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HOW MUCH HAVE AIR POLLUTION STANDARDS HURT EMPLOYMENT IN OHIO'S COAL MINES?

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In this paper, we examine the impact of the environmental laws on employment in Ohio coal mining. Our interest is to understand what the cost of past environmental legislation has been and what the likely cost of future environmental legislation might be.

In the late 1960's, the environment became an important political issue across the nation. There was strong feeling that the environment (we will focus on air pollution in this paper) was being used as a dumping ground. Firms acted as if they owned the air and used it freely to dump. Since no one individual owned the environment, it was not possible for someone to prevent the dumping by charging a fee. To protect the environment, it became necessary to have society claim rights to a pristine environment. Air was claimed as a good by the society when laws were passed to protect the environment. These laws required that firms could no longer simply dump pollution into the air. The impacts of cleaning the environment required that the majority of the pollution once freely pumped into the air had to go somewhere, or could not enter the production process at all.

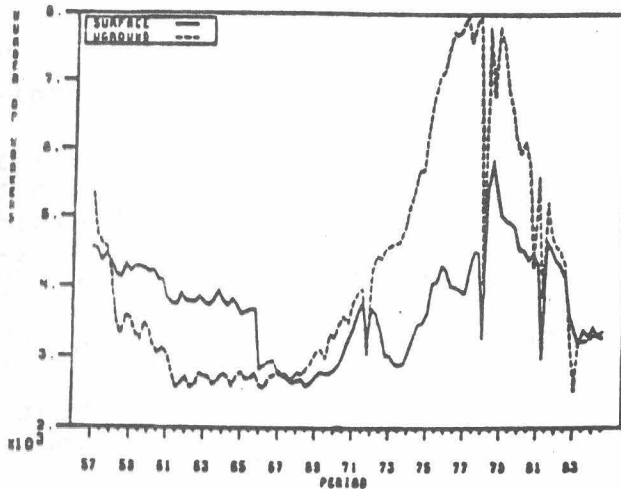
One of the major components of air pollution has been sulfur, and the main source of sulfur is the sulfur released when coal is burned. The impact of environmental laws should be particularly intense in Ohio where the coal has

a high sulfur content and generally cannot be burned without expensive pollution control technology. There is also a new threat on the horizon. The Canadian government is beginning to put pressure on the U.S. to reduce the amount of sulfur emissions in the U.S. and surely the Ohio coal industry will be hit hard again.

Before assessing the impact of the environmental laws on Ohio's coal mines, we need to examine what the pattern of employment and wages has been. Employment in Ohio's coal mines has been highly volatile over the past 30 years. The variation has been due to several factors. Coal has been replaced by cheaper oil and nuclear power over early parts of the period causing employment to fall. When the oil embargo hit, we would have expected employment to rise as coal became more cost effective. Figure 1 suggests that employment did rise. In more recent years, laws have been passed limiting the amount of air pollution that firms are allowed to emit. We would expect the market for coal to diminish because of these laws so that employment would not grow as quickly as it would in the absence of such laws. Employment in both underground mining and surface mining does decrease starting in about 1977.

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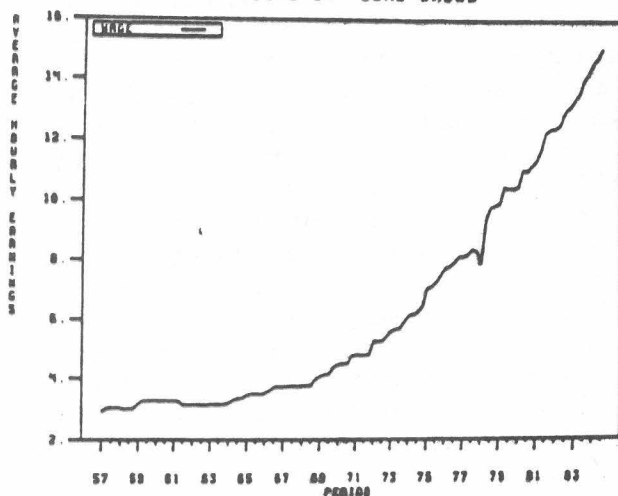
FIGURE 1: COAL EMPLOYMENT



COAL MINING EMPLOYMENT: 1957-1984

We begin with a look at employment and average hourly earning in the coal industry on a quarterly basis from 1957:1 to 1984:3. Both employment in underground mining and surface mining in Ohio are shown in Figure 1. From 1957 on, employment growth has not been steady. Wages (Figure 2) have been growing in a fairly regular way. From these graphs it is difficult to spot the trend or when the trend in growth of employment or wages changes, although the impacts of several strikes are quite evident. For that purpose we will need to examine the data using statistical techniques.

FIGURE 2: COAL WAGES



Before we turn to the statistics, we should examine what makes the quantity of coal mining labor change. The demand for coal miners depends on the quantity of coal sold. The quantity of coal sold depends on the relative price of coal compared to its substitutes. The largest part of the market for coal is used to generate electricity. In this market, oil is a substitute for coal and so is nuclear power. During the late 1950's and 1960's, coal was at a cost disadvantage compared to both oil and nuclear power. During that period, we would expect coal's share of the market to be reduced. This does not mean that the quantity of coal sold will not increase, but it does suggest that the market for coal will not grow as quickly as the market for other fuels. This is apparently what happened. While the output from coal mines increased over that period, employment fell until the late 1960's. The reduction in employment during this period was due in part to the fact that the productivity of the miners had increased. Thus the same number of miners could produce more coal than before. Due to differences in technology, labor productivity in underground mining is lower than labor productivity for surface mining. In any case, when the oil problems hit in the early 1970's, the market for coal improved and so did both the quantity of coal sold and the employment in Ohio's coal fields. In fact, the 1970's were a boom period for employment in Ohio coal mining. Still, by 1984 employment was below the levels of the 1950's.

We may summarize by saying that employment in mining is affected by the price of coal, the prices of other fuels, and the productivity of the miners. We would also expect that environmental laws would have some impact on employment since the environmental

laws reduce the amount of sulfur that can be emitted, and coal is a major source of sulfur in air emissions. Thus the passage and enforcement of air pollution controls would suggest that the market for coal would stagnate and hence the employment in coal mining should decline.

WHAT ARE THE ENVIRONMENTAL LAWS?

A complete discussion of the environmental laws is beyond the scope of this paper. It is important to note that air quality legislation was first passed in 1955 and then updated in 1967. These laws left the setting of air quality standards in the hands of the states. These laws were generally ineffective since there were few incentives to enforce them. By 1970, it was clear that the air quality laws had failed, and a new law was passed which gave the Environmental Protection Agency (EPA) the authority to set national air quality standards. States were required to submit plans which would implement the standards. The deadline for compliance was to be 1975 with possible slippage to 1977 for some particularly difficult situations. As 1977 came closer, it became apparent that compliance would not be attained. The Clean Air Act was amended in 1977 allowing the compliance to slip to 1982. Further slippage to 1987 was to be allowed for carbon monoxide and ozone.

In Ohio, by 1977, about 80% of the firms in the state were in compliance. But the problem was that the 20% not in compliance were responsible for nearly 80% of the air pollution. The state has a detailed plan to reach compliance, but full compliance has not yet been obtained.

We wish to understand the magnitude of the impact of environmental law on coal mining employment. It should be clear from the above that a discussion of mining employment requires that we distinguish surface mining from underground mining. Further, changes in employment may not occur, but it may happen that wages change to make employment stabilize. Thus to understand what happens to employment, we must subdivide employment into its two component parts and we must also examine what happens to the wage rate. So there are three series we wish to examine to see what the impact of the environmental law has been, wages, underground employment and surface employment. We collected quarterly data on these series from 1957 to 1984. The series were converted to growth rates. We then applied the methods of Box and Jenkins [1976] to these series.

Our problem is to understand how the environmental laws have impacted employment in coal mining in Ohio. The simplest technique is one where we examine the time series pattern of employment and then bring in the effect of the law by means of a dummy variable. The simplest dummy variable is a step function which has the disadvantage of a discrete jump at the time when the law is passed which assumes that overnight the impact of the law goes from zero to its full level. This seems unlikely to be true. The dummy variable is therefore modeled so that it can come into play more smoothly. Before the dummy can be introduced, the data series must be (covariance) stationary. The data series used in this study (the variables are expressed in terms of growth rates) exhibited this

characteristic so that further transformation was not necessary. We also removed data outliers. In the case of coalmining, there are strikes and other work stoppages which cause breaks in the series. Well known techniques were used to detect and adjust the outlier data points.¹ Once the outlier points are accounted for, we built the intervention models. We constructed an ARIMA (autoregressive integrated moving average) model for each series and then added the intervention term (dummy variable) to each model. When this process was completed, we were able to find the impact of the environmental laws in the coefficients of the intervention term. The Clean Air Act was passed in 1971 which would lead us to believe that the impact should be felt some time after that. We started the intervention term in 1971 and found that the coefficient for the intervention term was not statistically significant in any of the three equations. We then moved the intervention term forward by a year and redid the analysis with the same result. We continued this process for several iterations and were unable to find any meaningful impact of the environmental laws on any of the variables in question.

It is possible that the impact of the law is hidden because we were examining the variables one at a time. To overcome this problem and to account for other economic impacts, a more sophisticated model was developed. We built a five equation multivariate autoregressive moving average (MARMA) model which includes surface employment, underground employment, wages, coal prices, and oil prices, all expressed as growth rates. The MARMA model was constructed as recommended by Tiao and Box [1982]. Intervention terms were then added to the MARMA model in the equations for surface employment, underground employment, and the wage rate. The

intervention terms were first added to one equation at a time. We again searched for when the impact of the law started and we found that the intervention term was not statistically significant for any starting date for any variable. We then added the intervention term to all three at the same time and again found that the intervention was not statistically significant for any starting date.

We were unable to find any impact of the Clean Air Act on mining employment in Ohio. In one sense this is not surprising. Ohio has taken advantage of the possible slippage in compliance offered by the law. While the majority of the firms are in compliance, a majority of the heavy polluters are not in compliance. On the other hand, there has been concern for the miners and their livelihood and the potential impacts are considered an important political issue in Ohio.

SUMMARY

Our work suggests that through 1984, there has been no impact of the Clean Air Act on employment in Ohio's coal mines. We suspect that while the intent is to clean up the air, there has not been the political will needed to make the law work as it was intended. It is often possible for the legislature to pass laws which seem desirable but which have economic impacts which are undesirable and which cause the enforcement of the law to not occur.

ENDNOTE

- (1) A full discussion of the process used for handling outliers is contained in Appendix 1 of Wheeler, Hoag, and Reed [1988].

- (1) Box, G.E.P. and G.M. Jenkins. Time Series Analysis: Forecasting and Control, Revised Edition, San Francisco: Holden-Day Inc., 1976.
- (2) Tiao, G.C. and G.E.P. Box. "Modeling Multiple Time Series with Applications." Journal of the American Statistical Association, 1981, pp. 802-816.
- (3) Wheeler, M.V., J.H. Hoag, and J.D. Reed. "The Impact of Air Quality Standards on Coal Mining Employment in Ohio." Bowling Green State University - University of Toledo Working Paper in Economics, 1988.