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TAXING NATURAL RESOURCE PROJECTS

by

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TAXING NATURAL RESOURCE PROJECTS

1 Introduction

Taxing natural resource projects is becoming an increasingly complex task with a growing responsibility on the part of policy makers to improve their awareness of potential impacts of various fiscal packages upon government revenue and economic activity in the relevant industries. This paper seeks to illuminate issues in natural resource taxation, identifying by the use of objective tests good and bad elements from the viewpoint of revenue maximization. Other considerations such as allocative neutrality, resource conservation and environmental protection provide an additional rationale for taxation of natural resource activities. Nonetheless, revenue maximization is an omnipresent objective commonly receiving priority in policy formulation.

The next section defines the problem when attempting to design revenue sharing schemes involving natural resources. Performance criteria are derived from this analysis in the following section, providing objective tests by which various fiscal arrangements may be evaluated. These criteria are developed within the context of a hypothetical natural resource project. In Section Four a series of revenue collecting schemes are modelled. Then the criteria previously established are applied to each of the fiscal measures developed in the preceeding section. Certain important general themes are spelt out in Section Six on the basis of the analysis conducted in the paper.

2 Defining the Problem

Firms operating in extractive industries are potentially capable of realising various kinds of rents [1]. With perfect supply inelasticity in the very long run, an equilibrium price may be established which results in the realisation of super-normal profits. Rent is here operationally defined as the profits remaining after subtracting earnings which are just sufficient to bring forth the supply of the resource.

This working definition of rent is both related to and consistent with the practice adopted by large mineral-based companies of setting a minimum expected internal rate of return (IRR) which is necessary, but often not sufficient, to induce the decision to invest.[1] Representing the weighted average of possible IRR's, the weights reflecting the probability of the occurrence of each IRR, the minimum acceptable rate of return, or "hurdle rate", embodies a time preference for money. Such a preference is implicit in the IRR, calculated as that discount rate which equates the present value of outlays and proceeds associated with a project.[2]

High risk is a generally acknowledged characteristic of large natural resource based ventures [1,5 and 6]. Accordingly, the hurdle rate may vary from company to company and from project to project given a perceived level of risk. The essential point is that profits in excess of those representing the hurdle rate can be taxed rather heavily as their realization is unnecessary to induce the decision to invest. They are windfall gains.

An additional test commonly applied when evaluating alternative investment proposals is the payback period criterion. This is measured as the number of years required to recoup initial capital at risk. Hence, the payback period embodies a particularly heavy weighting in those situations marked by high political, geological and market risks. These risks, combined again with the time preference for money will motivate companies to endeavour to recover their investments in the shortest feasible time period.

Just as companies place a higher value on a dollar earned now than a dollar earned later, so too do governments exhibit a time preference for money. This rate of time preference, or the social discount rate in shadow pricing terminology, indicates the interest rate which equates the present social value of a future dollar with that of a dollar now.[3]

A further concept in the economics of the mineral sector deserving mention is recovery efficiency. It will invariably be in the interest of the government to ensure that reserves in a given deposit, deemed to be economically recoverable in the absence of taxation, should not be left in the ground as a result of onerous fiscal provisions. Not only is the government sacrificing revenue on these unutilised resources, its actions are not conducive to resource conservation.

Given this simple exposition of the complex influences to be considered when designing appropriate revenue collecting measures, as well as the conflicting objectives of government and company, it is not surprising that the optimal solution to government revenue maximization problems represents a compromise. The problem hereby defined is maximization of government revenue by balancing the possibility of deterring investments which are economically viable before tax against that of foregone revenue through the setting of excessively generous provisions. This involves permitting the company to realise its hurdle rate and a short payback period while taxing heavily any profits in excess of those representing the critical rate and providing sufficient incentive for recovery efficiency. Summarily stated, the government should direct its taxation towards rents.

3 A Hypothetical Natural Resource Project and Revenue Sharing Performance Criteria

A hypothetical natural resource project is described in Table 1. It could just as easily represent a venture in any extractive industry.[4] The various outlays, production values and revenues are intended to reflect the relationships typically faced in natural resource exploitation. To this point, however, the environment in which the company and the government are operating is a relatively simple one. Faced with certain outputs, prices and costs it would not be a difficult task to set mutually acceptable and government revenue maximizing conditions for the division of net cash flow.

In reality, large scale natural resource projects face high levels of uncertainty, a fact which has vitally important implications for the design of taxation policy. Uncertainty is here injected into the model by varying unit resource prices. In the first instance prices are set uniformly at $8 per unit. Successively lowered from $8 in year 7 to $7 in year 8 and $5 thereafter prices in the second set of manipulations exemplify the case of unanticipated reductions in profitability. The reverse situation is typified by the third instance in which unit prices rise in step-wise fashion from $8 in year 7 to $9 in the following year, $12 in year 9 and $15 thereafter. Alternative methods of simulating uncertainty such as the formulation of projects which have different geological characteristics, investment requirements or production costs could just as easily have been chosen without limiting the generality

TABLE 1: HYPOTHETICAL NATURAL RESOURCE PROJECT

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Exploration	50.0	1.5	12.7	13.5																
Capital expenditure					46.2	146.3	76.4													
Operating costs							11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Output (million units)							8.2	16.4	16.4	16.4	16.4	14.8	13.3	12.0	10.8	9.7	8.7	7.9	7.1	6.4
Price per unit							8	8	8	8	8	8	8	8	8	8	8	8	8	8
Value of output							65.6	131.2	131.2	131.2	131.2	118.4	106.4	96.0	86.4	77.6	69.6	63.2	56.8	51.2

Note: Unless otherwise stated, all financial data are expressed in millions of constant dollars.

of conclusions reached. The selected project features and data should not be regarded as a special case but as an attempt to conduct the analysis in specific terms.

Having developed the hypothetical project it remains in this section to arrive at the most appropriate criteria for testing the various tax schemes. These are directly deducible from the analysis of Section Two.

Should the application of taxes reduce the expected IRR below the company hurdle rate then the project will be rejected. Hence, the extent to which the tax scheme preserves the hurdle rate is the first criterion. A hurdle rate of 15 per cent is assumed.[5] Calculation of the after-tax IRR utilizes year 5 as the starting point when exploration activity has been completed and the decision on whether or not to invest is being made.

Relative success in approximating the after-tax and the pre-tax payback period is the second test. Payback is calculated on development costs only, as at the time of the investment decision exploratory outlays have been expended and therefore do not represent capital at risk. Payback is to be calculated to the nearest whole year.

The next step in revenue maximization involves taxing rather heavily the rents on highly profitable projects. With the timing of government receipts important, it is the present value of government revenue, rather than the undiscounted value, which forms the third criterion. Quite arbitrarily a social discount rate of 15 per cent is assumed. A different rate would affect the absolute present value of government revenue, but relative values would remain substantially unchanged. The present value of government receipts is calculated from year 7, the first year of potential flows to consolidated revenue.

Recovery efficiency should be maintained, the final criterion thus being the extent to which a particular fiscal regime permits that level of deposit recovery which would be achieved in the absence of taxation.

4 Modelling Alternative Revenue Sharing Measures

For the purpose of clear exposition a number of the fiscal schemes to be modelled are accompanied by the hypothetical manipulation for the project on which unit prices remain constant at $8.

Case 1: Corporate Income Tax

Assessed usually at a fixed rate on net income the corporate income tax is applied to the entire incorporated sector, regardless of whether or not particular industries generate rent. Commonly, the tax scheme contains "special provisions" which are designed to discriminate between industries by varying the effective rate of corporate tax. Among these provisions are accelerated depreciation allowances, carry-forward of losses, depletion allowances and so on. While it is not feasible here to discuss each special provision, a particular depreciation scheme has to be applied. Unless there is provision for asset revaluation the total depreciated sum will normally equal the total amount of capital expenditure allowable for depreciation purposes, regardless of depreciation method employed. Acceleration of write-off affects only the timing of after-tax receipts.

Because of the greater risk typically associated with extractive industries there is very often some allowable acceleration of depreciation over the conventional straight line method. In the example used (Table 2), capital expenditure is assumed to be depreciable at 10 per cent per annum over 10 years while exploration outlays are amortizable at 20 per cent annually over a five year period. By comparison with a straight line rate over the 14 years of operations in the hypothetical project these provisions represent an acceleration of write-off for tax purposes. A tax rate of 50 per cent is assumed. The rationale of such uniformity is to ensure that differences in performance are not simply the result of differential tax rates.

Case 2: Ad Valorem Royalty, 50 per cent

After specific royalties based upon quantity the ad valorem royalty is probably the easiest tax to administer; hence its popularity among taxing authorities. Calculated at a fixed percentage of the project-site value of the extracted resource[6] the ad valorem royalty is totally insensitive to the cost of production (Table 3).

Case 3: Production Sharing

A number of countries have opted for production sharing arrangements in an attempt to secure financial benefits from foreign activity in domestic oil production. Indonesia, Malaysia, Bangladesh, Burma, India and Egypt have differing terms and provisions, thus rendering

TABLE 2: CORPORATE INCOME TAX WITH CAPITAL EXPENDITURE DEPRECIABLE AT 10 PER CENT PER ANNUM AND EXPLORATION OUTLAYS DEDUCTIBLE AT 20 PER CENT PER ANNUM

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COMPANY:																				
Sales receipts							65.6	131.2	131.2	131.2	131.2	118.4	106.4	96.0	86.4	77.6	69.6	63.2	56.8	51.2
Operating costs							11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Depreciation							42.4	42.4	42.4	42.4	42.4	26.9	26.9	26.9	26.9	26.9	..			
Trading profit							11.4	77.0	77.0	77.0	77.0	79.7	67.7	57.3	47.7	38.9	57.8	51.4	45.0	39.4
Corporate income tax (50%)							5.7	38.5	38.5	38.5	38.5	39.8	33.8	28.6	23.8	19.4	28.9	25.7	22.5	19.7
Cash flow to company					-123.9	-146.5	-28.3	80.9	80.9	80.9	80.9	66.8	60.8	55.6	50.8	46.4	28.9	25.7	22.5	19.7
GOVERNMENT:																				
Corporate income tax							5.7	38.5	38.5	38.5	38.5	39.8	33.8	28.6	23.8	19.4	28.9	25.7	22.5	19.7
Government cash flow							5.7	38.5	38.5	38.5	38.5	39.8	33.8	28.6	23.8	19.4	28.9	25.7	22.5	19.7

TABLE 3: AD VALOREM ROYALTY OF 50 PER CENT

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COMPANY:																				
Sales receipts							65.6	131.2	131.2	131.2	131.2	118.4	106.4	96.0	86.4	77.6	69.6	63.2	56.8	51.2
Operating costs							11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Royalty (50%)							32.8	65.6	65.6	65.6	65.6	59.2	53.2	48.0	43.2	38.8	34.8	31.6	28.4	25.6
Exploration/capital expenditure					123.9	146.3	76.4													
Cash flow to company					-123.9	-146.3	-55.4	53.8	53.8	53.8	53.8	47.4	41.4	36.2	31.4	27.0	23.0	19.8	16.6	13.8
GOVERNMENT:																				
Royalty							32.8	65.6	65.6	65.6	65.6	59.2	53.2	48.0	43.2	38.8	34.8	31.6	28.4	25.6
Government cash flow							32.8	65.5	65.6	65.6	65.6	59.2	53.2	48.0	43.2	38.8	34.8	31.6	28.4	25.6

difficult the modelling of a "typical" production sharing arrangement.

The essential features of the Indonesian scheme are applied in an attempt to capture some representativeness. The State oil company (Pertamina) and the foreign contractor sign an agreement whereby the contractor finances all expenditures, recovering costs from up to 40 per cent of production valued at market price. The remaining oil is divided between "domestic market oil" and "profit oil". Domestic market oil is determined in proportion the contract area production is to total Indonesian crude production. The upper limit is 25 per cent, with 70 per cent of this production going to Pertamina. A price of only US$ 0.20 is paid for the 30 per cent of domestic market oil which is allocated to the company. "Profit oil" being the residual, is split 70:30 in favour of Pertamina and is valued at market prices.

A new arrangement which subdivides "profit oil"[7] will not be modelled here as it unnecessarily complicates an understanding of the basic characteristics of a production sharing scheme. For simplicity, the respective proportions of "cost recovery" and "domestic market" oil are assumed at their maximum levels of 40 per cent and 25 per cent, leaving 35 per cent of production for assessment as "profit oil" (Table 4).

Case 4: Resource Rent Tax, 50 per cent

As the resource rent tax (RRT)[8] is designed to tax only economic rent it normally will not deter a marginal investment. No RRT liabilities are to be incurred until the hurdle rate has been realised.

The first step in calculating RRT is to arrive at a figure, each year, called "net assessable receipts" (NAR), which is simply "assessable receipts" minus "deductible payments". Assessable receipts comprise gross sales revenue plus proceeds from the sale of assets. Deductible payments embrace all payments made by the company in earning its income with the exception of payments for the provision of capital, but including payment of any non-RRT taxes. Successful exploration outlays are included.

Each year from the beginning of the project the value of net assessable receipts is accumulated at the threshold rate which is set by the government and which in principle will equal the company hurdle rate. In year t the accumulated value of net assessable receipts to the end of year $t-1$ is added to the net assessable receipts figure of year t. The

TABLE 4: PRODUCTION SHARING

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COMPANY:																				
Cost recovery oil (40% @M.P.)[a]							26.2	52.5	52.5	52.5	52.5	47.4	42.6	38.4	34.6	31.0	27.8	25.3	22.7	20.5
Domestic market oil (25% @30:70 @ $0.20)[b]							0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Profit oil (35% @ 30:70 @M.P.)							6.9	13.8	13.8	13.8	13.8	12.4	11.2	10.1	9.1	8.2	7.3	6.6	6.0	5.4
Total revenue							33.2	66.5	66.5	66.5	66.5	60.0	54.0	48.7	43.9	39.3	35.2	32.0	28.8	26.0
Operating costs							11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Exploration/capital expenditure					123.9	146.3	76.4													
Cash flow to company					-123.9	-146.3	-55.0	54.7	54.7	54.7	54.7	48.2	42.2	36.9	32.1	27.5	23.4	20.2	17.0	14.2
GOVERNMENT:																				
Share of production (42% @M.P.)							27.6	55.1	55.1	55.1	55.1	49.7	44.7	40.3	36.3	32.6	29.2	26.5	23.9	21.5
Government cash flow							27.6	55.1	55.1	55.1	55.1	49.7	44.7	40.3	36.3	32.6	29.2	26.5	23.9	21.5

[a] 40% of output valued at the market price

[b] 30% of 25% of output valued at $0.20 per unit

[c] 30% of 35% of output valued at market price

resulting sum is the accumulated value of net assessable receipts for year $_t$. At least during the early life of the project and always in the case of a marginal project the accumulated value of net assessable receipts figure will be negative as accumulated outflows exceed accumulated receipts. Should this figure become positive it is evident that an IRR in excess of the threshold rate has been achieved. All subsequent positive net assessable receipts are subject to RRT.

Of course, if the company at any stage realises further negative net assessable receipts, either through trading losses or through additional capital expenditures on, say, secondary recovery facilities, then these losses are again compounded at the threshold rate until a positive figure is reached.

In the hypothetical example, (Table 5), the chosen threshold rate is 15 per cent, which corresponds to the assumed company hurdle rate. In reality this equality may not hold as the government may be ignorant of the value of the hurdle rate of a particular project and in any case may, given imperfect information, prefer the administrative ease of setting a uniform threshold rate for the entire industry.

A tax rate of 50 per cent is assumed. While in principle RRT could be levied at 100 per cent as it is applied only to rent, such a rate is not conducive to recovery efficiency. The company would desert the project at the onset of RRT as it faces the certainty of earning zero after-tax income. Thus, although a 100 per cent RRT rate is consistent with the decision to invest in the first place, it is not consistent with the continuation of operations once the hurdle rate has been achieved.

Case 5: Resource Rent Tax in Hybrid Form with Corporate Income Tax

Under the pure RRT scheme government receipts from the project are likely to be postponed for a number of years, thereby reducing their present value at a positive social discount rate. If the government finds it impossible to borrow funds on international capital markets at interest rates which are below the social discount rate then they may find it necessary to superimpose the RRT upon normal corporate income tax. This will have the effect of bringing forward the first flow of funds into consolidated revenue.

TABLE 5: RESOURCE RENT TAX PURE FORM

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COMPANY:																				
Sales receipts							65.6	131.2	131.2	131.2	131.2	118.4	106.4	96.0	86.4	77.6	69.6	63.2	56.8	51.2
Operating costs							11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Exploration/capital expenditure					123.9	146.3	76.4													
Net assessable receipts					-123.9	-146.3	-22.6	119.4	119.4	119.4	119.4	106.6	94.6	84.2	74.6	65.8	57.8	51.4	45.0	39.4
Accumulated value @ 15%					-123.9	-288.8	-354.7	-288.5	-212.3	-124.7	-24.0	79.0								
RRT (50%)							-	-	-	-	-	39.5	47.3	42.1	37.3	32.9	28.9	25.7	22.5	19.7
Cash flow to company					-123.9	-146.3	-22.6	119.4	119.4	119.4	119.4	67.1	47.3	42.1	37.3	32.9	28.9	25.7	22.5	19.7
GOVERNMENT:																				
RRT							-	-	-	-	-	39.5	47.3	42.1	37.3	32.9	28.9	25.7	22.5	19.7
Government cash flow							-	-	-	-	-	39.5	47.3	42.1	37.3	32.9	28.9	25.7	22.5	19.7

In order to reduce the likelihood of the revised tax package deterring potential investments, the threshold rate should normally be raised above the company hurdle rate. First payment of RRT will consequently occur later than under the pure RRT scheme, compensated for the government by early receipts from corporate income tax. However, in the model developed here (Table 6), the threshold rate has not been raised. The decision to leave the threshold rate unchanged has been made so as to more clearly demonstrate the hypothetical impact on RRT in conjunction with corporate income tax upon the post-RRT profitability of a project which is marginal after payment of the corporate income tax.

Case 6: Resource Rent Tax in Hybrid Form with Corporate Income Tax and Progressive RRT Scale

Highly prolific projects taxed at the RRT rate of 50 per cent will still yield significant rents for the company. A means of further tapping these rents for government use is the setting of a progressive RRT scale with two or more rates. Consider the case of two threshold rates, one of (x) per cent and the other of (x+y) per cent. Net assessable receipts are accumulated at (x) per cent until their accumulated value turns positive. Simultaneously net assessable receipts are independently accumulated at (x+y) per cent. Setting of RRT rates will entail a rate of (a) per cent for the lower threshold and (b < a) per cent for the upper thus yielding a marginal tax rate of (a+b) per cent on very high rents.

Under a system of progressive RRT rates, projects which are marginal ex poste will pay no rent taxes, thus preserving the rationale of the system. Investments which realize net revenues representing moderate rents are taxed at (a) per cent, while those which prove to be highly profitable are subject to the RRT rate of (a+b) per cent. In the hypothetical example of Table 7, (x) is 15 per cent, (x+y) is 20 per cent, (a) is 50 per cent and (b) is 25 per cent, yielding a marginal RRT rate, (a+b) of 75 per cent.

Case 7: Resource Rent Tax in Hybrid Form with Corporate Income Tax, Progressive RRT Scale and Tapering Provision

As was explained earlier, a very high effective RRT rate may induce premature abandonment of a project, thus sacrificing potential government revenue. Moreover, a rate which is appropriate early in the life of the project may not be the most suitable to later years when the reserve is nearing depletion and unit costs are rising as a result.

TABLE 6: RESOURCE RENT TAX IN HYBRID FORM WITH CORPORATE INCOME TAX

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COMPANY:																				
Sales receipts							65.6	131.2	131.2	131.2	131.2	118.4	106.4	96.0	86.4	77.6	69.6	63.2	56.8	51.2
Operating costs							11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Depreciation							42.4	42.4	42.4	42.4	42.4	26.9	26.9	26.9	26.9	26.9				
Trading profit							11.4	77.0	77.0	77.0	77.0	79.7	67.7	57.3	42.7	39.9	57.8	51.4	45.0	39.4
Corporate income tax (50%)							5.7	38.5	38.5	38.5	38.5	39.8	33.8	28.6	23.8	19.4	28.9	25.7	22.5	19.7
Pre-RRT cash flow to company[b]					-123.9	-146.3	-28.3	80.9	80.9	80.9	80.9	66.8	60.8	55.6	50.8	46.4	28.9	25.7	22.5	19.7
Accumulated value @ 15%					-123.9	-288.8	-360.4	-333.6	-302.7	-267.2	-226.4	-193.6	-161.8	-130.5	-99.3	-67.8	-49.1	-30.8	-12.9	0.0[a]
RRT (50%)							-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash flow to company					-123.9	-146.3	-28.3	80.9	80.9	80.9	80.9	66.8	60.8	55.6	50.8	46.4	28.9	25.7	22.5	19.7
GOVERNMENT:																				
Corporate income tax							5.7	38.5	38.5	38.5	38.5	39.8	33.8	28.6	23.8	19.4	28.9	25.7	22.5	19.7
RRT							-	-	-	-	-	-	-	-	-	-	-	-	-	-
Government cash flow							5.7	38.5	38.5	38.5	38.5	39.8	33.8	28.6	23.8	19.4	28.9	25.7	22.5	19.7

[a] Due to rounding error the actual figure is +4.9, which is close to zero

[b] That is, net assessable receipts

TABLE 7: RESOURCE RENT TAX IN HYBRID FORM WITH CORPORATE INCOME TAX AND PROGRESSIVE RRT SCALE

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COMPANY:																				
Sales receipts							65.6	131.2	131.2	131.2	131.2	118.4	106.4	96.0	86.4	77.6	69.6	63.2	56.8	51.2
Operating costs							11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Depreciation							42.2	42.2	42.2	42.2	42.2	26.9	26.9	26.9	26.9	26.9				
Trading profit							11.4	77.0	77.0	77.0	77.0	79.7	67.7	57.3	42.7	38.9	57.8	51.4	45.0	39.4
Corporate income tax (50%)							5.7	38.5	38.5	38.5	38.5	39.8	33.8	28.6	23.8	19.4	28.9	25.7	22.5	19.7
Pre-RRT cash flow to company[a]	-123.9	-146.3	-28.3	80.9	80.9	80.9	80.9	66.8	60.8	55.6	50.8	46.4	28.9	25.7	22.5	19.7				
Accumulated value @ 15%	-123.9	-288.8	-360.4	-333.6	-302.7	-267.2	-226.4	-193.6	-161.8	-130.5	-99.3	-67.8	-49.1	-30.8	-12.9	0.0				
RRT (50%)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Accumulated value @ 20%	-123.9	-301.2	-404.8	-425.1	-450.5	-482.6	-522.4	-586.2	-672.0	-784.4	-929.7	-1115.7	-1365.7	-1681.4	-2079.3	-2579.4				
RRT (25%)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash flow to company	-123.9	-146.3	-28.3	80.9	80.9	80.9	80.9	66.8	60.8	55.6	50.8	46.4	28.9	25.7	22.5	19.7				
GOVERNMENT:																				
Corporate income tax							5.7	38.5	38.5	38.5	38.5	39.8	33.8	28.6	23.8	19.4	28.9	25.7	22.5	19.7
RRT (i)							-	-	-	-	-	-	-	-	-	-	-	-	-	-
RRT (ii)							-	-	-	-	-	-	-	-	-	-	-	-	-	-
Government cash flow							5.7	38.5	38.5	38.5	38.5	39.8	33.8	28.6	23.8	19.4	28.9	25.7	22.5	19.7

[a] That is, net assessable receipts

There is an element in the basic RRT scheme of insurance against premature shutdown. Installation of secondary recovery facilities resulting in negative net assessable receipts will provide relief from RRT until these accumulated net outlays again turn positive, and this may in fact never occur. However, secondary investments may not be justified on certain projects and in any case they will not necessarily produce a negative net assessable receipts figure. Under such circumstances the tapering provision is desirable, it reduces the effective RRT rate.[9]

A minumum (non-discounted) return on depreciated investment is permitted before RRT is payable. This safeguard should not be confused with the original provision of allowing the company to realize its hurdle rate, which is a discounted rate of return on gross investment. Conceptually, the tapering provision return should equal the opportunity cost of invested capital. Certain investments such as roads cannot easily be divested and used on alternative project sites by the company. Others, such as labour, management and used equipment are relatively mobile. The government administrative task of calculating the opportunity cost of fixed and working company capital is very difficult. A fixed return of (z) per cent of total committed capital expenditure may simplify and expedite the calculations. On some projects this will be overly generous; on others it may cause premature shutdown. It does, however, recognise the need for adequate company cash flow late in the life of a project. In the hypothetical example (z) is assumed at 10 per cent.

Case 8: Resource Rent Tax in Hybrid Form with Corporate Income Tax Accumulation at Zero Interest Rate

Net assessable receipts are carried forward under this scheme, but are not compounded. As such, the arrangement canbe viewed as a special case of RRT, where the threshold rate is zero per cent.[10] By comparing the non-compounding of net assessable receipts with the conventional RRT scheme the effects of compounding the RRT system can be isolated. Apart from the threshold rate all other parameters remain unchanged from the case of RRT in hybrid form with corporate income tax.

Case 9: Petroleum Rent Royalty, 50 per cent

Introduced into Australian discussion by the Industries Assistance Commission [8], the Petroleum Rent Royalty (PRR) is similar to the hybrid form of RRT operating at a single threshold. Essential differences are the

calculation of PRR before income tax, the former being deductible in assessing the latter; and the assessment of PRR on a company rather than a project basis. While the latter provision is not easily modelled the former is. Accordingly, the effects of reversing the order of tax assessment are analysed in the hypothetical project (Table 8).

Case 10: The United Kingdom North Sea Oil Measures

Fiscal measures pertaining to oil companies operating on the United Kingdom Continental Shelf (UKCS) are quite complicated. Three taxes are payable: a royalty of $12\frac{1}{2}$ per cent assessed on the wellhead value of the oil; Petroleum Revenue Tax (PRT) at 45 per cent; and corporate income tax, currently 52 per cent.

For PRT purposes royalty payments are deductible, as are various special items, each having a particular objective. First, PRT should not be payable until the initial investment has been recovered, together with an allowance for profit and risk. This allowance should be specifically related to the geology and risk associated with North Sea ventures. The "uplift factor" is 75 per cent, leading to the following formula: PRT = 0 until Σ operating margin $> 1.75 \Sigma I$, where I is capital investment plus successful exploration outlays. Further, 100 per cent of abortive exploration outlays may be written off before PRT becomes payable.

Second, PRT should not discourage continued exploration and development of a producting field, nor should it discourage the development of marginal fields. An oil allowance of up to one million long tons per year, (approximately 7.5 million barrels of North Sea crude), may be deducted from assessable revenues. There is a maximum allowance of 10 million tons over the life of the field. To the extent that an oil allowance is not needed in a particular year it is carried forward.

Third, PRT should not cause recovery inefficiency with the premature abandonment of a field, and there should be safeguards against a fall in the price of oil. Should the application of PRT reduce pre-corporation tax return to below 30 per cent of capital expenditure than it will be cancelled. Further PRT will not exceed 80 per cent of the amount, if any, by which annual profits exceed 30 per cent of capital expenditure.

A "ring fence" has been drawn around the UKCS so that for PRT purposes company activities elsewhere in Britain are treated separately from those in North Sea waters. Corporate income tax is assessed after allowance for

TABLE 8: PETROLEUM RENT ROYALTY

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COMPANY:																				
Sales receipts							65.6	131.2	131.2	131.2	131.2	118.4	106.4	96.0	86.4	77.6	69.7	63.2	56.8	51.2
Operating costs							11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Exploration/capital expenditure					123.9	146.3	76.4													
Net cash receipts					-123.9	-146.3	-22.6	119.4	119.4	119.4	119.4	106.6	94.6	84.2	74.6	65.8	57.8	51.4	45.0	39.4
Accumulated value @ 15%					-123.9	-288.8	-354.7	-288.5	-212.3	-124.7	-24.0	79.0								
PRR (50%)							-	-	-	-	-	39.5	47.3	42.1	37.3	32.9	28.9	25.7	22.5	19.7
Depreciation							42.4	42.4	42.4	42.4	42.4	26.9	26.9	26.9	26.9	26.9				
Trading profit							11.4	77.0	77.0	77.0	77.0	40.2	20.4	15.2	10.4	6.0	28.9	25.7	22.5	19.7
Corporate income tax (50%)							5.7	38.5	38.5	38.5	38.5	20.1	10.2	7.6	5.2	3.0	14.4	12.8	11.2	9.8
Cash flow to company					-123.9	-146.3	-28.3	80.9	80.9	80.9	80.9	47.0	37.1	34.5	32.1	29.9	14.5	12.9	11.3	9.9
GOVERNMENT:																				
Corporate income tax							5.7	38.5	38.5	38.5	38.5	20.1	10.2	7.6	5.2	3.0	14.4	12.8	11.2	9.8
PRR							-	-	-	-	-	39.5	47.3	42.1	37.3	32.9	28.9	25.7	22.5	19.7
Government cash flow							5.7	38.5	38.5	38.5	38.5	59.6	57.5	49.7	42.5	35.9	43.3	38.5	33.7	29.5

royalty PRT and other normal corporate tax deductions. All capital expenditures are immediately expendable (Table 9).

5 Comparative Performance of Alternative Revenue Sharing Measures

In the absence of taxation the IRR under the $8 per unit assumption is 25 per cent. When output price progressively declines from $8 to $5 per unit the pre-tax IRR is 15 per cent, which is identical to the assumed company hurdle rate and by definition, indicates marginality. Prices were deliberately chosen to produce this result from subsequent demonstration purposes. Under the unit prices which escalate from $8 to $15 the IRR is 38 per cent. Significant rents are thus implicit in the $8 and $15 price regimes (Table 10).

Only the pure RRT scheme succeeds in preventing the after-tax IRR from falling below the hurdle rate at the lowest unit price level (Table 10). It also necessarily fails to collect any government revenue, for to do otherwise would render the project sub-marginal. Under these circumstances, given the assumption of the model that the sole objective of government relationships with natural resource projects is to maximize government revenue, the non-deterrence of the $5 project is of no significance to the government, providing zero fiscal benefit.

Should the project be able to bear say, corporate income tax, then it obviously bestows a benefit on the country through fiscal channels. The constant unit price of $8 has been chosen so as to produce a hypothetical project which is marginal after payment of corporation tax (Table 10). Once again the resource rent tax, in hybrid form with corporate income tax now, manages to avoid deterrence of the project (Table 10). RRT is not triggered when applied to hybrid form because the threshold rate just equals the post-tax company hurdle rate.

At the pre-tax IRR of 25 per cent on the $8 project the pure resource rent tax, on the other hand, is triggered. It does not reduce the post-RRT IRR to 15 per cent, as could be expected theoretically, for it is applied at a rate of 50 per cent rather than 100 per cent. Should the RRT rate have been raised to 100 per cent then the company would have ceased operations by year 13 (Table 5), with the absorption of all profits by RRT.

TABLE 9: THE UNITED KINGDOM NORTH SEA OIL MEASURES

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COMPANY:																				
Sales receipts							65.6	131.2	131.2	131.2	131.2	118.4	106.4	96.0	86.4	77.6	69.6	63.2	56.8	51.2
Operating costs							11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Royalty (12½%)							8.2	16.4	16.4	16.4	16.4	14.8	13.3	12.0	10.8	9.7	8.7	7.9	7.1	6.4
Operating margin							45.6	103.0	103.0	103.0	103.0	91.8	81.3	72.2	63.8	56.1	49.1	43.5	37.9	33.0
Cumulative operating margin[a]							45.6	148.6	251.6	354.6	457.6	549.4	630.7							
Oil Allowance													24.1	72.2	63.8	56.1	49.1	43.5	37.9	33.0
Net assessable receipts							-	-	-	-	-	-	-	-	-	-	-	-	-	-
PRT (45%)							-	-	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation (capital exp. only)							45.6	103.0	103.0	17.3										
Corporate income tax (52%)							-	-	-	44.5	53.5	47.7	42.2	37.5	33.1	29.1	25.5	22.6	19.7	17.1
Cash flow to company				-123.9	-146.3		-30.8	103.0	103.0	58.5	49.5	44.1	39.1	34.7	30.7	27.0	23.6	20.9	18.2	15.9
GOVERNMENT:																				
Royalty							8.2	16.4	16.4	16.4	16.4	14.8	13.3	12.0	10.8	9.7	8.7	7.9	7.1	6.4
PRT							-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corporate income tax							-	-	-	44.5	53.5	47.7	42.2	37.5	33.1	29.1	25.5	22.6	19.7	17.1
Government cash flow							8.2	16.4	16.4	60.9	69.9	62.5	55.5	49.5	43.9	38.8	34.2	30.5	26.8	23.5

[a] $1.75\Sigma I = 606.6$

TABLE 10: INTERNAL RATES OF RETURN ON TOTAL INVESTMENT FOR VARIOUS FISCAL SCHEMES UNDER ALTERNATIVE PRICE ASSUMPTIONS

	(per cent)		
	$5[a]	$8[b]	$15[c]
Ad valorem royalty	-	6	18
Production sharing	-	6	18
RRT hybrid at zero accumulation rate	5	10	17
United Kingdom North Sea Oil Measures	5	12	21
Petroleum rent royalty	8	12	18
RRT hybrid with progressive scale	8	15	19
RRT hybrid with progressive scale and tapering provision	8	15	20
RRT hybrid	8	15	21
Corporate income tax	8	15	25
RRT pure	15	21	30
No taxes	15	25	38

a. i.e. $8 in year 7, $7 in year 8 and $5 in years 9 to 20.

b. i.e. $8 in years 7 to 20.

c. i.e. $ in year 7, $9 in year 8 and $15 in years 9 to 20.

All other tax regimes as modelled deter the post-corporate income tax marginal project (Table 10). Particularly severe are the ad valorem royalty and production sharing, the former because of its insensitivity to capital requirements and actual operating cost experience. Production sharing, as modelled here, imposes an onerous burden upon the project largely because of the valuation of domestic market oil at a fixed 20 ¢ per unit and the division of profit oil in the ratio of 70:30 in favour of the government. The circumstances under which the relative shares of production were actually legislated, however, were those of oil prices around $13 per barrel, not $8 as is assumed here. Nevertheless, production sharing will certainly deter a number of projects which are economically viable before taxes. In other words, production sharing arrangements, too, are unrelated to net profits and to the need of the company to secure a minimum acceptable return on investment, a criticism which is to be repeated for all "non-rent" taxes.

Accumulation of net assessable receipts without interest in assessing RRT liabilities severs the relationship between the threshold rate and the hurdle rate and hence between RRT and the taxation of rents. In the model, accumulation without interest triggers a tax which siphons off some profits that do not represent rent, on the $8 project.

While the petroleum rent royalty could conceivably be made equivalent in its effects to RRT in hybrid form by raising its threshold rate it is apparent that at identical threshold and tax rates the PRR is more severe on company profits than is the hybrid RRT. Also among the more stringent of the modelled tax systems in the hypothetical examples is the UK North Sea Oil scheme. At the lowest price regime it permits only a 5 per cent IRR, rising to a still sub-marginal 12 per cent at a unit price of $8.

Interesting performances are registered on the upside potential represented by the $15 project (Tables 10 and 11). The objective now is to tax rents quite heavily, thereby collecting large amounts of government revenue in present value terms. In this regard the ad valorem royalty and RRT accumulated without interest record large gains (Table 11), but because of their disastrous effects upon the viability of less profitable projects have to be rejected on efficiency grounds.

TABLE 11: PRESENT VALUE OF GOVERNMENT CASH FLOW FOR VARIOUS FISCAL SCHEMES UNDER ALTERNATIVE PRICE ASSUMPTIONS

	$5[a]	$8[b]	$15[c]
Ad valorem royalty	239.4	340.6	548.4
Production sharing	201.2	286.3	460.8
RRT hybrid at zero accumulation rate	121.8	266.4	573.5
United Kingdom North Sea Oil measures	124.8	237.8	504.8
Petroleum rent royalty	93.0	242.9	554.9
RRT hybrid with progressive scale	93.0	194.1	539.5
RRT hybrid with progressive scale and tapering provision	93.0	194.1	523.6
RRT hybrid	93.0	194.1	506.5
Corporate income tax	93.0	194.1	402.0
RRT pure	0.0	97.3	305.3
No taxes	0.0	0.0	0.0

a.)
b.) See footnotes a,b,c, to Table 10.
c.)

Although production sharing allows one of the lowest company returns at the $15 price it does not generate among the highest levels of government revenue. The explanation for this assymetry lies in a quirk of the system as modelled - 30 per cent of "domestic market oil" escapes both the company and consolidated revenue, being sold at only 20 ¢ per unit. Consistent with earlier results the petroleum rent royalty taxes high profits very heavily. It also unfortunately treats low profits in a similar fashion.

The resource rent tax in hybrid form collects very large amounts of revenue, comparatively speaking, when rents are being generated, as in the $15 case. Even more efficient is the hybrid form of RRT which operates at progressive rates, for the second rate is also triggered under the highly profitable situation (Table 7), providing additional accretations of revenue to the government. Circumstances may be envisaged under which the higher marginal RRT rate would result in recovery inefficiency, granting insufficient incentive for the company to continue activities late in the life of the project. The tapering provision described earlier does come into operation on the $15 project, boosting post-tax profitability in later years and thereby facilitating a continuous and prolonged flow of funds into consolidated revenue.

Both the UK North Sea Oil package and corporate income tax fail to collect particularly large amounts of rent on the more profitable venture. The pure form of RRT is also unsatisfactory, capturing at a 50 per cent rate a relatively small proportion of rents.

The analysis of post-tax payback period (Table 12) is consistent with the findings for internal rates of return and the present value of government cash flow. Payout takes six, five and four years respectively under the alternative price regimes involving $5, $8 and $15, in the absence of taxation. Minimum payout is facilitated at all prices only by pure RRT, which defers first payment of pecuniary obligations to the government until later years. Immediate expensing of capital expenditures for corporate income tax purposes in the North Sea Oil arrangement also allows for very short payout. While there will actually be slight differences, due to rounding, in payback period among the various tax schemes based upon corporate income tax, these fiscal packages, as modelled, generally provide for a similar time span during which capital expenditure is recouped. The same cannot be said, however, for production sharing and the ad valorem royalty, both of which lengthen the payback period to what for the company

TABLE 12: PAYBACK PERIOD[a] FOR VARIOUS FISCAL SCHEMES UNDER ALTERNATIVE PRICE ASSUMPTIONS

	(year)		
	$5[b]	$8[c]	$15[d]
Ad valorem royalty	15	8	6
Production sharing	14	8	6
RRT hybrid at zero accumulation rate	7	6	5
United Kingdom North Sea Oil measures	6	5	5
Petroleum rent royalty	7	6	5
RRT hybrid with progressive scale	7	6	5
RRT hybrid with progressive scale and tapering	7	6	5
RRT hybrid	7	6	5
Corporate income tax	7	6	5
RRT pure	6	5	4
No taxes	6	5	4

a. To the nearest whole year.

b.)
c.) See footnotes a,b,c to Table 10.
d.)

would likely be an unacceptable time interval.

6 Generalized Conclusions

Although the models have been couched in very specific terms it is possible to arrive at a set of conclusions significant for taxation of all natural resource projects at any investment, cost and revenue levels.

Foremost among these conclusions is the superiority of a particular version of the resource rent tax, given perfect information by the government, over the alternative measures modelled here, in terms of maximizing the present value of government receipts from natural resource projects. This is the case where RRT combines with corporate income tax at progressive RRT rates and incorporates the safeguard tapering provision. Only pure RRT among the systems analysed is likely to succeed in not deterring a pre-tax marginal project. Its revenue collecting ability on the upside potential, however, is somewhat constrained. The hybrid form of RRT will deter a project which is marginal before taxes, purely because of the non-neutrality of the corporate income tax upon marginal returns. It may be argued, however, that non-deterrence of a pre-tax marginal project is of little benefit to the government, assuming that the sole objective of resource taxation is revenue collection. Under such conditions, deterrence of the marginal project through inclusion of corporate income tax in the package may be successfully traded off by the government for heavy taxation of rents if and when they are apparent.

A project which is marginal in the post-corporate income tax sense will not trigger RRT when the RRT threshold is set equal to the company hurdle rate. Windfall gains realized through any of price increases, cost reductions, lower-than-anticipated investment requirements or unexpectedly prolific reserves will incur RRT liabilities. At an RRT rate set too low, significant rents still accrue to the company. Premature abandonment of the deposit may be prompted by an RRT rate which is very high. The problem is that there is no single RRT rate which is appropriate to all projects under all price and cost conditions and at every point in the life of a project. A solution to this dilemma is the design of progressive RRT rates. Modest rents trigger only the lower rate while heavy windfall gains are siphoned off by the operation of the higher marginal rate. Again, however, the problem of the effect of high RRT rates upon recovery efficiency intrudes

upon the discussion. Herein lies the rationale of a well-designed tapering provision permitting a minimum agreed undiscounted rate of return on capital investment.

Accumulation of net assessable receipts at a compound interest rate which is less than the company hurdle rate severs the relationship between the tax and resource rents as the tax base. Marginal projects, even those which are marginal after corporate income tax, will be deterred.

Assessment of the rent tax before corporate income tax, as is done in the petroleum rent royalty system, can, in principle, be made equivalent to RRT in hybrid form with corporate income tax by an upward adjustment of the threshold rate and/or a lowering of the rent tax rate. There is , however, nothing to recommend this practice over the application of the hybrid form of RRT.

Despite the set of restrictive assumptions which had to be devised in order to appraise the UK North Sea Oil measures, a number of useful observations can be made. The $12\frac{1}{2}$ per cent ad valorem royalty combined with 52 per cent corporation tax produce a basic tax system which is highly non-neutral on the investment decision. The insensitivity of both of these taxes to the need of the company to achieve its hurdle rate and of the ad valorem royalty to actual cost experience will inevitably result in deterrence of some projects which before taxes are viable. On the upside potential the generous oil allowance and other concessions in the assessment of PRT substantially reduce the effective PRT rate. As a result, a large share of genuine rents remains with the company. By failing to directly relate the PRT formula to a minimum acceptable rate of return to the company the UK North Sea system is an inefficient collector of rent. These findings are identical to those of Cochrane and Francis[3] who utilize a different model.

"The wide disparity in net revenues between fields is consistent with the claim by Kemp[10]that present fiscal measures fail to ensure that the rates of returns between fields are brought closely together. There is an apparent tendency for the present tax structure to discriminate in favour of relatively low cost fields and against relatively high cost fields."

Thus, on both highly profitable and marginally profitable fields the UK North Sea oil package fares rather badly, its poor sensitivity to ex poste profit rates constraining its ability to concentrate upon rents.

Production sharing, regardless of whether it has a "domestic market oil" component such as the one modelled here, is also conceptually far from the optimal tax system for maximizing government revenue. It is not consciously geared towards the taxation of rents and will consequently tend to deter less profitable projects and/or to under-tax highly profitable investments, the direction of the bias depending upon production splits and the size of the cost recovery oil allowance.

Among the taxing arrangements developed the ad valorem royalty is the most inefficient means of collecting revenue. The extreme non-neutrality of such royalties upon the investment decision is in practice disguised by their application at relatively low rates in conjunction with other taxes, most commonly the corporation income tax. As a component of a taxation package the ad valorem royalty at anything but negligible rates will have a profound effect upon the after-tax viability of modestly profitable ventures. A large proportion of very high rents will, moreover, remain untapped by the royalty levied at a fixed percentage of revenue.

The formulated models abstract from certain complications of the real world which may have the effect of modifying, though not substantially altering the conclusions reached. A number of problems have not been examined. Intracorporate pricing among affiliates of a transnational corporation, other possible evasion methods and tax creditability are among these. Further, perfect information by the government on company financial data, and particularly the hurdle rate, is assumed.[11] Conditions of imperfect information may tempt governments to apply taxes which are easy to administer but which are inefficient in terms of revenue maximization. Rather than succumbing to this temptation governments would very likely derive greater fiscal benefit from directing their attention towards improving their information on company financial data and applying the resource rent tax.

FOOTNOTES

1. For evidence of this practice see Industries Assistance Commission [9].

2. Merrett and Sykes [12] provide an elaboration.

3. Further details are available in Little and Mirrlees [11].

4. The figures have been derived from Papua New Guinea [13].

5. This is consistent with the findings of Papua New Guinea [13] for the world oil industry.

6. That is exclusive of transportation cost.

7. For a discussion see Far Eastern Economic Review [4].

8. Developed by Garnaut and Ross [6].

9. The tapering provision represents an innovation to the Garnaut and Ross [6] scheme.

10. This represents a simplified version of a scheme proposed by Cary-Brown [2], which has been likened to RRT by Swan [14].

11. Garnaut and Ross [6] suggest methods of dealing with this problem.

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Some papers out of stock have subsequently been accepted for publication elsewhere in either unmodified or revised form. Details available to date of these and other papers appear below.

Working Papers in Economics that have been accepted for publication elsewhere

2.	I.G. Sharpe & R. G. Walker	Journal of Accounting Research, Fall 1975, 293-310.
3.	N. V. Lam	Journal of the Developing Economies, Vol. 17, No. 1, March 1979.
4.	V. B. Hall & M.L. King	New Zealand Economic Papers, 1976, 118-51.
5.	A. J. Phipps	Economic Record, September 1977, 297-319.
6.	N. V. Lam	Journal of Development Studies, Vol. 14, No. 1, October, 1977.
7.	I. G. Sharpe	Australian Journal of Management, April 1976, 85-106.
13.	I. G. Sharpe & P.A. Volker	Kredit Und Kapital, 1978.
21.	R. L. Brown	Australian Journal of Management, Vol. 3, No. 1, April 1978, 17-36.
23.	I.G. Sharpe & P.A. Volker	The Australian Monetary System in the 1970's , M. Porter (ed.), Supplement to the Economic Record, 1978, 160-170.