COAL MINING EMPLOYMENT IMPACTS FROM ACID RAIN CONTROLS

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ABSTRACT

The U.S. Senate Committee on the Environment and Public Works is considering legislative proposals to reduce emissions of long-range transport air pollutants which may be a major factor in acid depostion. Preliminary results indicate that these proposals will have substantial impacts on coal production and employment in northern Appalachia, a region with long-standing structural unemployment problems.

INTRODUCTION

Section 183 of the Clean Air Act Amendments of 1982 proposed by the Senate Committee on the Environment and Public Works calls for major reductions in sulfur dioxide emissions from 1980 levels in a 31 state area of the eastern United States by 1995. The purpose of these reductions is to reduce acid deposition in the United States and Canada. If the emissions reductions proposed in the bill (S.3041) are implemented, major impacts on the coal industry may be anticipated, with potential impacts on regional coal production, miner employment, and community structure in those communities affected by coal mining activities. The purpose of this paper is a preliminary analysis of the potential impacts on coal industry employment in the Appalachian states, focusing on the tradeoffs between environmental concerns and coal industry employment. We begin by presenting a brief overview of the issues and then proceed to an analysis of employment impacts.

BACKGROUND

Acid deposition, popularly referred to as acid rain, is largely a consequence of local and distant emissions of sulfur and nitrogen based gases from natural and man-made sources. In the atmosphere these emissions undergo chemical transformations, with some proportion returning to the earth in wet or dry form as acidifying compounds. Broad regions of North America receive acid deposition, and in many areas deposition rates are substantially in excess of that expected from "pure" atmosphere. This is particularly true in portions of the northeastern United States and southeastern Canada, regions where high deposition rates correspond to environmental systems highly sensitive to acid deposition. Major concerns have been expressed with regard to the potential effects on aquatic and terrestrial ecosystems, man-made materials, and human health.

While substantial uncertainties regarding the nature and severity of potential impacts and source-receptor relationships exist, there are many who believe that the potential hazards from waiting for better information may be too great or that the weight of existing evidence already favors immediate control efforts. Environmental groups and other interested parties, including the Canadian Government, have called for immediate and stringent emissions controls for sulfur and nitrogen oxide pollutants in the United States, particularly emissions from coal-fired power plants in the Ohio River Valley and other areas of the Midwest.

In its deliberations on the acid rain issue, the Senate Committee on the Environment and Public Works concluded that acid deposition is leading to widespread and long-term degradation of ecosystems and that remedial efforts are necessary. The proposed amendments to the Clean Air Act include a proposal to alter the Act by adding a new part (Part E) titled "Interstate Transport and Acid Precursor Reduction." This addition would establish an acid deposition impact region consisting of the states east of the Mississippi River and the five states contiguous to the Mississippi to the west. Central to this proposal are provisions for reductions in sulfur dioxide emissions in the impact region. Specifically, these provisions include: (1) a reduction of sulfur dioxide emissions of eight million tons from 1980 levels by 1995; (2) a requirement that increased emissions from major stationary sources be offset by decreases from existing sources in the region; and (3) an exemption to (2) in those states which had no utility plant in 1980 with sulfur dioxide emissions at a rate in excess of 1.2 million Btu. No specific provisions for reductions of nitrogen oxides emissions are included. Instead, the bill calls for information accumulation for the design of an effective control program for oxides of nitrogen.

Estimated 1980 sulfur dioxide emissions in the impact region are approximately 16.1 million tons. Consequently, the Senate proposal contained in the proposed Clean Air Act Amendments of 1982 calls for a reduction of nearly one-half of 1980 emissions by 1995. To put the magnitude of this reduction in perspective, it may be noted that emissions in the region are estimated to have been reduced by approximately two million tons from 1973 to 1980 (Pechan and Associates). The Senate proposal does not specify how the emissions reductions are to be allocated among the states or strategies for securing reductions. Instead, the provisions of the proposal direct Governors of the affected states to negotiate an allocation formula. If they fail to do so, the law provides for a default allocation scheme.

The economic consequences of the Senate proposal will depend upon the allocation scheme selected and the regulatory strategies used. Little can be said about these at present. However it can be anticipated that stringent emissions controls for coal-fired power plants as recommended by many proposals will have significant impacts on the coal market. The resulting reductions in total coal output from projected

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future levels coupled with regional shifts in production imply impacts on coal mining employment and those communities supported by mining activities. The impacts of significant reductions may be particularly acute in the Northeast and Midwest where coal-fired power plants are prevalent and where the coal produced is predominantly high sulfur coal. Even without the enactment of acid rain control legislation, the economic health of these regions is a matter of concern. This is particularly true for the Appalachian coal production region which includes areas with decling "smoke stack" industries and persistent structural unemployment problems. In states such as Pennsylvania with a current 14 percent unemployment rate (Pennsylvania Department of Labor and Statistics), stringent sulfur dioxide emissions controls will imply a worsening unemployment situation, particularly in rural areas. Rural communities dependent on the coal industry will witness declining secondary employment opportunities and other secondary socioeconomic impacts associated with regional reductions in coal production and coal-related employment.

In this paper a preliminary analysis of the potential impacts of more stringent emissions controls on coal mining employment in the Appalachian region is presented. Projections of employment impacts are developed by combining forecasts of coal production changes attributable to more stringent emissions controls with the output-employment relationships estimated in this paper. The coal production effects adopted for this analysis are presented in a recent Office of Technology Assessment (OTA) interim report; these impacts will be discussed further below. After assessing the output-employment relationships estimated here for the Appalachian region, the potential employment impacts of projected output changes with imposition of emissions controls to diminish acid rain are considered.

EMPLOYMENT IMPACTS MODEL

The employment impacts of emissions controls to diminish acid deposition will depend upon the effects on coal production and labor productivity. The effects on these two factors will be a consequence of the economic, technological, and institutional forces present, and a complete analysis must provide for an extensive accounting of these forces. Such an accounting is beyond the scope of this preliminary analysis. The alternative followed here was to adopt existing estimates of the output effects of acid rain control proposals and infer employment changes by applying estimates of output-employment relationships. Specifically, simple output-employment relationships are estimated for the two coal ranks found in the Appalachian region, anthracite and bituminous, and for two mining methods, surface[1] and underground. Employment is measured in this study by annual man-days of mining employment.[2]

The quantity of coal mined in the Appalachian region has increased over time, with the coal produced being predominantly bituminous coal consumed in electric power generation. Anthracite production, restricted to portions of eastern Pennsylvania, accounts for only a small proportion of regional coal output. Significant percentages of total coal output in the Appalachian region are obtained by both surface and underground mining techniques, with the proportion of total production contributed by surface mining methods increasing over time as in other areas of the nation. On average substantial differences in labor productivity exist between the two mining methods considered here.

Until the early 1970s the coal industry experienced substantial growth in labor productivity on average throughout the Nation. Productivity growth reflected two factors: adoption of advanced mining methods in both surface and deep mining, and the growing percentage of total output obtained by surface mining methods. However, in the early 1970s this trend reversed. The cause of this reversal is widely attributed to the Federal Coal Mine Health and Safety Act of 1969 (CMHSA). Factors influencing average productivity over time are incorporated in this study by inclusion of a time variable and a dummy variable for the Federal Coal Mine Health and Safety Act of 1969 for both coal types and mining methods, while regional variations in factors influencing employment such as geologic conditions are incorporated by inclusion of state dummy variables in the bituminous coal equations. Other variables hypothesized to capture better the productivity trends (e.g., a time-output interaction variable) were initially included but were rejected. Since mining labor productivity in the Appalachian region has not shown a consistent increase over time, capturing underlying trends in productivity was empirically difficult. The following specification was used for anthracite coal:

$$(1)\quad L^a_{it} = f(Q^a_{it}, D_t, t, E^a_{it})$$

where

L^a_{it} = Annual man-days of labor employed in anthracite mining by mining method i in year t;

Q^a_{it} = anthracite production by mining method i in year t;

D_t = legislative dummy variable for the Federal Coal Mine Health and Safety Act of 1969 (1 = legislation in effect; 0 = legislation not in effect)[3];

E^a_{it} = random error for mining method i in year t;

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[1] Surface mining techniques include strip and culm bank mining for anthracite and strip, auger, and strip-auger for bituminous coal.

[2] The total number of man-days of employment on an annual basis equals the average number of days worked.

[3] The impacts of the Federal Coal Mine Health and Safety Act of 1969 were assumed to begin in 1970 due to compliance lags.

$i = 1$ for underground mining; $i = 2$ for surface mining;

$t = 1, \ldots, T.$

For bituminous coal the specifications were consistent with the general functional form:

$$(2)\quad L^b_{irt} = g(Q^b_{irt}, S_{1t}, S_{2t}, \ldots, S_{6t}, D_t, t, E^b_{irt})$$

where

L^b_{irt} = annual man-days of labor employed in bituminous coal mining by mining method i, in state r, in year t;

Q^b_{irt} = bituminous production by mining method i, in state r, in year t;

D_t = legislative dummy variable for the Federal Coal Mine Health and Safety Act of 1969 (1 = legislation in effect; 0 = legislation not in effect);

S_{rt} = dummy variable for state r in year t;

E^b_{irt} = random error for mining method i, in state r, in year t;

$r = 1, 2, \ldots, 6$; (1=Kentucky; 2=Maryland; 3=Ohio; 4=Tennessee; 5=Virginia; 6=West Virginia);

$i = 1$ for underground mining; $i = 2$ for surface mining;

$t = 1, \ldots, T.$

Data used to estimate the relationships in (1) and (2) were obtained from the U.S. Bureau of Mines Minerals Yearbook, Mining Enforcement and Safety Administration (MESA) Informational Reports, and Department of Energy sources. Annual data were collected for the period 1960-1980 for anthracite produced in Pennsylvania and for bituminous coal mined in the seven Appalachian coal producing states: Kentucky, Maryland, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. While time-series and cross-section data (by state) were available for bituminous coal, only time-series data were available for anthracite, since anthracite coal production is confined to Pennsylvania.

Estimates were obtained for linear and double-log linear specifications using ordinary least squares procedures. It is recognized that OLS estimators are efficient for pooled time-series-cross-sectional data only with the simplest of possible error structures. However, our focus is on the output-employment parameters and the results presented in Table 1 show these generally to be statistically significant. Consequently, obtaining more efficient estimates was not considered a major concern for the purposes of this preliminary investigation. It was observed that the output-employment regression coefficients changed only minimally when corrected using the Parks Method.

For all cases (linear and double-log), the relationship of the independent variables as a group to the dependent labor variable was highly significant when judged by the F-statistic computed for each equation. However, in several equations not all variable coefficients were found to be significantly different from zero as determined by t-tests of the individual estimated coefficients. The estimated linear equations were, in general, more satisfactory than the estimated double-log functions, and only the former are presented here. The results presented in Table 1 were selected as the best representatives.

The coefficients for the output variables were statistically significant at the 0.01 level of significance for three of the four estimated equations; the output variable coefficient for deep-mined bituminous coal was statistically significant at the 0.05 level. In addition, the output variable coefficients had the expected positive sign, indicating that increases (decreases) in coal production will be accompanied by increases (decreases) in man-days of employment. Therefore, decreases in coal production due to acid rain abatement legislation which reduces coal output can be expected to result in miner lay-offs or in fewer days worked by the existing labor force, or both.

For underground and surface anthracite and for underground bituminous mining, the Federal Mine Health and Safety Act of 1969 adversely affected labor productivity, as anticipated, and led to increases in mine employment, particularly in underground mining of both coal types. Since other legislation was enacted in the 1970s that may have affected productivity and employment (e.g., the Surface Mining Control and Reclamation Act of 1977), the legislation dummy variable represents the joint employment impacts resulting from all legislation enacted during this decade, but particularly from the Federal Coal Mine Health and Safety Act of 1969. For surface-mined bituminous coal the legislation dummy variable coefficient was not statistically significant. Instead, the time trend coefficient for surface-mined bituminous coal was significant and positive, indicating declines in surface mining productivity for bituminous coal over time, a result consistent with findings published by the Electric Power Research Institute (EPRI). EPRI notes that this decline may be due to a number of factors concurrently affecting the bituminous mining industry: an increase in the number of young, inexperienced personnel hired as workers, engineers, and management; increases in strikes and other labor problems; changes in UMWA contracts; OMHSA and other Federal and state legislation; and the "increased use of more marginal mines and increased developmental costs, associated with the recent expansion in coal mining" (EPRI, p. 3-6).

Most of the state dummy variable coefficients in the bituminous coal equations were statistically significant, indicating significant differences between average labor productivity among the states, specifically between Pennsylvania and the six other coal producing Appalachian states. Differences for underground mining were particularly apparent, reflecting regional differences in underground mining conditions, capital vintage, and mine size.

Table 1. Coal Employment Equations for the Eastern U.S. Coal Production Region [a/]

Anthracite: Underground

(3) $L^a_{1t} = -213969 + 0.2249Q^a_{1t} + 217641D_t$ $R^2 = 0.975$
$(-2.871)\ (16.441)\ (3.124)$ $F = 335.818$
$n = 20$

Anthracite: Surface

(4) $L^a_{2t} = 161162 + 0.0626Q^a_{2t} - 16028t + 143341D_t$ $R^2 = 0.967$
$(1.097)\ (4.694)\ (-3.348)\ (4.925)$ $F = 135.041$
$n = 18$

Bituminous: Underground [b/]

(5) $L^b_{1rt} = 3884086 + 0.0890Q^b_{1rt} - 256687S_{1t} - 4120526S_{2t} - 3037636S_{3t}$ $R^2 = 0.977$
$(15.536)\ (1.952)\ (-1.594)\ (-15.789)\ (-14.063)$ $F = 649.509$
$n = 133$

$- 3790250S_{4t} - 1908278S_{5t} + 4017257S_{6t} + 518378D_t$
$(-15.305)\ (-10.707)\ (13.018)\ (6.213)$

Bituminous: Surface [b/]

(6) $L^b_{2rt} = 52808.431 + 0.0426Q^b_{2rt} + 12290t - 764072S_{1t} - 175405S_{2t}$ $R^2 = 0.922$
$(0.623)\ (15.753)\ (3.112)\ (-7.933)\ (-1.605)$ $F = 181.856$
$n = 132$

$- 325517S_{3t} - 161633S_{4t} - 210621S_{5t} - 120262S_{6t}$
$(-4.365)\ (-1.541)\ (-2.156)\ (-1.455)$

a/ t-statistics are shown in parentheses.
b/ Includes labor employed in mechanical cleaning plants.

OUTPUT AND EMPLOYMENT IMPACTS FROM ACID RAIN CONTROL

Assuming that relatively stable relationships exist between coal production and employment in coal mining, the impacts of acid rain control on mining employment will depend upon the impacts of such controls on coal production. Using the estimated output-employment relationships in Table 1 in conjunction with predictions of coal output response to acid rain control, the impacts of control legislation on coal industry employment can be estimated. The preliminary output response predictions used here are included in a recent OTA report (OTA, pp. DD-7 to DD-19) and are based on the ICF coal model, an adaptation of the Department of Energy (DOE) National Coal Model, that has been used to predict impacts of acid rain control proposals for a number of groups including the Environmental Protection Agency and DOE.

The production impacts of acid rain control strategies will be a consequence of the specific regulatory strategy followed. The predictions used here assume that regulations call for sulfur dioxide emissions reductions of 5, 10, and 13 million tons relative to a 1990 base case. In the base case, emissions and production levels are those projected assuming no additional emissions controls beyond those called for by present regulations.

The ICF solution minimizes the costs of emissions reductions to the electric utility industry. The least cost emissions control assumption used in projecting production impacts implies that utility coal demand for low sulfur coal will increase relative to coal with a high sulfur content. Again assuming a relatively stable relationship between output and employment, it follows that employment impacts will depend not only upon the change in aggregate demand but also upon regional shifts in demand from high to low sulfur coal supply regions.

The base case projections indicate that national coal production will increase approximately 60 percent between 1979 and 1990 (OTA, pp. DD-7, DD-10). This increase, however, will not be evenly distributed across the Nation. The predictions suggest that without acid rain control legislation, coal production in Northern Appalachia[4] will increase only 10 percent between

[4] Northern Appalachia includes Maryland, Northern West Virginia, Ohio and Pennsylvania.

1979 and 1990, while Central Appalachia[5] will witness a 50 percent increase. In both cases, the increase in coal production in the East will lag behind average national production increases achieved by 1990 (OTA, p. DD-11).

With acid rain control requiring reductions in sulfur dioxide emissions, regional shifts in production occur from those regions with high sulfur coal reserves to areas in which low sulfur coals predominate. In terms of the Appalachian coal producing region, preliminary predictions made by OTA indicate a shift in coal production from Northern Appalachia and the Midwest[4] to Central Appalachia and the Western U.S. The predicted net changes in production with versus without acid rain control legislation for Appalachia are shown in Table 2 for the three sulfur dioxide emissions reduction levels considered: 5, 10, and 13 million tons. For each level, the net change in mining employment in annual man-days resulting from sulfur dioxide emissions abatement is indicated.

Table 2 suggests that if acid rain control legislation is adopted requiring sulfur dioxide emissions to be reduced at least cost to the electric utility industry, there will be a significant loss of mining employment in Northern Appalachia, a region currently plagued by high unemployment rates. If a reduction of 5 million tons of sulfur dioxide nationally is required, this region will lose approximately 5,227 mining jobs from projected 1990 employment levels, assuming an average 220 working days per year. In addition, some jobs associated with anthracite coal preparation (not estimated here) will be lost. The most stringent legislation considered, a 13 million ton sulfur dioxide emissions reduction, will mean the loss of an estimated 12,021 jobs by 1990.[6]

In contrast, Central Appalachia will witness an employment increase in the coal mining industry both with and without the enactment of acid rain control legislation. Under the least stringent emissions reduction scenario (5 million tons reduction), 9,013 mining jobs[6] will be gained by 1990 in addition to the mining employment increases projected to occur in the absence of acid rain legislation, while mining jobs are projected[5] to increase by an estimated 18,778 jobs if regulations requiring a 13 million ton reduction are passed. In Central Appalacia the majority of the mining jobs created by production shifts to this region will be in strip mining.

[5] Central Appalachia includes Eastern Kentucky, Southern West Virginia, Tennessee and Virginia; the Midwest region includes Illinois, Indiana, and Western Kentucky.

[6] Based on a 220-day work year. This estimate includes the additional preparation plant workers that must be laid-off (hired) as a result of output decreases (increases), except those employed in anthracite mining operations.

Table 2. Projected Net Changes in Output and Employment From 1979 to 1990, With Versus Without Acid Rain Control Legislation.

	Sulfur Dioxide Emission Reduction		
Region	5 Million Tons	10 Million Tons	13 Million Tons
Northern Appalachia			
Net Output Change (%)[a/]	-10%	-20%	-23%
Net Employment Change (annual man-days)[b/]	-1,149,855 man-days	-2,299,711 man-days	-2,644,667 man-days
Central Appalachia			
Net Output Change (%)[a/]	+12%	+20%	+25%
Net Employment Change (annual man-days)[b/]	+1,982,939 man-days	+3,304,964 man-days	+4,131,057 man-days

[a/] Source: OTA, p. DD-11.

[b/] Derived from output-employment relationships estimated in Table 1.

CONCLUSIONS

The employment loss projections presented in this paper are dependent on the stability of the output-employment relationships estimated here and on the preliminary output change projections developed by OTA. OTA predictions of changes and shifts in regional coal production depend on the assumption that reductions in sulfur dioxide emissions will be met at least cost to the electric utility industry. At present, however, little is known about the allocation of reductions, and it is plausible that the strategies used to meet these reductions will not be consistent with a least cost solution. The variability between output projections developed by OTA and by the Peabody Coal Company and the UMWA indicates the uncertainty regarding output response, particularly regional output response, to alternative acid rain control proposals.

Projected losses in coal employment will also depend on the estimated relationships between coal production and mining employment. While the output-employment relationships estimated here are consistent with the coal industry employment-output ratios derived by Peabody Coal Company and the UMWA, more analysis of these relationships using alternative specifications is required. Since an examination of productivity growth for the Appalachian coal industry did not show a consistent increase as expected, capturing changes in labor productivity over time was particularly difficult.

However, despite these reservations, it is apparent that significant losses in mining employment can be anticipated in Northern Appalachia if acid rain control legislation is enacted. Results suggest that this region, plagued by the effects of declining basic industries and unemployment, can no longer be assured of continued growth in coal production. The implications of a significant decline in coal production in this region are particularly important for the miners affected and for rural areas dependent on mining activity. Although the adverse employment impacts affecting this region may be mitigated to some extent by the mobility of miners between regions in response to regional shifts in coal production, the impacts on local economies remain. These impacts may be significant.

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