Measuring the Primary Impacts of Severance Taxation: A Spatial Equilibrium Approach

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A spatial equilibrium model is used to quantify the effects of a severance tax on the Pennsylvania coal market. Two regions are identified: the Pennsylvania Market Area and an import/export region. The impacts on prices and quantities of coal supplied and demanded are found to be small. Little of the tax is exported from Pennsylvania, with a high proportion of the tax being passed back to Pennsylvania coal producers. Although the tax revenue exceeds the welfare losses in Pennsylvania, this result is very sensitive to the magnitude of the Pennsylvania own-price demand elasticity.

Introduction

Numerous states have adopted coal severance taxes as a means to generate state revenues (Stinson and Temple). A coal severance tax appears to be particularly attractive to states exporting significant quantities of coal. Montana and Wyoming are examples of such states in which coal severance taxes are an important revenue source. Pennsylvania is also a major coal producing state but does not currently have a coal severance tax. The taxation of coal mined in Pennyslvania would clearly add tax revenue, but could have negative impacts as well.

This paper investigates the primary economic impacts, both positive and negative, of a severance tax on Pennsylvania steam coal.[1] The issues of tax exportation and tax incidence discussed by Morgan and Mutti, Church and Gillis are addressed empirically. From Pennsylvania's perspective, the efficacy of a coal severance tax depends in part on the tax revenues generated relative to the negative effects on Pennsylvania producers and consumers. The negative impacts on producers occur only in Pennsylvania. A severance tax will reduce profits of Pennsylvania coal producers and presumably lead to job losses and reduced wages for coal miners as well. In contrast, consumers throughout the Northeast will be affected since a high proportion of Pennyslvania coal is used to generate electricity in other northeastern states. In general, the degree to which a severance tax will negatively affect Pennsylvania depends on the proportion of the tax that can be exported to out-of-state consumers. The extent to which a severance tax can be exported to other states and the incidence of the tax on producers and consumers within the taxing state are important concerns.

Using an approach similar to that in Campbell et al., Libbin and Boehlje, and Labys and Yang, a spatial equilibrium model is designed to portray the market for Pennsylvania steam coal including its relation to surrounding coal producing states. Using the model, the impacts of a severance tax on coal prices, consumption, production, tax revenue, and consumer and producer surplus are measured for Pennsylvania and for those states either importing Pennsylvania coal or exporting coal to the Northeast. These impacts are measured for alternative tax rates and for various supply and demand conditions in the trading regions. The sensitivity of the study results to changing supply and demand conditions for steam coal is examined.

Perspective

Pennsylvania currently produces an average 45 million tons of steam coal annually. Of this, 68% is used within Pennsylvania with the remainder exported out of state. A majority of the steam coal mined in Pennsylvania is distributed within the Pennsylvania Steam Coal Market (PSCM), a region defined by Melmed using Hogarty's LIFO/LOFI

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[1] Steam coal, used primarily to generate electricity, constitutes the majority of the coal mined in Pennsylvania.

test to include the states of Pennsylvania, New York, Massachusetts, Delaware, New Hampshire, New Jersey, and Maryland. In addition, Pennsylvania exports some steam coal to Ohio, West Virginia, and Kentucky. Ohio, West Virginia, and Kentucky supply most of the outside coal to PSCM (U.S. Department of Energy).

Pennsylvania has historically competed with West Virginia and Ohio in the northeastern steam coal market. A locational advantage has helped Pennsylvania to protect its market share. However, as electricity demand in the Northeast has grown, more coal is being purchased from these other states. A severance tax on Pennsylvania steam coal would increase coal imports from other states and decrease coal exports from Pennsylvania, as the relative prices of Pennsylvania coal and coal from other states change.

Empirical Analysis

Given this perspective, eight demand regions and three supply regions are identified. The eight demand regions include Pennsylvania, New York, Massachusetts, Delaware, New Hampshire, New Jersey, Maryland, and the rest of the world, or ROW. The supply sources include Pennsylvania underground coal, Pennsylvania surface coal, and all other suppliers of coal to the Pennsylvania Steam Coal Market. The standard spatial equilibrium model developed by Samuelson and operationalized by Takayama and Judge is used, and competitive equilibria under alternative tax rates are computed using quadratic programming. Specific severance tax rates of \$0.10, \$0.20, \$0.40, and \$0.80 per ton are considered. These rates are well within the range of severance tax rates in other eastern states (Stinson and Temple) and the rates proposed in Pennsylvania.

Steam coal demand is specified for each state in PSCM, and the demand for coal from Pennsylvania by ROW is an export (from PSCM) demand function. Pennsylvania coal production is described by steam coal supply functions for both surface and underground production. The small quantity of coal produced in Maryland and the coal supplied to PSCM from ROW is represented by an import (to PSCM) supply function. The costs of coal shipments between states within the regions are assumed to be linear in the quantities shipped.

The mathematical structure of the model is:

$$(1)\quad \max \sum_{i}^{8}\left(a_i y_i - \frac{1}{2} b_i y_i^2\right) - \sum_{j}^{3}\left(c_j x_j + \frac{1}{2} d_j x_j^2\right) - \sum_{i}^{8}\sum_{j}^{3} t_{ij} z_{ij},$$

subject to:

$$(2)\quad y_i \leq \sum_{j}^{3} z_{ij},\ i = 1, 2, \ldots, 8;$$

$$(3)\quad x_j \geq \sum_{i}^{8} z_{ij},\ j = 1, 2, 3; \text{ and}$$

$$(4)\quad y_i, x_j, z_{ij} \geq 0,\ i = 1, 2, \ldots, 8;\ j = 1, 2, 3;$$

where:

- y_i = quantity of steam coal consumed in state i of PSCM, i = 1, 2, . . . , 7;
- y_8 = quantity of steam coal exported to ROW from PSCM;
- x_1 = quantity of coal produced from underground mines in Pennsylvania;
- x_2 = quantity of coal produced from surface mines in Pennsylvania;
- x_3 = quantity of coal imported to PSCM from ROW;
- z_{ij} = quantity of coal shipped from supply source j to consumption point i;
- a_i = inverse demand function intercept, i = 1, 2, . . . , 8;
- b_i = inverse demand function slope, i = 1, 2, . . . , 8;
- c_j = inverse supply function intercept, j = 1, 2, 3;
- d_j = inverse supply function slope, j = 1, 2, 3; and
- t_{ij} = marginal cost of transporting coal from source j to i.

The objective function (1) is the net social payoff function and measures the total producer and consumer surplus from coal production and consumption (Takayama and Judge). The first seven constraints defined by (2) restrict coal consumption in each state in PSCM to no more than the amount of coal shipped to those states. The eighth constraint defined by (2) restricts the amount of Pennsylvania coal consumed in ROW to no more than the amount of coal shipped from Pennsylvania to ROW. The first two constraints defined by (3) restrict coal shipments from Pennsylvania mines to no more than the amount of coal produced by surface and underground mines in the state. The third constraint defined by (3) restricts coal consumption within PSCM of ROW imports to no more than the amount of coal shipped from ROW to states within PSCM. Maximizing (1) subject to (2), (3), and the nonnegativity constraints given by (4) yields quantities consistent with a competitive spatial equilibrium. Equilibrium supply and demand prices can be obtained respectively as the shadow prices

for (2) and (3) in an optimal solution (Takayama and Judge).

Parameters

The demand, supply, and transportation cost parameters are defined such that the pre-severance tax equilibrium corresponds to a set of benchmark prices and quantities under varying specifications of the supply and demand elasticities. Specifically, the intercepts and slopes of the demand and supply functions are:

$$(5)\quad a_i = \frac{\hat{P}_i^d\,(\epsilon_i - 1)}{\epsilon_i},\ i = 1, 2, \ldots, 8;$$

$$(6)\quad b_i = \frac{\hat{P}_i^d}{\hat{x}_i\epsilon_i},\ i = 1, 2, \ldots, 8;$$

$$(7)\quad c_j = \frac{\hat{P}_j^s(\eta_j - 1)}{\eta_j},\ j = 1, 2, 3;\ \text{and}$$

$$(8)\quad d_j = \frac{\hat{P}_j^s}{\hat{y}_j\eta_j},\ j = 1, 2, 3;$$

where:

$\hat{P}_i^d$ = benchmark demand price of delivered coal in state i, i = 1, 2, . . . , 7;
$\hat{P}_8^d$ = benchmark supply price of coal exported from PSCM to ROW;
ϵ_i = own-price elasticity of demand, i = 1, 2, . . . , 8;
$\hat{P}_j^s$ = benchmark supply price of coal from source j, j = 1, 2, 3; and
η_j = elasticity of supply, j = 1, 2, 3.

The benchmark prices and quantities are averages of prices and quantities for 1981–83, with prices in cents per million Btu and quantities measured in Btu. Data for computing benchmark prices and quantities were obtained from the *Cost and Quality of Fuels for Electric Utility Plants*, (1981–83 Annuals), published by the U.S. Department of Energy.

The benchmark demand price for each state within PSCM is the consumption-weighted average of the delivered cost of steam coal to utilities in the state during the period from 1981–83. Because supply and demand points have not been delineated within Pennsylvania, it is assumed for simplicity that mine-mouth prices are delivered prices in the state in competitive equilibrium. Thus, the benchmark supply price of coal produced in Pennsylvania is the benchmark demand price. Similarly, since specific origins and destinations within ROW have not been delineated, the export demand price is defined as the supply price paid in Pennsylvania prior to transport, while the import supply price is the price of coal shipped from ROW to PSCM when delivered in Pennsylvania. Accordingly, the benchmark export demand and import supply prices are the benchmark supply and demand prices in Pennsylvania. The cost per ton of shipping coal from Pennsylvania to another state in PSCM is defined as the average difference between the delivered price in the state and the delivered price in Pennsylvania. This definition assumes that delivered price differentials reflect transportation cost differentials within PSCM.

Because of the instability and structural changes in the coal market during the past two decades, reliable supply and demand elasticities cannot be estimated (Bohi). Rather than using estimated elasticities to define each of the supply and demand parameters used in the programming model, a range of plausible elasticities are used. The conventional economic wisdom is that steam coal demand and supply are inelastic, while excess supply and demand are, in general, elastic.

Simulations

Differences in the supply and demand conditions within PSCM and ROW are represented by alternative assumptions about demand and supply elasticities. Ten alternative scenarios are examined including a "base case" scenario defined by a set of plausible intermediate values of the relevant elasticities. For the base case, the own-price elasticities of demand in Pennsylvania and in the other states in PSCM are very inelastic. The unconditional demand elasticities[2] used in the base case are derived from 1981–83 average coal production and electricity data, in conjunction with the demand relationships estimated by Findeis and Shortle and the own-price elasticities of electricity demand estimated by Beierlein, Dunn, and McConnen. For the base case, the following elasticities are assumed:

1. Pennsylvania own-price demand elasticity: −0.01
2. PSCM own-price demand elasticity (excluding Pennsylvania): −0.29
3. Pennsylvania surface and underground supply elasticities: 0.4

[2] The unconditional own-price demand elasticity for coal incorporates the feedback effects of changing coal prices through the electricity market. A change in the coal price affects the quantity of electricity demanded, which in turn affects the quantity of coal utilized (See Findeis and Shortle).

4. Export demand elasticity: −2.0
5. Import supply elasticity: 2.0

For the other scenarios, the elasticities are varied from the base case in order to examine the economic implications of alternative elasticities and the sensitivity of the base case results. The Pennsylvania supply elasticity ranged from 0.2 to 1.0, the export demand elasticity from −1.0 to −4.0, and the import supply elasticity from 1.0 to 4.0. In addition, a Pennsylvania own-price demand elasticity of −0.03 is examined.

For each scenario, coal consumption in PSCM, Pennsylvania production, Pennsylvania exports to ROW, PSCM imports from ROW, and prices are uniquely determined by the model solution. However, the distribution of Pennsylvania coal output and ROW imports within PSCM is not uniquely determined, since ROW imports to PSCM are assumed to enter Pennsylvania at a price equal to the price in Pennsylvania. Since the distribution of Pennsylvania coal between Pennsylvania and the other states in PSCM affects the extent to which a tax can be exported from Pennsylvania, the allocation of post-tax Pennsylvania supply and ROW imports within PSCM is important. Different allocations may lead to differences in the total amount of tax that is paid by consumers outside Pennsylvania.

To address this problem, results are examined under two allocation rules that provide reasonable approximations to the actual distribution of Pennsylvania coal and ROW imports within PSCM. Specifically, Pennsylvania suppliers are assumed to maintain either (a) their current market share of Pennsylvania consumption, or (b) their current market share of PSCM consumption, excluding Pennsylvania. The impacts of each allocation are analyzed for the base case. Although the actual allocation may differ from these alternative assumptions, allocations (a) and (b) reflect the range of reasonable possibilities.

Base Case Scenario Impacts

The impacts of imposing a severance tax on the market structure represented by the base case are surprisingly small (Table 1). At the maximum tax rate ($0.80 per ton), the price of coal in Pennsylvania increases by only 0.57%. As a result, Pennsylvania consumption is negligibly affected, decreasing by less than 0.01%. Since a tax imposed on Pennsylvania coal will increase the relative price of coal supplied by Pennsylvania, the amount of coal exported from Pennsylvania decreases and the quantity of coal imported to PSCM from states other than Pennsylvania increases. In the base case, the quantity of coal supplied by Pennsylvania decreases by approximately 0.60%, while imports to PSCM and exports to ROW change by slightly more than 1% at the highest tax rate.

The tax revenues paid by producers and consumers in Pennsylvania, by consumers in the other states in PSCM, and by the import/export region are shown in Table 2. In the base case, Pennsylvania consumers and producers pay over 90% of a severance tax imposed on Pennsylvania steam coal regardless of the tax rate. Most of the remaining 10% of the tax is paid by consumers in the other six states in PSCM, with consumers in the import/export region paying less than 1% of the tax. As indicated in Table 2, the results are invariant to changes in the assumed allocation of coal within PSCM. Under each allocation the result is the same: very little of the tax can be exported from Pennsylvania.

The welfare burden of the tax is also concentrated in Pennsylvania (Table 3). An examination of the changes in producer and consumer surplus attributable to taxation indicates that a large proportion of the tax burden is borne by producers in Pennsylvania in the form of producer surplus losses. Producer surplus losses in Pennsylvania comprise approximately 75% of the tax-induced welfare losses,

Table 1. Percent Change in Pennsylvania Price, Pennsylvania Consumption, Pennsylvania Supply, Imports to PSCM, and Exports to ROW in Base Case

Tax Rate	Price in Pennsylvania	Pennsylvania Consumption	Pennsylvania Supply	Imports to PSCM[a]	Exports to ROW
($/ton)	(% change)				
0.10	0.0777	−0.0010	−0.0742	0.1460	−0.1381
0.20	0.1294	−0.0010	−0.1486	0.2943	−0.2879
0.40	0.3106	−0.0031	−0.2995	0.5885	−0.5890
0.80	0.5695	−0.0064	−0.5961	1.1765	−1.1762

[a]Including Pennsylvania.

Table 2. Tax Revenue Generated: Base Case

Tax Rate	Total Tax Revenue	Regional Revenue Source[a]			Percent of Tax Exported From Pennsylvania
		From Pennsylvania	From PSCM (exc. Pennsylvania)	From Import/Export Region	
($/ton)	(thous. $)	(thous. $)			(%)
Allocation Assumption (a)					
0.10	4,517.7	4,161.4	269.7	86.7	7.9
0.20	9,028.8	8,317.5	537.9	173.2	7.9
0.40	18,030.7	16,278.9	1,338.0	413.8	9.7
0.80	35,954.4	32,798.0	2,383.7	772.7	8.3
Allocation Assumption (b)					
0.10	4,517.0	4,160.4	270.6	86.7	7.9
0.20	9,028.8	8,315.6	540.0	173.2	7.9
0.40	18,030.7	16,237.1	1,379.8	413.8	9.9
0.80	35,954.4	32,752.4	2,429.3	772.7	8.9

[a]Regional revenue burdens for any tax rate for consumers are computed by multiplying the increase in the equilibrium price by the amount purchased from Pennsylvania suppliers at the tax rate. The revenue burden of Pennsylvania suppliers is the difference between the total revenue burden and the total revenue burden of consumers.

Table 3. Changes in Consumer and Producer Surplus in Base Case

Change in Consumer Surplus

Region	Tax Rate ($/ton) 0.10	0.20	0.40	0.80
	(thous. $)			
Pennsylvania	−944	−1,889	−4,721	−8,498
PSCM (exc. PA)	−572	−1,092	−2,345	−4,725
ROW[a]	−87	−173	−432	−773
TOTAL	−1,603	−3,154	−7,498	−13,996

Change in Producer Surplus

Region	Tax Rate ($/ton) 0.10	0.20	0.40	0.80
	(thous. $)			
Pennsylvania	−3,414	−6,826	−12,539	−26,142
PSCM (exc. PA)	0	0	0	0
ROW[a]	446	893	2,240	4,055
TOTAL	−2,968	−5,933	−10,299	−22,087

Total Change in Economic Surplus

Region	Tax Rate ($/ton) 0.10	0.20	0.40	0.80
	(thous. $)			
Pennsylvania	−4,358	−8,715	−17,260	−34,640
PSCM (exc. PA)	−572	−1,092	−2,345	−4,725
ROW	359	720	1,808	3,282
TOTAL	−4,571	−9,087	−17,797	−36,083

[a]Changes represent net surplus changes in ROW.

despite the inelastic coal demand. Welfare losses are particularly high among producers because the tax-induced increase in price results in increased imports from ROW to PSCM. Elastic imports from ROW prevent the tax from being passed forward to consumers to any significant extent and result in producer surplus gains in ROW. Consumer surplus losses are greatest in Pennsylvania. The other states in PSCM lose approximately one-half the consumer surplus lost in Pennsylvania, and the surplus losses in the import/export (ROW) region are small.

A comparison of the total welfare losses induced by a tax to total tax revenue indicates that the burden of a severance tax on Pennsylvania steam coal exceeds the tax revenue generated. However, from Pennsylvania's perspective, a comparison of the tax revenue gains to the welfare losses *in Pennsylvania* is warranted (Table 4). Although only part of the welfare effects are in Pennsylvania, all of the tax revenue accrues to Pennsylvania. A comparison of the instate revenue gains to the instate welfare losses indicates that in the base case the tax revenues exceed the welfare losses by a small amount. Pennsylvania is a net gainer but the net gains from taxation are minimal.

Sensitivity of Results

The results are contingent on the values of the elasticities defining the base case. Given structural changes in the coal industry (Bohi), the sensitivity of the base case results to alternative elasticity assumptions is examined. In particular, the sensitivity of the study results to changes in the import supply, export demand, Pennsylvania supply and Pennsylvania own-price demand elasticities is estimated.

Variation of the Import Supply and Export Demand Elasticities

Variations of the import supply elasticity between 1.0 and 4.0 and the export demand elasticity between -1.0 and -4.0 had little impact on estimated coal prices, consumption levels, and the quantity of steam coal supplied by Pennsylvania. These variables change by less than 1% over the ranges of import supply and export demand elasticities examined, with the results slightly more sensitive to variations in the import supply elasticity.

Variations of the import supply and export demand elasticities have a greater impact on the amount of tax exported and the distribution of the economic burden of the tax between producers and consumers. Pennsylvania's ability to export a tax on coal is diminished when the import supply is more elastic relative to the base case. For the import supply elasticity values examined here, Pennsylvania can export between 3.9 and 12.7% of the $0.80 tax. The higher percentages for each tax rate are associated with a more inelastic import supply.

Differences in the ability to export a tax are principally due to differences in the distribution of the tax revenue burden between producers and consumers. This distribution is affected significantly by the responsiveness of coal imports to tax-induced increases in the price of Pennsylvania coal. For the most elastic import supply elasticity considered here, 4.0, Pennsylvania producers pay $31.5 million of the tax, consumers in Pennsylvania pay $2.9 million, and consumers outside Pennsylvania pay $1.4 million. In total, consumers pay only 14% of the $0.80 tax, with 3.9% paid by outside consumers. This compares to $21.7 million by producers, $9.7 million by Pennsylvania consumers, and $4.6 million by consumers outside Pennsylvania when the import supply elasticity is 1.0. In this case consumers pay 40% of the tax, and 12.7% of the tax is exported. Pennsylvania coal producers pay a higher proportion of the tax when the import supply is more elastic, since the more elastic supply holds prices down.

Although the distribution of the economic burden varies significantly with changes in the import supply elasticity, the tax-induced welfare losses in Pennsylvania largely offset each other, causing the high and low estimates of the total welfare losses to vary by at most $1.4 million. A comparison of the total welfare losses in Pennsylvania to the total revenue raised by the tax indicates that tax revenue

Table 4. Tax Revenue and Tax Burden in Pennsylvania in Base Case

Tax Rate ($/ton)	Tax Burden in Pennsylvania (mil. $)	Total Tax Revenue
0.10	−4.36	4.52
0.20	−8.72	9.03
0.40	−17.26	18.03
0.80	−34.64	35.95

generally exceeds consumer plus producer surplus losses in the state, but only by a small amount. This is true for each of the elasticity assumptions.

Changes in the export demand elasticity have even smaller impacts on the study results. For the alternative export demand elasticities, the tax revenue paid by producers and consumers of steam coal in Pennyslvania varies by at most \$1.1 million and \$0.7 million, respectively. In total, the proportion of the tax that Pennsylvania can successfully export generally varies by less than 1% over the range of export demand elasticities. This compares to a range of nearly 9% for the import supply elasticities.

Similarly, variation of the export demand elasticity has little impact on the total economic burden of the tax. At the highest tax rate considered, the total economic burden in Pennsylvania ranges between \$34.4 and \$34.6 million. At lower tax rates the differential is even smaller. The export demand elasticity has little impact principally because little coal is exported to ROW.

Variations of the Pennsylvania Elasticities

The Pennsylvania own-price demand and supply elasticities are also varied to test the sensitivity of the base case results. Prices and consumption levels are more sensitive to the Pennsylvania supply elasticities than to import supply and export demand elasticities, but the effects remain small. Nevertheless, the impact on the distributions of tax revenue burden and economic burden between producers and consumers is again substantial. For example, at the \$0.80 tax rate, the tax revenue paid by Pennsylvania producers ranges from \$18.3 and \$30.5 million, by Pennsylvania consumers between \$3.7 and \$12.0 million, and by consumers outside Pennsylvania between \$1.8 and \$5.5 million. When Pennsylvania supply is more elastic than the base case, Pennsylvania is able to export more of the tax. Pennsylvania can export between 4.9 and 15.4% of the \$0.80 tax, with 15.4% corresponding to the most elastic case considered.

Changes in consumer and producer surplus also vary significantly in response to changes in the Pennsylvania supply elasticity. With the \$0.80 tax, surplus losses in Pennsylvania range from \$18.4 to \$30.6 million for producers and from \$4.7 to \$15.1 million for consumers. In comparison to the base case, consumer surplus losses increase and producer surplus losses decrease when Pennsylvania supply is more elastic. Regardless of the supply elasticity, the gains in tax revenue outweigh the tax-induced welfare losses in the state, although only by a small amount.

When the own-price elasticity of demand is varied to -0.03, the effects on the delivered price of coal and on coal consumption in Pennsylvania are negligible and the changes in total tax revenue are minimal as a result. However, losses in producer surplus increase significantly over the base case when the demand elasticity is varied. In the base case, producer surplus losses in Pennsylvania equal \$26.1 million with the \$0.80 tax. This compares to producer surplus losses of \$33.2 million when the own-price elasticity equals -0.03 and illustrates the principal impact of a change in the Pennsylvania own-price demand elasticity, i.e., when the demand for coal in Pennsylvania is even slightly more elastic, more producer surplus is lost. These losses are not offset by comparably smaller losses in consumer surplus.

Changes in the Pennsylvania demand elasticity therefore have important implications for tax adoption. At an own-price demand elasticity of -0.03, total consumer plus producer surplus losses in Pennsylvania exceed the tax revenues at each tax rate because of large losses in producer surplus. This results in a negative net welfare position for Pennsylvania.

Implications

The changes in delivered prices and consumption induced by a severance tax in Pennsylvania are small. Pennsylvania's price, consumption, and production vary less than 1% indicating that a severance tax will have minimal effects on Pennsylvania coal production levels and consumer prices. However, the ability of Pennsylvania to export a severance tax on coal is limited. Pennsylvania producers and consumers pay a majority of the tax under all scenarios. This is a reflection both of the high proportion of Pennsylvania coal consumed in the state and the inability of producers to pass tax-induced price increases on to consumers. The results show that states with substantial mineral reserves should not assume that a severance tax can provide tax revenues without significant negative effects. The assumption that Pennsylvania can export a significant proportion of a severance tax is invalid.

The impacts of a severance tax on Pennsylvania coal producers were substantial. Coal producers will bear most of the burden of the tax. Given the difficulties of the coal industry and the economic problems of coal mining areas, the wisdom of imposing a tax with these impacts is questionable. This is especially true, given the sensitivity of the results to changes in the own-price elasticity of demand in Pennsylvania. The base case value was

very inelastic. For more elastic values the producer surplus losses are even greater. In addition, with more elastic demand the in-state welfare losses exceed the tax revenues. Under the circumstances, coal severance taxation does not look attractive for Pennsylvania.

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