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ECONOMIC ASPECTS OF THE TAXATION OF DECONTROLLED NATURAL GAS: ABSTRACT

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Natural gas accounts for 27% of total energy production and almost 25% of total energy consumption in the United States. The market for natural gas is quite complex, both because of the nature of the product and because natural gas is subject to various tiers of government regulation. Under current legislation, there will be a phased elimination of controls on some categories of gas in 1985. Numerous suggestions have been made for complete decontrol at the wellhead. As a corollary to this debate, and the fiscal dilemma facing the United States, proposals for various taxes on natural gas have been made. One analogy is drawn to the crude oil windfall profits tax (COWPT) and suggests that the rise in price for those categories not already at market prices would form some sort of tax base on which a "windfall profits tax" would be levied.

This paper develops an analytical framework for, and a simulation of, the efficiency and revenue effects of two types of natural gas windfall profits taxes under alternative assumptions concerning supply elasticities and the course of future prices. Bracketing the reasonable estimates of production responses and future prices, the results include estimates of the induced changes in production and proven reserves as well as the division of incremental revenues among royalty owners, producers and governments.

We conclude that a tax on the decontrolled increment is likely to have major defects which outweigh the possible advantages. The tax is likely to be much more expensive and difficult to administer than COWPT. It is likely to distort various important incentives severely unless new gas is exempted. The potential

revenue from the tax is quite small unless substantial future price increases occur (perhaps occasion by large increases in real oil prices), but then the induced distortions in supply responses would be still worse, and the deadweight loses still larger.

Our conclusions are thus as follows:

1. There is substantial evidence that decontrol of natural gas is likely to produce a large increment to output and reserves even over as short a period as the next seven years.

2. The supply responses would be substantially mitigated with an excise tax on decontrolled increments; even a 30% tax rate on the difference between the market price and the scheduled price under existing legislation would produce a substantial curtailment of the supply response, a large deadweight loss, and a substantial allocative inefficiency per dollar of incremental federal receipts.

3. A large fraction of total incremental revenues under decontrol will be captured by federal and state royalties and bonuses, federal personal income taxes on private royalties, corporate income taxes, and state severance taxes anyway. The imposition of a windfall profits tax above and beyond these other taxes produces only modest incremental revenue, in part due to its deductability against corporate income taxes. Attempts to capture a larger share of the incremental revenue under decontrol would worsen the allocative distortion caused by the tax.

4. When the allocative inefficiency induced by the tax is smallest, the net revenue from the imposition of the windfall profits tax amounts to an annual rate of under one billion dollars.

5. The exemption of new drilling from the windfall profits tax would be a major improvement if such a tax must be adopted.

ECONOMIC ASPECTS OF THE TAXATION OF DECONTROLLED NATURAL GAS*

1. Introduction

Natural gas plays an important role in our economy. The production, distribution, and end use of some 16 trillion cubic feet of natural gas in 1983 accounted for nearly 25 percent of total energy consumption and 27 percent of total energy production in the United States. Likewise, in 1980 aggregate expenditure on natural gas in the U.S. made up 12 percent of total expenditure on energy and 1.8 percent of Gross National Product (GNP).[1]

The natural gas market is one of the most complex markets in the United States, both because of the nature of the product and because natural gas is subject to various tiers of government regulation. The wellhead price for interstate gas has been controlled by the federal government for three decades. In 1978 Congress passed the Natural Gas Policy Act (NGPA). This legislation extended the scope and complexity of the wellhead price controls, but it also provided for the phased elimination of controls on some categories of gas, beginning in January of 1985. Under NGPA, natural gas is often sold further down the use-chain at a price that is an average of low-priced controlled gas and higher priced gas from new sources. These and other regulatory practices lead to inefficiencies due to misallocation of production, alterations of incentives to explore and drill, and changes in the intertemporal decisions on production from existing reserves.

As a result, much attention has focused on the prospects for complete decontrol of natural gas at the wellhead. Several bills have been introduced by the Administration and in Congress, and there seems to be substantial agreement,

at least among economists and editorial writers, that decontrol is desirable. Because of the complexity of the market, and the potential redistribution of large sums of money, the nature, timing, and implementation of decontrol are subjects of intense debate.

As a corollary to this debate, some have proposed taxing the increments in wellhead revenues that might arise from price decontrol. An analogy is drawn to the crude oil windfall profits tax (COWPT) that was enacted when domestic crude oil prices were decontrolled in 1979-81. Thus, accompanying decontrol of all gas production, the rise in price for those categories not already at market prices would form some sort of tax base on which a "windfall profits tax" would be levied. Recent tax history suggests that the taxation of energy may be considered given pressure to raise revenue for the balance of the decade.[2] Consequently, the revenue and efficiency aspects of natural gas taxation should be examined carefully.

The purpose of this paper is to explore the economic effects of a natural gas windfall profits tax. The next section presents a somewhat more detailed discussion of the important features of the natural gas market and details our various scenarios for forecasting natural gas prices under wellhead price decontrol. Section 3 discusses the difficulties of defining the base of a windfall profits tax. Section 4 considers the likely incidence of such a tax in the short and long run.

Section 5 presents a simulation (building on the framework of Erickson (1982)) of the effects of two types of a natural gas windfall profits tax on the decontrolled increment under alternative scenarios with respect to natural gas prices and supply elasticities. The scenarios were chosen to bracket reasonable estimates of production responses and future prices. The results

include estimates of the induced changes in production and proven reserves as well as the division of incremental revenue among royalty owners, producers and government.

The principal results are presented in Section 6. There, we discuss the welfare costs of possible windfall profits taxes under different price and supply responses and compare these costs to the revenue raised.

The final section offers a conclusion based on the analysis in the previous sections. In summary, we conclude that a tax on the decontrolled increment is likely to have major defects which outweigh the possible advantages. The tax is likely to be inordinately expensive and difficult to administer; it is likely to distort various important incentives severely unless new gas is exempted; attempts to reduce these distortions are likely to worsen performance in other dimensions. The potential revenue from the tax is highly sensitive to assumed future prices. A continuation of current market conditions in real terms would not generate very much revenue for all this effort. Only a substantial increase in the real price of natural gas under decontrol (perhaps occasioned by a large increase in real oil prices) would be likely to generate substantial revenues. But the capricious nature of the potential redistribution of this revenue because of the nature of contractual arrangements in the industry and the substantial disincentives to produce, explore, and allocate gas efficiently argue against this type of tax.[3]

2. The Natural Gas Market

The natural gas market has numerous special characteristics which both warrant and complicate an analysis of the industry. Since natural gas is an exhaustible resource,[4] its value is greater than the cost of exploration and extraction and intertemporal choice is an inherent element of the exploration decision. However, there is uncertainty, prior to exploration, regarding the existence and size of a reservoir in a prospect. Since each potential bidder for a gas lease has a different estimate of the likelihood of profitable production, the analysis of who receives the difference between value and cost becomes quite complex.[5] In addition, natural gas and oil are often found and produced together so that the prices in one market affect supply in the other. Price controls on natural gas reduce the exploration and production of oil, its joint product. High oil prices will lead to additional discoveries of natural gas, as new drilling for oil is induced. At the same time, the two products are substitutes for each other in consumption so that prices for one product affect the demand for the other.

The exploration and production of natural gas at the wellhead is just a first step in a complicated and varied route to end use. Much natural gas is sold under long-term contracts to pipeline companies; these companies in turn often sell to local companies for distribution, who in turn sell to end users. The price in all these contracts is determined under government regulation. The maximum price producers receive was established by the Natural Gas Policy Act of 1978 (NGPA). This maximum price depends upon the year wells were drilled, the formation from which the gas is extended, whether the gas was originally committed to the interstate market, and other factors; all told, there are some 24 different maximum prices at which gas currently may be sold, ranging (in

April 1984) from $0.295 to $5.929 per thousand cubic feet. However, much of the gas produced from wells drilled after 1977 is scheduled under existing law to be decontrolled on January 1, 1985.[6]

These (partially) controlled prices in turn affect decisions by interstate transmission companies. The Federal Energy Regulatory Commission (FERC) limits the price pipelines can charge distributors to the acquisition cost of the gas plus a mark-up designed to allow the pipelines a "fair" rate of return on their assets. In addition, a substantial fraction of natural gas for residential use passes through at least one, usually state, regulatory agency in its pricing. Thus, a myriad of overlapping regulations affects the different states of production and their interaction.

The analysis of the effects of price decontrol and of a windfall profit tax on the natural gas market would seem to be extremely difficult. Fortunately, an assumption can be made which both simplifies the analysis and seems consistent with the evidence: the price of oil indirectly sets both a floor and a ceiling for the market price of decontrolled natural gas.

Although in the short-run oil and gas may not be close substitutes for some uses, gas turbines and steam generators used by electric utilities and industrial boilers are frequently capable of using either oil or gas, either immediately or after inexpensive retrofitting. This part of the natural gas market is extremely large, accounting for around 30 percent of natural gas consumption in 1980.[7] Thus, if gas prices to these users rose significantly above the heat-equivalent oil price, then the quantity of gas demanded would fall precipitously.[8]

There is also substantial evidence that oil prices will set a <u>floor</u> for gas prices. In large boilers which are dual-fired (i.e., can switch fuels at a turn of a valve), natural gas provided 89 percent of the energy.[9] This would

suggest that the possibility of increased consumption is limited. Between 1973 and 1979 however, industry decreased gas consumption by 21 percent while increasing oil consumption by 59 percent despite a growing difference between oil and gas prices.[10] Similarly, utilities also reduced their gas consumption in the 1970s, though demand for their product rose. This may be due to the fact that many industrial fuel users, faced with increased frequency of curtailments and a variety of overhanging federal controls over gas-use priorities, found the true economic cost of using oil was much less than that of using gas and thereby switched to a more reliable, though higher cost fuel. If decontrol meant a decreased probability of gas shortages, gas demand might increase substantially if the market price for decontrolled natural gas at the burner-tip fell below the heat-equivalent price of its competitor, heavy fuel oil. Since pipelines are regulated, this price -- less transport costs -- should be reflected in decontrolled wellhead prices.[11]

Obviously, estimates of the future price of decontrolled gas are enormously important to any evaluation of the likely effects on production, reserves, revenues, royalties, and tax receipts, and since many users of natural gas can shift to oil at the margin, and vice versa, forecasts of natural gas prices in a decontrolled market must be at least consistent with the oil prices implicit in any set of natural gas prices. Rather than attempting to provide a year by year forecast of oil prices or of the state of energy demand, we provide three scenarios, illustrative of possible paths for natural gas prices through 1991. They may be roughly described as follows:

1. Soft market continues. This scenario assumes that the price of (decontrolled) natural gas is $2.71 in 1984 and remains constant in real terms. Implicitly, it assumes that the decline in real gas prices experienced in 1981-83

3. Some Types of Taxes on Decontrolled Natural Gas

Although there are a myriad of possibilities for the taxation of decontrolled natural gas, the most common suggestion is to place some form of tax on a decontrolled increment, however defined. As with the Crude Oil Windfall Profits Tax, some base level of prices would be established, and any increase in price above this level (which may well increase through time) would be considered the decontrolled increment, and the tax applied as a fraction of this increase. The categories defined in the Natural Gas Policy Act (NGPA) of 1978 would be the most natural base from which to calculate such a "decontrolled increment" by category. Since under NGPA many categories of gas are due to be decontrolled in the next several years while substantial regulation will continue for other categories, the tax authorities might need to calculate the decontrolled increments from a large number of categories, each with its own potentially distinct price path under NGPA to establish the base of the tax.

In the analysis conducted below, estimates are provided for an archetypical natural gas excise tax on decontrolled increments. We calculate the decontrolled increment under assumed price scenarios for each distinct category under NGPA, and apply a tax rate to these differential increments to examine the likely response of natural gas production, reserves, and revenue raised by category.

The major issue concerning the potential allocative effects of such a "windfall profits tax" is the extent of any supply response to the reduced production and exploration incentives caused by this tax. Designers of a natural gas windfall profits tax may consider the exemption of certain types of gas (new gas and perhaps stripper gas) and/or the allowance of deduction against the tax for amounts reinvested in exploration for new deposits, issues which have risen with respect to the COWPT.

Exempting new drilling from the windfall profits tax would minimize the distortion involved at the so-called extensive margin. As we demonstrate below, even in as short a period as that through 1991, our results suggest that this would have substantial impacts on production and reserves.

Further, such a windfall profits tax will impact on royalty and bonus bids as well as interact with the existing tax structure. First, since the federal corporate income tax traditionally allows deductions for other taxes paid as part of the expenses of doing business, any "windfall profits tax" paid would be deductible from federal corporate income taxes. Thus the net effect for the Treasury would be only a fraction of the estimated gross windfall profits tax revenue.[12] Unless the effective corporate tax rate on natural gas were very low and/or the tax rate on the decontrolled increment was extremely high, the automatic revenue effects of increased corporate income taxes will swamp those generated by the net windfall profits tax. Similarly, substantial state revenue will accrue under existing tax laws and the net revenue from a natural gas windfall profits tax would be even less due to deductibility of incremental state severance taxes.

The views about the various potential deleterious effects of alternative tax types depend heavily upon one's views of the elasticities of supply and demand for natural gas. For example, if the opportunities for enhancements of the intensive margin are substantial for many categories of gas, a windfall profits tax on a decontrolled increment may substantially retard the potential enhanced production from existing wells. Thus, the supply response of old gas is important in trying to decide whether there would be any deleterious allocative effects of a windfall profits tax on a decontrolled increment. In the longer-run, there is substantial opportunity for intertemporal substitution in the production

and exploration decision for new gas. While there ultimately may be a fixed amount of natural gas available, and in this sense some very long-run supply indeed may be inelastic, clearly the rate of exploration and production can be altered significantly by the structure of returns available to exploration and production. We present below some estimates for the intermediate run response of new drilling to various after-tax producer netback prices assumed to accompany decontrol in any windfall profits tax scenario. Even very modest supply responses suggest substantial differences in supply through 1991.

4. The Incidence and Allocative Effects of a Natural Gas Windfall Profits Tax

The incidence and allocative effects of a so-called windfall profits tax on decontrolled natural gas, really an excise tax on the price increments, depend upon the responses of supply and demand.[13] According to the usual partial equilibrium analysis, the tax is borne by consumers and producers depending upon their relative elasticities of supply and demand. For example, if the demand curve is perfectly inelastic, consumers bear all of the tax; correspondingly, if it is perfectly elastic, they bear none of it. Moreover, since the difference between price and marginal cost equals unit rent, i.e., the return to landowners, when demand is perfectly elastic -- a case which we believe to be relevant for natural gas -- in the long-run, landowners will bear all of the burden of the tax.

If the tax reduces the amount of the commodity produced, a deadweight loss to society is incurred. This efficiency loss is measured by the difference between the demand and supply curves over the range of lost output, demand representing the marginal value to consumers, supply representing the long-run marginal cost of production. Clearly then, excises on commodities in elastic demand have very large deadweight losses per unit of output relative to those on commodities in inelastic demand.

Given the substitutability of natural gas and oil in many uses, the demand for natural gas can be represented as being perfectly elastic. Figure 1 depicts the consequences of the decontrol of natural gas for a particular natural gas category. Here, demand is given by DD and supply by S_0S_0. Were there no regulation, price would be P_e and output, Q_e. However, since price is regulated and capped at P_r, well below the potential market price for the gas, output is limited to Q_r. This implies a deadweight loss to society equal to the area between the supply and demand curves over the range of output Q_rQ_e (area ABC).

Figure 1 - Natural Gas Excise Tax on Decontrol Increment: Single Category

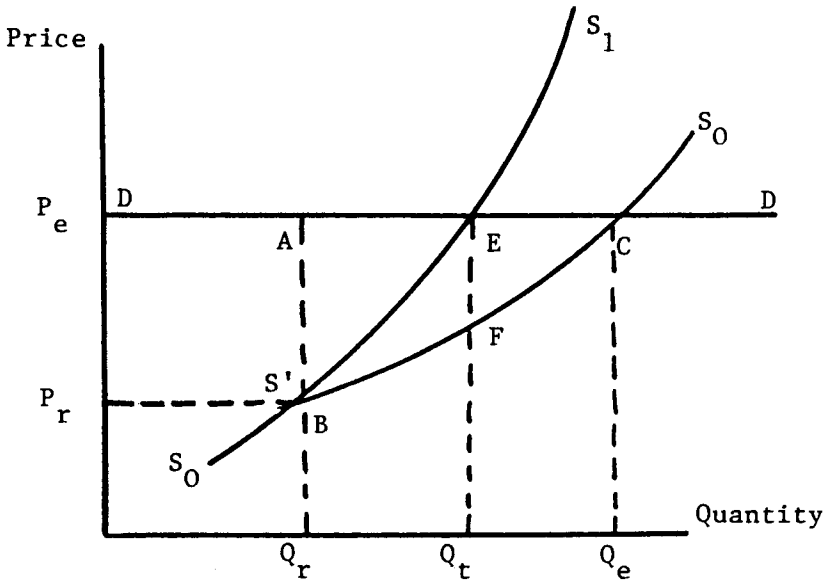
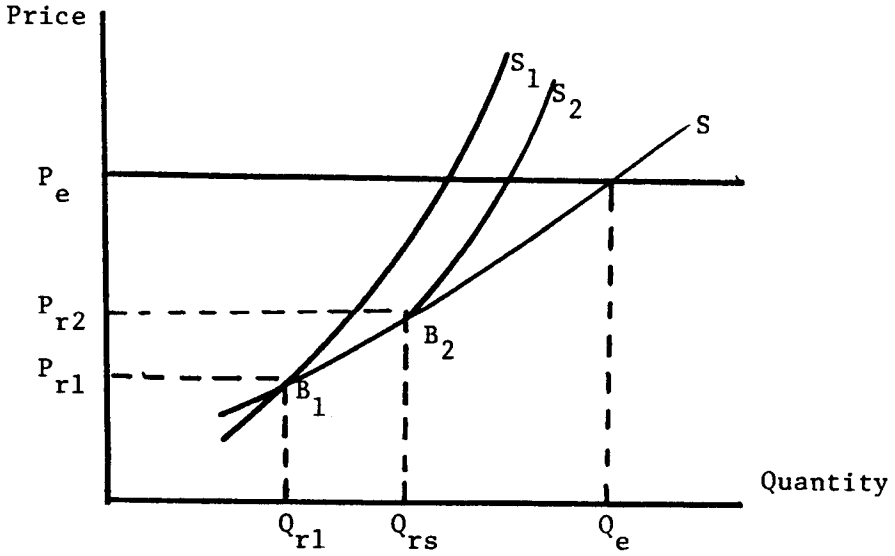


Figure 2 - Natural Gas Excise Tax on Decontrol Increments: Multiple Categories



If the price of the natural gas is decontrolled, price will rise to P_e and output to Q_e, eliminating this deadweight loss. Of course, a redistribution of the proceeds occurs. In the short-run the incremental revenues accrue to producers, royalty owners, and the government (through taxes), since lease payments to landowners are fixed. But over a span of time, lease bonuses will be renegotiated as new drilling and exploration occur, and any extra profits to producers will be competed away.

Suppose now that an excise tax is levied in proportion to the decontrol increment, $P_e - P_r$. That is, the tax rate is given by the formula

$$(1) \qquad t_i = \alpha(P_e - P_{ri})$$

where t_i is the value of the tax per unit of output, α is the proportion of the decontrolled increment taxed, and the subscript i refers to the particular natural gas category under consideration. Therefore, a new tax-inclusive supply curve $S'S_1$, above and to the left of S, but intersecting the original supply curve at the regulated price, will govern decision-making.[14] Decontrol coupled with the excise tax on the decontrolled increment therefore reduces output to Q_t. The assumption of the perfectly elastic demand curve means that all of the tax in the short-run will be borne by producers and royalty owners, and in the long-run by landowners, in the form of lower lease bonuses than would otherwise have occurred.

The tax imposes a deadweight loss on society when the reduced output is not compensated for elsewhere by increased output of other goods and services. However, the analysis of this welfare cost is more complicated in the case of an exhaustible resource such as natural gas since an alternative to production

today is leaving the gas in the ground and producing it (possibly) sometime in the future. We discuss the welfare costs associated with postponed production in more detail in Section 6. Nevertheless, given the substantial elasticity of natural gas demand, the response of supply to a tax on the decontrolled increment is likely to be substantial.

A windfall profits tax on natural gas (a tax on the decontrolled increment) creates a further complication (Figure 2). Under NGPA there is a distinct regulated price for each category of gas. With a substantially variegated system of regulated prices, and with the expansion of supply possible at both the intensive and extensive margins, the link between price and cost of production is lost so that natural gas is supplied from fields with widely different marginal cost. Thus, even the most basic allocative efficiency norm of equalizing the marginal cost among different sources of output is violated.

Under complete deregulation, the prices of the different categories (Figure 2 presents two categories for simplicity) are all increased to the new equilibrium price. In the long-run, continued drilling and exploration means that eventually all gas produced will be from new sources so that the marginal costs will be equalized for all uses. Gas will be allocated efficiently both among potential sources of supply and relative to alternative resources. A proportional tax on a decontrolled increment, however, introduces once again a wedge between the return to suppliers and the marginal value to consumers. This wedge varies systematically with the previous regulated price, being larger for those sources with a lower regulated price. Thus, the combined allocative effects of imposing even this simplified archetypical excise tax on decontrolled increments produces substantially varied tax rates per unit of output from different sources of supply of old gas. At least for a while, the tax again has potentially severe

allocative effects and introduces numerous potential complexities for decisions to enhance existing gas supplies.

In summary, the decontrol of natural gas will lead in the long-run to a more efficient allocation of society's scarce resources among competing uses. The current system of regulation, whatever its historical purposes, leads to an inefficiently reduced incentive to produce, explore, and drill. An excise tax on the decontrolled increment accompanying decontrol would re-introduce these allocative inefficiencies. Under our assumption of substantial elasticity of natural gas demand due to its substitution possibilities with respect to oil, the incidence of a tax in the long-run would be on the landowners; and in the short-run on producers and royalty owners. Further, if the demand for natural gas is less elastic than we have assumed in the short-run, some of the burden of the tax will be shifted to consumers.

Finally, in assessing the desirability of a windfall profits tax on natural gas, one needs to indentify the beneficiaries of continued price controls as well as those who would lose under decontrol. Producers of "high-cost" gas clearly benefit from the controlled price: under decontrol (expecially if explicit abrogation of contracts is permitted) these producers would receive substantially reduced prices for their gas. Also, to the extent that the average price to consumers is lower under current law than it would be under deregulation, consumers with access to the limited supply also benefit from price controls. However, at least some of these consumers may willingly pay higher prices to obtain a greater supply of gas. Finally, price controls on gas also benefits foreign energy producers in two ways: first, lower gas supply implies greater use of imported oil and gas and, second, lower gas prices discourage oil exploration and thus reduce domestic oil production.

5. Estimates of the Effects of a Windfall Profits Tax on Natural Gas

In this section, we present estimates of the effect of a windfall profits tax on natural gas supply and on government revenue. The tax is assumed to be levied on the "decontrolled increment"; thirty percent of the difference between the price forecast for NGPA for each category and prices under an immediate decontrol plan is taxed.[15] Further, we assume this tax is levied on both royalty owners and producers, is deductible from corporate income tax, and is non-negative (i.e., no refunds are paid to those who receive a lower price under decontrol). We also consider two tax bases: (1) tax is assessed on all gas production or (2) only production from currently existing wells is liable for tax.

In estimating the effect of such a tax, our critical assumption is that the market-clearing price of gas at the burner-tip is unaffected by the quantity of gas produced within the range of supply responses we consider. As a consequence of this assumption we obtain the otherwise paradoxical result that an increase in the price of gas leads to an increase in gas consumption. Since natural gas prices for many categories of gas are substantially below market-clearing levels, an increase in production is assumed to be absorbed by consumers who were previously being rationed either explicitly or implicitly. Dropping this assumption, as discussed later, would further strengthen the case against a windfall profits tax on gas.

The supply response is analyzed using the framework developed by Edward Erickson.[16] He decomposes the production response into three components: changes in reserves due to wells drilled in new fields, increases in reserves in existing fields due to price incentives, and decreases in the reserve to production ratio. Erickson calibrates his model using two extreme cases for

the path of future prices. The estimated response of reserves and production for these cases is based on "a combination of relevant historical information and expert opinion."[17] The supply response under intermediate price paths, such as those we consider, is determined as follows: producers forecast for each NGPA category and contract type the wellhead price, net of taxes and royalties, based on the intermediate price path. The response of production and reserves is based on a comparison between these intermediate net back prices and the corresponding net back prices based on Erickson's two extreme cases.

Our base case supply response uses parameters consistent with Erickson, except for the price-induced enhancements of old reserves. Other researchers have thought that the response of gas producers to higher prices would be substantially different, particularly with regard to additional reserves found in existing fields. A study done by the Department of Energy suggested a smaller response than Erickson, while studies by Shell and ARCO, and by the U.S. Congress, Office of Technology Assessment, as well as a more recent study by the Department of Energy, all released after Erickson had completed his model, had much larger estimates of additional price-induced reserves from old fields.[18] These more recent studies were based on extensive engineering data and forecasts and as such may be more complete. Our base case has a price-induced response which is roughly consistent with, but on the lower end, of these latest studies.

To allow for the uncertainty regarding supply estimates, we consider two additional sets of supply assumptions designed to bracket reasonable alternatives. In one case, the response of wells drilled in new fields, additional reserves found in existing fields, and reserve-to-production ratio to a given price difference in a category are all assumed to be 50 percent of the base case. In the other supply scenario, the price-induced response of wells drilled in new fields, the reserve-to-production ratios and that of reserves in old fields is 50 percent higher.

The tables following this section give the results under the various scenarios. Tables 1 to 3 give the additional gas production over the period through 1991 plus the additional final reserves at the end of 1991 compared with the value under the relevant NGPA case. This represents the total additions to producible gas over the period resulting from immediate decontrol for the different choices of a windfall profits tax. Since higher prices correspond to a lower reserve-to-production ratio, the increase in production for the different tax cases is proportionally greater than the increase, if any, in final reserves. The WPTA case is a 30 percent windfall profits tax on the decontrol increment for each category of gas, while WPTB exempts new drilling, but is otherwise the same as WPTA.

As the tables indicate, cumulative supply responses are substantial under decontrol. The incremental natural gas supply ranges from three to eleven trillion cubic feet in the current market, and nine to twenty-eight trillion cubic feet in the rebound price, scenario. Of this additional supply, a substantial proportion is a result of the supply response of "old gas" -- i.e., gas from fields discovered before mid-1977. The old gas response in the current price scenario ranges from 1.9 trillion cubic feet of additional supply under WPTA to 2.7 trillion cubic feet under decontrol with no windfall tax. Similarly, in the market rebound scenario, incremental supply due to the response of old gas ranges from 3.8 to 5.7 trillion cubic feet. However, under the assumption of a rebound in market conditions followed by rising real prices, a larger share of the incremental supply comes from new gas, as old gas accounts for between 7.5 and 11 trillion cubic feet.

Table 1

INCREMENTAL NATURAL GAS SUPPLY[a]
(cumulative 1984 to 1991 in tcf)

Price Scenario: Current Market Conditions Continue

Decontrol + Tax Scenario:	No Wpt	WPTA	WPTB
Base Case Supply Response	7.4	5.3	5.4
Supply Response 1 1/2 times base case	11.4	8.2	8.2
Supply Response one half times base case	3.6	2.6	2.6

[a]Over NGPA base case. Supply comprises changes in final reserves between 1991 and 1984 plus total production in 1984-1991.

Table 2

INCREMENTAL NATURAL GAS SUPPLY[a]
(Cumulative 1984 to 1991 in tcf)

Price Scenario: Market Rebound

Decontrol + Price Scenario	No WPT	WPTA	WPTB
Base Case Supply Response	18.5	11.6	13.9
Supply Response 1 1/2 times base case	27.6	17.6	20.4
Supply Response one half times base case	9.6	5.9	7.5

[a]Over NGPA base case. Supply comprises changes in final reserves between 1991 and 1984 plus total production in 1984-1991.

Table 3

INCREMENTAL NATURAL GAS SUPPLY[a]
(Cumulative 1984 to 1991 in tcf)

Price Scenario: Market rebound and rising real prices

Decontrol + Tax Scenario	No WPT	WPTA	WPTB
Base Case Supply Response	49.8	36.9	41.9

[a]Over NGPA base case. Supply comprises changes in final reserves between 1991 1984 plus total production in 1984-1991.

Tables 4 through 10 give the additional cumulative real revenues which result from the higher gas production and prices. The tables also show how this revenue is divided between the private and public sectors.[19] Of particular importance for the federal budget is the net increases in federal receipts. This figure includes: 1) windfall profits tax revenues adjusted for the reductions caused in the corporate income tax (since it is a deductible expense); 2) changes in royalties on federally-owned land; 3) the corporate tax revenues; and 4) individual income taxes on royalties and dividends.

We shall consider two cases in more detail: the current "soft" market continues and the market rebounds with the base case supply response. The windfall profits tax on all gas, assuming a 46 percent marginal corporate income tax rate, raises $5.8 and $13.4 billion, respectively, in present value terms; adjusting for the lost tax revenue from gas not sold and for lower royalties on federally-owned land, the net increase in federal receipts is $5.3 and $11.5 billion, respectively, over receipts from decontrol without windfall profits tax.

By exempting new drilling from the windfall profits tax, our calculations show that the federal government would probably gain more net revenue.[20] This striking result arises from a combination of factors. The federal government already collects substantial corporate income taxes from gas producers as well as royalties and bonuses on federally-owned land and individual income taxes on shareholders and royalty owners. The additional (net) tax revenue on gas produced from new wells after a windfall profits tax is imposed is approximately offset by the reduction in revenues from other sources due to fewer wells being drilled. The current "soft" market continues case shows virtually no difference in revenue or production between the two types of tax; for this case, the price controls under NGPA are not binding in categories where drilling occurs, and there is no decontrol increment to tax in these categories.

Table 4

INCREMENTAL REVENUES AND THEIR DISTRIBUTION
(cumulative 1984 to 1991 in discounted[a]
constant 1984 dollars, billions)

Price Scenario: Current market conditions continue
Supply Response: Base Case

Decontrol + Tax Scenario	No WPT	WPT=A	WPT=B
Total Incremental Revenues	34.7	31.7	31.8
Total Incremental Federal Receipts[b]	14.1	19.4	19.4
Gross Windfall Profits Tax	0.0	10.8	10.8
Net Windfall Profits Tax[c]	0.0	5.9	5.8
Total Incremental State Receipts[d]	4.0	3.0	3.0
Total Incremental Private Receipts[e]	16.7	9.4	9.4
Of which, Extra Cost	5.6	3.4	3.4

[a]Discounted at real rate = 3%

[b]Includes gross WPT, corporate income tax, royalties and bonuses from production on federal land, and personal income taxes on royalties and dividends.

[c]Adjusting for deductibility from corporate income tax.

[d]Includes state severance, property, corporate income, and personal income taxes and royalties and bonuses on state land.

[e]Includes retained earnings, costs, dividends, and private royalties, all net of taxes.

Table 5

INCREMENTAL REVENUES AND THEIR DISTRIBUTION
(cumulative 1984 to 1991 in discounted[a]
constant 1984 dollars, billions)

Price Scenario: Current market conditions continue
Supply Response: 1 1/2 times base case

Decontrol + Tax Scenario	No WPT	WPT=A	WPT=B
Total Incremental Revenues	40.3	35.7	35.8
Total Incremental Federal Receipts[b]	15.2	20.8	20.9
Gross Windfall Profits Tax	0.0	11.6	11.6
Net Windfall Profits Tax[c]	0.0	6.3	6.3
Total Incremental State Receipts[d]	4.5	3.4	3.4
Total Incremental Private Receipts[e]	20.6	11.6	11.7
Of which, Extra Cost	8.7	5.2	5.2

[a]Discounted at real rate = 3%

[b]Includes gross WPT, corporate income tax, royalties and bonuses from production on federal land, and personal income taxes on royalties and dividends.

[c]Adjusting for deductibility from corporate income tax.

[d]Includes state severance, property, corporate income, and personal income taxes and royalties and bonuses on state land.

[e]Includes retained earnings, costs, dividends, and private royalties, all net of taxes.

Table 6

INCREMENTAL REVENUES AND THEIR DISTRIBUTION
(cumulative 1984 to 1991 in discounted[a]
constant 1984 dollars, billions)

Price Scenario: Current market conditions continue
Supply Response: 1/2 times base case

Decontrol + Tax Scenario	No WPT	WPT=A	WPT=B
Total Incremental Revenues	29.4	27.9	28.0
Total Incremental Federal Receipts[b]	12.9	18.0	18.0
Gross Windfall Profits Tax	0.0	10.1	10.1
Net Windfall Profits Tax[c]	0.0	5.4	5.4
Total Incremental State Receipts[d]	3.5	2.7	2.7
Total Incremental Private Receipts[e]	12.9	7.2	7.3
Of which, Extra Cost	2.7	1.6	1.6

[a]Discounted at real rate = 3%

[b]Includes gross WPT, corporate income tax, royalties and bonuses from production on federal land, and personal income taxes on royalties and dividends.

[c]Adjusting for deductibility from corporate income tax.

[d]Includes state severance, property, corporate income, and personal income taxes and royalties and bonuses on state land.

[e]Includes retained earnings, costs, dividends, and private royalties, all net of taxes.

Table 7

INCREMENTAL REVENUES AND THEIR DISTRIBUTION
(cumulative 1984 to 1991 in discounted[a]
constant 1984 dollars, billions)

Price Scenario: Market rebounds
Supply Response: Base case

Decontrol + Tax Scenario	No WPT	WPT=A	WPT=B
Total Incremental Revenues	110.0	96.3	100.7
Total Incremental Federal Receipts[b]	41.3	52.8	53.0
Gross Windfall Profits Tax	0.0	24.8	24.3
Net Windfall Profits Tax[c]	0.0	13.4	13.1
Total Incremental State Receipts[d]	13.1	10.3	10.6
Total Incremental Private Receipts[e]	55.6	33.3	37.1
Of which, Extra Cost	21.9	11.7	14.9

[a]Discounted at real rate = 3%

[b]Includes gross WPT, corporate income tax, royalties and bonuses from production on federal land, and personal income taxes on royalties and dividends.

[c]Adjusting for deductibility from corporate income tax.

[d]Includes state severance, property, corporate income, and personal income taxes and royalties and bonuses on state land.

[e]Includes retained earnings, costs, dividends, and private royalties, all net of taxes.

Table 8

INCREMENTAL REVENUES AND THEIR DISTRIBUTION
(cumulative 1984 to 1991 in discounted[a]
constant 1984 dollars, billions)

Price Scenario: Market rebounds
Supply Response: 1 1/2 times base case

Decontrol + Tax Scenario	No WPT	WPT=A	WPT=B
Total Incremental Revenues	130.1	109.8	115.4
Total Incremental Federal Receipts[b]	45.2	57.1	57.5
Gross Windfall Profits Tax	0.0	27.1	26.6
Net Windfall Profits Tax[c]	0.0	14.6	14.4
Total Incremental State Receipts[d]	15.1	11.5	12.0
Total Incremental Private Receipts[e]	69.8	41.1	46.0
Of which, Extra Cost	33.1	18.1	22.1

[a]Discounted at real rate = 3%

[b]Includes gross WPT, corporate income tax, royalties and bonuses from production on federal land, and personal income taxes on royalties and dividends.

[c]Adjusting for deductibility from corporate income tax.

[d]Includes state severance, property, corporate income, and personal income taxes and royalties and bonuses on state land.

[e]Includes retained earnings, costs, dividends, and private royalties, all net of taxes.

Table 9

INCREMENTAL REVENUES AND THEIR DISTRIBUTION
(cumulative 1984 to 1991 in discounted[a]
constant 1984 dollars, billions)

Price Scenario: Market rebounds
Supply Response: 1 1/2 times base case

Decontrol + Tax Scenario	No WPT	WPT=A	WPT=B
Total Incremental Revenues	90.8	83.4	86.3
Total Incremental Federal Receipts[b]	37.6	48.5	48.6
Gross Windfall Profits Tax	0.0	22.6	22.1
Net Windfall Profits Tax[c]	0.0	12.2	11.9
Total Incremental State Receipts[d]	11.4	9.1	9.4
Total Incremental Private Receipts[e]	41.9	25.7	28.3
Of which, Extra Cost	11.2	5.6	7.8

[a]Discounted at real rate = 3%

[b]Includes gross WPT, corporate income tax, royalties and bonuses from production on federal land, and personal income taxes on royalties and dividends.

[c]Adjusting for deductibility from corporate income tax.

[d]Includes state severance, property, corporate income, and personal income taxes and royalties and bonuses on state land.

[e]Includes retained earnings, costs, dividends, and private royalties, all net of taxes.

Table 10

INCREMENTAL REVENUES AND THEIR DISTRIBUTION
(cumulative 1984 to 1991 in discounted[a]
constant 1984 dollars, billions)

Price Scenario: Market rebounds and real price growth
Supply Response: Base Case

Decontrol + Tax Scenario	No WPT	WPT=A	WPT=B
Total Incremental Revenues	250.9	217.4	229.7
Total Incremental Federal Receipts[b]	77.2	96.7	96.9
Gross Windfall Profits Tax	0.0	43.7	40.9
Net Windfall Profits Tax[c]	0.0	23.6	22.1
Total Incremental State Receipts[d]	27.0	21.1	22.3
Total Incremental Private Receipts[e]	146.7	99.5	110.6
Of which, Extra Cost	85.8	60.4	69.4

[a]Discounted at real rate = 3%

[b]Includes gross WPT, corporate income tax, royalties and bonuses from production on federal land, and personal income taxes on royalties and dividends.

[c]Adjusting for deductibility from corporate income tax.

[d]Includes state severance, property, corporate income, and personal income taxes and royalties and bonuses on state land.

[e]Includes retained earnings, costs, dividends, and private royalties, all net of taxes.

6. Welfare Cost

The efficiency loss associated with a tax is the decline in surplus in the private economy over and above the increase in government revenue. In the case of the proposed windfall profits tax on the decontrol increment, there are two sources of loss: compliance and administrative costs and the loss associated with smaller natural gas supplies.

Since additional gas supplies would substitute for energy imports, part of the welfare cost of the lower production caused by the tax might be reduced national security or greater upward pressure on OPEC prices. For example, a reduction of 6 trillion cubic feet of gas production is equivalent to roughly 1 billion additional barrels of oil imports. However, estimates of the "oil import premium" are fraught with uncertainties regarding the response of OPEC and other oil importers, as well as private stockpilers, and the indirect macroeconomic costs depend on the policy response of governmental authorities. Thus estimates of this premium range from $2.00 to $124.00 per barrel.[21]

Another portion of the total welfare cost is easier to estimate: the cost in lost private surplus and government revenues associated with the loss in gas production itself. The lower royalties, corporate income taxes, severance taxes, individual income taxes, and producer surplus because of the lower production are all part of welfare costs. A caveat is appropriate here. To the extent that production lost because of the tax is not lost forever, but merely postponed, this estimate would overstate the welfare cost.[22] The actual cost would instead be the loss in the present value of the total surplus due to postponement.

If property rights to the natural gas are secure and if producers are risk-neutral profit maximizers, any postponement of production must lower the expected present value of private surplus or the producers would have postponed in the absence of the tax. The degree to which producer surplus is lost depends on the time paths of netback prices and costs or production. If the energy market is in

equilibrium, the real price should be expected to rise, yet the present value of surplus for producers should fall. The change in the present value of government surplus (corporate income taxes, royalties on government land, etc.) depends on both the actual and expected time pattern of tax rates. If the government share is a constant fraction of private surplus, then the loss in government surplus is that factor times the private loss.

Any calculation of the ultimate loss in total surplus on postponed production would depend on numerous arbitrary assumptions. For this reason, especially since the fraction of production merely postponed is unknown, this adjustment -- like the countervailing adjustment due to the externalities associated with increased consumption of imported oil[23] -- shall be ignored in the calculations which follow.

Table 11 gives estimates of the deadweight loss of the two types of windfall taxes under price decontrol -- compared to decontrol without any windfall tax -- discounted back to the present for the different price-production response scenarios. It assumes that the deductible costs of the lost production are equal to the social costs of that production. With the current market price/base case supply assumptions, the discounted welfare cost of the windfall tax is found to be $0.7 billion through 1991.

These figures are not terribly meaningful unless they are compared to the revenue raised; virtually all taxes have some associated deadweight loss. Table 11 also reports, therefore, the deadweight loss as a fraction of the net change in federal receipts. For the current market/base supply response scenario, the welfare cost is 14 percent of the net increase in federal revenues for the comprehensive tax and 12 percent for the tax exempting new drilling.[24] These percentages rise as the price scenarios envision higher prices, and rise and fall with the

alternative assumed supply responses. For example, for the current market/higher supply response case, they are 20 and 17 percent respectively. For the market rebound/base supply response case, they 31 and 20 percent, respectively.

These percentages would be increased, of course, if compliance and administrative costs were included. Considering these costs would also lower the range of the estimates, since low percentage welfare cost estimates are in scenarios with small increases in federal revenues and since compliance and administrative costs are fairly independent of the revenue raised. The percentage costs would also rise if state as well as federal government revenues were included.

The overall level of the deadweight loss per dollar of revenue raised is at lease as large as those for other taxes.[25] All of these percentages were calculated assuming a marginal corporate income tax rate of 46 percent. We also tested the sensitivity of our results to alternative marginal rates. Fullerton and Henderson (1983) have estimated the marginal corporate rate in this sector at 32 percent, as has Auerbach (1984). These estimates account for the differential provisions of the corporate tax on structures and equipment, the deductibility of interest, the investment tax credit, etc. We therefore report the deadweight loss as a fraction of the additional revenue from the windfall profits tax for this tax rate in Table 12. As expected, these losses are smaller than when the 46 percent rate is assumed. The cost of lost production is smaller, since the net revenue raised by the windfall tax is greater, but the estimates are not qualitatively different from those assuming a 46 percent rate: the inefficiency per dollar of revenue raised is still large.[26]

Table 11

EFFICIENCY COSTS OF WINDFALL PROFITS TAX
ON DECONTROLLED NATURAL GAS

Price/Supply Response Scenario	Deadweight Loss ($ billion discounted to 1984)		Deadweight Loss as a percent of incremental Federal Receipts[a]	
	WPTA	WPTB	WPTA	WPTB
Current Market Conditions Continue				
Base case	0.7	0.7	14	12
1 1/2 times base case	1.1	1.0	20	17
One half times base case	0.4	0.3	7	6
Market Rebounds				
Base case	3.5	2.3	31	20
1 1/2 times base case	5.4	3.7	45	30
One half times base case	1.9	1.2	17	10
Market Rebounds + Rising Real Prices				
Base case	8.1	4.8	41	24

[a]Includes receipts from corporate income tax, windfall profits tax, royalties and bonuses from production on federal land and personal income taxes on royalties and dividends.

Table 12

Ratio of Deadweight Loss to Incremental Federal Receipts[a] for different assumed Effective Corporate Tax Rates

Production Response Scenario		WPTA		WPTB	
		Ratio of DWL to Incremental Fed Receipts	Ratio as fraction of ratio assuming 46% corp tax rate	Ratio of DWL to Incremental Fed Receipts	Ratio as fraction of ratio assuming 46% corp tax rate
Assumed effective rate = 32%					
Current Market Continues	Base case	11%	79%	10%	83%
Market Rebounds	Base case	25	81	16	80
Market Rebounds	1 1/2 times base case	36	80	25	83
Market Rebounds	One half times base case	14	82	9	90
Rising Prices	Base case	33	80	20	83

[a]Includes receipts from coporate income tax, windfall profits tax, royalties and bonuses from production on federal land and personal income taxes on royalties and dividends.

8. Conclusion

We have traced through a variety of the complexities of the market for natural gas, current regulatory procedures, and the likely response of natural gas supply to decontrol and taxation. Several important conclusions emerge from our analysis. First, there is substantial evidence that (bracketing the range of published estimates of supply responses) decontrol of natural gas is likely to produce a substantial increment to output and reserves even over as short a period as that through 1991. However, the supply response depends crucially upon what one assumes about the path of natural gas prices. We have argued that these are likely to be tied closely to the path of real oil prices. Our analysis identifies three hypothetical scenarios. Only in the scenario where the soft market continued and supply elasticities were low was the supply response to decontrol modest. In our market rebound and rebound plus rising real price scenarios, substantial additional natural gas supply was forthcoming over the decade.

Second, these supply responses would be substantially mitigated with an excise tax on decontrolled increments; even a 30 percent tax rate on the difference between the market price and the scheduled price under existing legislation would produce a substantial curtailment of the supply response, a large deadweight loss, and a substantial allocative inefficiency per dollar of incremental federal receipts relative to other potential revenue sources.[27]

Third, in general, a large fraction of total incremental revenues under decontrol will be captured by federal and state royalties and bonuses, federal personal income taxes on private royalties, corporate income

taxes, and state severance taxes. An imposition of a windfall profits tax above and beyond these other taxes produces only modest incremental revenue, in part due to its deductibility against corporate income taxes. Any attempt to capture a still larger share of the incremental revenue under decontrol, e.g., with a higher tax rate, would worsen the allocative distortion caused by the tax. The already substantial deadweight losses would increase still further.

Fourth, under the scenario where the allocative inefficiency induced by the tax is smallest -- our so-called current soft market continues scenario -- the net revenues from the imposition of the windfall profits tax is small, amounting to an annual rate of under one billion dollars. This might not even be sufficient to cover the substantial public and private administrative and compliance costs in setting up this new tax.

Fifth, the exemption of new drilling from the windfall profits tax would be a major improvement if such a tax must be adopted. The allocative inefficiency of the tax would be reduced substantially, with no loss and perhaps a gain, to net federal revenues (all taxes plus royalties).

Sixth, not only the supply response but the incremental federal revenues depend substantially on the future course of prices (as they do under the crude oil windfall profits tax). The dilemma facing sensible tax policy in this area is therefore twofold: uncertainty concerning the potential revenue would be quite unfortunate for budget planning purposes and the supply response and price paths most conducive to yielding substantial additional revenues are those which produce large efficiency costs for the economy in terms of reduced natural gas supply. These price paths might well be caused by an oil crisis driving up the real price of oil; thus, whatever external benefit from enhanced gas supply exists would be increased in these cases.

Finally, a variety of the assumptions incorporated in the analysis are central to some of the conclusions. For example, if one believes that substitution of natural gas and oil were quite imperfect over the long-run, the demand for natural gas may be less elastic than we have assumed, and therefore, the supply reduction induced by a tax may be less than we have estimated. In addition, the total incremental revenues may be larger than we anticipate, and in particular, a substantial fraction might be shifted onto consumers, at least in the short-run. Also, estimates of the effective marginal tax rate in any activity, and in particular in our study for natural gas production and exploration, differ widely, and are sometimes far short of the statutory rate. If this is the case, less incremental federal revenue will be raised, and a larger fraction of this will be raised by the windfall profits tax if its deductibility at the margin produces less tax savings because of a lower effective marginal tax rate.

Even with these provisos in mind, our analysis suggests that a tax on the decontrolled increment pursuant to natural gas decontrol and in analogy with the crude oil windfall profits tax, may be a far less efficient means of raising revenues than often supposed based on a cursory -- and inaccurate -- assumption of quite inelastic supply and demand.

FOOTNOTES

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1. These percentages are calculated from data in Energy Information Administration, (EIA), (1984), and U.S. Department of Commerce (1983).
2. See, for example, Congressional Budget Office (1984).
3. To the extent that taxes on natural gas or on energy are thought to be necessary, broad-based excises are likely to be more efficient and much less costly to administer.
4. By exhaustible resource, we mean that there is a fixed, though possibly unknown, quantity of the resource available at a given cost of exploration and extraction with existing technology.
5. See Robinson (1983a) for discussion of some of these theoretical issues.
6. Energy Information Administration (EIA) (1981) p. 69.
7. Ibid., p. 88.
8. Distributors might price discriminate, charging higher prices (over and above any extra costs) to users -- such as residences and small businesses -- with inelastic demands. However profits of utilities are likely to have been maximized already because they have separated the markets, and any further price change would reduce profits. The price of decontrolled gas at the wellhead might rise above the market-clearing price if only a portion of gas is deregulated (as happened with deep gas in 1980 and 1981) since pipelines charge the average acquisition cost plus their mark up. Since contracts are long-term and since the cushion of low price controlled gas is scheduled to diminish rapidly, pipelines will probably not follow such a risky strategy. See Means (1981) for an interesting analysis of price effects upon deregulation.

9. EIA, (1981), p. 95.

10. Ibid., p.89.

11. This process will be speeded by the existence of oil-parity and most-favored nation deregulation clauses. Though only 8 percent of the volume of gas production prior to NGPA contained oil parity deregulation clauses, these prices could rapidly spread to other producers through the favored-nation clause. Ibid., p.75.

12. This fraction would be equal to one minus the effective marginal corporate income tax rate on natural gas times the incremental revenue.

13. McDonald's (1982) analysis assumes natural gas demand is much less elastic than we assume. He therefore predicts price increases and partial shifting to consumers.

14. While the possibility of prices falling below the regulated prices under NGPA are usually dismissed, they are in fact not impossible in the real world. However, we confine ourselves to positive tax rates.

15. The particular decontrol plan analyzed originally was designed to simulate S.1715, the Administration's recent proposal. We assume decontrol as of January 1, 1984 with prices in existing contracts adjusting to the market-clearing level in periods as long as three years. The latter feature reflects the proposed abrogation of contracts; the speed of adjustment in existing contracts is designed to match that mandated under S.1715.

16. Erickson (1982).

17. Ibid., p. 11.

18. See U.S. Department of Energy (1981), ARCO (1983), Shell (1983), OTA (1984) and U.S. Department of Energy (1984).

19. The assumption regarding royalty rates and the fraction of gas production on federally- and state-owned land by categories follows those of Erickson

(1982, Appendix II). We assume an effective marginal corporate income tax rate of 46 percent and that the tax deductible costs of additional gas production is an average of the relevant net back prices to producers under NGPA and decontrol (i.e., this assumes a linear marginal cost curve for additional production).

20. However, exempting new drilling does reduce the revenue which accrues to private royalty owners under all but the rising price scenario.

21. See Broadman (1981).

22. See Robinson (1983b), and the papers in Brannon (1975). A permanent loss in production could occur if marginal properties were abandoned.

23. The lost import premium depends on the fraction postponed as well.

24. Eventually, of course, all old gas will be produced and therefore the deadweight loss from the tax-induced reduction in old gas production will decline towards zero. However, the incremental federal receipts from old gas production also will fall to zero. Consequently, the ratio may not change substantially beyond the time horizon for the production of old gas (say the year 2000).

25. For example, see Shoven and Whalley (1979). The marginal deadweight loss per dollar of additional revenue will be roughly proportional to marginal tax rates, whereas total deadweight loss rises with the tax rate squared. Additional general revenue therefore has a deadweight loss on the order of 20 to 30 percent of incremental revenue.

26. Gravelle (1983) estimates a marginal effective corporate tax rate of 12 percent for the mining sector. Such a low rate would substantially decrease the inefficiency per dollar of revenues raised to about three-fourths of those using the 32 percent rate, and one-half those using the 46 percent rate.

27. The costs of inefficiencies are somewhat smaller, however, when new drilling is exempted from the tax and in scenarios with a low supply response.

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