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The Incidence of Coal Severance Taxes: Political Perceptions and Economic Realities

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Public finance literature in recent years has addressed at some length the states' ability to "export" a portion of their tax bases.[1] The political dimensions of the issue, however, have changed considerably. National attention now focuses on energy prices, their changes relative to other commodity prices, and relative price changes between particular energy sources.[2] The coal severance tax policies of the western states have proved to be of particular interest and concern in the discussion regarding tax exportation and energy prices. Amendments to the Power Plant and Industrial Fuel Use Act of 1978 have been introduced in both houses of Congress to limit coal severance taxes imposed by the states to no more than 12½% of the value of the coal f.o.b. mine.[3]

The political leaders from states that import coal differ significantly in their perception of the incidence of the severance tax from economists who have examined the issue. In the coal importing states, both the political leaders and many of the utilities that purchase coal generally perceive that coal imported from coal producing states with coal severance taxes is costlier as a result of the taxes. They argue that ultimately coal severance taxes lead to higher prices for electricity, because the major consumers of steam coal, the utilities, simply pass the tax forward to consumers of electricity. On the other hand, some economists have argued

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1. *See* McLure, *Commodity Tax Incidence*, 17 NAT'L TAX J. 187 (1964); McLure, *The Interregional Incidence of General Regional Taxes*, 24 PUB. FIN. 457 (1969); McLure, *Taxation, Substitution and Industrial Location*, 70 J. POL. ECON. (1970); Hogan and Shelton, *Interstate Tax Exportation and States' Fiscal Structures*, 26 NAT'L TAX J. 553 (1973); D. PHARES, WHO PAYS STATE AND LOCAL TAXES? (1980).

2. S. SCHURR, J. DARMSTADTER, W. RAMSAY, H. PERRY, AND M. RUSSELL, ENERGY IN AMERICA'S FUTURE: THE CHOICES BEFORE US 1–65 (1979).

3. S. 178, 97th Cong., 1st Sess. (1981); H.R. 1313, 97th Cong., 1st Sess. (1981). House and Senate versions differ primarily in that the Senate version applies only to coal mined on federally owned lands.

that in fact the tax is passed backward to landowners who own the coal, to labor in the form of lower wages, and to the owners of capital.

This dichotomy of viewpoints has become increasingly important in light of the general concern over energy prices and the specific debate over the limitation of state severance taxes on coal. We will first present the two positions in the debate with excerpts from the written records of the two sides. We will then examine the economics of tax shifting and tax exportation, briefly summarizing the major issues. We knowingly present the extreme positions in the debate because these extremes will help illustrate the issues at hand. Some empirically estimated price effects of severance taxes follow. We will conclude the paper by examining the implications of the empirical results with regard to the tax exportation issue.

I. THE POLICY DEBATE

The Political Perceptions

Proponents of limitations on the state severance tax rely primarily on the argument that the western states have become engaged in a major income redistribution effort and, at the same time, have hampered our domestic efforts to achieve "energy independence." They point to Montana's adoption of a 30% rate as a prime example of such detrimental taxation. Some argue that as a result of coal severance taxes, the price faced by the consumer—and in the case of steam coal, the major consumer is the electric utility industry—is higher than it would otherwise be and that revenues are transferred to the coal producing state from the coal importing states. Both the coal importing and exporting states agree that the price of coal should include compensation for any "externalities" created by the mining of the coal, such as problems caused by "boomtown" phenomena or environmental degradation. The current controversy, however, results from taxation in excess of the level necessary to compensate for implicit costs. Senator Durenberger of Minnesota argues that the revenues from the severance tax far exceed the social cost of mining the coal. He states:

> There are millions of Americans who now depend on this coal for their electricity supply. They ought to pay the entire cost of producing and transporting coal. But they ought not to be charged billions of dollars over a period of years to support general governmental programs for citizens in other states. Their right to freedom from an unconstitutional tax imposed by a State in which they have no vote is every bit as important as the right of the producing States to be compensated for the impacts of coal mining and energy production. . . .

> The States have the right to recover from the producers and consumers of coal, oil, gas, other energy resources, and other mined or harvested commodities, the costs which the States and their local governments experience as a result of production. One would expect a close correlation between the tax and expenditures made to mitigate impacts.
>
> But how are the severance taxes used? Are they spent to mitigate the impacts of mining and energy production? No, Mr. President, they are not. . . . Only a small portion of the funds are used directly to mitigate impacts.[4]

Two more short excerpts from speeches supporting the legislation to limit severance taxes further illustrate the political perceptions of the incidence issue. Senator Bensten of Texas argues:

> These high rates of State taxation on a resource that is the property of all Americans also drives up the cost of energy. Let me give you an example from the State I represent, the State of Texas. It is estimated that by 1985 Texas will burn almost 24 million tons of low sulfur Wyoming and Montana coal. Enactment of this legislation will save the consumers of my State tens of millions of dollars on their utility bills. We are dealing with a basic inequity here, Mr. President. Why should the people of San Antonio pay sky high severance taxes to Montana and Wyoming for coal extracted from Federal lands, coal that is simply not the property of Wyoming and Montana?[5]

Senator Bumpers from the neighboring state of Arkansas makes a similar argument. Bumpers stresses the inequity of imposing high severance taxes on the citizens of Arkansas, because they have such a relatively low per capita income. He states:

> Let me give you a few statistics here which I think you will find interesting. There are 20 states that are almost totally dependent on coal from these Western states. Who are the customers? The utilities. And what do the utilities do? Frankly, they would like to see this bill passed. But, if it does not, they are just going to pass it on to their consumers. The fine people in my State of Arkansas, who just happen to rank 48th in per capita income, are going to have to pay that $3. a ton in their electric bills and yours are, too, and do not forget it.[6]

These statements indicate that all or most of the coal severance taxes are viewed as a burden passed forward to consumers of coal, who all too often are consumers in states other than those levying the taxes. No

4. S. Rep. No. 127, 97th Cong., 1st Sess. 369 (1981).
5. *Id.* at 370.
6. *Id.* at 371.

empirical evidence supporting this perception accompanies such speeches, however, and as we shall see, the arguments are based on implicit assumptions about the coal market that some economists have questioned.

The Economic Realities

Several economists who have been aalyzing coal severance taxes issues over the past several years argue that little, if any, of the tax is actually shifted forward. They contend that a state wishing to export all or even part of a severance tax must control a significant share of the market, which is to say they must have market dominance.

Malcolm Gillis makes the following arguments:

> In the case of coal, no single taxing jurisdiction occupies anything resembling a dominant position in the relevant market. Each jurisdiction by itself faces relatively elastic demand. Therefore, the possibilities of substantial exporting of severance taxes on coal exports to nonresident consumers would be exceedingly slim. Rather, in the short run, higher severance taxes would be borne by recipients of rents, in this case any quasi-rents accruing to labor and capital in the taxed industry, and resource rents received by owners of coal-mining rights. In the long run, such taxes would be largely borne by resource rents. Only to the extent that these quasi-rents and resource rents are received by out-of-state factor owners would any tax exportation take place. In particular, to the degree that such taxes reduced the profits of coal-mining firms with share ownership concentrated outside the taxing jurisdiction, a substantial share of severance taxes could of course be exported to nonresidents. But resident labor in the taxed industry could bear some of the burden as well, particularly if unionization in the industry has resulted in workers receiving wages above the competitive wage rate, as is particularly likely in such states as West Virginia, where 95 percent of the mines are unionized.[7]

Charles McLure, in commenting on Gillis's paper, makes a similar argument with regard to a coal producing state's ability to export a severance tax to consumers of other states. He states, perhaps even more strongly than Gillis, that the tax will be shifted backward rather than forward.

> A crucial element in the theory of tax exporting is the degree of dominance of the relevant market by the taxing jurisdiction or jurisdictions. If, for example, a state with only a tiny share of the national market for coal were to impose a severance tax on coal, it is highly unlikely that it would be able to export the tax to consumers

7. Gillis, *Sevrance Taxes and Energy Resources in the United States: A Tale of Two Minerals*, 10 GROWTH AND CHANGE 63 (1979).

> in other states through higher prices for coal. Competition from coal mined in other states would prevent it. A far more likely result is that the tax would be borne by the owners of the firms extracting the coal (in the short run) or by owners of coal deposits (in the long run in which contracts are renegotiable). In either event the tax may be exported, but the mechanism of exporting is not what naive proponents of such severance taxes seem to have in mind . . .[8]

McLure continues by making the following observations about the Montana tax:

> It would seem unlikely that Montana or any other state could export a tax on coal to conumers, since, even within the narrow market for coal, the requisite market dominance simply is not there.[9]

As already mentioned, we have selected extreme analytical positions. However, other economists have made similar arguments.[10]. One important characteristic of most of the arguments by the economists and the politicians warrants special attention—they are largely based on *a priori* assumptions about the operation of the coal markets in the United States, with little or no empirical analysis of the actual incidence of coal severance taxes.

The Simple Geometry of Tax Shifting and Tax Exportation

Alternative state tax policy objectives have been analyzed extensively in the literature.[11] For example, a state might pursue such objectives as maximizing aggregate economic activity within the state or maximizing tax exportation. The discussion presented above concerns the adoption of a severance tax for maximizing tax exportation. A model state is depicted in Figure 1.[12] For expositional purposes, we will assume that the state has both large intrastate and interstate markets for its coal, with the interstate market being the dominant market. We also will assume that its production represents a significant proportion of the national coal

8. McLure, *Severance Taxes on Energy Resources in the United States: Comment*, 10 GROWTH AND CHANGE 72 (1979).

9. *Id.* at 73.

10. Usually these arguments include numerous caveats which relate to the short-run and allow for some forward shifting in this period because of intitutional factors. For a good discussion of these factors, *see* NATIONAL RESEARCH COUNCIL, ENERGY TAXATION: AN ANALYSIS OF SELECTED TAXES 47–48 (1980). For a comparison of how severance taxes relate to other taxes an electric utility might pay, *see* D. ZIMMERMAN, MONTANA COAL AND THE ELECTRICITY GENERATED BY MONTANA COAL: INCIDENCE ANALYSES OF STATE TAXATION AND ESTIMATES OF TAX PER KWH AND MILLION BTUS (1981).

11. *See* Russell and Toenjes, *Natural Gas Producer Regulation and Taxation* (Michigan State University Public Utility Paper 1971); A. CHURCH, TAXATION OF NONRENEWABLE RESOURCES (1981); and Shelton and Morgan, *Resource Taxation, Tax Exportation, and Regional Energy Policies*, 17 NAT. RES. J. 261 (1977).

12. This analysis is based on Shelton and Morgan, *supra* note 11.

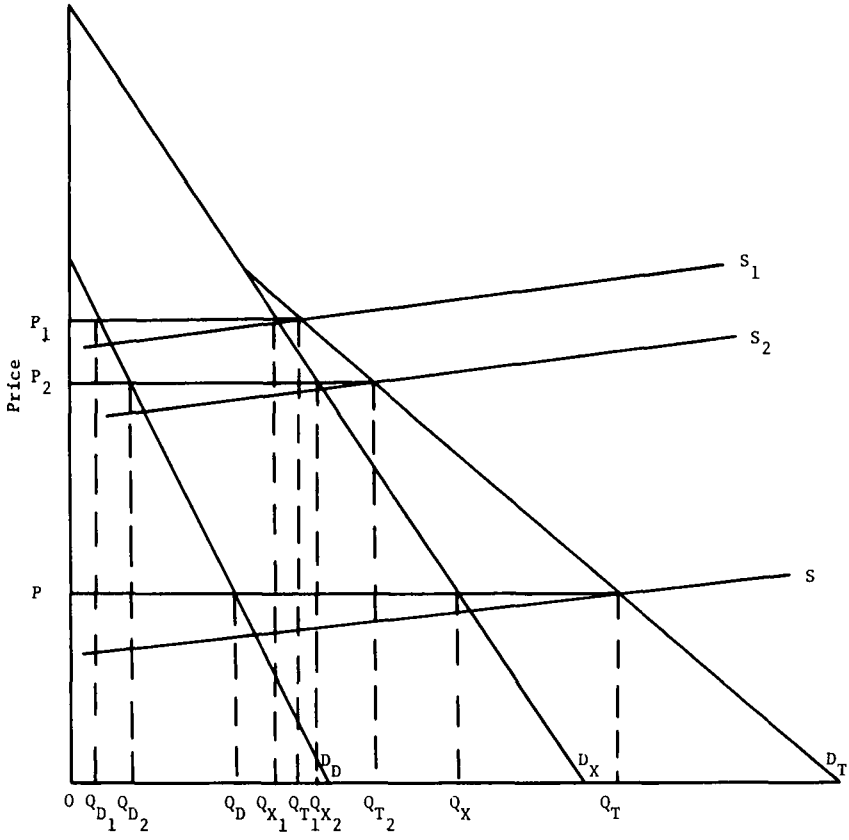

FIGURE 1.

market. In many respects, these assumptions correspond to the view of coal exporting states held by the politicians sponsoring legislation to limit state severance taxes. In Figure 1, the interstate demand is shown as D_X; the intrastate demand is depicted as D_D; and the total demand, which is simply the horizontal summation of the interstate and intrastate demand curves, is depicted as D_T. The state's supply curve is shown as S. The initial equilibrium quantities in the respective markets are simply P, Q_D, Q_X, and Q_T. We will assume that the severance tax levied by the state is a per unit tax and its effect is to shift the supply curve upward to the left, which is shown as a shift from S to S_1. The demand curve that is of interest to the state is the export demand curve. The state will attempt to shift the supply curve into the elastic portion of the interstate demand

curve, with the new equilibrium price and quantities being P_1 and Q_{D1} and Q_{X1} and Q_{T1}.

The relative elasticities of the demand and supply curves present the central issue in examining whether tax exportation can be an effective tax policy. In the case being examined, elasticity of the export demand curve relative to the state's supply curve determines the effectiveness of a tax export policy. In general, we can say that the more inelastic the export demand curve relative to the supply curve, the greater the opportunities for effective tax exportation.

The adoption of a state property tax yields interesting results. The tax has the effect of changing the profit stream over time of a given coal deposit and makes current production relatively more attractive than future production. Therefore, for any given price, a greater quantity will be supplied by producers which, in turn, means that an increase in the property tax has the opposite effect of a severance tax. This effect has been described as 'mining-out from under the tax.'[13] Figure 1 represents the effect of a property tax as a shift in the supply curve from S_1 to S_2.

II. THE EMPIRICAL EVIDENCE

The Framework for Estimating the Incidence of Coal Severance Taxes

The intricacies and interactions of the regional coal markets of the United States are quite complex. Regional differences in coal quality, mining techniques, and spatially differentiated demand centers, as well as the mode choices in transportation, combine to make the market structure difficult to model. Superimposed on the traditional market interactions are direct and indirect taxes levied by some of the coal producing states which may affect the final market price of coal.

Empirical estimation of the severance tax incidence should be conducted within a formal supply and demand framework. Of course, market adjustments due to the imposition of a severance tax occur through changes in the (pre-taxed) minemouth price of coal. Furthermore, the difference between the *observed* prices received by mine owners and the *observed* price paid by consumers includes the transportation tariff, the full severance tax, and other excise-type taxes. We will focus only on the severance tax since this is the tax being addressed in this paper. Ideally, the delivered price of coal with the tax should be compared with the price that would have been charged without the tax. Such a comparison can be accomplished indirectly by estimating the relevant supply and demand curves. Accordingly, we formulate an implicit demand function for each coal burning electric utility. This demand formula expresses the quantity

13. CHURCH, *supra* note 11 at 67–72.

of coal (Q_d) that the utility will purchase as a function of the delivered price (P_d) and other determinants of demand (a vector X_i).

The implicit demand curve:

$$\text{[Eq. 1(a)]} \qquad Q_d = a + b\,P_d + \Sigma c_i\,X_i + e,$$

with a, b, and c representing the estimated coefficients and e the error term. Similarly, an implicit supply curve represents each mine's supply function. The formula below relates each mine's desired quantity (Q_s) to a vector of determinants of supply (Z_j). The relevant price to producers, however, is the FOB minemouth price (P_m) of coal (excluding severance tax).

The implicit supply curve:

$$\text{[Eq. 1(b)]} \qquad Q_s = \alpha + \beta\,P_m + \Sigma\,\gamma_j\,Z_j + \epsilon,$$

with α, β, and γ_j representing the estimated coefficients and ϵ the error term. The difference between the selling price to consumers and the price received by mineowners represents the transportation tariff plus the full severance tax (and other excise-type taxes which we are ignoring for expositive purposes).

$$\text{[Eq. 1(c)]} \qquad P_d \equiv P_M + \text{TARIFF} + \text{Severance Tax}.$$

In this formulation, we assume that transportation tariffs are set independently of the contract price of coal. Importantly, the actual tariff charged may not reflect the true cost of transportation, i.e., railroads may be extracting (spatial) monopoly rents. We also assume that when utilities bargain with coal producers, they know what the likely rail tariff will be on typical shipments, and they can evaluate alternative sources of coal accounting for transportation charges. This formulation does not address the issue of whether the transportation tariffs are set to extract spatial rent. When a transaction has occurred, desired supply quantity (Q_s) equals the desired demand (Q_d). Then, from a set of observed transactions and delivered prices, we can estimate the supply and demand system in the reduced form model of the equation system in 1(a) through 1(c).

The reduced form estimation equation is as follows:

$$\text{Eq. (2)} \qquad P_d = A + \Sigma B_j\,Z_j + \Sigma C_i X_i + D\,\{\text{Tariff} + \text{Severance Tax}\}$$

where:

$$A = (\alpha - a)/(b - \beta)$$
$$B_j = \gamma_j/(b - \beta)$$
$$C_i = c_i/(b - \beta)$$
$$D = B/(B - b)$$

and

$$0 < D < 1$$

The empirical hypothesis to be tested in this study is whether or not coal severance taxes are passed on to consumers. The share of tax passed forward is expressed as the estimated value of D. The model formulated here, in which the coefficient D represents the joint cost of the rail tariff and severance tax, has some intuitive appeal given our assumptions. Econometric reasons also necessitate using this formulation, as explained shortly.

The Empirical Data Base

The electric utilities report salient statistics on the cost and quality of each fuel shipment received. This information, published by the Department of Energy on Form 423, provides a rich data source to examine a substantial component of the United States coal markets. The following analysis uses the Form 423 data base for shipments during the period 1976 through and including 1980. The timeliness of this data also provides an opportunity to examine a key regional energy market after the energy "crisis" became apparent. Such recent data is not generally available at the regional level.

Among the coal characteristics reported on Form 423 are the sulfur content (% by weight), ash content (% by weight), energy content (Btu's per lb.) and the total quantity shipped (in tons) and sources (by state) of each coal shipment. The form also reflects whether the coal originated from deep or surface mining operations. These characteristics are included in the statistical analysis to account for shipment-specific quality differences.

In the formulation presented above, the actual rail tariff charge, rather than an estimate of transportation cost, is used as the operant variable. Form 423 does not identify the mode of shipment. Therefore, we have limited the empirical analysis to shipments of coal to distances greater than 100 miles and to tonnage greater than 5,000 tons in order to eliminate shorthauls delivered by truck. To estimate the rail tariff for each shipment, we formulated an auxiliary set of regressions relating the rail charge per ton as a function of distance and distance squared. Separate equations were estimated for east to east and west to east shipments. These were estimated using reported tariff charges of rail shipments compiled by Mobil Oil Company. As we were able to obtain the rail tariffs for 1977, we inflated the estimated rail charges for other years, using the producer price index for bituminous coal shipments by rail.

We independently estimated the distance of each shipment from state of origin to state of destination using the rail distances as defined in the National Coal Model.[14] We then compared the estimated "average" rail

14. *The National Coal Model Description and Documentation*, U.S. Department of Commerce [NTIS (PB-263 334)]. Prepared for Federal Energy Administration, Washington, D.C. (Oct. 1976).

tariff charge for each shipment using the distance of each shipment in the estimated rail rate equations. As already mentioned, to the extent that the average rail tariff structure does not reflect the underlying costs, our estimates should be considered estimates of typical rail tariff charges rather than rail transportation costs.

There are several types of transactions by which utilities buy coal from suppliers. The Form 423 data distinguished between three major categories: 1) spot market purchase; 2) the initial shipment under a new contract; and 3) repeat shipments under a long-term contract. Some long term contracts permit price adjustments through escalator clauses and are identified in the data base. Our empirical analysis examines marginal changes in the average market price induced by state taxation behavior. Hence, multiple shipments with the same contract price would represent duplicate observations. Therefore, we have excluded repetitive shipments under old contracts unless they include the escalator clause. We have analyzed the new long term contracts separately from spot market operations because of the differences in market interaction. Spot market transactions represent short-term non-repetitive purchases. The demand and supply characteristics tend to be much more inelastic with prices subject to much more volatility.

The general pattern of coal shipments discernible from Form 423 data can be found in Table 1, which summarizes our analysis of shipments made during the period 1976 through 1980. We have used the Mississippi River to differentiate between eastern and western coal producers. Two reasons make the midwestern market (Indiana, Illinois, Iowa, Michigan, Minnesota, and Wisconsin) of particular interest. First, much of the political discussion has centered on the impact of western coal severance taxes on midwestern utilities. Second, the midwestern market is one of the more interesting markets to examine because it is a market in which eastern and western coals compete directly. Eastern suppliers still serve a somewhat protected east coast market (including Florida and Georgia), while western mines supply the Pacific coast and southwestern states (including Texas) in the same protected manner.

An evaluation of the impact of state taxing policies necessitates calculating the effective state severance tax rates for the period in question. Through examination of state documents and telephone interviews with state officials, we compiled a set of effective severance tax rates for each of the important mining states during the period 1976 through 1980. Significant changes in the tax structures during the sample period were incorporated in the tax rate series. For example, New Mexico imposed an ad valorem tax in 1976, but changed to a unit tax in 1977. The rates we compiled were cross checked with other sources where possible.

The vagaries of each state's tax structure can pose quite complex an-

TABLE 1.

Regional patterns of coal shipments (excluding repeat shipments without escalator clauses and spot contract shipments)

Number of Coal Shipments from 1976–1980			
	MARKETS		
Source	Indiana, Illinois Iowa	Michigan, Minnesota Wisconsin	Total
Western States			
Colorado	94	0	94
Missouri	37	0	37
Montana	371	663	1,034
North Dakota	0	30	30
Utah	24	0	24
Wyoming	260	11	271
Total	786	704	1,490
Eastern States			
Illinois	1,144	715	1,859
Indiana	1,122	82	1,204
Iowa	2	0	2
Kentucky	107	823	930
Ohio	0	253	253
Pennsylvania	0	84	84
Virginia	0	4	4
West Virginia	2	80	82
Total	2,377	2,041	4,418
TOTAL	3,163	2,745	5,908

alytical problems and often require some simplifications.[15] We have attempted, however, to maintain important peculiarities of the key mining states. For example, Montana has both a per unit tax structure and a simpler ad valorem tax.[16] The per unit tax has several rates depending upon the size of the shipment. The ad valorem tax structure has two rates. Shipments of coal with an energy content greater than ,000 Btu's per pound are taxed at a 30% rate, while coal with a lesser energy content is taxed at a 20% rate. The tax structure yielding the higher revenue is the one imposed. For the period under examination this was the ad valorem

15. *See* Church, *supra* note 11 and ZIMMERMAN, *supra* note 10.

16. The state also imposes a differential tax for deep mined coal. However, none of the reported shipments from Montana during the period analyzed came from deep mines.

tax. We assigned either the 20% or 30% rate based on the reported Btu content of coal on the Form 423 data.[17]

The taxing states use both ad valorem and unit tax schemes. To develop a consistent severance tax series, the ad valorem taxes were recomputed to an equivalent per unit rate. This adjustment was required for the ad valorem taxes levied by Kentucky, Montana, New Mexico (in 1976), West Virginia and Wyoming. Calculating the equivalent effective tax requires establishing the selling price net of transportation. To approximate this price, we used the selling price net of the estimated rail tariff rate.

Other state taxes also may affect the price of coal. Often, determining the effective rates of sales and property taxes on the selling price of coal is intrinsically more difficult than determining effective rates for severance taxes. The differences in the nominal tax rate structures, tax bases and exemptions greatly complicate determinations of the actual effective rate of sales and property taxes. Consequently, we chose to use only indicator variables which are set equal to one if a state imposed a sales or property tax which would be applied to coal mining activity. Local taxes were excluded from consideration in determining these dummy variables, since the focus is on state taxation policy.

Table 2 summarizes the set of taxes imposed by key coal mining states in 1976 and 1980. The table indicates those states which imposed an ad valorem severance tax and presents the estimated unit tax equivalent (in nominal $/tons) in parentheses. The table indicates a large range in the level of the severance tax rates imposed by the states in 1980, with the smallest level of 4 cents per ton levied by Ohio and the largest tax of $2.95 per ton imposed by Montana on coal shipments with an average Btu content greater than 7,000.

The data series spans a period when energy markets and the economy experienced inflationary pressure. We therefore converted all price data from nominal to constant 1980 dollars using the GNP deflator. In addition, the major characteristic of coal from the point of view of the utilities is the energy content. We therefore converted other coal quality data and prices to a million Btu (MBtu) bases.

17. One interesting anomaly observed in the data is that during the period 1976–1980, shipments of coal from Montana mines to Montana utilities, under new contract, were all reported as having an energy content of less than 7,000 Btus per pound. Out of state shipments have averaged a higher Btu content of around 8,600. The tax rate structure enhances the use of lower Btu coal within the boundaries of Montana. Since the ash content and sulfur content of the coal is roughly similar, using the lower energy coal will require a greater volume of coal to be burned to provide the same amount of electricity than if the higher Btu coal were utilized. This could increase the total level of particulates and sulfur residuals released unless abated. Therefore, an indirect cost to Montana residents is a potentially greater rate of pollutants, even though the tax has been espoused as an environmental tax.

TABLE 2.

Property and sales taxes on coal for years 1976 and/or 1980, and severance taxes on coal for years 1976 and 1980[a]

State	Property Tax	Sales Tax	Unit Severance Tax Nominal $/10 1976	1980
Colorado	Yes	Yes	0.071	0.607
Illinois	No	No		
Indiana	No	No		
Iowa	No	No		
Maryland	No	No		
Missouri	No	No		
Montana[b]	Yes	No	(1.27, 1.75)	(2.13, 2.95)
North Dakota	No	No	0.650	0.850
Ohio	No	Yes	0.040	0.040
Pennsylvania	No	No		
Utah	Yes	Yes		
Virginia	No	No		
West Virginia[b]	Yes	No	(0.80)	(1.06)
Wyoming[b]	Yes	Yes	(0.23)	(0.78)

[a]Excludes all local severance tax levies.
[b]States with ad valorem severance taxes.

The Empirical Analysis of Severance Tax Incidence

As described earlier, the empirical test to be conducted requires us to estimate a reduced form supply and demand system. In the reduced form (Eq. 2), the severance tax incidence can be obtained from the coefficient for the charges which intervene between the observed delivered price and the unobserved minemouth price received by the mine operator. The data described above provides several determinants which can be classified as supply or demand oriented characteristics.

One of the major cost differentials in regional coal production is whether coal is produced by surface mining or underground mining. In the analysis, we include a dummy variable which is set to one for deep mined coal. The coefficient is expected to be positive, indicating the greater average cost of deep mined coal. The quantity in a shipment may yield economies of scale in production and shipment. To capture these, the total quantity is included as a supply related variable. Its expected sign is negative. Finally, contracts that include an escalator clause which allows the original contract price to be renegotiated are indicated with a dummy variable. The sign of the coefficient of the term poses an empirical question

and depends on the average bargaining ability of producers, which, in turn, is reflected in the final terms of the contract. If these producers are very successful and are able to maintain prices above the market average, the sign will be positive. If producers with escalator clauses lag behind general market trends, the sign will be negative.

Various coal quality characteristics can affect the demand price the utilities are willing to pay for coal. In order to standardize for the energy content of various coals, the dependent variable (selling price) has been expressed as constant dollars (1980) per million Btu's. Even with this standardization the Btu price of coal varies considerably. For example, some coal in Montana sells for about 30 cents per million Btu while some higher Btu coal sells for about 90 cents (per million Btus) in Wyoming. The transformation to account for Btu variations appears to be nonlinear. Low Btu coal may require considerably more handling cost (i.e., more tons of coal processed) for a given energy content. Therefore, we have included the energy content of coal for each shipment as an explanatory variable. The sign is expected to be positive, indicating a premium will be paid for high Btu coal. Similarly, the ash and sulfur content of coal will affect the demand price. The greater the ash and sulfur, the lower the price. The signs of the coefficients for ash and sulfur (measured as pounds per million Btus) therefore should be negative. Several exploratory analyses, not reported here, also indicated that the ash content tends to be nonlinearly related to the price when measured on a Btu basis. Consequently, we have included a term (ash content squared) to capture this nonlinearity.

The input price is also likely to be partially determined by alternative prices of coal available to a utility. To capture the alternative market price, we have used the average price of coal by intra-state shipments for Indiana, Illinois and Iowa. The expected sign of this local price variable is positive: the greater the local price, the higher the imported price may be.[18]

Sales and property taxes may also affect the price to consumers, as discussed earlier. To test for this possibility, we include in the analysis the dummy variables for sales and property taxes described in the data base section. The coefficient will measure only the average impact on the market price of these taxes imposed by some states because we are using dummy variables, rather than actual effective rates. The coefficients of these variables cannot be interpreted as an incidence rate. However, the

18. In several exploratory analyses, time dummies were included in the analysis as well. These, however, were highly correlated with the local price variables, and when entered caused the local prices to become insignificant. We felt it preferable to keep the local price variables, as the time dummies may not only pick up general rise in local prices, but other factors (such as increases in severance taxes) as well.

sign of the coefficients will indicate the directional impact on price of imposing the tax.

As already mentioned, true property taxes are expected to have a negative sign. High property taxes arguably encourage mine operators to increase their mining activities in order to mine-out from under the property tax.[19] Therefore, if producers are willing to sell their coal at a lower price in order to sell coal more quickly, the coefficient of the property tax variable will be negative.

The severance tax incidence can be estimated from the coefficient of the joint cost of rail tariff and severance tax imposed on each shipment. As was stated earlier, this joint estimate is necessary on econometric grounds. It is known that high severance taxes are charged by western states (Wyoming and Montana) which also happen to make long distance shipments with high per unit rail tariffs. This spatial association can result in spurious correlations and present difficulty in estimation. Indeed, this was the case for several alternative models, in that we found that multicollinearity between the rail charge and severance tax precluded independent estimation.

The sign of the incidence coefficient is expected to be positive, with a value between 0 and 1. With the current formulations, the value of the coefficient can be interpreted as the share of severance tax and rail tariff charges passed through to utilities purchasing coal.

Some coal producing regions of the country could conceivably export more of their severance tax than other regions because of differences in demand conditions confronting different regions. For example, if some state faces a relatively more inelastic demand function, perhaps because of some special characteristic of the coal or its favorable spatial location, that state presumably could pass more of a severance tax forward. As mentioned above, a strong positive correlation exists between per unit severance taxes and per unit rail tariff. In order to test whether there is interaction between these variables which we have not accounted for under our joint estimation procedures, we have included an interactive term. The severance tax rate is multiplied by the distance of the shipment providing a measure of the interaction of distance and tax rate. The coefficient of the term could be negative (positive), indicating that the greater the distance the lower (greater) the occurrence of forward shifting.

The complete set of variables described above were included in a set of regression equations using data for the years 1976 through 1980. We considered two regional definitions for the area of competition between eastern and western coal suppliers. The first region included Indiana, Illinois, and

19. CHURCH, *supra* note 11 at 67–72.

Iowa. A second area, comprised of the previously listed states and the states of Minnesota, Michigan and Wisconsin, was also considered.

As stated earlier, we excluded all repeat shipments unless they included an escalator clause. We also included only shipments over 5,000 tons to better reflect the rail tariff charges reported by the Mobil Oil report. And, finally, we analyzed the long term contracts separately from the spot market shipments. Our primary focus is in the impact of the severance tax on the long term market price. The spot market, of course, is affected by many short term fluctuations. We felt including the spot market for comparative purposes would prove useful nonetheless.

The price to the utility of each shipment is reported in terms of 1980 dollars per million Btus. This selling price is used as the dependent variable in the regression. Observations in which any of the variables were missing were excluded from the analysis, but a large sample still remained.

Tables 3 and 4 present the results of the four regression analyses. The explanatory variables are grouped by the classifications established in the general discussion. All coefficients for the long term markets are statistically significant at the 1% level and the overall equation (R^2) is acceptable. Our expectations concerning the signs of all variables for which an *a priori* argument was advanced are met.

The regression equation results indicate that on average about 29% of coal severance taxes are passed through to consumers in Indiana, Illinois, and Iowa. For the broader market area which also includes Michigan, Minnesota, and Wisconsin, approximately 40% of the severance tax is passed forward. The analysis also indicates that sales taxes result in some forward shifting. On average, producers in states which impose a sales tax receive $0.37 per million Btus more in the three state market area. The severance tax/distance interactive term has a positive sign that indicates that shipments from long distances, primarily Montana and Wyoming, may pass through somewhat more of the severance tax than shipments from producing states closer to the midwestern market.

The property tax variables in the long term results have negative signs indicating that producers may be attempting to mine-out from under the tax in those states which impose a property tax on coal. Another empirical finding in the long term results relates to the effectiveness of escalator clauses to maintain market prices. Interestingly, the escalator clause appears to be an insufficient means for keeping up with market trends.

Several of the coal characteristic variables tend not to be important in the spot market equations.[20] In addition, severance tax incidence tends

20. The coal characteristic variables that tend not to be important in the spot market equations are primarily quantity and ash content.

TABLE 3

Shipments of over 5,000 tons of coal to utilities in a three-state market area (Indiana, Illinois, Iowa)

Dependent variable: selling price to utility in 1980 dollars per million Btu's

Variables	Long Term Contracts		Spot Market Sales	
	Coefficient	Standard Error	Coefficient	Standard Error
Intercept	−0.718	0.115	−1.128	0.116
Supply Characteristics				
Deep Minedp5.5[a]	0.171	0.011	0.123	0.013
Quantity (thousand tons)	−0.591	0.067	0.069[b]	0.231
Escalator Clause[a]	−0.238	0.032	n.a.	n.a.
Demand Characteristics				
Energy Content Btu/Ton	0.055	0.004	0.057	0.004
Sulfur Content lb/MBtu	−0.044	0.006	−0.039	0.005
Ash Content lb/MBtu	−0.052	0.006	−0.008[c]	0.004
Ash × Ash (lb/MBtu)^2	0.002	0.0002	0.0002[b]	0.0001
Local Market Price $1980/MBtu	1.208	0.034	1.042	0.036
Supply State Taxes				
Property[a]	−0.382	0.046	−0.004[b]	0.026
Sales[a]	0.374	0.042	0.004[b]	0.026
Severance Tax Variables				
Rail Tariff + Severance Tax ($1980/MBtu)	0.289	0.050	0.656	0.071
Severance Tax × Distance (1,000 miles)	0.897	0.113	0.336[b]	0.254
Mean Price = 1.092			Mean Price = 1.05	
R^2 = 63.8%			R^2 = 51.0%	
Number of shipments = 3,114			Number of shipments = 2,446	

[a]Dummy variables.
[b]Not significant at 5% level.
[c]Significant at 5% level.
Coefficients not marked are significant at 1% level.

to be higher in the spot market than in the long term market. The difference may reflect inelasticity in the short term demand by utilities which need to enter the spot market for large shipments.

In summary, the empirical results indicate that generally about 29 to 40% of the coal severance taxes are passed through to consumers. Standard calculations, however, indicate a rather large margin of error; a conservative estimate of two standard deviations yields a plus or minus 10% range. Furthermore, the results indicate that the higher western severance taxes, on average, may be shifted forward to midwestern mar-

TABLE 4.

Shipments of over 5,000 tons of coal to utilities in a six-state market area (Indiana, Illinois, Iowa, Michigan, Minnesota, Wisconsin)

Dependent variable: selling price to utility in 1980 dollars per million Btu's

Variables	Long Term Contracts		Spot Market Sales	
	Coefficient	Standard Error	Coefficient	Standard Error
Intercept	−1.250	0.066	−1.077	0.082
Supply Characteristics				
Deep Mined[a]	0.073	0.007	0.073	0.009
Quantity (thousand tons)	−0.664	0.049	−0.130[b]	0.197
Escalator Clause[a]	−0.092	0.018	n.a.	n.a.
Demand Characteristics				
Energy Content[a] (MBtu/tons)	0.062	0.002	0.054	0.003
Sulfur Content (lb/MBtu)	−0.036	0.004	−0.043	0.004
Ash Content (lb/MBtu)	−0.028	0.004	−0.002[b]	0.003
Ash × Ash $(lb/MBtu)^2$	0.001	0.0001	0.00004[b]	0.0001
Local Market Price ($1980/MBtu)	1.268	0.023	1.035	0.029
Supply State Taxes				
Property[a]	−0.153	0.011	−0.090	0.015
Sales[a]	0.151	0.010	0.083	0.013
Severance Tax Variables				
Rail Tariff + Severance Tax ($1980/MBtu)	0.410	0.028	0.548	0.037
Severance Tax × Distance (1,000 miles)	0.373	0.050	0.690	0.163
Mean Btu price = $1.13			Mean Btu Price = $1.16	
R^2 = 65%			R^2 = 62%	
Number of shipments = 5,860			Number of shipments = 3,631	

[a]Dummy variables.
[b]Not significant at 5% level.
Coefficients not marked are significant at 1% level.

kets to a greater degree than those severance taxes imposed by non-western states. Given the indirect method used to estimate rail tariff charges, the analysis cannot differentiate the potential split in spatial rents among railroad, mineowners, and state taxing authorities. The results nevertheless do indicate that states which apply severance taxes are not necessarily recapturing spatial rents previously taken by the railroads.

III. SUMMARY AND CONCLUSIONS

We began this paper by presenting a dichotomy of views regarding the ability of states to export their coal severance taxes to consumers in other states. The politicians in the coal importing states argue that most or all

of the tax is passed forward in the form of higher prices. Some (and we hasten to add not all) economists argue that little, if any, of the tax is passed forward in the short-run or the long-run. Our empirical evidence suggests that we might summarize the merits of these positions by analogy to the proverbial dispute over a half empty, or half full, glass of water. The politicians and the economists are both half right or they are both half wrong.

In some sense our five year empirical test was neither of the traditional short-run nor of the traditional long-run, but rather of the intermediate run. The time period in question suffices in length to permit some marginal adjustments in the capital stock of the transportation system and existing mines. Considering the length of time required to open new mines or construct new transportation links, however, the empirical results do not capture the long-term incidence of coal severance taxes.

The extreme positions between the practical politician, who views the "real world" and the economist arguing from the perspective of perfectly competitive markets can perhaps best be illustrated with this accounting identity: final selling price = transportation charges + severance tax + minemouth price. In the *very* short-run, the politician is correct in some circumstances. The final selling price can be approximated by adding the taxes and transportation charges to the current minemouth price. The economist recognizes that market forces will limit the forward shifting. Indeed, in perfectly competitive markets, the individual producers in taxing states will be forced to lower their minemouth charge to absorb the tax. Nevertheless, as our analysis suggests, these market adjustments require time. This is especially true in the case of coal in which large capital investments in transportation facilities and coal mining equipment might be required to bring about equilibrium in the regional systems of markets. Indeed, our empirical analysis indicates that coal producers are able to shift forward some of the severance tax. The evidence also demonstrates that there can be regional differences.

One final point warrants emphasis. This paper serves to underscore the pitfalls of sweeping institutional adjustment factors aside. As others have recognized, and this paper has verified empirically, there are spatial rents to be captured in the short-run and these can accrue to states as well as railroads.[21] While it is true that no state may have long-run dominance in the production of coal, we have shown that in the short-run, both the requisite adjustments in the mining industry and especially in the transportation system act as constraints to the competitive adjustment process and allow for partial exporting of the severance tax base.

21. Zimmerman, *Rent and Regulation in Unit-Train Rate Determination*, 10 THE BELL J. ECON. (1977).