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Fine Tuning the Net Profit Share Leasing System for Offshore Petroleum Resources

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Abstract

The Department of Energy recently adopted a net profit sharing system for leasing development rights to offshore petroleum resources. Proponents of the system claim that it will foster greater competition for offshore leases, and encourage development of small and marginal offshore petroleum deposits. This paper examines several difficulties inherent in the net profit sharing system which reduce the probability that these objectives will be achieved.

FINE TUNING THE NET PROFIT SHARE LEASING SYSTEM FOR OFFSHORE PETROLEUM RESOURCES

1. Introduction

The Department of Energy recently adopted an innovative system for leasing development rights to offshore petroleum resources. The system is based on the concept of net profit sharing (NPS), and is currently being used on an experimental basis in all federal sales of offshore petroleum tracts. Proponents of the NPS system claim that it will foster greater competition in offshore lease sales by reducing the financial burden of front-end payments that arise under the traditional cash bonus bidding system. Proponents also claim that the NPS system will encourage development of small and marginal offshore petroleum deposits.

This paper examines several difficulties inherent in the NPS leasing system which reduce the probability that its objectives can be achieved. The impact of the NPS system depends on the values assigned to two critical policy parameters: the profit sharing rate and the capital recovery factor. As we show below, the desired effect of the NPS system can easily be reversed if policymakers are not careful in selecting compatible values for these two parameters. Moreover, parameter values that are appropriate for one tract may be inappropriate for other tracts. Thus, a considerable amount of fine tuning and adjustment is required to match the parameters of the NPS leasing system to characteristics of individual tracts offered for sale. Below we discuss the type and extent of fine tuning that is required, and describe difficulties inherent in administering such a system.

The remainder of the paper is organized as follows. The historical development of offshore leasing policy in the U.S. leading to adoption of the NPS system is reviewed briefly in Section 2. The general structure and specific objectives of the NPS system are described in Section 3. In Section 4 we develop a simplified, heuristic model of the impact of the NPS system on offshore petroleum leases. The implications of our analysis for public policy are summarized in the concluding Section 5.

2. Historical Background

Since 1954 the federal government has relied on simple sealed-bid auctions to award exploration and development rights on offshore petroleum tracts. Under the traditional cash bonus bidding system, each tract is awarded to the highest bidder in exchange for the stated amount of the bid (i.e., the cash bonus) and a royalty override on subsequent production, typically one-sixth of gross revenues. The bonus bid is a simple mechanism for capturing mineral rents that accrue on individual offshore tracts. In many instances prospective rents have been quite large, and recently the magnitude of winning bids for individual tracts has frequently exceeded $100 million.

The size of initial cash outlays required to enter the market for offshore petroleum leases has led some observers to believe that participation by small firms has been restricted, and that the degree of competition for tracts would increase under alternative auction procedures that reduce the magnitude of winning bids.[1] In response to this concern, Congress stipulated in the Outer Continental Shelf Lands Act Amendments of 1978 that, subsequent to the Act, at least 20% of all

offshore tracts be offered under alternative bidding procedures that rely less heavily on front-end cash bonus payments.

Following Congress's mandate, the Department of Energy recently implemented several new leasing systems. Of these, the NPS system represents the most radical departure from earlier procedures. The NPS system was adopted amid much controversy and strong reservations have been expressed regarding its structure and method of implementation.[2] It is still too early to judge from actual experience whether the NPS system has been successful in achieving its stated objectives. However, it is possible to identify and examine several aspects of the system that would appear, a priori, to jeopardize its performance.

3. Structure and Objectives of the NPS System

The NPS system eliminates the traditional government royalty interest in offshore oil and gas fields and puts in its place a system of payments based on a fixed percentage of the net income earned by offshore operators. This percentage is called the profit sharing rate. Certain deductions from gross revenues are permitted before arriving at net income subject to profit sharing, the two principal deductions being based on the levels of operating and investment expenditures.

The treatment of operating expenditures is straightforward; they are deducted from gross production revenues on a current basis as incurred. Deductions based on investment expenditures are somewhat more complicated. Investment expenditures incurred before production begins are depreciated and written off, as usual, against the firm's income for purposes of computing corporate income tax liability. In addition,

however, these capital expenditures are accumulated in a special capital account. Once production begins, the operator is permitted to write off the outstanding balance in the special capital account against current income to arrive at net income subject to profit sharing. That is, exploration and development expenditures can be recovered in their entirety by the operator before any profit sharing payments are due.

The operator is not directly permitted to recover accrued interest on the outstanding balance in the special capital account, even though several years may separate the time of investment expenditures and subsequent production. In lieu of interest, the government permits some return to invested capital through a device called the capital recovery factor. If the capital recovery factor is specified to be 2.0, for example, the operator may deduct from gross revenues twice the amount of the outstanding balance in the special capital account to arrive at income subject to profit sharing.

NPS deductions from the special capital account are different than, but taken in addition to, the usual depreciation deductions allowed by the corporate income tax code. For purposes of computing corporate income tax liabilities, investment expenditures are depreciated and deducted from current income. Current income may be generated either by production from the field in question or by other activities of the company. For the purpose of computing profit sharing liabilities, investment expenditures may be deducted only against income generated by the field in question (this entails a delay since production does not start immediately), and once production begins the investment expenditures may be deducted as rapidly as revenues permit, rather than being depreciated over a specified number of years.

Offshore leases awarded under the NPS system are still awarded on the basis of a sealed-bid auction. The applicable profit sharing rate and capital recovery factor are specified by the government for each tract prior to the auction. Companies then bid for the tracts in the customary fashion, except that profit sharing payments will take the place of royalty payments once production commences.

The objective of the NPS system is twofold. First, by appropriate manipulation of the profit sharing rate and capital recovery factor, the government may be able to capture a greater share of available mineral rents in the form of production-related payments (rather than in the form of bonus payments) than is possible under a straight production royalty scheme. This seems sensible since the royalty is essentially a flat excise tax that is not based on profits. If the NPS system is successfully structured to capture a larger share of the rents in the form of production-related payments, then it follows that the net present value of each tract (as reckoned by the companies) will decline, as will the magnitude of tendered bids.[3] Thus, the NPS system is intended to be a device for indirectly reducing capital barriers to entry in the market for offshore tracts. Second, by eliminating royalties, it is hoped that development and production decisions will not be distorted by the "artificial" royalty component of marginal cost that in the past may have discouraged production of marginal resources. This would have the effect of increasing the magnitude of total mineral rents captured by society.[4]

These objectives were summarized by the government in the statement promulgating the NPS leasing system:[5]

> Congress's perception was that large cash bonus payments may inhibit competition for OCS leases by preventing smaller independent firms from participating in OCS development. By design, use of a net profit share system places greater emphasis on contingency payments for generating fair returns to the government, and thereby less reliance on the initial cash bonus. Reduction of cash bonus bids constitutes a primary effect intended under the proposal. The proposal was also intended to result in increased production of oil and gas from the OCS, foster development of marginal oil and gas fields, increase effective competition for OCS leases, and free more funds for exploration in addition to increasing total revenues to the public.

As we show in the next section, the NPS system may or may not have the intended effects. The system will succeed in reducing the level of bonus bids only if the net present value of NPS payments is greater than the net present value of royalties that have been eliminated. The NPS system will foster the development of marginal fields only if the chosen capital recovery factor properly compensates the operator for the cost of invested capital. Whether the fiscal parameters of the NPS system can be properly manipulated to achieve both objectives simultaneously seems very much in doubt. The difficulties inherent in this task are discussed further in the next section.

4. A Heuristic Model of the NPS Leasing System

The economic effects of the NPS system can be analyzed using a simplified two-period model of an offshore petroleum lease. Although reliance on a two-period analysis blurs many of the subtler points related to offshore petroleum development, it has the advantage of clarifying the influence of alternative tax and leasing policies. Consequently, the central features of optimal policy design are brought to

the fore. The basic features of our simplified model are described below.

We assume all exploration and development expenditures are incurred in the first period of the lease's life. All production takes place in the second period. After the second period, production is terminated and the lease is abandoned. We use the following notation to describe the characteristics of the lease:

I = exploration and development expenditures ($)

P = wellhead price of petroleum ($/barrel)

Q = production volume (barrels)

C = production cost ($/barrel)

i = discount rate (%)

r = production royalty rate (%)

t = marginal corporate income tax rate (%)

x = profit sharing rate (%)

f = capital recovery factor

Using this notation, we can characterize the after-tax net present value of a given lease offered either under the cash bonus bidding system or the NPS system. The net present value of the lease offered under the cash bonus bidding system (i.e., a conventional "royalty lease") is given by NPV_1:

$$(1) \qquad NPV_1 = (1-t)\cdot\left[\frac{(1-r)PQ-CO}{1+i} - I\right].$$

This value is the sum of the following terms. In the first period the company experiences net exploration and development expenses equal to

$-(1-t)I$.[6] In the second period the operator receives net income from production in the amount $(1-r)PQ-CQ$, and incurs a tax liability of $-t[(1-r)PQ-CQ]$.

The net present value of a lease offered under the NPS system (i.e., a "profit sharing lease") is given by NPV_2:

$$(2) \qquad NPV_2 = (1-t)\cdot[(PQ-CQ) \cdot \frac{(1-x)}{(1+i)} - I\cdot(1 - \frac{xf}{1+i})].$$

This value is the sum of the following terms. In the first period the operator incurs the same net development expenses as before, equal to $-(1-t)I$. In the second period the operator receives higher net income from production (due to elimination of the royalty) in the amount $PQ-CQ$; but also incurs a net profit sharing liability in the amount $-x(PQ-CQ-fI)$.[7] In addition, the operator incurs a second period tax liability in the amount $-t[PQ-CQ-x(PQ-CQ-fI)]$.

Because the entire history of an actual lease is condensed into just two periods in our simplified model, some care must be taken in interpreting certain of the parameters that appear in Equations (1) and (2). Specifically, the investment cost (I) should be interpreted as the net present value of a stream of investment expenditures that usually extend over four or five years. Similarly, the total production volume (Q) is typically distributed over a large number of years, commencing at the time that development expenditures have been completed. Therefore, the term Q should be thought of as the "present barrel equivalent" of future production flows, in the manner described by Adelman.[8] The discount factor $(1+i)$ that links the two periods of our model represents the annual discount rate compounded

over the period until production commences (typically four or five years).

The difference in net present values of the two leases is found by subtracting (2) from (1):

$$(3) \qquad NPV_1 - NPV_2 = -\frac{(1-t)}{(1+i)} \cdot [rPQ - x(PQ-CQ) + xfI].$$

Equation 3 permits a direct comparison of the value of the lease offered under the alternative leasing systems:[9]

$$(4) \qquad NPV_1 \gtrless NPV_2 \quad \text{if and only if} \quad x(P-C-fI/Q) \gtrless rP.$$

Objective 1: Reducing Lease Values

Condition (4) implies that the NPS system will succeed in reducing the value of the lease if and only if net profit sharing receipts exceed the amount of royalties foregone. It should be clear that for a given capital recovery factor (f) the value of the two leases will be equal if and only if an appropriate profit sharing rate (x) is chosen. The unique rate of profit sharing that equilibrates the values of the two leases can be determined by solving the equality version of (4) explicitly for x:

$$(5) \qquad x(f) = \frac{rP}{P-C-fI/Q}.$$

If the NPS system is to succeed in lowering the net present value of offshore leases, then a profit sharing rate in excess of the value in Equation (5) must be adopted. Of course, the range of acceptable profit sharing rates depends on the stipulated capital recovery factor; the two parameters cannot be set independently.

It is also true that for given values of the profit sharing rate and capital recovery factor, there is a unique development cost that equilibrates the net present values of the two leases. The equilibrating unit capital cost (I/Q) is determined by solving the equality version of (4) explicitly for I/Q (hereafter, I/Q will be denoted by "k"):

$$(6) \qquad k(x,f) = \frac{1}{f} \cdot [P(1-r/x) - C].$$

If the unit development cost for a given tract exceeds k(x,f), then the NPV of the profit sharing lease will exceed that of the royalty lease, in contradiction to the stated objective of the NPS program. The implication is that if the two NPS parameters (x and f) are set uniformly over all tracts, then the first objective of the NPS system (i.e., lowering tract values) may be achieved on low-cost tracts, but probably not on high cost tracts.

We illustrate these results by plotting the locus of net-present-value-equilibrating pairs (x,f) for several hypothetical offshore tracts (see Figure 1). Arbitrarily setting the wellhead price (P) equal to $1 per barrel (this is a numeraire to which the results are invariant) and production cost equal to $0.05 per barrel, we focus on three tracts that vary widely in terms of unit development costs. We have arbitrarily chosen the cases: k = $0.15, $0.30, and $0.45 per barrel. The results in Figure 1 also reflect the assumption that the royalty rate applicable to the royalty lease is 1/6, which corresponds to historical practice.

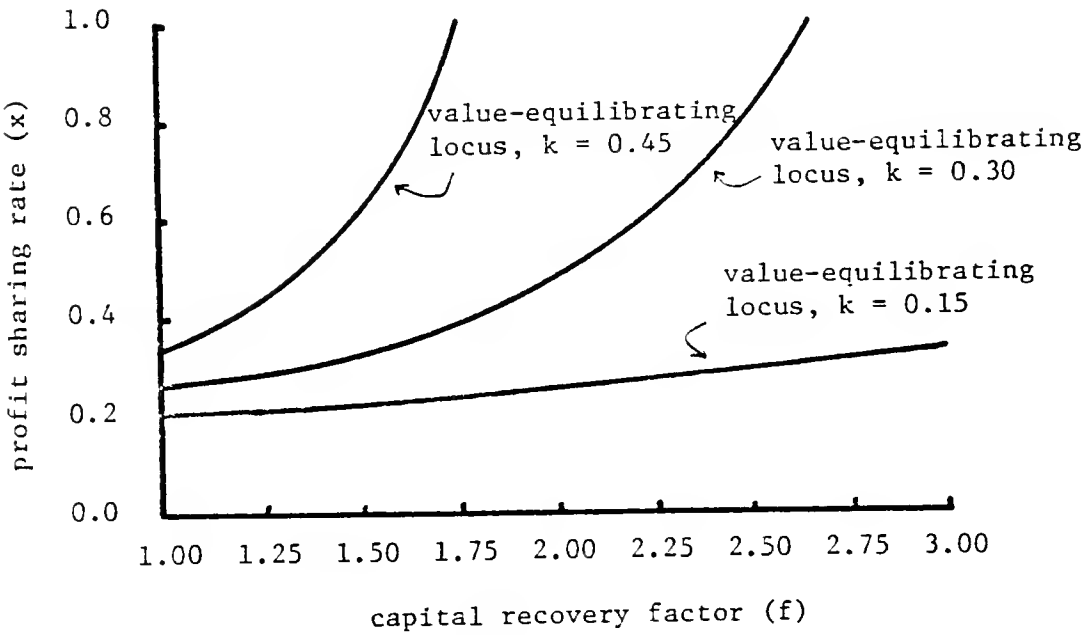
Figure 1 can be interpreted in the following way: points lying to the northwest of any particular locus represent all possible combinations

FIGURE 1

EFFECT OF NPS FISCAL PARAMETERS

ON THE VALUE OF OFFSHORE TRACTS

Points (x,f) lying northwest (southeast) of a given locus reduce (increase) the value of the associated NPS lease, relative to the value of a comparable royalty lease.



Note: Calculations are based on the following values. P = 1.00; C = 0.05; r = 1/6.

of profit sharing rates and capital recovery factors that will succeed in reducing the value of the specified NPS lease below the value of a corresponding royalty lease. For example, if the capital recovery factor is set at 1.5, then on a low-cost tract (i.e., k = 0.15) the profit sharing rate must be at least 23% to ensure a reduction in the net present value of the tract. The profit sharing rate on a high-cost lease (i.e., k = 0.45) must be at least 60% if the NPS system is to achieve its first objective. These results are invariant to the firm's discount rate and marginal income tax rate.

Objective 2: Fostering Development of Marginal Fields

The before-tax net present value (NPV_0) of a given tract is given by:

$$(7) \qquad NPV_0 = \frac{PQ-CQ}{1+i} - I.$$

The after-tax net present value of the same tract can then, by rearranging terms in Equation (2), be written as:

$$(8) \qquad NPV_2 = (1-t) \cdot [NPV_0 - x \cdot \frac{(PQ-CQ-fI)}{1+i}].$$

By definition, all marginal tracts obey the property: $NPV_0 = 0$.[10] That is:

$$(9) \qquad k = \frac{P-C}{1+i} .$$

Upon inspection of Equation (8), we see that the NPS system will be neutral regarding development of marginal fields (i.e., $NPV_2 = 0$ if and only if $NPV_0 = 0$) if and only if:

$$P-C-fk \leq 0 \qquad \text{whenever} \qquad k = (P-C)/(1+i).$$

The neutrality condition can be expressed equivalently as:

$$P-C-[f(P-C)/(1+i)] \leq 0,$$

which implies that the capital recovery factor must be set to satisfy:

$$(10) \qquad f \geq 1+i.$$

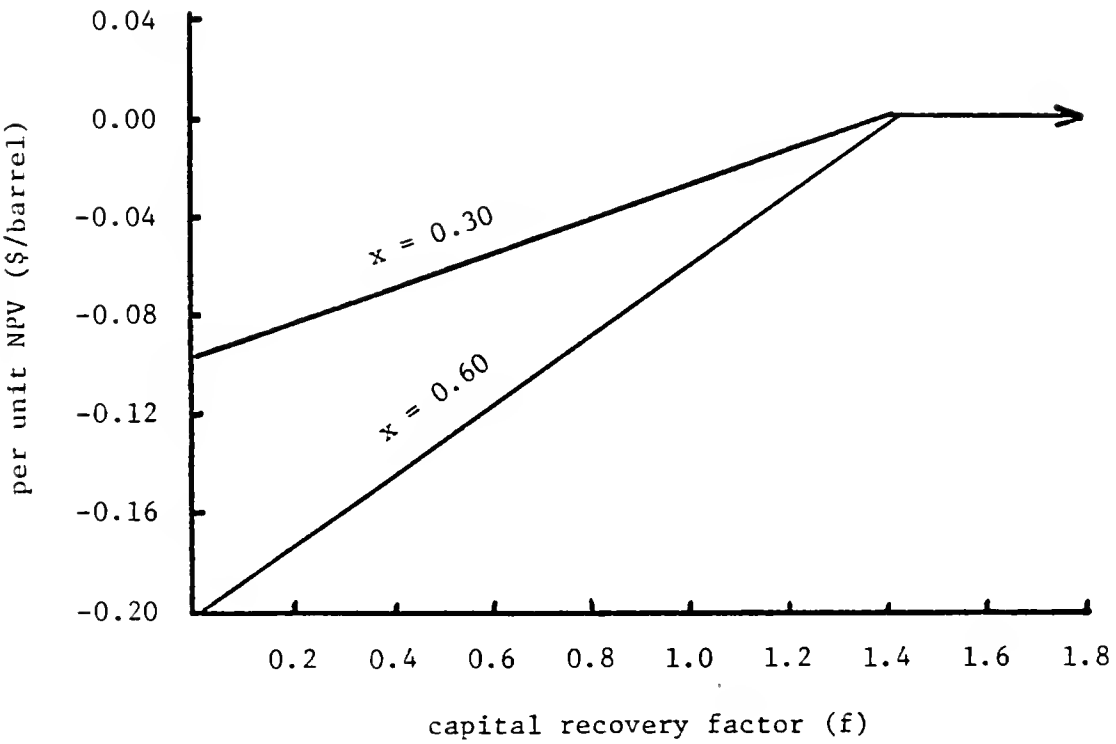
This result accords with simple intuition. It says that the capital recovery factor must at least equal the operator's discount factor. If it does not, the NPS system does not permit the operator to recover his full cost of invested capital, and the after-tax net present value of a marginal field will be negative.[11]

The effect of alternative capital recovery factors on the after-tax net present value of a marginal field is illustrated in Figure 2, for selected values of the discount rate and net profit sharing rate. We report results based on the assumption that i = 45%. Recall that an interval of four to five years typically separates production from exploration and development expenditures. An annual discount rate of 8% compounded for five years yields a discount rate of approximately 45%, so this is probably a realistic rate to consider. As shown in Figure 2, the after-tax net present value of a marginal tract decreases linearly (from a starting point of zero) as the capital recovery factor is reduced below the operator's discount factor. Because the NPS system does not subsidize losses (i.e., payments flow only from the producer to the government), the NPS system will not encourage the development of submarginal fields, nor increase the value of marginal fields. However, if applied carelessly, the NPS system can easily discourage development of marginal or nearly marginal fields.

FIGURE 2:

NPV OF A MARGINAL FIELD, AS A FUNCTION OF "f"

FOR GIVEN VALUES OF x.



Note: Calculations are based on the following values.
P = 1.00; C = 0.05; i = 0.45; k = (P-C)/(1+i).

Achieving Both Objectives Simultaneously

We have so far identified certain constraints on fiscal parameters of the NPS system that must be satisfied if this new leasing program is to succeed in lowering tract values. We have identified a separate constraint that must be satisfied if the NPS system is to avoid discouraging development of marginal fields. In this section we juxtapose both constraints to identify the range of NPS fiscal parameters that will succeed in meeting both objectives simultaneously.

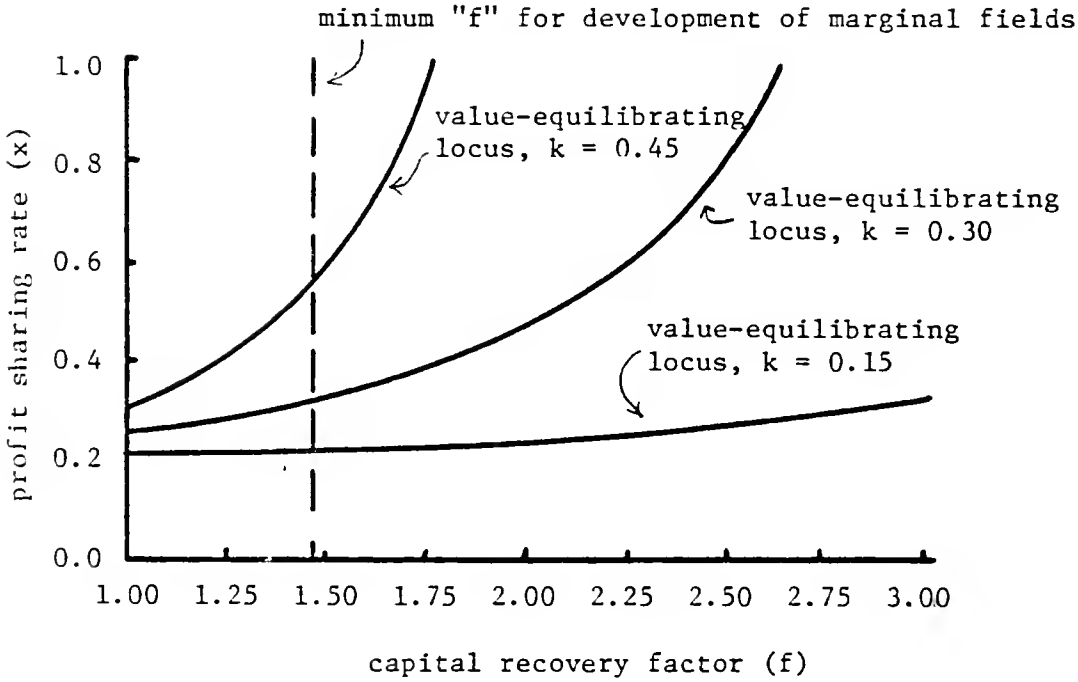
Figure 3 presents illustrative results based on the three hypothetical tracts considered earlier (i.e., low, medium, and high development cost). The set of NPS parameters (f,x) that satisfy the first objective, for a given tract, is as before indicated by the set of points lying northwest of the corresponding value-equilibrating locus. The set of NPS parameters that satisfy the second objective is indicated by the set of points lying to the right of the vertical line. The size and location of the intersection of these two sets will vary considerably, depending on the magnitude of development and operating costs and the length of the pre-production delay. Regarding the high-development-cost tract ($k = .45$) depicted in Figure 3, the range of acceptable NPS parameters is quite restricted; the profit sharing rate must be at least 60%, while the capital recovery factor can vary only between 1.45 and (at most) 1.75. The acceptable region would shrink even further if the magnitude of operating costs were increased ($C > .05$), or if the development period were extended ($i > .45$). In fact, if the development period were eight years (which implies $i = .85$) it is impossible to find any pair of NPS parameters (x,f) that accomplishes

FIGURE 3:

VALUES OF THE NPS FISCAL PARAMETERS THAT

ACHIEVE BOTH POLICY OBJECTIVES

Points (x,f) lying northwest (southeast) of a given locus reduce (increase) the value of the associated offshore tract, relative to the value of a comparable royalty tract. Points (x,f) lying west of the vertical line discourage development of marginal tracts.



Note: Calculations are based on the following values.
P = 1.00; C = 0.05; i = 0.45; r = 1/6.

the objectives of the NPS program. On lower-development-cost tracts, parameter selection is much easier. By setting a very high capital recovery factor ($f > 2.0$), and a moderately high profit sharing rate ($x > .30$), administrators can be reasonably assured that the dual objectives of the NPS system will be achieved on low-development-cost tracts ($k = .15$). The problem here is to know, a priori, which are the low-development-cost tracts. This is especially important since the NPS system would backfire if the values $f = 2.0$ and $x = .30$ were mistakenly applied to a high-cost tract.

Unfortunately, there is no single setting for the NPS parameters that can be applied indiscriminately to all tracts and yield the desired results. Figure 4 illustrates the extent of fine tuning that may be required. Two tracts are depicted in the figure. The first tract is inherently less valuable and probably smaller than the second tract. It can be developed rapidly, and the development program is not capital intensive. The second tract is more capital intensive and requires a much longer development period. The sets of NPS parameter values appropriate to the respective tracts are indicated by the shaded areas. The two sets are disjoint. None of the parameter settings appropriate for the first tract can safely be applied to the second tract, and vice versa.

5. Implications for Leasing Policy

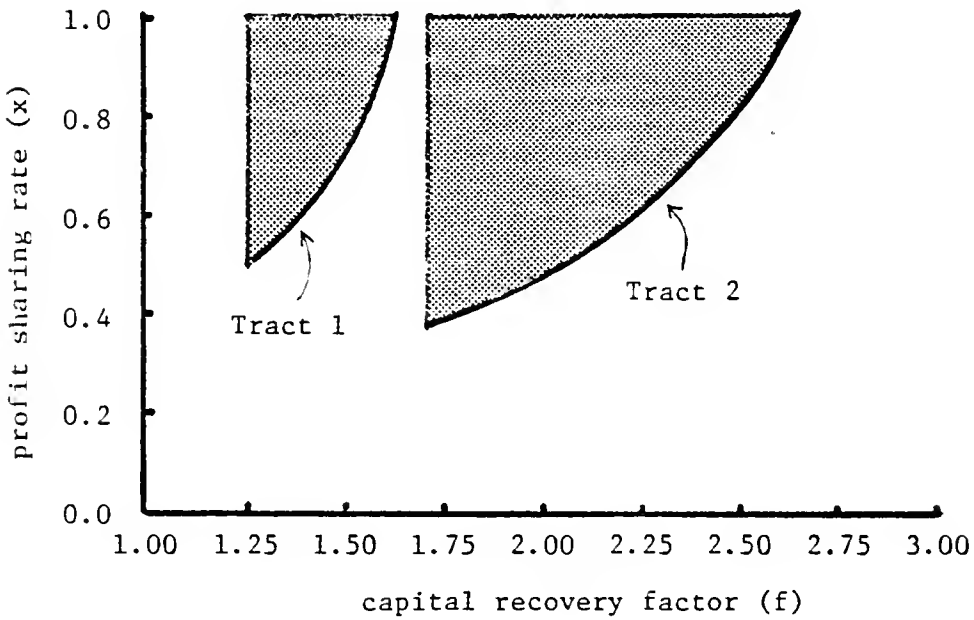
Our main conclusion is that a considerable amount of fine tuning and adjustment may be required to suit the parameters of the NPS leasing system to characteristics of individual tracts offered for sale. Some generalizations are possible. For example, it appears from our numerical results that a minimum profit sharing rate of approximately 30%

FIGURE 4:

FEASIBLE NPS PARAMETER SETS

FOR DISSIMILAR OFFSHORE TRACTS

Each shaded region represents all combinations of the NPS fiscal parameters (x,f) appropriate for the associated tract.



Note: Calculations are based on the following values.
Tract 1: P=1.00; C=0.25; k=0.35; i=0.26; r=1/6.
Tract 2: P=1.00; C=0.05; k=0.30; i=0.71; r=1/6.

must be applied across the board if the NPS system is to succeed in reducing the value of offshore tracts. This finding is consistent with the government's current stipulation that "the net profit share rate shall not be less than 30%" on any tract offered under the NPS leasing system.[12] However, on relatively high-cost tracts, this will hardly suffice. Our results indicate that a minimum rate of 60% is probably necessary to ensure the success of the NPS program whenever development costs constitute a significant fraction of total revenues.

In actuality, the magnitude of unit development costs varies greatly across tracts, even within a fairly homogeneous geological area. Consequently, the task facing administrators of the NPS leasing system is not easy. For example, within one recent sale of seventy leases in the western Gulf of Mexico (Sale 62), exploration and development costs, expressed as a fraction of the value of underlying resources, were estimated to vary (across tracts) between 0.14 and 3.41, with an average value of 0.66 and standard deviation of 0.58.[13] These numbers correspond to the value of our parameter "k", which we varied only between 0.15 and 0.45. Thus, the critical importance of tailoring the fiscal parameters of the NPS system to suit characteristics of individual tracts is probably understated in the present study.

The need to tailor parameters of the NPS leasing system to characteristics of individual tracts was recognized early in the development of the NPS system. An internal study conducted by the Department of Energy concluded that:[14]

> Ceteris paribus, system performance depends on the relative magnitude of exploration costs versus development and production costs. Experimentation

> with costs representative of a particular sale region will always be necessary to "fine tune" a system and determine the parameters that generate "optimal" lease development and production behavior.

This concern was carried over into the Department of Energy's statement that accompanied final promulgation of NPS regulations:[15]

> In theory, tailoring capital recovery factors to individual tracts operates to serve the purposes of the regulation more closely .... The capital recovery factor is unique to each lease and selected on the basis of cost and resource expectations.

Unfortunately, the idea of fine tuning the fiscal parameters of the NPS system has not carried over into actual practice. Uniform profit sharing rates and capital recovery factors are routinely applied to all leases offered in offshore lease sales. For example, all leases offered under the NPS system in Sale 62 were offered subject to a capital recovery factor of 1.5 and profit sharing rate of 30%, despite the considerable variation in unit development costs that we have noted. Although it is undoubtedly easier to administer the NPS leasing system on a uniform basis, this practice would appear to jeopardize the success of the program.

There are several reasons why the government might be reluctant to administer the NPS leasing system more closely. The most obvious, perhaps, is that to do so requires much information that is not available until after the leases have been sold. It is very difficult to determine whether a specific tract will be high-cost or low-cost until the geological formation has been drilled and the volume and physical properties of the underlying petroleum ascertained. Although these factors can be estimated a priori, the variance inherent in such estimates is

very large. Without reliable information, there really is no basis for setting or varying the NPS fiscal parameters.

It is also probably true that by setting these parameters differentially across tracts, the government would run the risk of telegraphing to industry, before the sale, something about the government's internal appraisal of the value of the tract. There is not much danger in this if government and industry appraisals concur; but if potential bidders are given the impression that government has undervalued certain tracts, they may be tempted to bid less than fair market value, or at least their perception of it.

In conclusion, success of the NPS leasing system relies heavily on government's ability to fine tune the system and apply its provisions differentially across tracts. The government, meanwhile, appears unable or unwilling to administer the program in this fashion. If we must rely on rigid and uniform profit sharing rules and conventions, the underlying rationale for the NPS leasing system is weakened considerably.

FOOTNOTES

[1]In this paper we address the question of whether the NPS leasing system can be effective in reducing the magnitude of winning bids. Whether that would lead to greater participation by small firms and increased competition is a separate issue. Frankly, we doubt that capital barriers have restricted competition in the market for offshore petroleum leases. Empirical evidence to support our view is discussed by Smith [1982].

[2]An extensive summary of public comments is provided by the Department of Energy [1980], pp. 36785-36793.

[3]Although the bids tendered by individual participants might not, for strategic reasons, correspond exactly to the expected net present value of an offered tract (see Reece [1978]), there is a substantial body of empirical evidence which indicates that the magnitude of winning bids has on average been quite close to the net present value of offered tracts (see Mead and Sorenson [1980]).

[4]A third possible effect of the NPS system, though not one of its stated goals, is to redistribute risk between industry and government. Although intuition suggests that profit sharing shifts risk from industry to government, the opposite result can also occur. See Sebenius and Stan [1982] for an example.

[5]Department of Energy [1980], p. 36785.

[6]We assume the operator has sufficient taxable income from other sources to immediately deduct current investment expenditures, even though the field in question generates no revenues in the first period when the investment expenditure occurs. The investment expenditures are deducted in full for tax purposes, rather than being depreciated over time. We follow this convention because it renders the income tax regime nondistortive and simplifies the presentation somewhat. However, the conclusions reported below regarding optimal design of the NPS leasing system are not dependent on this simplification.

[7]To be clear, the net profit sharing liability is the maximum of $-x(PQ-CQ-fI)$ and zero. That is, payments do not flow from the government to the operator when net income is negative. Consequently, a simpler form of Equation (2) applies if $PQ-CQ-fI < 0$.

[8]Adelman [1972], p. 50.

[9]In comparing the two lease types, we are assuming the volume of production from the underlying tract and all associated costs are the same for both. In fact, production volume and costs for a given tract may be marginally affected by specific terms of the respective leases. In as much as the NPS system eliminates distortive royalties, for example, it probably increases the value of the tract somewhat. However, these effects are of second-order importance, so we abstract from them here.

[10]Since the income tax system is assumed to be neutral, the after-tax net present value of a marginal field is also zero.

[11]One extreme is where the capital recovery factor is set to zero, in which case the profit sharing system becomes very much like a straight royalty scheme under which payments are based on gross (not net) revenues.

[12]Department of Energy [1980], p. 36800.

[13]These figures are based on tract-specific estimates of recoverable reserves and exploration and development costs prepared by the U.S. Geological Survey for the purpose of valuing the leases offered in Sale 62.

[14]Department of Energy [1979], pp. 62-64.

[15]Department of Energy [1980], pp. 36786-36787.

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