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Firm Behaviour Under Alternative Bidding Systems for US OCS Hydrocarbon Leases\*

> by Federico Foders January 1985

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#### Abstract

One of the least settled issues in US offshore oil policy is the "best" scheme to capture resource rents arising from hydrocarbon production. This paper analyses the impact of alternative bidding systems on the intertemporal production path and on the firm's investment decision. It concludes that with the exception of the pure profit share system all other pure or mixed bidding systems are likely to have a distortive effect on production and, thus, eventually lead to a dissipation of economic rent. Further, no leasing system authorised by current public law is found to be neutral regarding investment decisions.

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#### I. Introduction

One of the least settled issues in US offshore oil policy is the "best" scheme to capture resource rents arising from hydrocarbon production. After almost twenty years of mineral rights assignment on the basis of bonus bidding, the landowner (the federal government in this case) began to experiment with alternative systems (Table 1). Payment schedules other than a cash bonus with a fixed ad-valorem royalty were already authorized by the Outer Continental Shelf Lands Act of 1954 but not explicitly required until the 1978 amendments became effective as public law. The amendments determine that alternative schemes must be used in not less than 20 percent and not more than 60 percent of the total area offered for lease<sup>1</sup>.

This regulation can be considered to be an outcome of the long debate on the pros and cons for the traditional bonus bidding system. Opponents of this system have argued that it would constitute a serious obstacle to competition because it discriminated against small firms. Given the type of auction used, a sealed bid, first-price auction, a few big oil companies would benefit from oligopolistic behaviour by submitting bids that systematically underestimate the true tract value. This would finally prevent the government from receiving a "fair" value for the leases<sup>2</sup>.

In spite of the plausibility of this argument, empirical evidence published hitherto has clearly failed to prove its relevance<sup>3</sup>. In any case, these results could perhaps help to better understand how the traditional bidding system works, but certainly not to

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For a recent review of institutional issues see DESVOUSGES, PIETTE (1984).

<sup>&</sup>lt;sup>2</sup> These arguments have been put forward very often. For a discussion see, for example, REECE (1978).

<sup>&</sup>lt;sup>3</sup> To the extent that the level of rates of return in the offshore oil industry serves as an indicator for competition, the discussion between MEAD et al. (1982) and DWORIN et al. (1983) in the National Tax Journal is a good example of ambiguity in this field of empirical research.

Table 1	-	Bidding	Systems	for	US	ocs	Hydrocarbon	Leases
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	Bidding System	s Authorized	Bidding Systems Used (1954-1980)		
Bid	Variable	Fixed Payment	Year of Sale	No. of Tracts Leased	
1.	Cash bonus	Constant royalty	1954-1980	3529	
2.	Cash bonus	Diminishing or sliding scale royalty	1978 1979 1980	87 175 41	
3.	Cash bonus	Net profit share	1980	59	
4.	Cash bonus	Constant royalty and a net profit share	- <b></b> .	-	
5.	Constant royalty	Cash bonus	1974 1977	8 30	
6.	Constant royalty	Work commitment	-	-	
7.	Constant royalty	Cash bonus and a work commitment	-	-	
8.	Net profit share	Cash bonus	-	-	
9.	Work Com- mitment	Cash bonus and a diminishing or sliding scale royalty	-	_	
10.	Work Com- mitment	Cash bonus and a constant royalty	-	-	
11.	Other		-	-	

Source: OCSLAA (1978); USDOI (1982); OGJ, var. issues.

judge its performance relative to alternative schemes. Unfortunately, a thorough empirical analysis of the alternative systems is not feasible yet due to the fact that only a very small number of tracts have been so far offered for lease under alternative payment schemes; most of these schemes have not even been implemented yet (Table 1)<sup>1</sup>. Therefore, for the time being, qualitative and simulation studies of different bidding systems have more to say on their relative performance<sup>2</sup>.

Going through publications along these lines reveals that most of them take the view of the landowner; they aim at identifying the bidding system which maximizes economic rent capture by the government<sup>3</sup>. While it can hardly be denied that every particular bidding system has a specific impact on government revenue from leasing, it is not at all clear why there should be a special distribution problem in the offshore oil industry which is absent in other industries. For natural resources are capital assets and should be treated just like capital is being treated in other industries<sup>4</sup>.

Economists who stress the relevance of distributional aspects in offshore hydrocarbon leases obviously look at oil resources in

- <sup>2</sup> Simulation experiments were done, among others, by ROGGE MARSH (1980) and SLADE (1984).
- <sup>3</sup> See REECE (1979), KALTER et al. (1975), GARNAUT, CLUNIES ROSS (1983), ROBINSON (1982), EMERSON, GARNAUT (1984).
- <sup>4</sup> Capital usually generates three kinds of income: income accruing to capital owners, income accruing to capital users, and income accruing to the government in concept of tax revenue. The fact that in the case of the US OCS the government expects to receive two kinds of income, income from ownership and income from taxation, is, of course, a feature that makes this business somewhat different from others. But fortunately, this difference does not seem to offer any complications.

<sup>&</sup>lt;sup>1</sup> It should be noted that even in the case of productive tracts leased in the 1970s, many of them did not start to produce before the beginning of the 1980s. This means that an ex post empirical analysis based on historical data of these tracts will have to be postponed until the hydrocarbons discovered have been exhausted. Less reliable but earlier analysis can, of course, proceed on the basis of extrapolated data.

the same way David Ricardo looked at land from the viewpoint of the labour theory of value. Ricardo had to make a difference between capital and land simply because the return to land could not be explained as the reward to past labour. Today we know the inconsistencies of the labour theory of value and that applying marginal productivity or opportunity cost analysis the economic distinction between capital and land necessarily disappears<sup>1, 2</sup>.

Apart from there being no sound reason to concentrate on distributional problems in offshore oil, it is very often forgotten that there might be a trade-off between efficiency on the one hand and the objective of income maximization by the landowner on the other. At least from a certain threshold of lease payments upwards, these payments could represent such a burden to the resource user that he/she could be induced to decide to turn to other more profitable activities. Thus, in the long run, income maximization by the lessor could have the opposite effect, namely, instead of resulting in high lease revenue until the resource is depleted actual lease revenue could decline very early, while a substantial part of the resource stock remains in the ground<sup>3</sup>. This argument sounds like a Laffer Curve for government income

A long line of economists (among others A. MARSHALL, K. MENGER, and John S. MILL) realized that there was no good reason for confining Ricardo's theory of rent differential to land; the same idea could readily be applied to all forms of capital and also to labour. In spite of this, the concept of surplus differential did not have much success and proved impractical for taxation.

<sup>&</sup>lt;sup>2</sup> In the US, firms engaged in OCS leases are already subject to special tax treatment. On the one hand they are allowed to take advantage of a depletion allowance and, further, to expense certain costs (intangible drilling costs, dry hole costs) as incurred; on the other, they are subject to the Windfall Profits Tax which directly influences the profitability of off-shore operations, in spite of being deductable from the tax base for the Corporation Income Tax.

<sup>&</sup>lt;sup>3</sup> Evidence of such a tendency to overtax natural resource ventures has been found by EMERSON and LLOYD (1983) for Australia and by EMERSON et al. (1984) for Indonesia. Also KEMP and ROSE (1984) conclude in their comparative study of sixteen fiscal regimes applied to oil production that "the majority of systems extracted over 100 per cent of the economic rents ... providing a direct disincentive to field development" (KEMP, ROSE, 1984, p. 194).

from offshore leases. It is illustrated in Figure 1 where  $T_0$  represents the leasing rate that leads to the highest total income from hydrocarbon leases; every rate higher than  $T_0$  interferes with profitability and thus induces firms to withdraw from the offshore business. A lower interest in offshore oil ultimately decreases total government revenue from offshore leases<sup>1</sup>.

In the present paper the case is made for an efficient leasing system. It is argued that the best use of natural resources by society can be achieved only if the regime to govern offshore hydrocarbon production is characterized by allocative efficiency instead of revenue maximization by the landowner. This is the view of the resource user but it is also strongly suggested by recent research in the theory of natural resources, a line of economic thought more often than not ignored in discussions of issues in public lands management. The rationale for this approach is given in Section II which also deals with the impact of alternative bidding systems on the optimal intertemporal rate of mineral extraction. In Section III the influence of different lease payments on the firm's investment decision is analyzed. Finally, in the last section the main findings are summarized and some conclusions for offshore oil policy are drawn.

II. The Impact of Alternative Bidding Systems on Offshore Hydrocarbon Production

A standard proposition in natural resources theory is that privately and socially optimal time paths of resource extraction can be achieved in a competitive economy provided the producer bears the corresponding user or opportunity costs (Dasgupta, Heal, 1979; Siebert, 1983b). In an intertemporal context user costs represent the utility foregone to future generations due to today's production. They are equal to the net present value of the resource stock, with the discount rate reflecting the weight of future generations in the cake-eating problem. In policy terms,

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In fact, it not only reduces the government's income from public lands but also ordinary tax revenue from offshore oil.





user costs stand for the lessee's payments to the landowner for the mineral rights<sup>1</sup>. If competitive markets exist, both for the mineral rights and for the minerals themselves, the resulting user costs will lead to an optimal time profile of resource production without distorting investment decisions<sup>2</sup>. If, however, the lessee is required to pay in excess of what the correct user costs would be optimal intertemporal allocation is unlikely and

<sup>2</sup> Such an outcome is subject to given time patterns of mineral scarcity and interest rates.

<sup>&</sup>lt;sup>1</sup> It is also possible to charge these user costs through specific taxes instead of leasing payments. Examples of this are the Brown Tax and the Resource Rent Tax. On this see GARNAUT and CLUNIES ROSS (1983).

the potential economic rent could be totally dissipated. Similarly, if the lessee is not required to pay any user costs misallocation of resources and mineral rent dissipation would follow<sup>1</sup>. It is therefore a relevant policy question to identify the bidding system that is comparatively less distortive with respect to the firm's production and investment plans. In this section cash bonus bidding, royalty bidding, and profit share bidding shall be discussed, both as pure schemes and as the variable part of a mixed system including fixed payments. Whilst this section deals with the effects of these systems on production, the next section will address their impact on investment.

The effect of a cash bonus on production can be easily studied if it is assumed that the individual firm will treat the bonus payment for productive leases as ordinary fixed costs for the purpose of long-term production planning. For this case, Siebert (1983a) has shown that fixed costs are not neutral for the firm's intertemporal supply behaviour. Particularly, for any given price path exogenous increases in fixed costs will lead to higher than optimal production rates and thus to sooner resource depletion (production path P1 in Figure 2). Only a cash bonus payment that truly reflects the (expected) user costs will guarantee neutrality in the sense that it creates an incentive for the firm to choose the optimal rate of extraction (production path Po in Figure 2). A bonus that overestimates the value of a tract will thus have an impact on production similar to that of a higher interest rate<sup>2</sup>: Current profits compare favourably with the present value of future profits giving the firm an incentive to extract now.

<sup>&</sup>lt;sup>1</sup> It should be stressed that this result holds only under government ownership of public lands. If the lessee were given full ownership over the resources, these would become a part of his/her capital assets. Then, competitive capital and mineral markets would contribute to an efficient use of natural resources.

<sup>&</sup>lt;sup>2</sup> This result contrasts with the widely held opinion in the literature on OCS leases that the bonus bidding system is neutral. See MCDONALD (1979) and MEAD et al. (1983). The alleged neutrality of bonus bidding is usually derived from a static analysis.

Figure 2 - Extraction Paths and Cumulated Hydrocarbon Production under Different Leasing Rates



It is sometimes maintained that winning bids are always too high and that there is always some "money left on the table". If such a proposition were true, any bidding system and especially bonus bidding would be distortive by definition. But this argument is not convincing, for firms usually determine the profit-maximizing bonus for profitable ventures before submitting their bids. It could be incompatible with their profit-maximizing behaviour if they would go for a tract at any price. This does, however, not mean that firms participating at lease auctions do not have a certain range within which to set the final bid. But it should be clear that such (narrow) ranges have nothing to do with "money left on the table". On the other hand, differences among bids submitted for the same tract by different firms reflect differences in the individual firm's endowment with information and in the firm's expectations about the risk of drilling a dry hole, the size of the potential resource stock, future hydrocarbon prices, production costs and interest rates. Auctions have been shown to cope quite well with such uncertainties because they function as "economizers of information" (Smith, 1982). Of course, the risk of over- or underestimating the value of a given tract remains with the firm. But this risk is always present in entrepreneurial activity when future projects have to be evaluated. The fact that bad estimates of tract values may have distortive production effects adds a new kind of risk to the risks just mentioned. However, bad estimates are risks inherent to the process of bidding under uncertainty and not to a particular bidding system.

The impact of an ad-valorem royalty on production has been formally analyzed by Dasgupta, Heal and Stiglitz (1980) and by Long and Sinn (1984). As it turns out, constant royalties are never neutral; they work like a lower interest rate in that they create incentives for a postponement of production (production path P, in Figure 2). Optimal royalties can be derived but only for the variable case. A variable royalty that declines over time at a different pace than the optimal royalty has an effect similar to that of a constant royalty: the firm will thus postpone production. In contrast, if the variable royalty increases more steeply than the optimal royalty, its impact on production resembles the one of a higher interest rate: the firm has an incentive to accelerate current production because the present value of future profits does not compare favourably with current profits (production path P, in Figure 2). In terms of production cumulated over a finite time horizon a rising royalty will result in a higher than optimal rate of production and in an early resource exhaustion (point t<sub>1</sub> in Figure 2); a falling royalty will lower the production rate and thus a share of the resource stock will remain in the ground at the end of the period.

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The influence of profit shares has been also addressed by Dasgupta, Heal and Stiglitz (1980). These authors find that a constant profit share has no distortive effect on intertemporal resource extraction. A variable profit share, though, has consequences for production: a rising profit share brings about a higher than optimal rate of production and rapid resource depletion, in analogy to a rising royalty. Finally, a falling profit share contributes to slower than optimal resource extraction.

The results from natural resources theory reviewed above in the context of US OCS hydrocarbon leases are also helpful in establishing the neutrality of mixed bidding systems which are actually used in OCS lease sales (Table 1). A cash bonus with either a fixed constant royalty or a sliding scale royalty is thus always more distortive than a cash bonus associated to a fixed profit share. In the latter scheme there is only one potential source of production distortions, the cash bonus, whereas in the former both the variable and the fixed parts can be non-neutral. On the same token, royalty bidding with a fixed profit share should be more neutral than a system with the same bid variable but stipulating either a fixed bonus or another royalty. Then, a cash bonus with a fixed profit share should be as good or bad as royalty bidding with a fixed profit share. Finally, profit share bidding should be much less distortive than any one of the above systems, independently of the fixed payment stipulated. However, it must be stressed that pure profit share bidding is superior to all other pure or mixed schemes with respect to production neutrality<sup>1</sup>.

III: The Impact of Alternative Bidding Systems on Investment

Firms interested in offshore hydrocarbons face the problem of having to compete for mineral rights at public auctions on the basis of pre-exploratory information on the tracts offered for

<sup>&</sup>lt;sup>1</sup> LELAND (1978) draws a similar conclusion.

lease. Every firm can further be assumed to have identified the tracts it perceives to be profitable and to have established the corresponding probability of drilling a dry well. Thus the typical firm can be thought of as willing to pick a portfolio of tracts subject to its attitude towards risk and its budget constraint. For simplicity, let us assume here, that this problem can be reduced to the ranking of alternative projects with the same risk according to some profitability criterion. Taking, for example, the (expected) net present value (NPV) as an indicator of profitability it is easy to find out that the NPV of a project is a decreasing function of the lease payments as shown in Figure 3. It can be seen from Figure 3 that the characteristic features of a project (prices, production, costs, etc.), together with alternative leasing rates, determine the slope of the NPV curve. A particular royalty or profit share - if constant - will determine only a point on the curve; different royalties and profit shares will thus bring about a movement along the curve. In contrast, different cash bonus payments will shift the NPV curve to the left (higher bonus) or to the right (lower bonus).

Obviously, a given NPV level is compatible with alternative pure as well as mixed lease payments. Also, a given NPV level can be associated with different values of the variable and fixed parts of a given mixed bidding system. Consequently, a given impact on the NPV can be achieved using very different payment systems, the latter being virtually interchangeable. Now, what happens when two projects are compared? This can be seen from Figure 4. If the firm decides to bid a cash bonus equal to bo for project II and its fixed royalty is lower than  $R_0$ , then project I appears to be more profitable than project II. If the fixed royalty for project I lies somewhere between  $R_0$  and  $R'_0$ , then project II turns out to be more profitable. But if the firm sets its optimal bonus at b, project II will remain more profitable for all royalties lower than R'o. Changing the combination of variable and fixed payments may lead to different outcomes regarding the ranking of two or more projects.





From the above discussion the following conclusions can be drawn. First, lease payments always have an impact on profitability and, thus, on investment decisions. Second, the ranking of projects can be significantly affected by mixed bidding systems. It is, unfortunately, an empirical question dependent on every particular set of projects to determine the influence of alternative bidding systems with respect to project rankings<sup>1</sup>. There is no such thing as a bidding system that is neutral for resource allocation.

For mixed systems to have a similar effect as pure systems it is necessary to assume that firms subtract the fixed part of the lease payments from the amount bid in order to arrive at a quasi-pure scheme (DAVIS et al., 1933). Only pure systems of variable payments can avoid the situation that some tracts can be offered for lease under unprofitable lease conditions.

Figure 4 - Net Present Value of Two Tracts under Different Payment Schemes



These qualitative conclusions are in line with empirical studies of the impact of alternative fiscal systems on the development of offshore oil fields<sup>1</sup>. For, due to the importance of lease payments for profitability, high cost (i. e. deep water) or otherwise marginal fields will be seriously affected particularly by fixed payments, which do not take into consideration exploration and development costs.

<sup>1</sup> See, for example, KEMP and ROSE (1984).

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#### IV. Summary of Findings and Policy Conclusions

The admittedly limited qualitative analysis in this paper has shown that the selection of an optimal bidding system is not an easy matter. With the exception of the pure profit share system, all other pure or mixed bidding systems are likely to have a distortive effect on production and, thus, eventually lead to a misallocation of resources and to a dissipation of economic rent. Regarding the profitability of tracts offered for lease, no leasing system authorized by current public law can be said to be neutral. Unfortunately, it is not possible to generally identify the lease payment which would be least distortive for investment decisions.

The high sensitivity of resource extraction and its profitability with respect to alternative bidding systems has some important consequences for offshore oil policy. First, mixed systems with one part fixed by the landowner without taking into account costs of individual firms are always a second best solution compared to pure bidding systems. Wrongly set leasing rates might discriminate against smaller firms. Also, they could be considered to constitute disincentives for the development of smaller or marginal reservoirs. Second, only pure profit share bidding without any lower bounds (these depend on the particular project) can guarantee efficient resource allocation in the offshore industry as well as an efficient use of natural resources without dissipating mineral rents. References

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