Taxation of Electricity Generation: The Economic Efficiency and Equity Bases for Regionalism within the Federal System

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In 1975, New Mexico enacted a tax on the generation of electricity. The tax of four-tenths of one mill per net kilowatt hour applied to all persons generating electricity within the state for purpose of sale; a credit against gross receipts tax liability was allowed for electricity consumed within the state. The act was challenged by five public utility companies as being prohibited by federal statute as well as on other grounds. The New Mexico Supreme Court rejected the challenge, but the United States Supreme Court subsequently ruled that the Electrical Energy Tax Act was invalid. The act was invalid under the supremacy clause of the United States Constitution as imposing a discriminatory tax prohibited by Section 2121(a) of the Tax Reform Act of 1976, which was a valid exercise of Congressional power under the commerce clause of the Constitution. Thus, the New Mexico Electrical Energy Tax Act of 1975 is dead. However, the issue of taxation of electricity generation is alive since the state of New Mexico will attempt to draft a statute that comports with the
requirements of the Tax Reform Act of 1976, to wit a non-discriminatory tax.

For purposes of the Tax Reform Act electricity tax prohibition, "a tax is discriminatory if it results, either directly or indirectly, in a greater tax burden on electricity which is generated and transmitted in interstate commerce than on electricity which is generated and transmitted in intrastate commerce." The present article addresses this issue of discrimination between interstate and intrastate sales of electricity. The article suggests that the federal concern for economic efficiency can be reconciled with the regional concern for equity in the utilization of resources. The accomplishment of this reconciliation requires that New Mexico place a tax on electricity generation without preferential tax credits to New Mexican purchasers and that the tax rate be set high enough that the electricity purchasers compensate the public for all public costs that result from the generation of electricity.

A PRELIMINARY ECONOMIC ANALYSIS

In terms of economic theory, the imposition of a state electrical energy tax can be an attempt to create a socially optimal rate of electricity production by adjusting the price of electricity to reflect marginal social cost. Let \( X \) represent the electricity produced for sale within the state and let \( X_2 \) represent the electricity produced for sale in other states. Total electrical output is:

\[
X = X_1 + X_2
\]  

(1)

The production of electricity entails costs which are not borne by the producers and consumers of electricity. These costs are called external costs or social costs. Electricity production in New Mexico produces social costs which include the damage to the societal interests in lands that have been stripped for coal. Social costs are also incurred in the development of cooperating inputs for electricity generation, such as the construction of mine roads when direct and indirect tax payments are less than the public investment in the construction and maintenance of these roads. Let \( y \) represent the amount of land ravaged by strip mining as well as the amount of development of cooperating inputs; \( y \) is an increasing function of electricity production, \( X \):

\[
y = y(X), \quad y'(X) > 0.\]

(2)

Suppose that under existing pollution control standards, $\beta$ per cent of the pollutants are required to be removed before emission, $\beta Z(X)$. The emitted pollutants, $(1 - \beta) Z(X)$, constitute a public cost incurred by New Mexico and this cost can be incorporated into a social welfare function for New Mexico, $U_1$. This function, $U_1$, also incorporates the benefit of electricity sold within the state, $X_1$. The societal cost of generating electricity for both intrastate and interstate is represented by $(1 - \beta) Z(X_1 + X_2)^9$ and $Y(X_1 + X_2)^{10}$.

$$U_1 = U_1 [X_1, (1 - \beta) Z(X_1 + X_2), Y(X_1 + X_2)]$$

$$\frac{\partial U_1}{\partial X_1} > 0; \frac{\partial U_1}{\partial Z} < 0; \frac{\partial U_1}{\partial Y} < 0.$$  

The social welfare function for customers in states other than New Mexico, $U_2$, is solely a function of the amount of electricity sold outside of New Mexico, $X_2$. These customers do not have social welfare function components representing land and air degradation, since they are not members of the public of New Mexico$^{11}$ and do not directly bear the burden of land and air degradation. The social welfare function for these customers is:

$$U_2 = U_2 (X_2), U_2'(X_2) > 0.$$  

The total social welfare$^{12}$ is measured by the sum of the two social welfare functions [equations (4) and (5)]$^{13}$:

$$W = W (U_1, U_2) = U_1 + U_2.$$  

Electricity production requires resource inputs such as coal, labor and amortized capital expenditures. The cost of this production, $C$, is a function of the total amount of electricity produced, $X$, and the control of pollution, $\beta Z(X)$. Input prices are assumed to be constant. Total cost of production increases at an increasing rate where entrepreneurial and technological limitations are met. The total cost of electricity production (including pollution control) is defined by:

$$C = C[X, \beta Z(X)], \frac{\partial C}{\partial X} > 0; \frac{\partial C}{\partial Z} > 0.$$  

Thus, where $(\beta \frac{\partial C}{\partial Z}) Z'(X)$ is the marginal cost of removing $\beta$ per-
percent of pollutants Z generated by the production of the marginal unit of X, the marginal production cost, MC, is specified by:

\[ MC = \frac{\partial C}{\partial X} + (\beta \frac{\partial C}{\partial Z}) Z'(X). \]  

(7)

In Figure 1, total cost of production is shown as the curve AA, where total production, X, is depicted on the horizontal axis and dollar amounts are indicated on the vertical axis. The curve AA incorporates both production costs and pollution control costs, all of which are functions of electricity output, X. The total welfare function [equation (6)] is shown as the curve BB. The standard theory of consumer preference suggests that the total welfare function would increase at a decreasing rate. However, the curve BB indicates net benefits in that the impact of electricity production on environmental quality is included in the New Mexico social welfare function [equation (4)]. Environmental damage shifts the curve BB downward from what it would be without the inclusion of the environmental impact and may well make the curve BB turn downward at a lower level of electricity production.

The optimal level of electricity production is the level that would maximize net social benefits; net social benefit, \( \pi \), is defined as:

\[ \pi = W - C. \]  

(8)

The first order conditions for maximizing \( \pi \) are obtained by setting the partial derivatives of equation (9) equal to zero:

\[ U_1'(X_1) + (1-\beta) \left( \frac{\partial U_1}{\partial Z} \frac{\partial Z}{\partial X_1} + \frac{\partial U_1}{\partial Y} \frac{\partial Y}{\partial X_1} \right) - \left( \frac{\partial C}{\partial X_1} + \beta \frac{\partial C}{\partial Z} \frac{\partial Z}{\partial X_1} \right) = 0 \]

(9)

\[ U_2'(X_2) + (1-\beta) \left( \frac{\partial U_1}{\partial Z} \frac{\partial Z}{\partial X_2} + \frac{\partial U_1}{\partial Y} \frac{\partial Y}{\partial X_2} \right) - \left( \frac{\partial C}{\partial X_2} + \beta \frac{\partial C}{\partial Z} \frac{\partial Z}{\partial X_2} \right) = 0 \]

Thus, economic efficiency is maintained if the price, P, is equal to marginal social cost, which is the sum of marginal production cost,

\[ \left( \frac{\partial C}{\partial X} + \beta \frac{\partial C}{\partial Z} Z'(X) \right), \]

and marginal social damage,

\[ (1-\beta) \frac{\partial U_1}{\partial Z} Z'(X) + \frac{\partial U_1}{\partial Y} Y'(X). \]

14. \( W \) is defined by equation (6).
\( C \) is defined by equation (7).
\[ P = \left[ \frac{\partial C}{\partial X} + \beta \frac{\partial C}{\partial Z} Z'(X) \right] - \left[ (1-\beta) \frac{\partial U_1}{\partial Z} Z'(X) + \frac{\partial U_1}{\partial Y} Y'(X) \right] \tag{10} \]

THE PRINCIPAL ARGUMENT

If a purpose of an electricity generation tax is to adjust the level of generation to reflect marginal social cost,\(^{15}\) then the preliminary economic analysis has implications for the drafting of a new state tax act. The output of electricity corresponding to a social welfare maximum in Figure 1 occurs where curves AA and BB have identical slopes (at output \(X^0\)). Before the optimal level of \(X^0\) is reached, each additional unit of electricity engenders net benefits since benefits (pursuing the curve BB) are increasing faster than incremental production costs (following the curve AA). After the optimal level of \(X^0\) is reached, marginal production costs exceed marginal benefits.

The optimal level of electricity generation can be achieved if the appropriate price, \(P\) as defined by equation (11), is charged. This price, \(P\), is the marginal cost of production (including pollution control)\(^{16}\) plus an adjustment factor reflecting the marginal environmental damage inflicted upon New Mexico. However, a tax credit against gross receipt tax liability is not an economically sound means to incorporate the environmental adjustment factor into the state tax policy. A condition of economic efficiency or social optimality\(^{17}\) of electricity generation requires that New Mexico customers pay the same price\(^{18}\) "at the power plant" for electricity as out-of-state customers. Economic efficiency requires that the price of electricity to both in-state and out-of-state users be identical in order that the socially optimal amount of electricity is consumed by each customer. A tax credit would result in a lower tax and ultimately a lower final price for New Mexico customers which would encourage a level of

\(^{15}\) Marginal social damage of New Mexico consumption is defined by
\[ \left[ (1-\beta) \frac{\partial U_1}{\partial Z} \frac{\partial Z}{\partial X_1} + \frac{\partial U_1}{\partial Y} \frac{\partial Y}{\partial X_1} \right] \].

\(^{16}\) The marginal cost of production (including pollution control) would otherwise be the theoretical basis for the price of electricity. Since the price of electricity is regulated by the states through legislation and public utility commissions, it should not be assumed that real prices reflect the marginal cost of production. Of course, if the electric utilities were unregulated, then prices would be higher and services more restricted.

\(^{17}\) See equation (11).

\(^{18}\) Including tax.
New Mexico consumption of electricity higher than the socially optimal level.\(^{19}\)

There are at least two strategies to permit a transfer payment from

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19. Here, the question is whether a tax credit against gross receipts tax liability is a tool to closely align final prices for intrastate consumers with final prices for interstate consumers. The problem is resolved by recognizing that the policies of state taxation have several bases. In the case of taxation of electricity generation, there can be a policy of attempting an approach to a socially optimal level of electricity generation. On the other hand, gross receipts taxation is a general tax directed towards having business firms share the burden of state expenses in proportion to the volume of each firm’s business (which is presumably in proportion to the benefits that each firm receives from the state). General business taxes vary among the states since the revenue needs and policies of the states vary. Thus, the final prices billed to customers for electricity generated in New Mexico could properly vary among the states.
consumers of electricity to New Mexico in order to compensate New Mexico for the environmental damage inflicted upon New Mexico by electricity generation. One strategy would be for New Mexico to negotiate a lump sum payment. While this might be done in several ways, this strategy is probably only feasible by making the lump sum payment a condition for licensing. A second strategy is to charge a tax that includes compensation for the environmental degradation.

The amount of payment which should be paid can be derived in several different ways. One way is depicted in Figure 2, in which the demand for electrical energy is shown as a function of price. Dollar amounts are on the vertical axis and the amount of electricity output is on the horizontal axis. The curve AA indicates the non-resident demand for electricity and the curve BB indicates the aggregate demand for electricity by residents of New Mexico and non-residents. The marginal social cost of generating electricity in areas other

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20. The amounts would vary with alternative formulations. The present formulation follows conventional economic theory.
than New Mexico\textsuperscript{21} is indicated as the curve CC. If the areas which consume the electricity were to suffer the pollution created by the electricity, \(X^1\) would be the optimal quantity of electricity produced. However, the social cost of generating electricity in New Mexico is less than generating the electricity in the prime consuming areas.\textsuperscript{22} Thus, the curve CC lies above the curve DD, which represents the marginal social cost of electricity produced in New Mexico. The economically efficient amount of electricity to be produced for consumption in both New Mexico and other states is indicated by the intersection of the aggregate demand curve BB and the New Mexico marginal social curve DD. That amount is \(X^0\). This point is identical to the socially optimal level of output and price derived in Figure 1 and in equation (11).

Since the generation of electricity is located in New Mexico, purchasers in other states consume more electricity, \(X^2\), at a lower price, \(P^0\), than these purchasers would consume if the generation site were located in their airsheds and political power were exercised to internalize the externalities of the generation of electricity. These benefits of more electricity at lower price are quantified by the shaded triangle in Figure 2.\textsuperscript{23} The area of this triangle is the measure of these purchasing's economic "willingness\textsuperscript{24}" to pay for cleaner air. This "willingness" to pay is the lump sum which should be negotiated as a condition for licensing if this factor is not included within a non-discriminatory tax.

CONCLUSION

The incorporation into an electricity generation tax of factors for regional impact meets the criterion of economic efficiency and the federal concern for interstate commerce. The tax rate must be equal for intrastate and interstate purchasers and the tax rate should incor-

\textsuperscript{21} For example, consider the placing of a large facility near Los Angeles.
\textsuperscript{22} The rich coal reserves in the Southwest constitute a relatively inexpensive energy source and it appears to be economically feasible to transmit electricity rather than to haul coal. Secondly, conventional economics would suggest that pollution costs are less where there are fewer and poorer people. New Mexico is a relatively sparsely settled state that ranks forty-eighth among the fifty states in per capita income. In the calculus of conventional economics, wealth is a factor underlying the willingness to pay for various degrees of environmental cleanliness. However, conventional economics is simply a tool for analysis and the authors of this article repudiate any connotation that persons of varying wealth have correspondingly varying rights to a clean environment. The authors believe that the environmental rights of the poor are equal to those of the wealthy, which is one of the reasons for this article.
\textsuperscript{23} The corners of the triangle are the points \((X', P'), (X^2, P^0), (X^1, P^0)\).
\textsuperscript{24} Political or psychological "willingness" is distinguished.
porate into private costs the marginal environmental damages incurred in the generation of electricity within the state.\textsuperscript{25} Lump-sum compensation should also be considered as a possible condition for the licensing of electricity generation facilities in order to share the net benefits created by siting within the state.

25. The state legislature could declare in a preamble to an electricity generation tax act that: one, the generation of electricity is detrimental to the health and welfare of the people of New Mexico and is destructive of natural, scenic and aesthetic values of the environment of New Mexico; two, a purpose of the tax is to provide an economic incentive to reduce the use of electricity both within and outside of the state of New Mexico and, thus, reduce the detrimental and destructive effects of electricity generation within the state.