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THE IMPACT OF THE 1969 COAL MINE HEALTH AND SAFETY ACT AND THE CLEAN AIR ACTS ON COAL MINING EMPLOYMENT IN OHIO AND ILLINOIS

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Employment in coal mining in Ohio has followed a roller coaster ride. Employment in 1957 was about 9,300 miners (*Division of Mines Report and Report on Ohio Mineral Industries*, various years). By the mid-1960s employment had fallen to 5,400 miners. Employment rose as nuclear power started to fall into disrepute, especially as oil prices also skyrocketed. The oil embargo and general disruption of the oil market apparently caused coal to gain market share. Coal mining employment in Ohio climbed to nearly 12,200 by 1977. As the environmental movement gained strength, coal employment fell again, reaching its lowest levels in 30 years. By 1991 employment was down to about 2,800 miners.

The picture was not so grim in Illinois. In 1957 coal mining employment was about 11,000 in Illinois. By 1967 it fell to almost 8,000 miners, but by 1979 had increased to nearly 17,000. By 1985, however, coal mining employment was down to about 13,000.

For the U.S. as a whole a similar pattern occurred. In 1957 coal mining employment was about 210,000. It fell to almost 110,000 in 1969, rose to about 210,000 by 1979, and fell to 110,000 in 1991.

The question I wish to address is what impacts environmental and health legislation had on high sulfur coal mining employment in Ohio, Illinois, and the U.S. This paper examines some simple linear regressions relating employment in coal mining in Ohio, Illinois, and the U.S. to several variables including oil price, coal price, and average hourly earnings

* This research was supported by a summer grant from the Faculty Research Committee of Bowling Green State University. Special thanks to Mark Wheeler for assistance and support. Discussions with Jim LeSage and Susan Pozo were also extremely useful, as were reviewer comments.

in real terms for bituminous coal miners. Three hypotheses will be examined.

- Have the laws had different impacts upon coal mining employment in the states?
- Have the laws had a different impact on coal mining employment in the state compared to the nation as a whole?
- Have the economic variables affected coal mining employment differently in the states?

Legislation

It is important to understand the legislative history before examining the data. There have been a series of environmental acts that have affected coal mining employment. I will focus on two legislative directions: the clean air acts and strip mining reclamation legislation.

The Clean Air Act was passed in 1963, but Congress did not provide the EPA with the power to set uniform standards until 1970. (This history draws on Rosenbaum, 1991, p. 180ff.) New source performance standards (NSPS) were imposed by a 1970 act that limited the sulfur emissions of power plants built after 1971. The standard could be met by burning low sulfur coal. This standard was opposed by eastern and mid-western coal producers, where most high sulfur coal is found. Producers argued that the law was biased against high sulfur coal and would shift production and employment to regions where low sulfur coal was readily available (i.e., in the west). The 1970 act also established national ambient air quality standards. These standards were set for seven pollutants, including sulfur oxides. These standards were to be met by 1982, a deadline that later was extended. In addition, each state was required to develop a state implementation plan for enforcement. States were required to force businesses to employ technology to reduce pollution in regions where standards had not been met. These plans were to be approved by 1979. Congress revised the Clean Air Act in 1977 to include a requirement that the sulfur dioxide emissions had to be cut 90 percent. This provision effectively removed the incentive to not use high sulfur coal, because all new power plants would require scrubbers. This change in the law was supported by environmental groups and coal producers in states with predominantly high sulfur coal. There have been more efforts recently to reduce sulfur oxides from burning coal further because of acid rain concerns.

A surface mining reclamation law was passed in 1977. Its basic impact has been to raise the cost of mining by surface methods. The act also may impact deep mining methods, but the effect is small compared to the impact on surface mining methods. The act imposes costs per ton of coal mined to be set aside for reclamation. The main difficulty in assessing the impact of such a law is that mining conditions vary considerably from state to state. In states where surface mining is done on

flat land, the costs of reclamation are likely to be far different than in locations where strip mining is done in mountain terrain. Various states also have laws requiring reclamation of strip-mined lands.

These laws impact Ohio and Illinois coal mining. Because coal in these states is largely high sulfur, coal has been affected adversely by the 1971 law. Coal in Ohio and Illinois may have been helped by 1977 amendments to the act. Ohio and Illinois coal generally would be hurt by any law attempting to reduce acid rain. The surface mining reclamation law also has impacted both states. For example, about half the coal mined in Ohio is strip mined. The reclamation law is likely to hurt strip mining relative to underground mining. It is not clear that there is a particular effect on Ohio or Illinois coal that is different from other states due to the reclamation law. Thus, we should expect Ohio and Illinois coal mining employment to fall after 1977. It clearly has. But one question addressed here is whether Ohio's coal has been hurt relative to other high sulfur coal-producing states. I begin by looking at theory and data.

Theory and Data

This paper examines change in coal mining employment in Ohio and Illinois. One question is whether the Coal Mine Health and Safety Act or the Clean Air Acts have impacted coal mining employment in Ohio and Illinois. Coal from Ohio and Illinois is largely of high sulfur content. It could be that these states have lost market share and thus employment in coal mining in part due to the sulfur content of their coal and because of environmental legislation. A comparison between coal mining employment in Illinois and Ohio will be made to discover whether and the extent to which these laws have had a different impact on either state.

Our focus is coal mining employment. This variable is important because it is a direct measure of economic conditions in the coal mining areas. It is not unusual for there to be few alternative sources of employment in coal mining areas. As mining employment falls, the local economy declines. These workers are not likely to find employment in manufacturing, as little manufacturing exists in these areas. Tons mined is not as good a measure of economic well-being because labor productivity does vary over time, and an increase in tons mined may not mean more jobs.

The employment data are monthly and represent production workers. The Ohio data run from 1957 through 1991. The Illinois data also start in 1957 but end in 1985. Using the simplest economic model, there will be both supply and demand factors that determine employment. First, on the demand side, it generally is true that the quantity of coal mined increases as the economy grows. A general increase in economic activity should increase the quantity of coal mined and increase employment. Aggregate U.S. employment is included to capture this

effect. Economic conditions in the state may have significant impacts on coal mining employment. For example, if the state economy is growing rapidly and employment in general rises, we would expect the demand for energy, coal, and coal miners also to grow. The state employment variable may capture such state-specific effects better than the U.S. employment variable does.

Second, if market opportunities for coal improve, employment should rise. An improvement in market opportunities could occur if the price of coal were to fall compared to other fuels. This could be accomplished if the price of coal fell (did not rise as fast as other fuels) or the price of another fuel rose (faster than the price of coal). Therefore, a monthly price index for bituminous coal, obtained from the Producer Price Index, is included in the regression. The market for coal may have improved during the 1970s when the oil embargo occurred and the market for oil was disrupted. During this period the oil price rose dramatically. For this reason, a monthly price index (from the Producer Price Index) for oil is included in the calculation. The price index is for residual fuel oil, an important utility fuel. The impact of the price of oil on coal mining employment depends on the extent to which coal can be substituted for oil in the production of energy. If it is difficult for utilities to switch from oil to coal, the impact of the higher price of oil may be small, at least in the short run (in which case variation in the oil price may not explain much of the variation in coal mining employment).

The factors discussed above are factors that would cause the demand for labor to shift. Another source of shift in demand is change in labor productivity. Productivity changes are generated from a variety of sources, including changes in technology. In this case, room and pillar or strip mining were the primary mining technologies early in the period. Increases in bucket size probably have had a measurable impact on surface mining labor productivity, and the introduction of long wall methods have had a substantial impact on underground mining productivity. In addition, there have been a variety of impacts on productivity due to government regulations. The 1969 Federal Coal Mine Health and Safety Act likely had impacts mainly on underground mining. A surface mining reclamation act was passed in 1977 that primarily impacted surface mining. Because of the Clean Air Act it is likely that the percent of coal cleaned may have changed over time. If a lower percentage of coal were cleaned as time passed, productivity would rise. There are other sources of change in productivity. Over time mining may be forced into geologically more challenging coals; therefore, productivity falls. Also, if coal mining firms change size, there may be variations in productivity due to the size of firms. If these factors affect productivity, they also affect employment, the variable considered here.

The only variables above for which monthly data are available are the laws. Representation of the laws and the impact on employment will be discussed below. The other productivity changes, to the extent they are measured directly, are captured in the time trend.

If there were no other factors affecting coal mining employment, then the data could be used to estimate the supply of labor in Ohio coal mining. There are some factors, however, that cause supply to shift. The primary supply side variable is other wage rates and employment opportunities in other industries. If coal miners typically choose industry X as their best alternative, the wage in industry X could be included as a measure of other wages. There is no uniform best alternative for coal miners, however, so we have no alternative wage in the equation. The best alternative is to express the wage in real terms (money wage divided by CPI).

A second factor determined by the market is the wage rate. Coal mining employment is likely to depend upon the wage rate. For our purposes, the wage rate is measured by average hourly earnings. Average hourly earnings for coal miners is reported in *Earnings Hours and Employment* for each month except July. The missing July observation starts in 1962 and extends to the end of the sample period. The missing values are replaced by the average of the two contiguous observations. Average hourly earnings are converted to real average hourly earnings by dividing by the Consumer Price Index.

There are likely to be other factors affecting the marketability of coal and the quantity of employment in coal mines, but the main effects probably are those listed above. To examine the relative impacts of these factors, some empirical work has been done.

Labor strife has been an important factor in the coal mining industry. There were 17 strikes from 1957 through 1991. These strikes will cloud our ability to detect other variables. Therefore, a strike dummy is included for each strike period. There are some complications associated with this process. First, the strikes sometimes extended from one month to another. In this case, a separate strike dummy is used in each month because the strike may have lasted a different number of days in each month and hence would have had a different impact on each month. To overcome any possible seasonal impact, dummy variables are used. Each month of the year is treated as a separate season, so there are 12 seasonal dummy variables.¹ This procedure effectively includes the intercept in each of the coefficients for the monthly dummies.

¹ Later, the data will be differenced so only 11 monthly dummies will be used to avoid collinearity.

Estimation and Results

There are different ways to interpret regressions. The regressions could be used to estimate either the supply of or demand for coal mining employment. Because wage and employment data presumably are generated by supply and demand, however, we encounter an identification problem. This can be overcome by two stage least squares or an instrument variable technique. If labor demand or supply were the focus, this would be done. On the other hand, it is not strictly the forces of supply and demand that determine wages and employment because the coal industry is unionized. One way to view the regression equations is to assume that there is some process that determines employment, and that the process depends on the factors discussed above. The regressions tell us something about this process. It is this point of view that will be pursued here.

Prior to running the regressions, all economic variables are converted to natural logs and differenced. This facilitates interpretation as growth rates. The growth rate variables are checked for unit roots using an augmented Dickey-Fuller test.² No unit roots are found. For consistency, the dummy variables are differenced.

The focus is how the Ohio or Illinois coal miner has fared. One way to look at the question is in terms of employment. If employment has fallen, then surely the coal mining industry has suffered. Another standard of comparison is how Ohio or Illinois compares with the U.S. as a whole. Is Ohio or Illinois coal mining employment increasing or decreasing relative to U.S. total employment? An alternative comparison is to examine one state's experience relative to that of another state. Is Ohio coal unique, or is Illinois coal unique?

Four laws have been enacted in the period that likely have had measurable impacts on employment. In 1969 the Coal Mine Health and Safety Law was passed. In 1970 amendments were made to the Clean

² The augmented Dickey-Fuller will be discussed as it was applied to the wage series. The test is used in the same way for the other series. We are testing to see if the differenced series has a unit root. The first step is to run a regression with \ln wage as the dependent variable and time, the strike, and month dummies as independent variables. The residuals are saved and differenced. Denote the differenced residual as u_t . Now difference u_t ; call differenced u , du . Now form a regression

$$du_t = \beta_0 + \beta_1 u_{t-1} + \sum_{j=1}^k \beta_{j+1} du_{t-j}$$

where k is chosen by selecting the k that provides the smallest Akaike information criteria value. The coefficient β_1 is subject to the Dickey-Fuller test. Find $(\beta_1 - 1)/s.e.$ and compare to the critical values published in Engle and Yoo (1987). In this case, I use a critical value of -3.45. In no case is there evidence of a unit root in the differenced series.

Air Act. In 1977 there were other amendments to the Clean Air Act. In 1977 the Surface Mining Control and Reclamation Act was enacted. Because the last two laws were passed within days of each other, they are represented by one dummy variable. Each of the other laws is represented by a separate dummy variable. It is unlikely that any of these laws had an immediate significant impact. Thus, a (0, 1) dummy is inappropriate. To overcome some of the impacts of an immediate shift imposed by a (0, 1) dummy, the dummy is allowed to taper, so the shape is that of a cumulative normal distribution that started in the year after the law was passed and reached full impact by the end of 1991 (when differenced, the dummy has the shape of a standard normal probability density function). It is arbitrary to select a shape and a time by which full compliance is achieved. On the other hand, it seems likely that this shape is preferred to an abrupt step—for the last laws considered, the impact had at least 12 years to be felt. If they had no impact in that time, it is doubtful if they had any impact. Another important clean air act passed in 1990. The impact of this law probably was not apparent by December 1991.

Did the 1977 Clean Air Act Amendments have a differential impact on coal mining employment in Illinois compared to that in Ohio? First, what was the expected impact of the law? Did firms believe it would be enforced? Prior to the 1977 amendments there is little evidence that laws had been enforced; why should the 1977 amendments differ? If Congress cared enough to pass a new law, on the other hand, it might indicate new resolve. Carter was president; he had strong environmental interests. The law also included an enforcement provision. There were reasons to believe that there would be some effort to enforce the new law. The new source performance standards only applied to new capacity, so there might not have been a dramatic influence on coal mining employment in the short run. It would be unreasonable to expect the impact of the 1977 amendments to begin when the law was passed. For that reason, the dummy variable representing the law was begun in January 1978. This suggests that the laws had an impact on the growth rate of coal mining employment in the U.S., Ohio, or Illinois. The results of the regressions are shown below in Table 1.³

Some important observations follow:

- In no case is any law statistically significant at the 5 percent level.
- The 1969 law has a significant positive impact in Illinois at the 10 percent level, but not for the U.S. as a whole. The 1969 law

³ Similar regressions (including an exchange rate series, the valuation of the special drawing right, based on the dollar, the Deutschmark, the pound sterling, the French franc, and the Japanese yen) are calculated. This variable has no impact on the results and is never statistically significant.

has a significant impact at the 10 percent level in Ohio when Ohio employment is a regressor, but not when U.S. employment is the regressor.

- The 1970 law has a negative impact at the 10 percent level in Ohio and Illinois. The law is not statistically significant for the U.S. as a whole.
- The 1977 law dummy is not statistically significant for the U.S., Ohio, or Illinois.

With regard to the economic variables,

- The wage is statistically significant at the 5 percent level in the U.S. as a whole, at the 10 percent level in Ohio, and not statistically significant in Illinois.
- The coal price is statistically significant at the 5 percent level in both the U.S. and Illinois, but is not statistically significant in Ohio.
- The oil price is significant at the 5 percent level in Ohio and is not statistically significant in either the U.S. or Illinois.
- The U.S. employment variable is statistically significant at the 5 percent level in Illinois and at the 10 percent level in the U.S.

Discussion

The sample period in Illinois is not the same as for Ohio and the U.S. Some differences may be due to this fact.

What is the impact of the various laws on employment? Normally, any law mandating more labor would be expected to drive up the cost of coal. The increase in cost should cause coal to become relatively less attractive as an energy source. This should cause coal employment to fall. The 1969 Health and Safety Act caused the rate of growth of coal employment to rise, although the impact is not significantly different from zero at the 5 percent level. There is an impact on Illinois employment at the 10 percent level. How can this happen? The law has two effects on employment. The first effect is to increase employment due to the mandated increase in labor. The second effect is to raise the price of coal due to increases in labor used for safety purposes. The increase in price should reduce the quantity of coal sold and thus coal mining employment. The increase in employment due to the law appears to have more than offset the reduction in employment due to the higher coal price.

The 1970 Clean Air Act Amendments have had a negative impact on employment that is significant at the 10 percent level in both Ohio and Illinois. The act reduced the market opportunity for coal, and no offsetting impact on employment is mandated by the act. The impact is significant in both Ohio and Illinois, but not in the entire U.S. This supports the hypothesis that higher sulfur coal states were impacted by the 1970 Clean Air Act Amendments in a way different from the U.S. as a whole.

The 1977 dummy is not significant in any case. There are many reasons. First, the dummy represents two laws. The laws (a surface

Table 1—Regression Results

	U.S. 1957-1991	Ohio 1957-1991		Illinois 1957-1985	
Time	-.00001 (-1.57)	-.00001 (-1.45)	-.00001 (-1.38)	-.00001 (-1.60)	-.00001 (-.71)
Wage	.6538* (4.20)	.2617** (1.69)	.2630** (1.69)	-.0826 (-.86)	-.0958 (-.98)
Coal Price	.2806* (2.27)	.0313 (.25)	.0288 (.23)	.1795* (2.33)	.1626* (2.08)
Oil Price	-.0145 (-.44)	.0970* (2.96)	.0977* (2.98)	.0188 (.63)	.0191 (.63)
U.S. Employ.	.9761** (1.92)	.2961 (.58)		1.0433* (3.16)	
Ohio Employ.			.1114 (.33)		
Illinois Employ.					.3083 (1.17)
Law 69	6.3959 (.93)	11.1422 (1.63)	11.4014** (1.67)	8.2787** (1.89)	8.5005** (1.91)
Law 70	-6.2164 (-.89)	-11.7164** (-1.69)	-11.9706** (-1.73)	-8.0118** (-1.82)	-8.4226** (-1.88)
Law 77	.1932 (.24)	.6857 (.84)	.6990 (.85)	.4312 (.76)	.4303 (.74)
R ²	.9405	.8459	.8457	.9924	.9922
DW	2.32	2.40	2.40	2.43	2.41

t-statistics in parentheses

* Significant at the 5 percent level

** Significant at the 10 percent level

Strike and monthly dummies are not reported in all equations

mining reclamation act and amendments to the Clean Air Act) may have had opposite impacts. The second possibility is that the surface mining act was not enforced in the Reagan or Bush administrations and had little impact. If so, we expect the dummy to measure the impact of the Clean Air Act Amendments. It is possible that the 1977 Clean Air Act Amendments did not have the impact on employment they were designed to have. Again, one aim of the 1977 Clean Air Act

Amendments was to keep eastern high sulfur coal from being punished because of environmental laws.

Consider now the economic variables. In the U.S. equation both the wage and coal price are statistically significant at the 5 percent level. The wage is significant in Ohio at the 10 percent level, and the coal price is significant at the 10 percent level in Illinois. It is not obvious what the impact of the coal price should be in mining employment. For example, if the demand for coal increases and causes the price of coal to rise, the demand for coal mining labor will rise—all else equal, employment will rise. This would yield a positive relation between coal price and employment. On the other hand, if there is an increase in the supply of coal caused by some technological factor, the price of coal would fall and whether mining employment would rise or fall would depend on whether the impact of coal price on employment demand was larger or smaller than the impact of the change in marginal product of labor (due to the new technology). Whatever the cause, the impact is positive in the case of the U.S., mildly positive in Illinois, and not significantly different from zero in Ohio.

An increase in wages can accompany either an increase or a decrease in employment, depending on whether labor supply or labor demand shifted. Only in the U.S. is the wage statistically significant, and in this case it is positive. This suggests that demand factors may have been more important than supply factors over the time period.

We would expect oil prices to have a positive sign. As oil becomes more expensive, coal becomes a better substitute for oil. Thus, mining employment should rise. Only in Ohio is the oil price statistically significant. This is something of a puzzle, as Ohio coal is presumably a utility fuel, and the midwest is not heavily dependent on oil. One possible explanation is that the biggest reduction in Ohio coal shipments was to Michigan, and Michigan was probably switching to nuclear power. Thus, oil price, which fell after 1978, acts as a proxy for the growth of nuclear power and the reduced market for Ohio coal.

Mining employment in Illinois is connected in a statistically significant way at the 5 percent level with U.S. employment. But the Ohio coefficient is not statistically significant. This suggests that mining employment patterns in Illinois (but not Ohio) are related to nationwide employment trends. When the state employment variable is included in the equation, it is not statistically significant in either state. Ohio's coal mining employment experience does not mimic either state or national employment trends. Illinois coal mining employment seems to be related to national employment trends, but not to state trends. It is not possible from this evidence to conclude that coal miners are in a generally better or worse position than other workers in their respective states.

Overall, the statistical analysis indicates that the two states differ. They are impacted by different economic variables and in somewhat dif-

ferent ways by the laws. When we compare the states to the U.S. as a whole, it again appears that both states differ from the whole. While this is not surprising, it does point up that policy is likely to have differential impacts on various parts of the nation.

Summary

This paper presents empirical evidence that laws may have differential impacts on various states. The 1969 Federal Coal Mine Health and Safety Act had a statistically significant impact (10 percent level) in Illinois, but not in Ohio or the U.S. as a whole. The 1970 Clean Air Act Amendments had the impact they were expected to have (namely, they reduced employment in high sulfur states). There is no statistically significant impact on the U.S. as a whole, indicating that employment probably shifted from high sulfur states to the west where low sulfur coals are found. The 1977 amendments and Surface Reclamation Act together seem to have no statistically significant impact in Ohio, Illinois, or the U.S. The 1977 amendments may have stopped the substitution of western coal for eastern and midwestern coal, but they did not return midwestern coal to its previous levels of employment.

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