114	0.835	9.99
Petroleum & coal products	-2.324	-0.537	1.550	1.339	0.060	0.149	1.044	5.06
Rubber & misc. plastics	-3.199	-1.288	0.784	0.819	0.045	0.049	1.058	9.86
Blown & pressed glass products	-1.358	-9.291	0.902	0.917	0.153	0.362	1.038	8.73
Cement	0.444	-0.185	0.755	0.845	0.492	0.438	1.086	6.07
Structural clay products	-0.142	-0.298	1.083	0.906	0.190	0.214	1.282	1.19
Misc. glass & nonmetal	0.322	0.365	0.965	0.924	0.095	0.074	1.076	9.73
Blast furnace & basic steel	4.190	9.522	0.699	0.859	0.279	0.246	1.182	152.63
Iron & steel foundries	-1.622	0.344	0.983	0.974	0.103	0.120	1.172	8.99
Nonferrous rolling & drawing	0.728	0.464	*	0.846	0.108	0.085	1.196	13.66
All other primary & secondary metal	-0.160	-0.268	1.111	0.432	0.182	0.586	1.009	16.89
Cans & shipping containers	0.460	-0.174	1.015	0.912	0.024	0.033	1.037	1.14
Cutlery, hand tools	0.328	-0.046	*	0.747	0.021	0.023	1.217	0.77
Plumbing & heating goods	-2.849	-1.011	0.947	0.918	0.028	0.029	1.144	1.03
Fabricated structural, metal products	-1.980	-0.582	0.837	0.857	0.023	0.021	1.154	2.27
All forging & stamping	-0.997	-1.514	1.092	0.862	0.032	0.039	1.237	4.49
Plating, polishing, coating, etc.	0.274	-0.238	0.790	0.712	0.081	0.073	1.092	2.14
Scrap machinery, misc fabricated metal & ord	-1.904	-2.703	0.965	0.879	0.033	0.026	0.932	3.77

Table 5 (continued)
Variables Used in the Regressions

Industry	'72-'77 Indiana Competitive Shift	'77-'82 Indiana Competitive Shift	Indiana/ Texas Price/BTU	Indiana/ USA Price/BTU	Energy/ Value Added IN 1977	Energy/ Value Added US 1977	Labor Cost IN/TEX 1977	Gross Potential Savings**
Farm & garden machinery	-1.103	-0.676	*	0.880	0.021	0.021	1.232	1.01
Construction & related	-1.239	-0.861	0.930	0.548	0.021	0.030	0.994	1.21
Metalworking machinery	1.081	0.005	0.841	0.932	0.018	0.019	1.287	1.32
General industrial machinery	-1.262	-4.800	0.919	0.871	0.021	0.021	1.095	3.28
Refrigeration & service	0.323	-0.376	0.743	0.725	0.026	0.021	1.229	1.42
All other nonelectric machinery	-2.674	-5.740	0.839	1.205	0.018	0.012	1.169	4.16
Electric industrial apparatus	-2.791	-2.272	0.710	1.002	0.022	0.027	0.873	1.83
Electric light & wiring devices	0.494	-1.008	0.699	0.679	0.026	0.023	1.664	2.12
Communication equipment	-2.576	-5.108	0.690	0.694	0.012	0.012	0.939	1.24
Electronic components, accessories	-6.151	-5.367	0.833	0.757	0.026	0.023	0.797	1.52
Household appliances, radio, & TV, misc. electric	-2.961	-8.479	0.745	0.815	0.017	0.020	1.114	9.92
Motor vehicles & equipment	1.600	-10.243	0.969	0.795	0.025	0.025	1.170	15.67
Shipbuilding	0.660	-0.507	1.591	0.816	0.016	0.021	0.988	0.26
All other transportation	0.730	-6.135	1.041	0.805	0.028	0.017	1.068	6.89
Measuring & control devices	0.509	-2.955	1.500	1.270	0.012	0.014	0.857	0.31
Toys & sporting goods	0.620	-0.008	*	0.848	0.017	0.020	1.084	0.18
Other misc. manufactures	0.447	-0.357	1.034	0.912	0.023	0.022	1.298	0.85

* not available
** in millions of 1972 dollars