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A REEXAMINATION OF THE
CRUDE OIL WINDFALL PROFIT TAX

In the April issue of the *Natural Resources Journal,* Professor Stephen L. McDonald[1] reaches two major conclusions regarding the crude oil windfall profit tax:

1. The incidence of the tax falls on operators and landowners (increasingly on the latter with the passage of time).
2. The tax results in reduced domestic output and increased imports of crude oil.

The purpose of this paper is to demonstrate that neither conclusion is justified. The second conclusion results from a misspecification of the problem. This will be demonstrated, and the first conclusion will be taken up subsequent to a proper reformulation of the analysis.

McDONALD'S ANALYSIS

Professor McDonald's second conclusion results from an analysis such as the following:[2] D is domestic demand and S is long-run domestic supply without the tax. P_w is the world price of oil, at which it is assumed that the import supply is perfectly elastic. Conse-

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1. S. McDonald, *The Incidence and Effects of the Crude Oil Windfall Profit Tax,* 21 NAT. RES. J. 332 (1981).
2. This diagram has been simplified from the one appearing on page 337 of McDonald's paper in that price deregulation is omitted. The issue, here, is the effects of the windfall profit tax, so I will assume that domestic prices are already deregulated, and I will only consider the effects of the tax.

quently, domestic consumption is Q_2, domestic production is Q_1, with imports of $Q_2 - Q_1$. The tax (according to McDonald) shifts the long-run supply to S+T,[3] reducing domestic production to Q_1' and increasing imports to $Q_2 - Q_1'$.

However, at first glance, it appears strange that a tax levied on profits, rather than output, would have a non-neutral effect on production decisions. The problem lies in the static formulation of the domestic oil market. The domestic supply curve is implicitly derived from profit maximizing decisions of domestic oil producers. These producers own exhaustible stocks of oil (or are leasing the rights to produce from such stocks). The exhaustible nature of the resource mandates that producing firms optimize an intertemporal profit stream from their operations. If the windfall profit tax reduces current production, then future production (and, consequently, future windfall tax payments) will increase. Whether or not this reaction (reduced current production) will increase the present value of
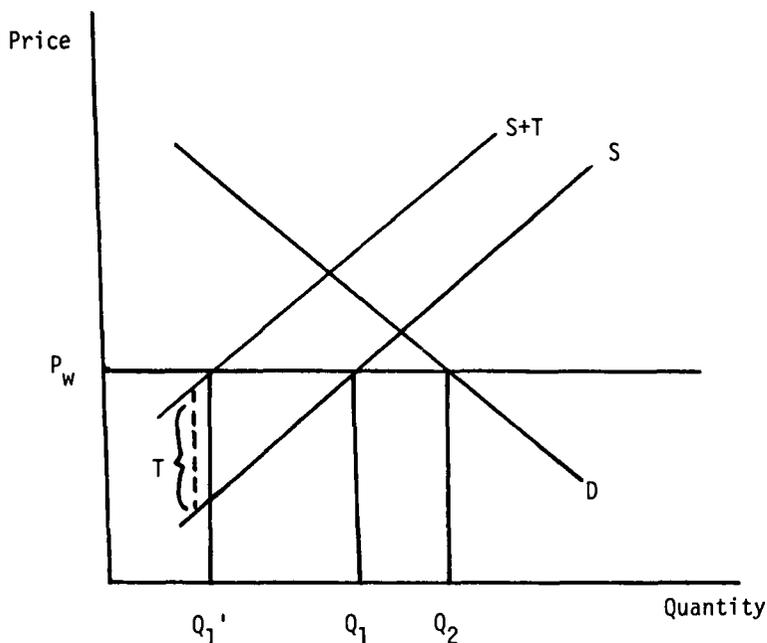

FIGURE 1

Price and Output in the United States with the Windfall Profit Tax

3. McDonald assumes that the tax rate is uniform for all oil within a given tier.

profits can only be ascertained by formulating the intertemporal profit maximization problem for domestic oil producers.

A REFORMULATION

For the sake of simplicity, I will make the following assumptions:[4]

1. There are two time periods, denoted by subscripts. This is done to keep the analysis simple. The results are readily generalizable to any finite number of time periods.
2. World prices, p_1 and p_2, are assumed to be given uniform prices for imported oil, and are beyond the control of domestic oil producers. Further, the imposition of the windfall profits tax does not affect these world prices.
3. $C(X_i)$, i=1,2 is the time invariant extraction cost function for domestic producers, where X_i is the quantity extracted in period i.
4. $\beta = \frac{1}{1+r}$ is the discount factor, where r is the real discount rate. Since I am using the real rather than the nominal discount rate, assume that all prices are expressed in real magnitudes.
5. q_i, i=1,2 is the base price for establishing the windfall profit tax. Since the base price is to be adjusted for inflation,[5] $q_1 = q_2$. This is only true for tier one and tier two oil, as tier three oil is to be adjusted for inflation plus two percent.[6] More on tier three oil later.
6. t is the windfall profit tax rate which is constant with regards to quantity produced, but varies across the three tiers and type of oil producer.[7]

Consider a domestic oil producer possessing an oil stock of Z barrels of oil. This oil is to be allocated between production in period one, X_1, and production in period two, X_2. Assume that it will be profitable to produce the entire stock of oil within the two time periods, so that $X_1 + X_2 = Z$.[8] The intertemporal profit maximization problem for a representative producer is given by:

$$\max_{X_1, X_2} \left\{ \pi_1(X_1) + \beta \pi_2(X_2) \right\} \text{ subject to } X_1 + X_2 = Z$$

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4. These assumptions follow McDonald as closely as possible, with the exception that his static problem is transformed into a two-tiered problem, in order to capture the exhaustible nature of the resource.

5. McDonald, *supra* note 1, at 331-332.

6. *Id.* at 332.

7. *Id.* at 331-332.

8. Also, assume that the property rights allow for unextracted period one oil $(Z-X_1)$ to be extracted in period two by the domestic producer. That is, no common property problems exist for the producer. If the oil stock is not exclusively owned, then there is no assurance that oil not extracted by one producer will not be extracted by another producer. In such a case, the static analysis of McDonald may be more appropriate.

where π_i is the ith period profit function. Specifically,

$$\pi_1(X_1) = p_1 X_1 - C(X_1) - t(p_1 - q) X_1$$

and

$$\pi_2(X_2) = p_2(Z - X_1) - C(Z - X_1) - t(p_2 - q)(Z - X_1).$$

The first and second terms in each profit function denote the total revenue and total extraction cost, respectively. The last terms represent the windfall profit tax payments, which are the product of the appropriate tax rate, the production level, and the difference between the world price and the base price.

The first order condition[9] for this intertemporal problem is given by:

$$(1) \quad p_1 - C'(X_1) - t(p_1 - q) = \beta [p_2 - C'(Z - X_1) - t(p_2 - q)]$$

This is the usual marginal revenue equals marginal cost condition.[10]

If there were no windfall profit tax, then the problem would be simplified by omission of the tax terms, and profit maximization would be given by X_1^* from the following:

$$(2) \quad p_1 - C'(X_1^*) = \beta [p_2 - C'(Z - X_1^*)]$$

i.e. $\pi_1'(X_1) = \beta \pi_2'(Z - X_1)$, as indicated in Figure 2. Comparison of (1) and (2) will establish the production effect of the windfall profit tax. To do this, transform (1) to

$$(3) \quad p_1 - C'(X_1) = \beta [p_2 - C'(Z - X_1)] + Q$$

where $Q = t(p_1 - q) - \beta t(p_2 - q) = t(p_1 - p_2) - tq(1 - \beta)$. The sign of Q will establish the bias that results from imposition of the windfall profit tax.

THE EFFECT OF THE TAX

Note that domestic production will be unaffected by the tax if and only if $Q = 0$, i.e.

$$p_1 - \beta p_2 = q(1 - \beta)$$

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9. Assume the second order condition is satisfied, i.e.
   $$-C''(X_1) - C''(Z - X_1) < 0$$
A monotonically increasing marginal extraction cost function will ensure this.
   10. This can be seen by rewriting (1) as
   $$p_1 = C'(x_1) + t(p_1 - q) + \beta [p_2 - C'(Z - X_1) - t(p_2 - q)]$$
The left hand side is first period marginal revenue, while the right hand side consists of three marginal cost terms:
   (i) marginal extraction costs
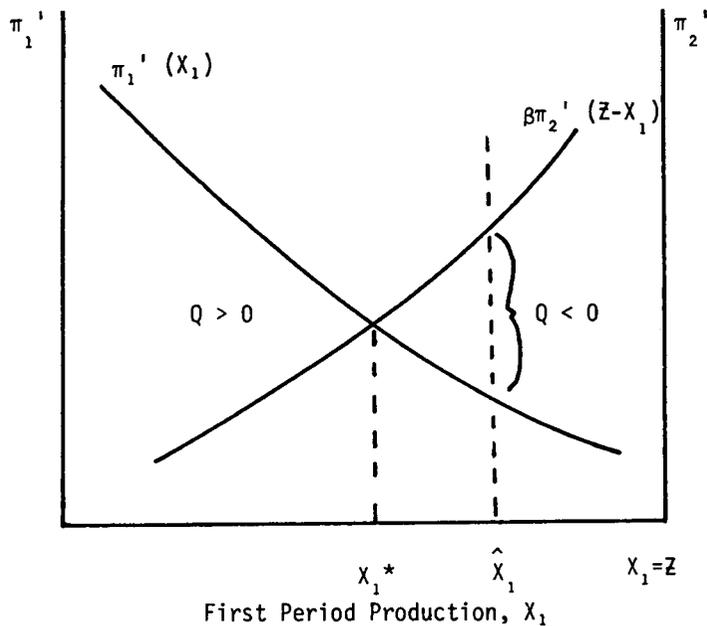   (ii) marginal windfall profit taxes
   (iii) marginal users' cost

FIGURE 2

Optimal Production for a Domestic Oil Producer

This would only be satisfied accidently, as world prices are assumed to be set by OPEC and the base price is independently set by the United States government. Of course, the base price could intentionally be set at a level satisfying this condition, in which case the tax will be allocatively neutral.

More generally, two cases can be distinguished:

Case I: World prices satisfy the inequality.

$$p_1 < \beta p_2$$

Then, $Q < 0$, and, as seen in Figure 2, initial extraction with the tax ($\hat{X}_1$) will increase relative to the no-tax optimal extraction level (X_1^*). An example of conditions under which this inequality will hold, is where OPEC prices are set at competitive levels (or alternatively, where OPEC is not an effective cartel, as suggested by some economists[11]) and extraction costs are increasing over time.[12]

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11. For example, Walter J. Mead made this claim in "A Reexamination of Oil Pricing," delivered at the *Eighth International Conference on Long-Term Energy Strategy and Global Economic Cooperation,* August 27, 1981 at the University of Colorado, Boulder.

12. *See, for example,* P. S. Dasgupta and G. M. Heal, ECONOMIC THEORY AND EXHAUSTIBLE RESOURCES (1979), especially Chapter 6.

Case II: World prices satisfy the inequality

$$p_1 > \beta p_2$$

Then the sign of Q cannot be determined a priori. Conditions under which this inequality would hold include:[13]

(i) World prices are set competitively with decreasing extraction costs over time,

(ii) OPEC acts as a profit maximizing monopoly facing increasing demand elasticity over time and constant marginal extraction costs.

Evidently, the impact of the windfall profit tax upon domestic production (and on imports) cannot be ascertained from a static analysis. In general, the result will depend upon how rapidly world oil prices are rising. If world prices rise at a rate greater than the rate of interest (Case I), then domestic production will *increase!* If world prices rise at a slower rate than the rate of interest (Case II), domestic production can either increase or decrease as a result of the imposition of the tax. The intuitive explanation is that the tax is geared to the difference between the world and base prices. If world prices raise rapidly, the windfall tax will rise rapidly and present production will be favored over future production. An important result is that proper setting of the base price (so that Q=0) can leave domestic production unaffected. The oil windfall profit tax need not distort production decisions at all and if a distortion occurs, it can be either increased or decreased extraction, depending upon the behavior of OPEC prices. recent evidence on OPEC prices is not sufficient to develop a convincing argument in favor of Case I or II.

INCIDENCE

If domestic extraction is not affected by the tax, there will be no excess tax burden, although there will be a redistribution from domestic producers to the United States Treasury. Since world prices are assumed invariant with respect to the imposition of the tax, consumers will not share in any tax burden that would result from distorted domestic production. If domestic production is affected (regardless of whether it increases or decreases relative to the no-tax situation), domestic producers and landowners will share the tax burden. The analysis of incidence must also take place in an intertemporal framework.

If production is affected, profits will be reduced (since they are

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13. *Id.* at ch. 6 and 11.

maximized without the tax, according to (2)), so that producers will share the tax burden. Eventually, if the markets for leases and oil producing properties are perfectly competitive, and in long-run equilibrium, the landowners will bear the loss in the form of lower lease payments and property values. It is to be expected that the United States Treasury will bear a large part of this, as the largest domestic landowner for oil producing purposes.[14]

OTHER CONSIDERATIONS

There are two special circumstances concerning the windfall profit tax worth noting. First, for tier three oil, the base price is adjusted for inflation *plus two percent,* so that in real terms, $q_1 < q_2$. The Q will be of the form

$$t(p_1 - \beta p_2) - t(q_1 - \beta q_2)$$

Since $q_1 < q_2$, $q_1 - \beta q_2 < q_1(1-\beta)$ so that Q will be greater than for oil from tiers one and two. This increases the tendency for tier three production to be reduced due to imposition of the windfall profit tax.

The other condition involves the effective life of the tax. As noted by McDonald,[15] the tax was intended to be terminated after 10-14 years. This exerts a force leading to decrease current extraction. This can be seen in Figure 2 as an increase in the future marginal profit function, $\pi_2'(Z-X_1)$. But, this termination is not assured, and due to discounting, is reduced in magnitude. And, neither of the considerations alter the conclusion that the windfall profit tax can either stimulate or retard domestic extraction, depending on the time path of prices, the discount rate, and the base price level of the tax.

DALE E. LEHMAN
Assistant Professor of Economics
University of Colorado, Boulder

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14. For example, according to "USGS Releases Revised U.S. Oil and Gas Resource Estimates," U.S. Department of Interior, March 26, 1974 (press release), onshore U.S. reserves of oil were estimated to be between 63 and 80 billion barrels, while offshore reserves were put at 11-14 billion barrels. For undiscovered recoverable resources, the onshore and offshore ranges are 135-270 and 65-130, respectively. Of the 135-270 billion barrels onshore, 25-50 were in Alaska. Alaskan and offshore oil are predominantly owned by the U.S. government, as well as a good part of the remaining onshore oil.

15. McDonald, *supra* note 1, at 337.

ⁿ   THE INCIDENCE AND EFFECTS OF THE
CRUDE OIL WINDFALL PROFIT TAX: A REPLY TO LEHMAN

In my recent article, "The Incidence and Effects of the Crude Oil Windfall Profit Tax,"[1] I concluded that the incidence is on operators and land-owners, with the burden on the latter increasing with time, and that the principal effect is to reduce domestic output and increase imports. I used a comparative static analysis in which the demand for domestic crude is perfectly elastic at the world price and the short- and long-run marginal cost functions are shifted up by the tax (which is an excise tax, not a true profits tax).

Professor Lehman challenges both of my conclusions, principally the one that domestic output is reduced by the tax. In regard to this point, he uses the familiar theory of the optimum time-distribution of production from a fixed stock, showing that "the windfall profit tax can either stimulate or retard domestic extraction, depending on the time path of prices, the discount rate, and the base price level of the tax."

Unfortunately for his thesis (and for the welfare of the domestic oil industry) Lehman's method of analysis is irrelevant to the industry's actual condition and response to a new tax. As a practical matter under the existing regulatory regime, the industry cannot respond to a tax by altering the time-distribution of extraction except as the latter may be affected by the abandonment decision. To respond as Lehman supposes, the industry would have to be characterized by (1) unitized reservoirs and (2) freedom from what goes as conservation regulation. In the absence of unitization the individual operator has no choice but to produce at capacity (to avoid adverse drainage) or at the regulated rate, regardless of the profit that might be gained by altering the time-distribution of extraction. Without freedom from production restrictions, even unitized operators cannot rationally respond to a profit inducement.

I am particularly sensitive to this point because for twenty years I have been arguing that state and federal regulators *should*, in the interest of economic efficiency, require all reservoirs to be unitized and allow operators complete freedom as to well density and production rate.[2] The unhappy fact remains that these regulatory conditions still do not obtain in any jurisdiction. In the old "market-demand" states, well spacing and production rates are still constrained by depth-acreage allowable schedules. In most other states, and in the federal

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1. 21 NAT. RES. J. 332 (1981).
2. Most extensively in STEPHEN L. MCDONALD, PETROLEUM CONSERVATION IN THE UNITED STATES: AN ECONOMIC ANALYSIS (1971).

jurisdiction, production is constrained by the concept of MER (maximum efficient rate). Everywhere conservation is equated with preventing "physical waste;" nowhere are operators permitted to alter production rates because it is profitable to do so.

It is with real regret, then, that I conclude that Lehman's analysis, however attractive as pure theory, is not appropriate to answering the question whether domestic production would be increased or decreased by the windfall profit tax. My analysis concentrates on shifts at the margin, where operators do have freedom (to abandon or not to explore), and is therefore appropriate. My conclusion stands that the tax contracts the intensive and extensive margins of domestic production.

On incidence, despite Lehman's opening statement that my conclusion is not justified, we appear to have no real difference. Changes in the time-distribution of extraction from pre-existing reservoirs do not alter the fact that, with the world price fixed, lease bonuses sunk, and royalty rates specified by contract, the short-run burden of the tax falls on operators and royalty owners in proportion to their shares in input. As for long-run incidence, Lehman must admit that even within his framework the tax reduces the prospective profitability of potential oil lands. Therefore, in his own words, "Eventually, if the markets for leases and oil producing properties are perfectly competitive, and in long-run equilibrium, the landowners will bear the loss in the form of lower lease payments and property values." That is exactly my conclusion.

STEPHEN L. McDONALD
Professor of Economics
The University of Texas at Austin