Comparison of Petroleum Fiscal Systems and Auctions

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Radford Schantz, US Interior Dept.
Walter Stromquist, Swarthmore College

Abstract

A petroleum fiscal system comprises the taxes, royalties, and similar terms in the lease or contract to explore for or produce oil and gas. A government, as seller of the rights, enacts its distinctive petroleum laws that provide for these terms, determining an offer price. Globally, a large variety of terms are in use, and the fiscal system can provide for an auction that determines the value of the bonus or other bidding variables. The bonus determines which buyer is awarded the rights, and it also serves as a self-adjusting fiscal term that fine-tunes the offer price to fit particular oil prospects and markets. To the extent that different auction formats lead to different results, the format is a significant element of the fiscal system. The oil companies, who are buyers, select rights to purchase by comparing offer prices; comparison among offers is complicated by the diverse quality, risk, and cost of resources offered, as well as the diversity of fiscal systems. The focus in this paper is on the seller who designs a fiscal system with two conflicting goods in view: gaining tax revenue for itself and attracting investment in the competitive market. The trade-off of these goods for a government can be represented with utility theory, and as governments evidently have different utility functions, they can have different fiscal systems generating offer prices. The paper presents empirical models of petroleum fiscal systems around the world and shows how to use them to help assess the current and possible future performance of a fiscal system and auction format. A selection of offshore oil regimes provides a real-life example of a competitive market where multinational oil companies invest globally. The countries are selected from around the world to illustrate diverse fiscal systems, ranging from the US lease system to various other types of licenses and production-sharing contracts. For each country in the selection, three or more oil fields are modeled using field-specific data and engineering methods. The models in each instance estimate the government and private revenues, and the relative shares or "take," given the fiscal terms and auction formats that apply to it. These measures are calculated for actual and possible future prices and costs. The results are plotted to show the comparative performance of the fiscal systems. The same metrics can be used by a government to gauge the implications of changing its terms and auction design.

Petroleum fiscal systems

A petroleum fiscal system comprises the taxes, royalties, and similar terms in the lease or contract to explore for or produce oil and gas. A government, as seller of the rights, enacts its distinctive petroleum laws that provide for these terms; when the system is specified for particular resources at a particular time, it determines the seller's offer price.[1]

Why do countries have special fiscal regimes for petroleum? Why not just impose the usual corporate income tax? That is a possible system, but probably it is never used, for the following reasons.

Mineral production amounts to liquidating natural assets. That is a costly step in two regards. There is a large extraction cost. More to the present point, there is an opportunity cost. When in ground, the asset appreciates (positive or negative).[2] Extraction cashes out the asset, as the "wasting asset" is to be no more. From the broad, social perspective, cash-out is beneficial if alternative investments are expected to give higher return than oil in the ground, and the net benefit of the liquidation is the incremental return (not, generally, the whole cash-out value).

A government does not know ahead of time how it intends to use the proceeds from cash-outs over the decades of an asset liquidation program. So, a critical aspect of policy is to decide *who* is initially given the proceeds from liquidation, that is, to decide how to divide the cash-out value to government or private sector entities who subsequently determine how it is spent. While the reinvestment of the cash-out is a subject of a large literature (e.g., sustainability), this paper focuses on the fiscal system.

In this context, the agents -- government or private firms -- are proxies for the future investments or spending that they are likely to make with their shares of the liquidation proceeds. There are two simplified alternatives:

(a) Government collects the full cash-out (and handles its reinvestment as authorized). Or,

(b) Government collects nothing for the cash-out, allowing it to remain with the private developer, enhancing profit (and then the private firm reinvests the money to maximize profits to owners).[3]

[1] The US is unusual in allowing private ownership and sale of oil and gas resources. This paper includes only the fiscal system for the resources that are currently owned by the Federal government.

[2] By the well-known Hotelling principle, the value of reserves ought to appreciate at the rate of interest. The appreciation might be due to price or cost (technology) change. Uncertainty about these variables can be represented with real options models.

[3] Government oil resources are not given to firms for speculative asset holding, and work must commence within a generally short time frame.

Consider a few pros and cons of (a) versus (b). First, in the case where a foreign oil company is developing resources of a small economy, the government might emphasize (a) to ensure that the reinvestment stays within the country. It might also be that the government has particular investments in mind that a private firm might not make. In the opposite case of where owners of a company are largely (or entirely) same-nation, private companies per (b) might be trusted to use their expertise to reinvest efficiently, which is to some extent in the nation's best interest. It may be supposed that profits left to the company will at least partly be efficiently reinvested in the oil or other energy sectors, which is useful if the government wishes to promote that sector. (To these ends, the law might establish special agents that receive and invest funds, such as national oil companies or permanent funds.)

A simple, though imperfect, measure of the division of asset value is the "take," a colorful term from the oil business. Government take is (as explained further below):

$$\frac{PV(Government\ revenue)}{PV(Government\ revenue + Private\ net\ revenue)}$$

The mirror ratio is private take. *Take is relative, not absolute, revenue.* Take is not the only consideration in policy; the absolute value matters: a small take from a large project can amount to more than a large take from a small one.

Microeconomics of fiscal systems

This section sets up the framework of fiscal system assessment. While it is at an abstract and simplified level, the framework that it sets up will (next section) be populated with empirical data.

The overall theory given in this section is the familiar one of social utility subject to a constraint. In this theory, there are two goods: government revenue and private net revenue (which, as mentioned, are proxies for two different bundles of investments and spending). The reader sees that these goods relate to the asset liquidation strategies (a) and (b) above.

Between these two goods, there is a revenue transformation constraint (RTC). The revenue transformation constraint consists of the optimal combinations of government and private revenues that are feasible given the fiscal system and the underlying drivers of the value of the natural asset. Different fiscal systems generate different transformation constraints.

A simple model of a fiscal system is used in this section to illustrate the revenue constraint. As it is the system most likely to be familiar to readers, let us look at a simplified version of the US concessionary system. There is no government ownership or working interest in the field, and the lease is sold to oil firms by auction. There are 3 fiscal terms: a corporate income tax (ignoring for now any special deductions); a royalty on gross revenue; and the winning bid at auction for the lease (signature bonus).

$$\mathbf{ProfitPV} = \sum_{x=1} (Q_x (P_x - \mathbf{c}\mathbf{O}_x) - \mathbf{c}\mathbf{K}_x - \mathbf{Royalty}_x - \mathbf{Tax}_{x-} - \mathbf{Bonus}_0)\,(1+i)^{-x}$$

$$\mathbf{Royalty}_x = r\, Q_x\, P_x$$

$$\mathbf{Tax}_x = t\,(Q_x\,(P_x - \mathbf{c}\mathbf{O}_x) - \mathbf{c}\mathbf{K}_x)$$

$$\mathbf{Bonus}_0 = b\,\mathbf{ProfitPV}$$

Where:

P	oil price
c	cost index; in base case, c=1
O	operating (variable) cost
Q	production, principally determined by the resource
K	cap cost, excluding bonus
t	tax rate
r	royalty rate
b	bid factor
i	discount rate
x	year

For this simplified model, cK is expensed. Depreciation and depletion are not modeled (in contrast with the detailed models presented later in this paper). Tax losses here are treated as positive cash flow, without carry forward (i.e., the company applies tax gains and losses to other projects). The bonus is paid before the project begins.

Present value is calculated with a discount rate. In this context, it represents the cost of capital, or the minimum expected return needed by the firm to make the investment. Any positive net PV to the firm can be considered “excess profit” in the economists’ sense of the phrases.

Note that the 3 fiscal terms – royalty, tax, bonus -- substitute for each other to a certain extent. In order of precedence, the royalty comes first. It is a deduction from tax and bonus, but neither of them is a deduction from royalty. Royalty in this system is a relatively simple term that applies whenever the lease is in producing status. Tax and bonus are co-determined; bonus is a deduction from taxable income, and tax is accounted for when bonus is determined by a bidder.

The RTC

The revenue transformation constraint is the locus of feasible combinations of government and private revenue for a project. For this simple illustrative system, the tradeoff of government versus private revenue (with price and cost fixed) is a straight line with slope -45 degrees. Higher price and lower cost indices shift the line out.

A particular setting of the fiscal terms determines one point along the RTC . The illustration below gives a numerical example. A base case is assumed as presented in the table.

Table 1. Illustrative model: base. R=1/6, t=.35,b=.1, discount=.05[4]

Year	Prod	Inc	Royalty	Opcost	PreBonus	Capcost	Pretax	Tax	Posttax	Govrev
1	0	0	0.	0	0.	0	-354.762	-124.167	-230.595	230.595
2	0	0	0.	0	0.	0	0.	0.	0.	0.
3	0	0	0.	0	-100.	100	-100.	-35.	-65.	-35.
4	0	0	0.	0	0.	0	0.	0.	0.	0.
5	0	0	0.	0	-500.	500	-500.	-175.	-325.	-175.
6	5	500	83.3333	50	-133.333	500	-133.333	-46.6667	-86.6667	36.6667
7	10	1000	166.667	100	733.333	0	733.333	256.667	476.667	423.333
8	10	1000	166.667	100	733.333	0	733.333	256.667	476.667	423.333
9	9	900	150.	90	660.	0	660.	231.	429.	381.
10	8	800	133.333	80	586.667	0	586.667	205.333	381.333	338.667
11	7	700	116.667	70	513.333	0	513.333	179.667	333.667	296.333
12	6	600	100.	60	440.	0	440.	154.	286.	254.
13	5	500	83.3333	50	366.667	0	366.667	128.333	238.333	211.667
14	4	400	66.6667	40	293.333	0	293.333	102.667	190.667	169.333
15	3	300	50.	30	220.	0	220.	77.	143.	127.
16	0	0	0.	0	-50.	50	-50.	-17.5	-32.5	-17.5
PV	0	4186.78	697.796	418.678	2196.14	874.16	1858.28	650.396	1207.88	1686.06.

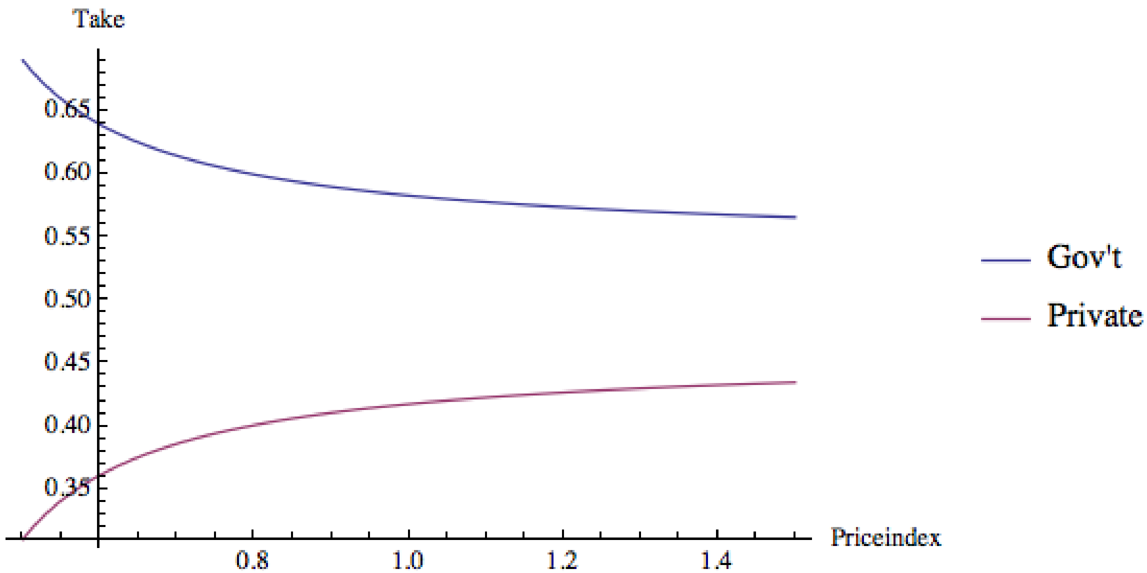
The total PV value of the field happens to be about $2894. With these parameters, the fiscal terms imply that the government revenue is $1686, leaving $1208 for the private firm as excess profit. Government take is 58%. Varying the fiscal parameters increases or lowers the government share, moving up or down the fixed RTC.

The RTC is shifted by changed prices, costs, or other project parameters. Consider higher prices (with unchanged costs). The next figure assumes that fiscal terms are fixed and shows how higher prices in themselves lead to lower government take and higher private take. Higher prices shift the RTC out, potentially increasing the revenues to both government and private sector. That does not necessarily mean that the shares are unaffected. Price change can affect the sharing of profit. In the illustrative system, as in the actual US system for instance, lower prices imply greater government take, even while absolute government revenue is less. That is the regressive character of this particular

[4] In this illustration, the bonus one year before the project begins is $350, and it is future-valued one year to be included in cash flow.

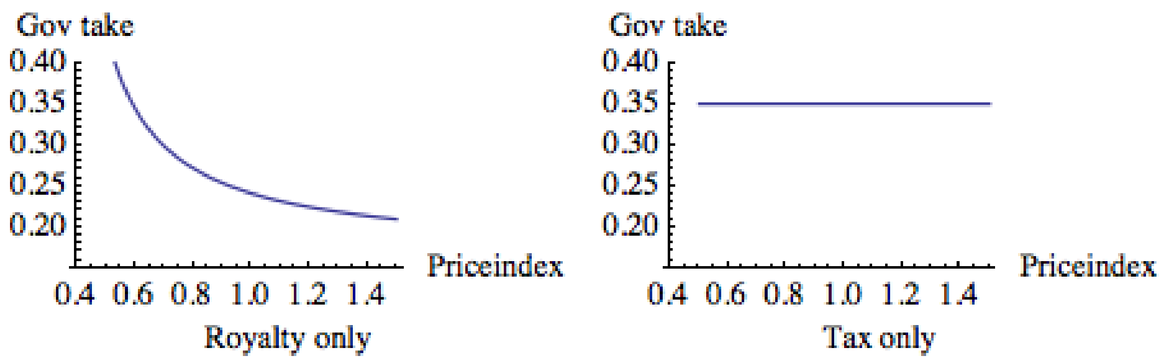
system. Cost increase likewise increases take in this system. Not all systems are regressive, as will be shown later in the paper; instead some are neutral or progressive.

Figure 1



The regressive character comes from the royalty in this illustrative model. To show that, the following two figures contrast 2 hypothetical settings of royalties and taxes in the simple model. One has only r active while t and b are zero; the other has only t active while r and b are zero. For both figures, price changes. As shown, while the royalty-only take varies in a strongly regressive manner, the tax-only government take is flat over the range of prices; it is a neutral system. Similarly, a pure b setting would be neutral in this model.

Figure 2

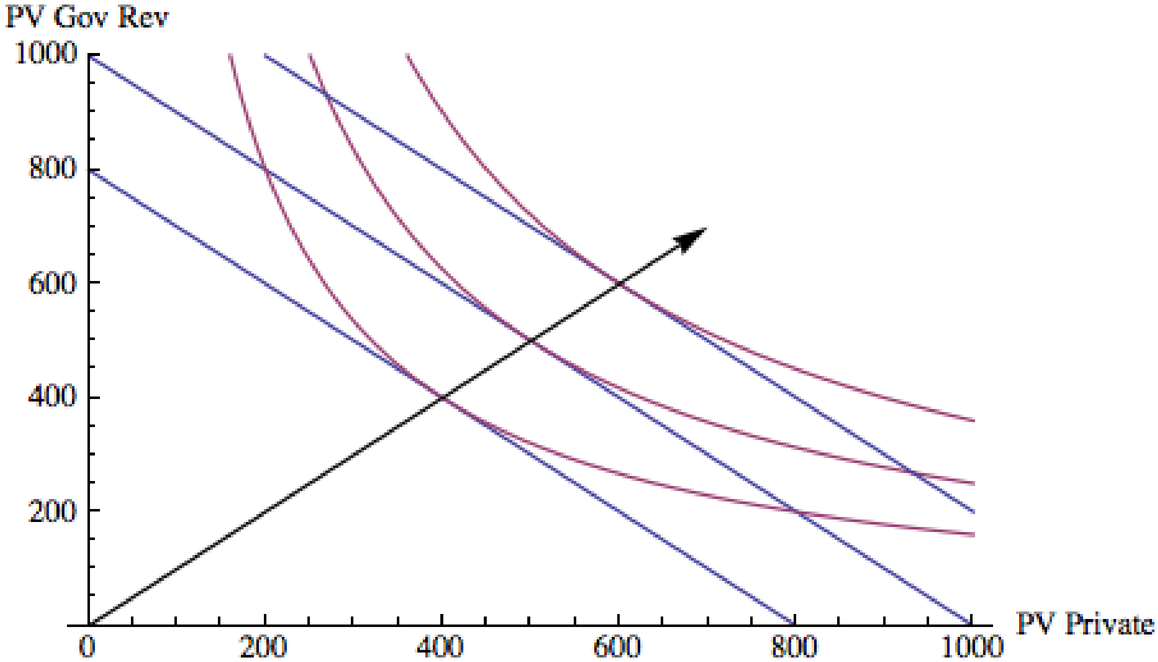


Social preference

The government has direct control of r and t, and it has indirect influence on b. We may distinguish between the long-term policy as set forth by the petroleum laws and the sale-by-sale setting of parameters as authorized and limited by the laws. Abstracting from the legal details, however, how does the government set the terms, sale-by-sale? The analysis in this section assumes that government implements social preference. Preference is analyzed here using simple utility theory.

The next figure illustrates one way in which the government might set the fiscal terms for several levels of the RTC, corresponding to different levels of overall profit. As illustrated, government has chosen a 50% government take at all RTC levels. It is assumed to be doing that because it maximizes social utility. That utility corresponds to the indifference curves illustrated (using a Cobb-Douglas function). The government's income offer curve is shown by the arrow.

Figure 3



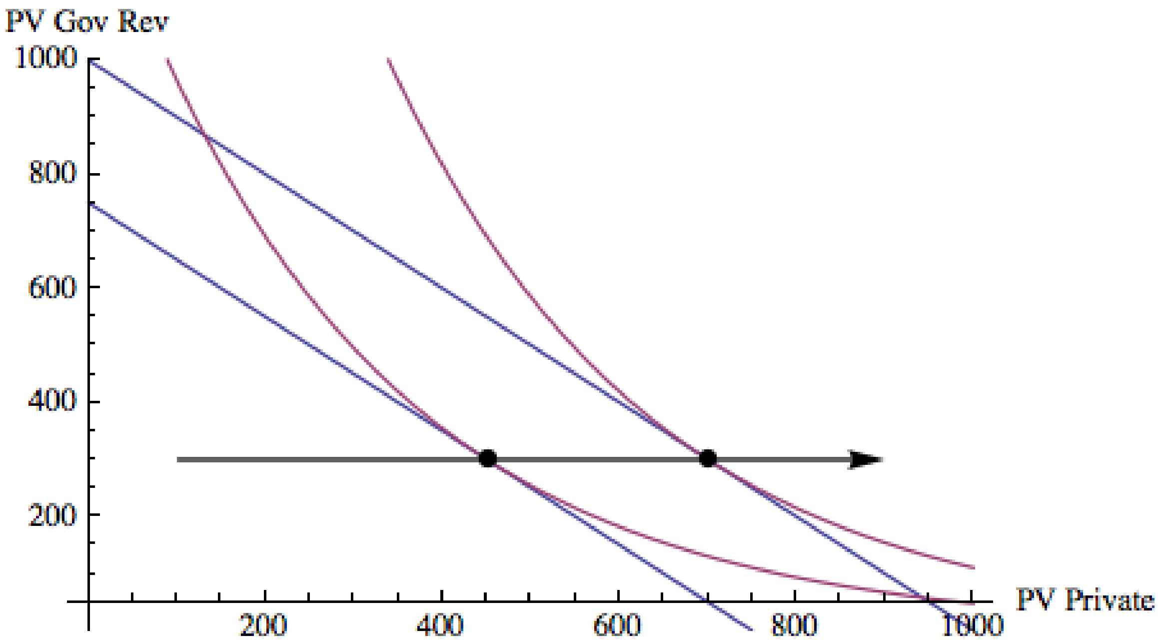
As drawn, that is a neutral system. To achieve this, either the r term is simply zero or it is adjusted continually to generate neutrality.

A neutral system does not need to have equal shares (as in the preceding figure). Neutrality means that it keeps the same share – the same take -- over all RTC's, regardless of whether the share gives more to government or private. Graphically, neutrality is indicated by an income-offer curve that is a straight line starting at the origin.

The next figure illustrates how a regressive system might be consistent with social utility maximization. It shows s a simple utility function in which one good – government revenue -- is a necessity (*Log(x) + y/300*). The government wants some revenue even if prices are low. Besides helping to fund needed government programs, it encourages efficiency. On the high side of possible prices, additional profit accrues to the firm, which may invest it.

Graphically, the regressive system has an income-offer curve that starts above the origin and cuts through RTC's at points that reduce the government take as the RTC's progress out (as below). A progressive system would have the opposite characteristics.

Figure 4



Even with a royalty, which would be regressive if fixed, the government might mitigate the regressivity by adjusting r when prices are high or low. That behavior was partly exemplified by the US government over the years, 2007-8. As oil prices rose, the deepwater offshore royalty was raised as shown below.

Table 2

Year	Oil price, $/bbl	Gas price, $/mcf	Royalty (deepwater Gulf of Mexico)
2005	$56	$9	1/8
2007	$72	$7	Changed to 1/6
2008	$100	$9	Changed to 3/16

The following figure gives a simplistic illustration of this apparent policy. [5]

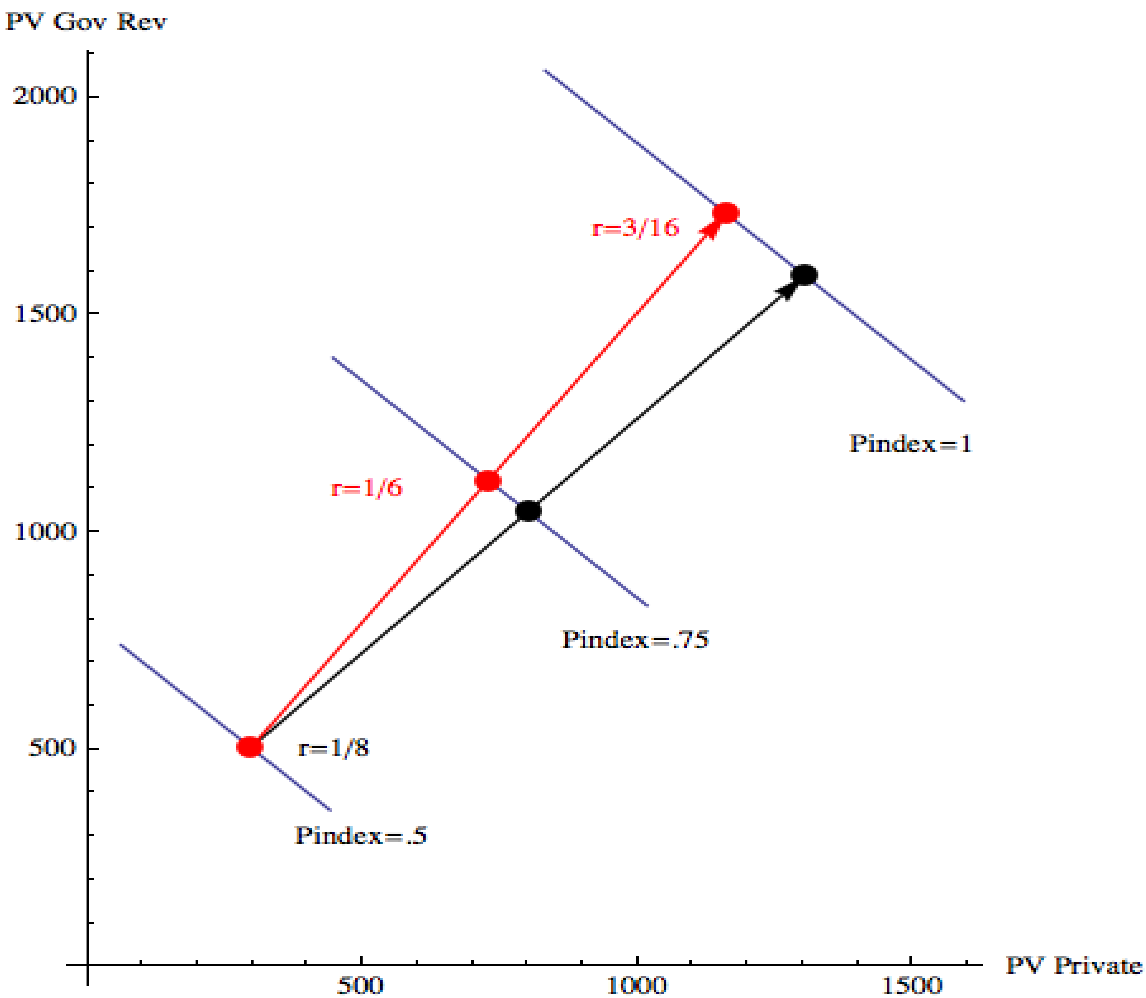
- Using the same simple model described earlier, 3 RTC's corresponding to 3 oil price levels are shown.
- There are 2 policy scenarios. One, in red, represents the actual royalty settings. For the mid level, r is 1/6. For the low level, it is 1/8, and for the high level it is 3/16. The other, in black, is a counterfactual case where the rate is fixed at 1/8.

[5] Offshore royalties in the Federal system are set at the administration's discretion above a minimum of 1/8. There is no established rule about when to change the royalty rate. IHS CERA in its contract report noted that unpredictable changes in terms can be a deterrent to investors.

- The positions of the preferred and inferior points are calculated with the simple model. It might appear that the two points on an RTC are closer together than might have been expected, given the relatively large change in r. The reason is that the change in r is partly offset by opposite changes in tax and bonus. The positions of the points reflect the overall change in take.
- These scenarios imply 2 different income-offer curves. The red curve is close to neutral, while the black one would be more regressive.

That policy suggests a preference to reduce regressivity on the up side. That is not apparently matched on the downside, at least so far. While natural gas prices have fallen back down over the past few years, the royalty on deepwater gas has remained 3/16.

Figure 5.



Auctions and fiscal systems

The bid factor, b, is different in many ways from the other terms, r and t. In relation to the fiscal system, the salient characteristic of the bonus is that it is paid up-front, while the amounts due for other terms depend on production. (The bid variable is often the bonus but can also be work commitment, as in Canada, or other variables.)

Bid factor usually means a bid as a fraction of the bidder's perception of value and can be called with more clarity the ex ante bid factor. The bid factor in oil lease auctions arises from two circumstances. These are well known and can be covered very briefly here.

First, one wishes not to bid higher than necessary to win. This applies differently to single round versus multiround auctions. In single round, such as sealed bid, it implies a complex tradeoff, where a higher bid increase both odds of winning and odds of leaving money on table. In multiround, the best strategy is simply to bid higher, but no higher, than the competition, up to one's full value; so the bid factor of the winning bidder is the ratio of 2nd highest value among the bidders to the true value. Second, in all formats, the bid is reduced by uncertainty about the value of the field, to avoid the winner's curse.[6]

Two aspects of an auction that influence the bid factor can be touched on here – the formal structure, or format, and the offering size.

The auction format overall consists of the initial auction format and the post auction adjustment. The bonus to the government is generally provided only by the initial auction. For the initial auction, there are 4 broad types of auction format that can be considered for an oil auction, shown below.

Table 3

	1 round	multiround
Single item only	Sealed: Offshore US oil	Sequential ascending: Onshore US oil
Combinations allowed	Combinatorial: London bus route	Simultaneous ascending: Offshore US wind; electromagnetic spectrum

Combination are often touted as an improvement when small leases covering a large oil field can be more efficiently developed together; and as such, it might enable higher winning bids. That might be; however, there is no general theoretical result (Cantillon and Pesendorfer, 2006). In the US oil lease auctions, this type of efficiency is arranged partly in the post-auction phase. In that system, it is relatively easy to reassign leases or alter the operating interests, to arrange

[6] Ascending auctions like that for US oil leases might mitigate but not eliminate the winner's curse to the extent that private information about a prospect is disclosed by the bidding.

for efficient field development, consistent with Coase's well-known theory (Cheng and Tan, 2007).

The offering size means how many leases, and of what size, are offered in an auction, and whether the auction is regularly repeated for an area. US lease blocks are relatively small. In the US, both offshore and onshore, offerings are area-wide in the sense of offering all available blocks in area for lease; those not sold are re-offered next auction (sometimes as frequently as annually) along with newly-expired leases. The large offering is widely believed to reduce competition per lease, and indeed the majority of leases go to an unopposed bidder, for both ascending and sealed bid auctions. Low expected competition clearly tends to depress bid factors. Contrariwise, the area-wide offering likely increases the number of leases sold, so the overall effect on aggregate revenue is ambiguous (cf. Opaluch et al, 2009).

Empirical studies of alternative auctions

Empirical research into bid functions is summarized in (Hendricks and Porter, 2007). One empirical study that is especially relevant is the 2008 Interior Department laboratory bidding experiment (Opaluch et al, 2009).

The experiments were sponsored to investigate the differences between sealed-bid (FP) and simultaneous ascending multiround (MR) formats for oil leases. The experimental settings included both high competition (competitive) and low competition (open) settings. Combinations were not allowed as the simulated block values did not provide for synergies among blocks. To represent uncertainty, each bidder was given an individual signal about the value of each block offered, and the signals were determined before the auction starts by a random draw from a single distribution (known to all) around the true value. To represent a developer's capacity constraints, each bidder was limited to winning 3 items. The open setting offered many more items than could be won, spreading bidder interest thinly.

The most readily apparent result of the experiments was that bids were higher in the competitive than in the open offering. But within each setting, there were weak differences between MR and FP results, overall. The results confirmed the common view that (a) there is a positive correlation between perceived item value and number of competitors for that item, and (b) as a consequence, MR yields higher bonus for high-value items and FP yields higher bonus for mid-value items. Also, in the open setting, the multiple uncertainties in FP format lead cautious bidders to bid for more of the low-value items, as a hedge if they lose on their highly-valued targets.

In terms of total bonus revenue, MP raised slightly more revenue (in both settings) than FP, in part by selling a higher number of items. However, the share of aggregate true value captured by MR was slightly less than that of FP. This relates to the ex-post bid factor. In that respect, the difference in settings was dramatic:

Table 4. Bonus %of true value, in aggregate, for DOI experiment

	MP	FP
Competitive	59%	63%
Open	38%	45%

Recognizing econometric problems with parametric estimation of bid functions from these results, the study employed quantile regression. The estimates are given below (All coefficients are significant at p=0.001.)

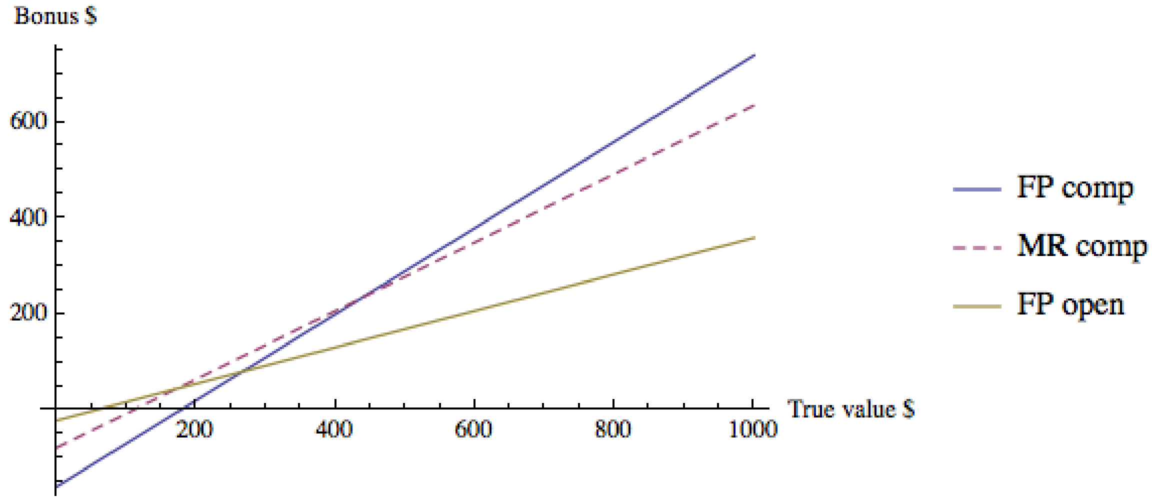
The base treatment was a FP auction in the competitive environment. The median bid was 89.8% of value, but shaded down by a constant of -159 (where the range of possible values is 0 to1000). In the MR treatment, the effective median bid percentage dropped to 71.3% of true value, but the constant level of bid shading also fell to 78.4. Comparing the base treatment to the open FP treatment, the median bid was only 38.0% of true value, but additionally shaded by only 21.3. The comparison of these treatments is graphed below.

Table 5

Variable	**Coefficient**	**Std Err**
Coefficient on true value		
Median bid share of value in base (FP competitive)	0.898	0.032
TrueValue × MR: adjustment	-0.185	0.060
TrueValue × Open: adjustment	-0.518	0.081
Constant		
Base (FP competitive)	-159.580	21.676
MR: adjustment	81.103	31.528
Open: adjustment	138.291	38.887

N=1249 Pseudo-R2 = 0.298

Figure 6. Bid factor regression lines



Companies in actual US oil and gas lease sales appear to have bid factors smaller than the FP open case. The experimental results suggest that bidders have two different strategies for the high-value and the low-value leases. Accounting for those strategies in the context of the actual dimensions of the area-wide offering might help explain the lower factors. Greater uncertainty about item value in the actual auction would also explain lower factors.

The current US offshore auction format and offering tend to promote low bid factors. That is consistent with an emphasis on r and t as the main terms for collecting the government take. If (hypothetically) the government wishes to shift that balance of terms, it appears feasible to raise the bid factor to a modest degree by a combination of changing the offering size and, to a lesser extent, the format.[7]

Pre-tax and post-tax bonus

Earlier, when the simple model was described, it was noted that bonus and income tax are co-determined. This section expands on that observation.

A simplified version of our already-simple model shows the connection of bonus and tax (the royalty and cost terms are omitted):

$$B = b\ (1 - t)\ (PQ - B)$$

Let us see what this implies regarding the interpretation and use of empirical bid factors. We proceed to substitute for B on the right-hand side:

$$B = b\ (1 - t)\ (PQ - b\ (1 - t)\ (PQ - B))$$

After repeatedly rearranging and substituting, we end up with:

[7] In the past, a technical obstacle to smaller offering size in US oil lease auctions was the difficulty of selecting which blocks to include in a small offering.

$$B = \left(b(1-t) - b^2(1-t)^2 + b^3(1-t)^3 - b^4(1-t)^4 + \ldots\right)PQ \pm b^{\infty}(1-t)^{\infty} B;$$

As b and t are between 0 and 1, the last term, $b^{inf}(1\text{-}t)^{inf}$ B, goes to zero. Similarly, the coefficients, $b^x (1\text{-}t)^x$, get smaller and smaller as x is larger. For instance, suppose:

```
b = .2; t = .3;
Table[b^x (1 - t)^x, {x, 1, 5}]
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```
{0.14, 0.0196, 0.002744, 0.00038416, 0.0000537824}
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Thus the terms become pretty insignificant after 2 or 3 iterations. The alternating series converges to 0, and we calculate that:

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Sum[(-1)^(x - 1) b^x (1 - t)^x, {x, 1, Infinity}]
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which equals 0.122807. Note that 0.2 divided by (1-t) is 0.14.

The point here is that there is a pre-tax and a post-tax definition of “bid factor.”

- The pre-tax bid is actually a bid on both the net (post-tax) asset value and on the tax benefit of the bonus; these two things are bundled, as it were.
- An actual cash bid in a real auction is the pre-tax bid, for the asset and tax benefit bundle. Econometric analysis would be based on observations of pre-tax bids.
- The post-tax bid factor is the bid as a share of the net asset value. That is how it is defined in our simple model.

Empirical analysis of selected fiscal systems

With the background established, the paper now turns to comparative analysis of actual fiscal systems.

Five selected fiscal systems were modeled in detail. For each fiscal system, 3 or more oil fields were modeled, each associated with its own RTC’s. Then a simple experiment using these models was performed, namely doubling the oil price. Only the oil price was doubled, and gas price, cost indices, and fiscal settings were not changed.

The results show the current settings of the fiscal systems, the current government take and absolute revenues, and the presence of regressivity (assuming settings are not changed when the oil price doubles).

Data

The data were collected and models built under contract in 2011 by IHS CERA.[8] The original data set covered a sample of 29 onshore and offshore oil and gas fiscal systems with generally 3 oil and 3 gas fields for each system, and more fields for the US.

For present purposes, a subset of the IHS CERA models covering only the offshore oil fiscal systems suffices UK, US Gulf of Mexico deepwater (> 400 ft), Angola, Malaysia, and Norway.

Revenues and take in this paper are in terms of present value. Note that, in the oil business (and the IHS CERA contract report), it is more common to define take with undiscounted revenues. Take in a front-loaded system (like the US) is relatively larger in PV terms. The take numbers are significantly different depending on what discount rate, or none, is assumed.[9]

Angola and Malaysia have a NOC working interest in the project. The PV reimbursement of the NOC is included in the private revenues, as though the NOC were an enterprise separate from the government. This is the typical treatment of NOC's when defining take.

The base case reflects the following assumptions. The baseline world oil price is $75/bbl (admittedly low currently but it is acceptable for comparative purposes in this paper). Baseline natural gas prices are $6/mcf in North America, $8/mcf in Europe, and $10/mcf in Asia. The discount rate is 10%.

The fiscal systems are briefly described next:

UK – The main terms are a corporate income tax and a supplemental petroleum income tax. There are no bonus or royalty.

US Gulf of Mexico deepwater – The terms have been summarized above where the simple theoretical model was presented. The simple model omits, notably, the depreciation and depletion provisions of the income tax, whereas, in contrast, the IHS CERA model includes them (for the US and the other systems as well). The baseline royalty is 3/16.

Angola – This production sharing agreement contract (PSA) includes a (nonrecoverable) bonus, social contribution, profit sharing on a sliding scale, and income tax. The state has 20% participation through discovery.

Malaysia – The Malaysian PSA has 40% state participation through discovery. It has a royalty, profit sharing, income tax, and provision for excess profits tax (but no bonus)

[8] The contract report was made available on Interior Department websites but not otherwise published. The models have not otherwise been made public. IHS CERA proposed a method of comparison of fiscal systems that is different from the method in our paper.
[9] Cf. IHS CERA (2010) p 90

Norway – This tax system has a corporate income tax and a special petroleum tax, also on net income (no bonus or royalty).

Results

The PV revenues and takes for the base case and the high price case for the systems by field are given in the table. Note again that these takes are defined with PV revenues.

Two general observations:

- For most fields, the increase in revenue due to doubling the oil price is greater than double. That reflects, of course, that the revenues here are net of costs, and costs do not change in this simulation.
- Other simulations performed stipulated cost increase; they show smaller revenues than the base, as expected.

The results for each system are plotted below. The plots show:

a) the base case preferences for government versus private revenue for each field;

b) the hypothetical income-offer curves for each field assuming the fiscal terms are not changed as the oil price doubles.

UK – The UK system gives nearly equal shares to government and the private company. It is nearly neutral, which is not surprising as it has only income tax terms, and they are evidently set to have incidence close to neutral.

US – The Federal system in the deepwater Gulf of Mexico gives a larger share in the base to the government. The system is regressive, so the government share is less strongly favored in the high price scenario, assuming the royalty rate remains fixed.[10]

Angola – Angola also gives a larger share in the base to the government, and the system is regressive.

Malaysia – Malaysia gives a larger share in the base to the government, and the system is regressive.

Norway – Norway gives a larger share to the government, and the system is slightly regressive at the low end, otherwise nearly neutral.[11] It has only income tax terms.

[10] These US results show a larger government take than the US numbers given in IHS CERA contract report, and the reason is that the PV definition of take, that we use, emphasizes the government take from the upfront bonus and the heavy royalty burden in initial production years.

[11] IHS CERA, using a gross revenue definition of take, finds Norway to be one of the few systems that is progressive.

Countries with regressive systems impose a large government take, e.g. above 70%, at fields where the profit margin is small. When the margin is negative, the take exceeds 100% (but is shown in the table as 1).[12] The UK and Norway have fairly neutral systems and avoid that situation.

Changing fiscal settings

The next step in the analysis will be to use the detailed IHS CERA models to examine changing fiscal settings. This topic is introduced above with the simple illustrative model. For that model, the RTC is a straight line. For detailed, realistic models, that is not necessarily the case. Also, the shift of the RTC due to price or cost change is not necessarily a parallel shift for the detailed, realistic models.

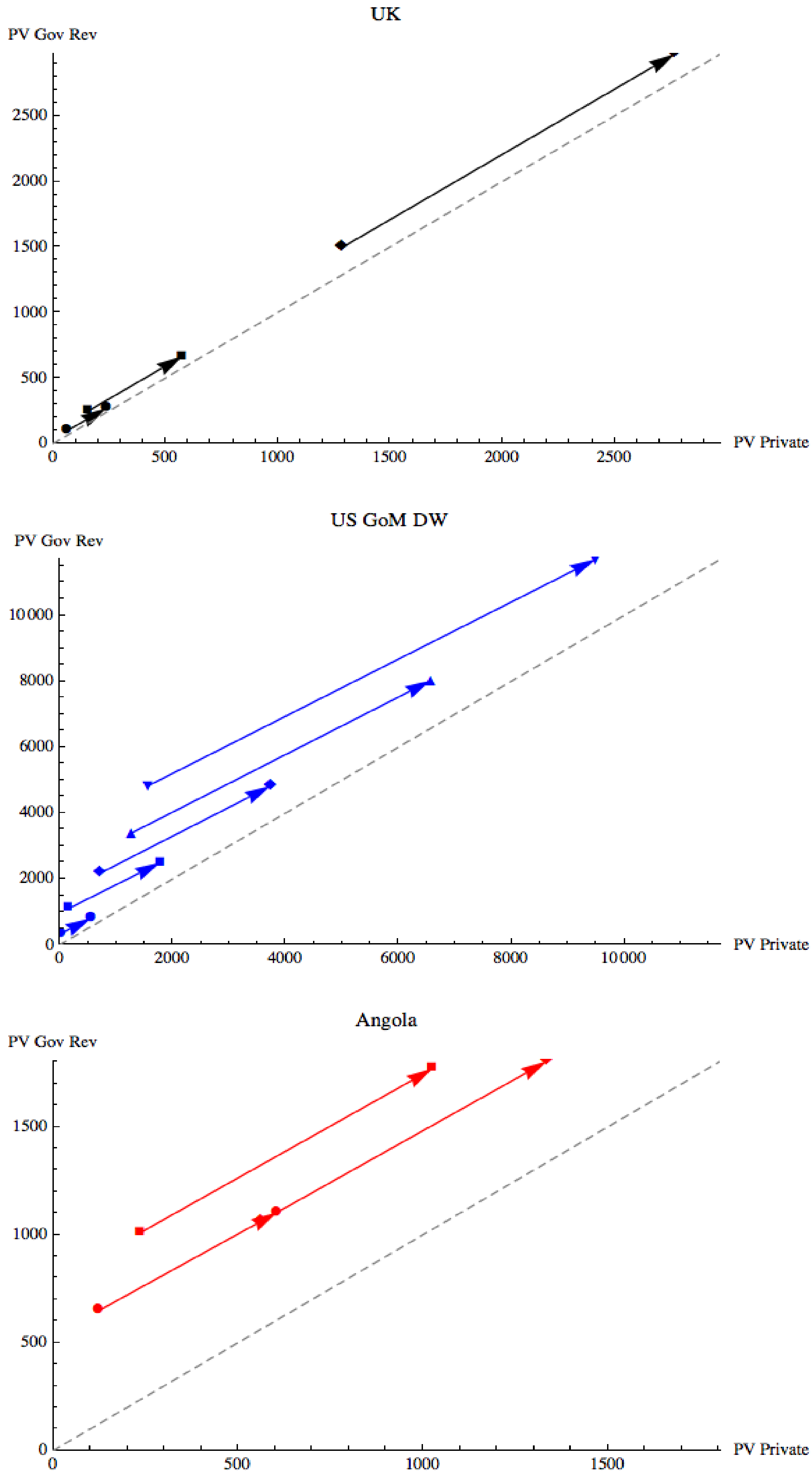
[12] One might ask how the margin can be negative – in that case, why would any investment take place? The answer is that the IHS CERA models are based on actual fields, and some of them have been developed in hopes presumably that the oil price would be greater than the $75 assumed in our base case. Also, the IHS CERA cost estimates are highly conservative.

Table 6. PV Government and Private Revenues for Selected Fiscal Systems and Fields, Base Case and Double Oil Price ($MM)

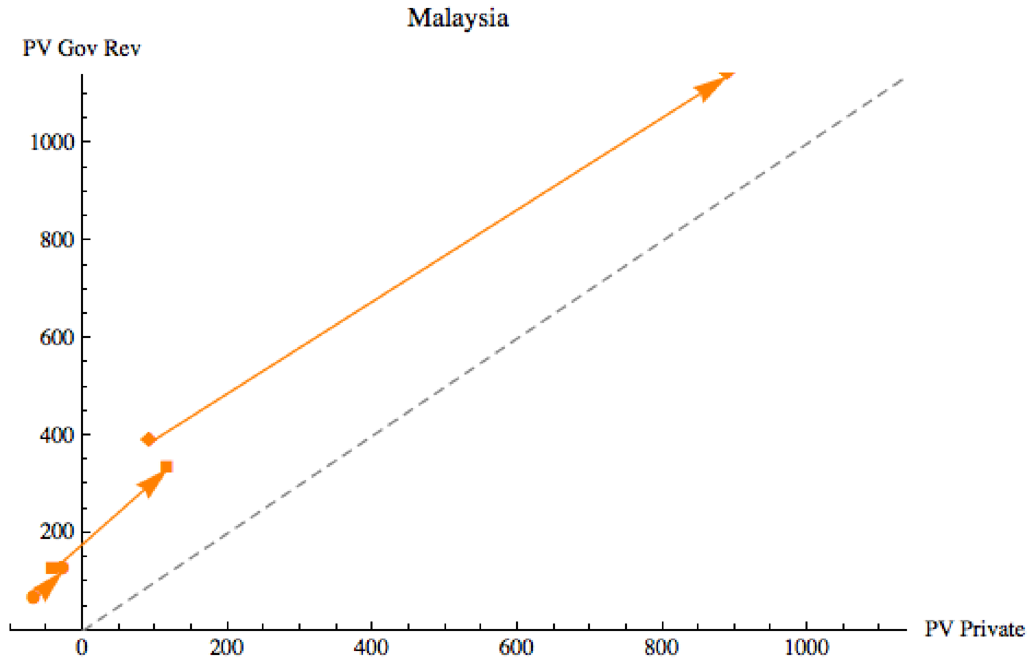
	Priv Base	Gov't Base	Gov Take Base	Priv HiP	Gov't Hi P	Gov Take Hi P
UK 10	61	97	0.613924	237	268	0.530693
UK 25	157	250	0.614251	576	665	0.535858
UK 89	1285	1494	0.537603	2767	2970	0.517692
US Gulf deep 30	16	337	0.954674	555	804	0.591611
US Gulf deep 100	160	1104	0.873418	1783	2496	0.583314
US Gulf deep 200	711	2170	0.753211	3733	4816	0.563341
US Gulf deep 400	1265	3386	0.728015	6572	8020	0.549616
US Gulf deep 800	1567	4827	0.754926	9488	11698	0.552157
Angola 100	123	648	0.840467	605	1103	0.645785
Angola 200	237	1011	0.810096	1026	1769	0.632916
Angola 500	562	1062	0.653941	1335	1804	0.574705
Malaysia 10	-67	64	1	-27	123	1
Malaysia 25	-41	124	1	118	333	0.738359
Malaysia 55	92	385	0.807128	890	1138	0.561144
Norway 15	-69	25	1	78	169	0.684211
Norway 40	68	192	0.738462	368	557	0.602162
Norway 95	617	883	0.588667	1236	1651	0.571874

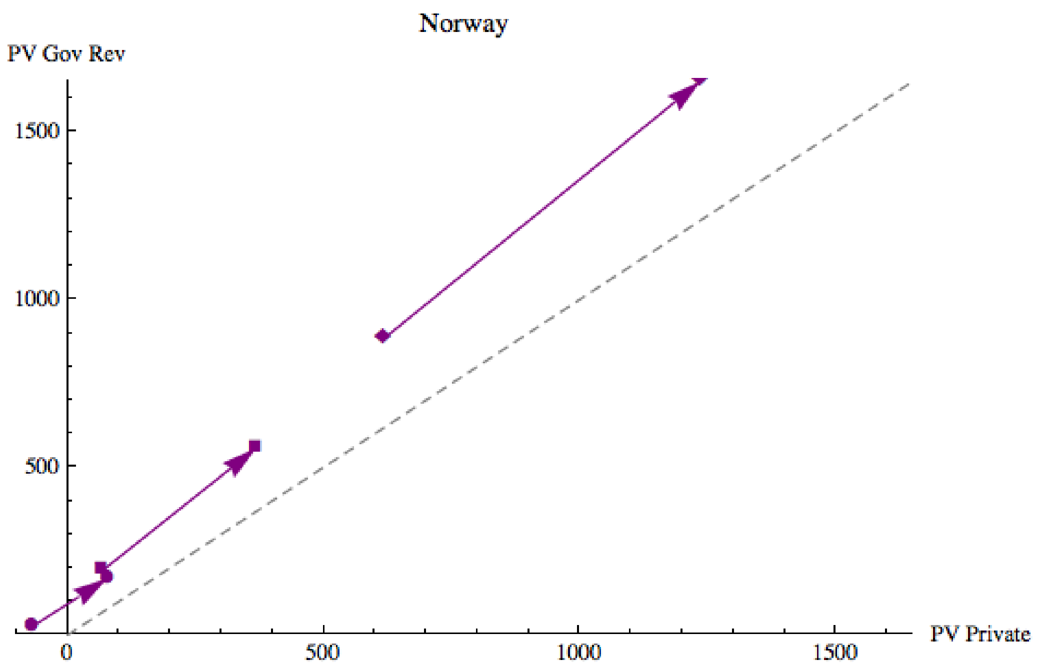
Notes. Revenues are present values (at 10% discount), and take similarly is defined with present values.

Figure 7


UK
PV Gov Rev
PV Private
0
500
1000
1500
2000
2500
US GoM DW
4000
6000
8000
10000
Angola

(Figure continued)





Comparing fiscal systems

In an international, competitive market for petroleum rights, a government with a certain prospect to license is competing with other governments that have similar prospects to offer. One presumes that a variant of a law of one price applies.

The main point to make in that regard is that, if the PV private net revenue is positive, then the minimum return for a typical investor is being met or exceeded. In that sense, any offering with a positive private net revenue is competitive. When comparing several fields with positive PV, it is likely that the one giving the most net revenue to the private firm is ranked first by investors, but in general there will be demand sufficient for all of the fields to be licensed. In this regard, a problem for licensing a field would occur only if its PV private net revenue is negative.

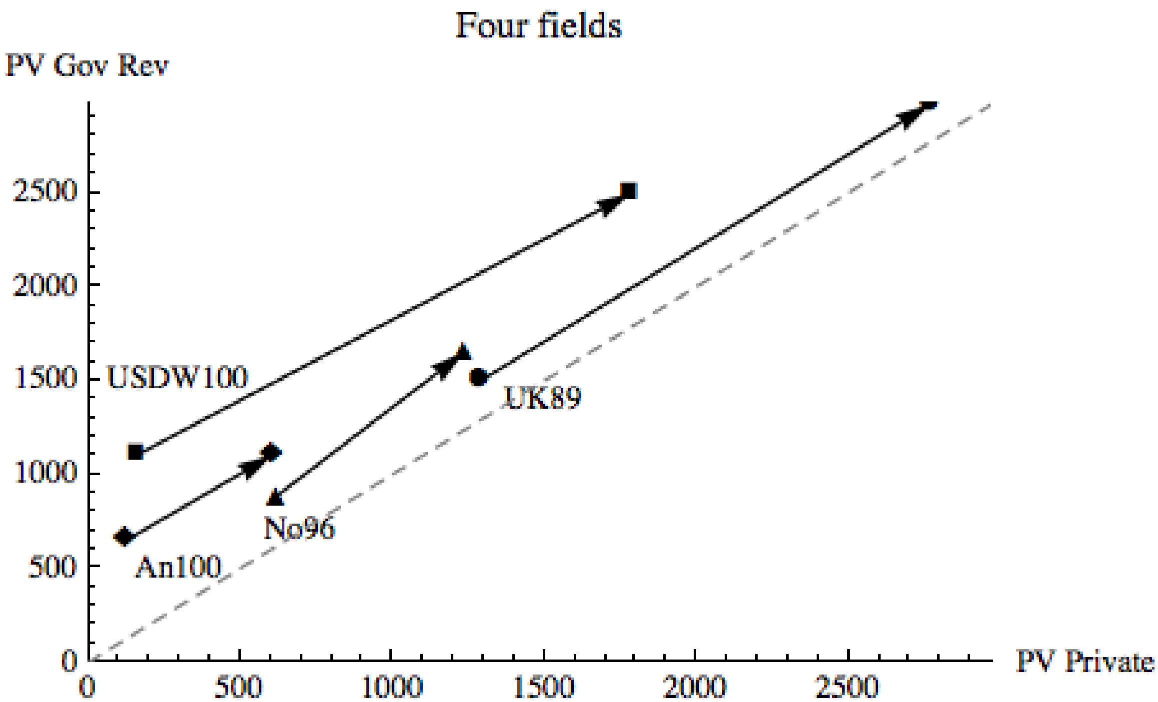
The belief in “one price” might be modified by consideration of complications in the market; for instance, buyers are not homogenous but, instead, each company is judging the lands for license in relation to its particular portfolio objectives. The diversity of buyer objectives means that there can also be a diversity of government offers, since a seller need only find one buyer for its particular offer. Relating to that fact, some countries are riskier places to invest than others, and the higher cost of capital in riskier countries means a larger rate must be applied in calculating the PV private net return there. (IHS CERA used the same for all countries.)

We might combine roughly similar prospects and contrast their fiscal arrangements in a single chart. One example is given below, for four fields in the IHS CERA data that are fairly similar in size, roughly 100 mmbbl. The price-doubling scenario is shown as well as the base case.

Although the fields are roughly the same size in terms of reserves, they have different base revenues because their costs are different. The doubling of price affects each field somewhat differently, due partly to the size of the profit margin at each.

All four fields yield positive PV private net revenue, so all can be attractive to investors, and indeed all are actual developments. The US appears to have social preferences that call for the greatest government take, in PV terms, in the group, at least as regards these four fields. This relates to the regressivity of the US fiscal system, which places a large government take on a field with small profit margin in the base case.

Figure 8



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