Rent Royalties*

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On neutrality grounds, royalties designed to tax only the economic rent of mining or petroleum operations are preferable to royalty schemes currently used in Australia. The Resource Rent type of royalty generally has a predictable but asymmetrical effect on the probability distribution of the net present value of projects being considered for investment. This effect is independent of the characteristics of individual projects, and so with appropriate selection of the operating parameters, this royalty scheme would not greatly affect the screening of projects for investment purposes.

Introduction

A Musgravian separation of efficiency and equity effects[1] is useful when considering the issues related to a policy of import parity pricing of energy products. However, in practice the two effects cannot be separated: a policy of import parity pricing designed to improve the allocation of resources will always have equity side effects. Further, a policy aimed at changing the equity effects of such a pricing policy may itself have associated efficiency effects.

The policy in Australia of moving from below world prices of domestically-produced crude oil to import parity has been implemented primarily on efficiency grounds. Nevertheless, a redistribution of income from previously subsidized consumers to crude oil producers is one obvious equity side effect of this policy. It may appear that this resulting redistribution of incomes is only related to equity effects, and as such best left to the government for consideration. However, if the government decides to redistribute the gains from domestic crude oil production by imposing royalties, the method by which these royalties are imposed can adversely affect efficient resource allocation. The royalties ideally should be levied so as not to affect investment decisions after income tax.

Discounted cash flow techniques are often used as the initial screening process to identify potentially viable investment projects. The two measures most commonly used are the discounted net present value and the internal rate of return. The ideal royalty scheme should not affect either the screening of potential investments nor the ranking of these with regard to expected profitability. The theory of income-tax schemes which are neutral regarding investment screening decisions can be used to design such a royalty scheme which can then be compared to the currently used royalty schemes regarding investment neutrality.

The two neutral income-tax schemes which will be considered here are the Brown Tax and the practical version of this tax, the Resource Rent Tax. Two comparisons form the main body of the paper: the comparison of the Brown Tax, the Resource Rent Tax and the existing Australian company tax schemes; and the comparison of a Resource Rent Tax applied as a royalty before and after company tax. Discussions of the general practical difficulties associated with a Resource Rent type of scheme are outside the scope of the paper.

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[1] Musgrave (1959), Chapter 1.

The Brown Tax Scheme

Discounting the stream of expected net capital expenditures and net receipts of a project at the internal rate of return *before tax* results in the following equality:

$$C = R \qquad (1)$$

where C = discounted net capital expenditures in each year,
R = discounted net receipts in each year,

and assuming that the sum of the net receipts is not less than the sum of the total of the capital expenditures.

Brown (1948) showed that applying a company tax scheme, which incorporates full loss offset[2] and immediate expensing of all capital expenditure, to the same stream of capital expenditures and receipts results in the discounted equality[3],

$$C(1 - t) = R(1 - t) \qquad (2)$$

where t = the company tax rate.

The cost of capital is reduced (through the immediate depreciation allowances) by the same proportion (the rate tax) as the net receipts are reduced by the tax payments in each period. Therefore, the internal rate of return after applying this Brown Tax Scheme is equal to that before tax. After tax, investment screening decisions made using the internal rate of return criterion would be the same as those made before tax.

The Brown Tax would also remain neutral if investment screening was based on the discounted net present value criterion. Equation (1) can be expressed more generally to show the net present value, NPV, before tax when using any discount rate. That is,

$$NPV_b = R - C. \qquad (3)$$

Similarly, equation (2) can be expressed more generally to show the net present value after the Brown Tax using any discount rate. That is,

$$NPV_t = (R - C)(1 - t). \qquad (4)$$

Equation (4) shows that applied to all sectors, the tax would reduce the absolute value of the NPV of all potential projects by the same proportion (the tax rate) and so the scheme would again be neutral across the whole economy. Swan (1976) also showed this using the general present value formula.

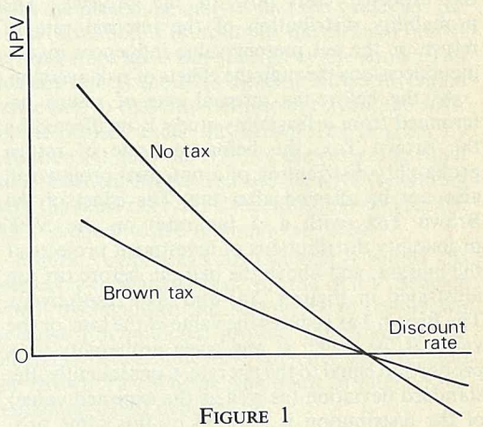


FIGURE 1

Other discussions of the Brown Tax Scheme are given by Musgrave[4] and Sumner (1975).

The relation between the discounted NPV curve of a project before and after the Brown Tax (with a ·5 tax rate) is shown in Figure 1. This shows the internal rate of return constant after the tax and the NPV reduced by 50 per cent at each discount rate.

When screening investment projects, entrepreneurs are not simply concerned with the internal

[2] A loss is incurred if the revenue earned in an income period is less than the allowable depreciation deductions plus the operating costs in that period, and with full loss offset either, (i) sufficient income from other sources is available from which to deduct any losses incurred, or (ii) the government gives a rebate equal to any loss times the tax rate.

[3] With immediate expensing of capital expenditure, the value of the cash flow in the nth income period, V_n, is given by,

$$V_n = R_n - C_n - t(R_n - C_n)$$

where R_n = net receipts in period n, and
C_n = capital expenditure in period n.

Full loss offset maintains the identity if $(R_n - C_n)$ is negative in any period. Because,

$$\sum_{i=1}^{n} \frac{tX_i}{(1+r)^i} = t\sum_{i=1}^{n} \frac{X_i}{(1+r)^i}, \text{ and}$$

$$\sum_{i=1}^{n} \frac{X_i + Y_i}{(1+r)^i} = \sum_{i=1}^{n} \frac{X_i}{(1+r)^i} + \sum_{i=1}^{n} \frac{Y_i}{(1+r)^i}$$

where r = the discount rate, and
X_i and Y_i are the ith values of two series of n numbers,

then if the stream of cash flows is discounted at the rate which sets the net present value, NPV, of this stream to zero,

$$0 = R - C - t(R - C)$$

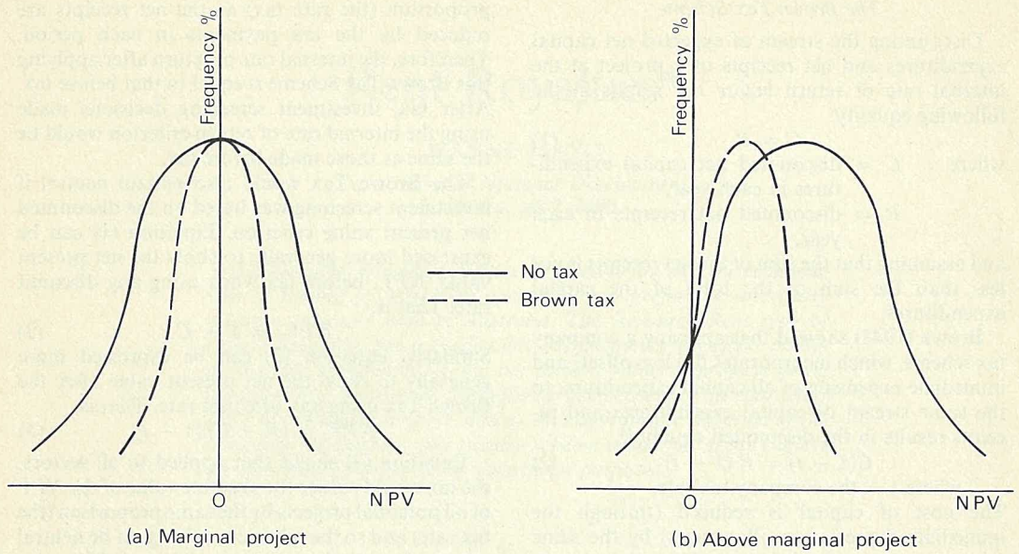
That is, with discounting at the internal rate of return,

$$C(1 - t) = R(1 - t),$$

or discounting at any discount rate,

$$NPV_t = (R - C)(1 - t).$$

[4] Musgrave (1959), Chapter 14.



(a) Marginal project (b) Above marginal project

FIGURE 2

rate of return or net present value determined from the expected cash flow of the projects. The probability distribution of the internal rate of return or the net present value influences investment decisions through the effects of risk aversion.

As the before-tax internal rate of return determined from a feasibility study is unaffected by the Brown Tax, the before-tax rate of return probability distribution of a potential project will also not be affected after tax. The effect of the Brown Tax (with a ·5 tax rate) on the *NPV* probability distributions of investment projects at the margin, and above the margin, before tax are illustrated in Figures 2(a) and 2(b) respectively. The Brown Tax reduces the value of the loss, or the value of the profit, at any given probability by a proportion equal to the tax rate. Consequently, the standard deviation (as well as the expected value) of the distribution is reduced by this same proportion.

Again investment screening decisions based on consideration of the *NPV* probability distribution would not be affected by a Brown Tax applied economy wide. Although the tax would reduce the uncertainty associated with potential projects, this uncertainty would be reduced by the same proportion for all projects.[5] As the tax rate approached 1·0 the expected *NPV* of all projects would approach zero and the graphs on Figures 2(a) and 2(b) would approach a vertical straight line cutting the *NPV* axis at zero representing a situation where normal profits are guaranteed. On Figure 1, a tax rate just less than 1·0 would result in a line almost touching the discount rate axis but still actually cutting the axis at the before-tax rate of return value.

Under this ideal neutral tax scheme, the discount rate used by entrepreneurs to estimate the *NPV* probability distribution of projects would be the same whether the estimation was carried out before or after tax. That is, the after-tax discount rate would be independent of the company tax rate and (assuming perfect mobility of capital) would be equal to the time preference rate of money. Using the *NPV* probability distribution, projects would be evaluated with the same discount rate and decisions made according to the resulting distribution and the entrepreneurs' attitude to risk.

A risk component would only be incorporated into the discount rate if investment decisions were based solely on the *NPV* determined from each project's expected cash flow. In this case (which is commonly used in practice), the risk inclusive discount rate should be considered as a proxy for the effect of a characteristic level of variance of the *NPV* probability distribution for projects under consideration. All the equations in this paper represent this determination of a single *NPV* determination based on the expected cash flow.[6] Alternatively, the equations represent a situation of certainty with regard to the future cash flow or represent but one *NPV* estimation out of all possible results.

[5] However, the ranking of projects may be affected if the entrepreneur's trade-off between expected *NPV* and the associated variance is not linear.

Resource Rent Tax Scheme

A variant of the Brown Tax, which does not incorporate full loss offset with the associated rebate payment requirements, is the Resource Rent Tax (RRT). The RRT Scheme was proposed by Garnaut and Clunies Ross (1975) specifically for large natural resource projects which are supplied and financed from foreign sources.[7]

This scheme is equivalent to the Brown Tax Scheme except that if net receipts are less than the allowable deductions in any period, then the loss is carried forward with an added interest component per year (at a specified 'threshold' rate) to be offset against any future income. This overcomes the requirement for government rebate payments. Garnaut and Clunies Ross proposed that the threshold rate would ideally be set in relation to a value considered to be equal to the risk inclusive discount rate appropriate to the corresponding industry.[8]

The interest component on losses carried forward is designed to maintain the value of these deductions so that when sufficient income is available the benefit obtained from these deductions is equivalent (in present value terms) to having full loss offset provisions. Individual investments made in years when sufficient income is available to deduct immediately the full amount of the capital expenditure would be subject to the Brown type of tax. The after-tax internal rate of return of these individual investments then would be equal to their before-tax return.

By carrying losses forward with a specified interest rate instead of allowing full loss offset, the RRT Scheme differs from the Brown Tax Scheme with regard to

(1) the cash flow stream (and stream of taxation payments) resulting from the same project, and
(2) the treatment of projects where sufficient revenue is not generated to absorb fully the losses carried forward.

Comparison of the RRT and the Brown Tax Schemes

Figure 3 shows comparisons of *NPV* curves for the no-tax, Brown-Tax and RRT situations for an above-marginal operation and a marginal operation with the *NPV* determined from the expected cash flow of the operations. A ·5 tax rate applies to both taxation schemes and sufficient income is assumed to be generated to absorb fully the losses carried forward with the RRT Scheme. The results of feasibility studies of a hypothetical oil-field operation under different taxation schemes (shown in Table 1) also contrast the differences between the Brown Tax and the RRT Schemes. Although the values in Table 1 were obtained using a computer program designed for cash flow analysis[9], many of the figures in the table could be determined directly from the preceding analysis and the values for the no-tax situation. For example: the internal rate of return before tax is not affected by the Brown Tax Scheme nor by the RRT Scheme with a threshold rate equal to that internal rate of return; the *NPV* of the project under the Brown Tax is given by equation (4); and the *NPV* of the project is equal under both the Brown Tax and the RRT (operating with the same tax rate) if the threshold rate for the RRT is equal to the discount rate used.

Figure 3 emphasizes the fact that it is only the loss-carry-forward aspect of the RRT Scheme which distinguishes this scheme from the Brown Scheme. For potential projects the extent of the difference between the *NPV* curves of the RRT and the Brown Tax Scheme (the point of intersection remaining fixed) depends on,

[6] In the text, the distinction is made between the 'expected *NPV*' based on the complete *NPV* probability distribution and the *NPV* based on the expected cash flow.

[7] The discussion of the RRT is broadened by Garnaut and Clunies Ross (1979).

[8] As mentioned earlier, this risk inclusive discount rate should be considered as a proxy for the effect of a characteristic level of variance of the *NPV* probability distribution for projects in a particular industry.

[9] The program (IRR), written by the author, is stored on the Industries Assistance Commission disk pack, Canberra. The simulated effects of the royalty schemes presented later in the paper were also obtained from this program. The results of these case studies are for illustrative purposes only and must not be regarded as indicating the profitability of oil fields yielding the stated volume of oil. Numerous other factors, including the location of the field, the structural complexity of the associated stratigraphy and the properties of the source rock, influence this profitability.

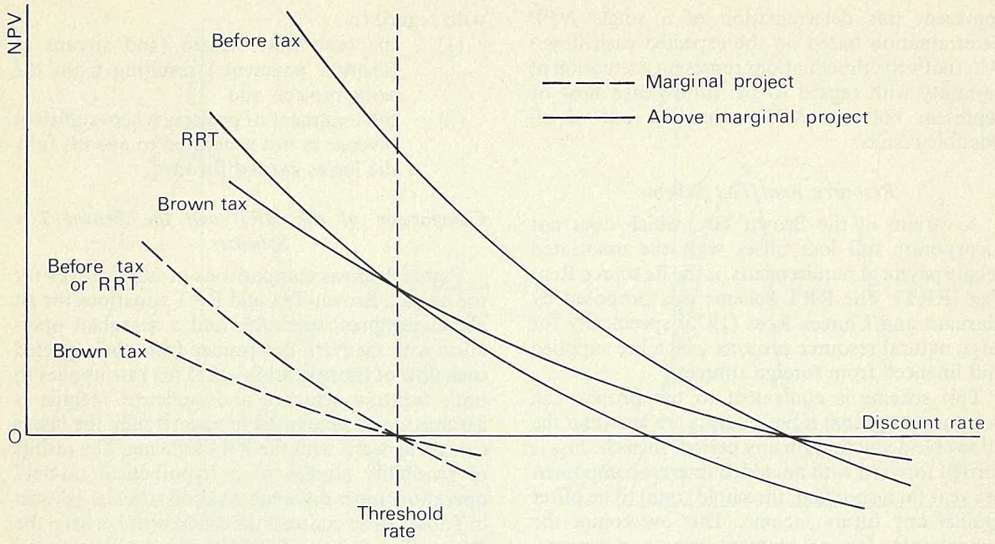


FIGURE 3

(1) the proportion of capital expenditure which cannot be immediately deducted to that which can be immediately offset against income, and

(2) the extent to which these losses have to be carried forward before sufficient revenue is available.

The difference between the RRT and Brown Tax *NPV* curves is maximized with marginal projects where, in fact, all the capital expenditure must be carried forward and the deductions are only just absorbed fully in the last period of operations. The curves of the two schemes would correspond when no losses are expected to be realized in any period of operation of a potential project.

The total income tax paid by the same project under the RRT Scheme and the Brown Tax Scheme would be considerably different. Under the RRT Scheme if the project is marginal so that the pre-tax *NPV* equals zero and if the threshold rate is set equal to the corresponding discount rate the project will pay zero income tax.[10] This is because the capital expenditure outlays in the early no-income years of the project are carried forward at the same rate as the discount rate applied to the later net receipts. Thus, only that portion of the profits which is greater than the opportunity cost of investing in the project (the economic rent) is taxed by the RRT Scheme.

In contrast, under the Brown Tax Scheme even marginal operations would pay income tax. With this scheme, early reduction in net annual capital outlays is balanced by later higher (than with the RRT Scheme) taxable income. However, if these taxation payments are discounted at the internal rate of return of the project, the present value of the tax paid will be equal to the government rebate payments (discounted at the same rate). Therefore, the discounted taxation and rebate payments from marginal operations will also be zero under the Brown Tax Scheme.

With above marginal projects, the after-RRT rate of return is reduced below the pre-tax rate but is maintained above the threshold rate. In present value terms, the relation between the two schemes depends on the discount rate used by the entrepreneur who is screening the investment project and the threshold rate to apply with the RRT Scheme. As shown in Figure 3, the two taxes are equivalent with regard to the *NPV* based on the expected cash flow if the discount rate for present value determination is equal to the threshold rate.[11] That is, under these circumstances (and assuming

[10] More generally, if the threshold rate is set equal to or greater than the discount rate.

[11] Using the internal rate of return criterion the Brown Tax would give a higher rate of return, but with intersecting present value curves (see Figure 3) the *NPV* is really the appropriate measure.

TABLE 1

Oilfield Case Study[a]

Taxation Scheme	Internal Rate of Return %	*NPV* of Project (discounted at 10%) $m	*NPV* of Project (discounted at 15%) $m	Total Tax Paid $m	*NPV* of Tax paid (discounted at 10%) $m
1 *No Tax*	29·5	545	296	0	0
2 *Brown Tax*					
·45 Tax Rate	29·5	300	163	792[b]	245
·75 Tax Rate	29·5	136	74	1320	409
3 *RRT*[c] (·45 tax rate)					
15% threshold rate	24·9	327	163	664	218
25% threshold rate	27·7	420	226	447	125
29·5 % threshold rate	29·5	545	296	0	0
4 *5-year depreciation of capital expenditure* (·45 tax)					
Losses carried forward	22·1	261	114	792	284
Full loss offset	25·9	283	143	792	262

[a] Total production of 230 million barrels at a world parity of $10.24 is assumed.
Life of project = 20 years.
Total capital expenditure = $391 m in first six years.

[b] $169m of taxation rebates would have been received in the first 5 years and $961m taxation payments made in the remaining 15 years.

[c] There are no losses which cannot eventually be deducted in full.

no unrecouped losses) the RRT will reduce a positive *NPV* by a proportion equal to the tax rate (equation [4]).

However, unrecouped losses under the RRT Scheme would be common and the Brown Tax Scheme would be preferred because of the full loss offset provisions. This would be particularly relevant, for example, with the mining and petroleum industry where losses by exploration companies are common, as are losses at the closing stages of production. The expected *NPV* after tax of all projects (including marginal projects) would be reduced by the likelihood of unrecouped losses under the RRT Scheme. This can be illustrated with reference to Figure 2.

Unrecouped losses, say at the closing stages of production, could mean that the RRT reduces the before-tax value of each positive *NPV* by more than the tax-rate proportion. Further, the RRT does not reduce the probability associated with each negative *NPV*, as the RRT generally affects the *NPV* only when this is positive.[12] Consequently, for projects which have some chance of incurring losses before tax, the expected *NPV* will be reduced because the *NPV* frequency distribution will be negatively skewed by the RRT. This means that the rate of tax with the RRT is not independent of the discount rate, nor therefore, the threshold rate.[13]

In sum, the Brown Tax reduces the pre-tax *NPV* at each level of probability for all potential projects by a proportion equal to the tax rate. In contrast, assuming no unrecouped losses are associated with positive net present values and with discounting at the threshold rate, the RRT only reduces positive net present values by this proportion, negative values generally not being affected. Therefore, whereas the Brown Tax has a symmetrical effect on the *NPV* probability distribution of a project, the RRT will skew this distribution negatively.

[12] The size of a negative pre-tax *NPV* could, in fact, be increased by the RRT if, in some periods, net receipts were greater than allowable deductions.

[13] The threshold rate and the tax rate with the RRT may appear to be independent, the values being chosen to reflect a government's priorities in relation to not distorting investment decisions and to raising revenue respectively. However, because of this effect on the *NPV* probability distribution, the RRT tax rate and threshold rate are inter-related.

Consequently, the discount rate would be directly affected by the RRT, but generally this would be affected in a predictable way because of the proportional effect on the positive net present values. The effect of the RRT would not markedly depend on the characteristics of individual projects. Therefore, with the application of an RRT economy wide, the relation between the before and after-tax discount rates would be changed but with appropriate threshold setting there may be no marked effect on the screening of potential projects.

Applying the RRT on a company rather than a project basis would reduce the likelihood of unrecouped losses. Losses from unsuccessful ventures or at the closing stages of successful projects could be offset against income from other successful projects within the one company and the RRT would operate as a Brown Tax. However, the RRT would not be neutral with regard to the investment screening decisions made by small companies with no income from which to deduct losses.

Australian Taxation Scheme

In contrast to the above two neutral taxation schemes, with the existing Australian taxation scheme full loss offset is not applicable unless sufficient other income is available to offset fully any losses. Loss carry forward is allowed only on an historical value basis. Therefore, of two potential projects with the same internal rate of return or net present value before tax, the enterprise with the longer loss carry forward period will be relatively disadvantaged by this tax system. Consequently, such a tax system may result in some projects (with relatively short loss-carry-forward periods) which were sub-marginal before tax being undertaken after tax, and vice-versa.

Further, capital expenditure is not immediately deductible with the existing scheme. Allowable deductions based on the historical value of capital expenditure are given by straight-line or declining-balance schedules.

Assuming full loss offset, the identity showing the *NPV* of the expected cash flow of a project under the existing scheme is (in the notation of equation [4]),

$$NPV_t = R - C - t\,(R - D) \qquad (5)$$

where $D =$ discounted present value of the stream of allowable deductions for capital expenditure.

Not included explicitly in this identity is the deductibility of interest payments on loan funds, nor the taxing of interest receipts, which are both part of the existing taxation scheme. With full loss offset, the effect on equation (5) of all interest payments and interest receipts being treated symmetrically would be an implicit change in the discount rate (Swan, 1976) with no direct distortive effect on investment decisions. Distortions from any asymmetry in the treatment of interest payments and receipts under the existing taxation scheme are ignored here.

Therefore, with full loss effect and first assuming that the company tax has no effect on the before-tax discount rate[14], the before-tax net present value, $R - C$, is reduced after tax by the proportion,

$$t\frac{R - D}{R - C}$$

This proportional reduction in the NPV_b would vary from project to project depending on the amount of capital expenditure relative to the expected net receipts, as well as the write-off period of the associated capital expenditure. Further, differing loan to equity ratios and loan interest rates will change this proportional reduction between projects.

As with the RRT, the before-tax *NPV* probability distribution is also negatively skewed by the existing taxation scheme. The probability of achieving each level of profit is reduced and the probability of achieving some negative net present values is actually increased. However, the amount of these changes will vary with each project. Therefore, even when the after-tax discount rate is adjusted to account for the non-neutralities of the existing taxation scheme, some projects marginal before tax could be sub-marginal after tax and the ranking of projects screened as potentially viable could be markedly affected.[15]

[14] Apart from income effects and the effects of the interest treatment, there is also the additional effect on the discount rate after tax due to the non-neutrality of this taxation scheme.

[15] Swan (1976, p. 172) showed that with loss of economic value depreciation, symmetric treatment of interest and full loss offset the *NPV* is again reduced by a proportion,

$$\frac{(1 + i)\,(1 - t)}{1 + i\,(1 - t)}$$

where $i =$ the discount rate before company taxation, thus maintaining neutrality of investment screening decisions.

Consequently, on neutrality grounds either the RRT or the Brown Tax Scheme would be preferable to the existing scheme. Nevertheless, taking the existing income-tax scheme and any associated non-neutralities as given, additional royalty revenue could be raised by applying one of these schemes which tax only economic rent. Given that some industries, notably the natural resources industries, are subject to royalties, one of these rent royalties applied in addition to company tax may be the best way to raise this additional revenue with a minimum effect on investment screening decisions.

Royalty Schemes and the Australian Taxation Scheme

Profit Royalties

The most common types of royalties applied to the Australian mining and petroleum industries are unit, *ad valorem* and profit royalties. The *NPV* identity of the existing taxation scheme, assuming full loss offset, deductibility of debt interest payments and incorporating tax deductible profit royalties is,

$$NPV_r = R - C - t[R - D - r(R - D)] - r(R - D)$$

where $r =$ profit royalty rate.

Therefore, with the same discount rate as before the royalty,

$$NPV_r = NPV_t\left[1 - \frac{(R - D)(r - tr)}{NPV_t}\right]$$

where NPV_t is an in equation (5).

That is,

$$NPV_r = NPV_t\left[1 - \frac{r(1 - t)}{(R - C)/(R - D) - t}\right] \qquad (6)$$

Consequently, the before-royalty *NPV* of each project would not be reduced by the same proportion after the introduction of profit royalties.[16]

[16] A profit royalty incorporated into a Brown income-tax scheme would not affect marginal screening decisions as the *NPV* identity in this case would be,

$NPV_r = R - C - t(R - C - r(R - C)) - r(R - C)$

i.e. $NPV_r = (R - C)\,(1 - (t + r - tr))$,

Thus, the before-tax and royalty *NPV*, $R - C$, is reduced by a constant proportion after both income tax and royalties and the tax plus royalty would have a symmetrical effect on the *NPV* probability distribution. Similarly,

Non-Profit Royalties

Similarly, tax deductible unit or *ad valorem* royalties would not be neutral regarding investment screening decisions as the *NPV* identity in relation to the existing tax scheme (under the above assumptions) would be,

$$NPV_r = R - C - t\,(R - D - N) - N$$

where $N =$ the discounted present value of the non-profit royalties.

That is[17],

$$NPV_r = NPV_t\left[1 - \frac{N(1 - t)}{NPV_t}\right] \qquad (7)$$

Both profit and non-profit royalties do not reduce the *NPV* (based on the expected cash flow) of each project by the same proportion. Further, equation (6) and equation (7) indicate that both profit and non-profit royalties applied in conjunction with the existing taxation scheme reduce the probability of achieving each level of profit while increasing the probability of achieving each level of loss.[18] Thus, those royalties tend to skew the after-tax *NPV* frequency distribution negatively reducing the expected rate of return (by an amount which depends on the characteristics of each project) and the investment opportunities in the corresponding industry.

RRT and Brown Tax as Royalties

In contrast, as shown in Figures 2(a) and (b) either the RRT (assuming no unrecouped losses) or the Brown Tax applied as a royalty scheme after

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a royalty operating as an additional component on the income-tax rate within a Brown income tax scheme would not affect marginal decisions as in this case,

$$NPV_r = (R - C)\,(1 - (t + r)).$$

[17] Unlike a profit royalty, unit or *ad valorem* royalties would affect marginal screening decisions even if applied in addition to a Brown type income tax scheme. For example, with an *ad valorem* royalty applied to net receipts,

$$NPV_r = R - C - t\,(R - C - rR) - rR,$$

where $r =$ *ad valorem* royalty rate.

Therefore, if the *NPV* before tax and royalties were zero (and so remained zero after the Brown Tax) the *ad valorem* royalty would reduce this by the amount $r\,(R - tR)$ if the discount rate was unchanged.

[18] With equation (6), if $NPV_t > 0$, $(R - C)/(R - D) > t$ and the profit royalty reduces the *NPV*, but if $NPV_t < 0$, $(R - C)/(R - D) < t$ and so the royalty again reduces the *NPV*.

TABLE 2

Government Take[a] and Producer Return[b] from Hypothetical Oil Fields with Different Rent Royalty Threshold Rates

	Hypothetical Fields[c]		
	200m bbl.	250m bbl.	400m bbl.
After-Tax Rent Royalty			
15% threshold *NPV*	−8·1	1·7	55
Government take	219	227	634
Internal rate of return	14·3%	15·1%	17·6%
20% threshold *NPV*	−8·1	3·4	110
Government take	219	222	527
Internal rate of return	14·3%	15·3%	19·5%
Before-Tax Rent Royalty			
20% threshold *NPV*	−14·5	−0·4	46
Government take	230	274	648
Internal rate of return	13·6%	14·9%	17·3%
25% threshold *NPV*	−8·1	3·4	97
Government take	219	222	556
Internal rate of return	14·3%	15·3%	19·2%
Profits Royalty (·50 rate)			
NPV	−62·8	−48·6	−23·5
Government take	299	313	755
Internal rate of return	8·4%	10·4	13·8%
$2 Unit			
NPV	−85·0	−43·0	20·7
Government take	325	295	670
Internal rate of return	6·4%	11·4%	15·9%

(a) Company tax, royalties plus petroleum rent royalty, in millions of dollars. Values are over the life of the field in present value terms discounted at 10 per cent.

(b) Determined under the following assumptions: ·45 company tax rate: ·50 petroleum rent royalty rate; 12·5% *ad valorem* State royalties; 5-year write-off of capital expenditure and immediate expensing of exploration expenditure; and a price of $10·24 per barrel. The *NPV* is given in millions of dollars discounted at 15 per cent.

(c) Size of field in millions of barrels.

company tax, affect the before-royalty *NPV* frequency distribution symmetrically, acting to reduce the profits and losses in the same proportion which is independent of the characteristics of the particular project. Therefore, regardless of any non-neutral effects of the income-tax system, these theoretical royalty schemes would not further affect marginal screening decisions.

With these neutral royalty schemes applied after company tax, the before-royalty *NPV* based on the expected cash flow of above marginal projects would be reduced but only by a proportion equal to the royalty rate. The *NPV* of a potential project with one of these neutral royalty schemes applied after the existing income tax scheme is,

$$NPV_r = R - C - t(R - D) - r(R - t(R - D)) \quad (8)$$

where r = the royalty rate.

That is,

$$NPV_r = NPV_t - r(NPV_t),$$

where NPV_t is as in equation (5).

The application of such royalty schemes to an individual industry may cause an entrepreneur to rank a potentially viable project in this industry below a project previously ranked equal in an industry not subject to the royalty. Nevertheless, the project subject to the royalty would still have an expected *NPV* greater than zero and so would still be screened as a viable project.[19] Further, these royalties would not affect the ranking of projects within the industry subject to the royalty.[20]

In sum, given the existing taxation system and the desire to raise additional royalty revenue in some industries without adversely affecting investment screening in these industries, a royalty scheme in the form of the ideal RRT Scheme or the Brown Tax Scheme is preferable to other forms of royalties currently used in Australia. Table 2 illustrates the adverse effects which additional unit or profit royalties would have on investment decisions in the petroleum industry. If a rate of 15 per cent were the appropriate post-tax risk-inclusive discount rate for the industry, some projects which would have been undertaken before the additional royalty would be discouraged by these royalties. However, the rent royalty (applied either after company tax or before company tax with the appropriate pre-tax threshold rate) would have no effect on exploration and development decisions.

The Brown Tax applied as a royalty scheme would require royalty rebate payments when losses were achieved. Therefore, despite practical problems associated with unrecouped losses and with selecting an appropriate threshold rate for loss carry forward, a royalty system based on the RRT Scheme may be the variant preferred by governments. However, as seen from the earlier analysis of the RRT, with this type of royalty, unrecouped losses can cause positive net present values to be reduced by more than the proportional reduction shown in equation (8) and can affect the expected *NPV* by skewing the *NPV* frequency distribution.

Consequently, investment could be reduced in an industry subject to the RRT type royalty and ranking of projects within the industry could also be affected. However, unlike the existing royalty schemes, the RRT type of royalty would generally affect the *NPV* probability distribution in a predictable way[21], so that with appropriate combinations of threshold and royalty rates, these distortions could be minimized.[22] Therefore, even with unrecouped losses, the RRT royalty is preferred to existing royalty schemes.

If the RRT royalty were applied on a company basis rather than a project basis the importance of both unrecouped losses and the threshold rate would be reduced. For large highly profitable companies loss carry forward would only be required on the first operation of the company. With all subsequent projects sufficient income would be available to offset fully losses immediately and the RRT royalty would then operate as a Brown Tax with these projects.[23] However, as indicated earlier, small companies would be relatively disadvantaged by a company based scheme.

Rent Royalties

Garnaut and Clunies Ross (1975) indicated that the RRT Scheme could be incorporated within an existing tax scheme instead of as a combined income-tax and royalty scheme. In this case, Garnaut and Clunies Ross suggested that the scheme would be applied after tax.

Applying the RRT royalty after tax would require after-income-tax losses to be carried forward with an added interest component (at a specified threshold rate) to be deducted from the future after-tax receipts. The losses and after-tax receipts would be determined as in the existing income-tax system except that interest payments would not be deductible and capital expenditure would be immediately deductible.

Before-Tax Rent Royalty versus After-Tax Rent Royalty

The RRT royalty scheme could also be applied before income tax, as suggested by the Industries

[19] With perfect mobility of capital the investment would be undertaken if it returns enough to satisfy any investor's discount rate.

[20] Again assuming linear risk functions.

[21] With the appropriate threshold rate, the RRT royalty would generally reduce positive net present values by a proportion equal to the royalty rate, and negative values would generally not be affected.

[22] The threshold-tax rate inter-relation, which means that a reduced tax rate with the same (or increased) threshold rate is required in order to minimize this distortionary effect, and which is implied here, is also referred to by Garnaut and Clunies Ross (1979) in a discussion using risk inclusive discount rates.

[23] Whether operating on a project or company basis, if the associated company had other activities not subject to the royalty, avoidance of royalty payments through profit manipulation would remain perhaps the most difficult problem associated with such a scheme. Legislative controls have been enacted in the United Kingdom to attempt to stop the avoidance of Petroleum Revenue Tax payments.

Assistance Commission when reporting on pricing in the crude oil industry (IAC, 1976) with the royalty payments being deductible from assessable income for income tax. In this case, the excess of deductible expenditure (capital expenditure, operating costs and State royalties) over total revenue in each period would be carried forward with interest. Royalties would be levied at the specific rate when the total revenue exceeded the amount carried forward plus any deductible expenditure in that period. Royalties so levied would be then deductible for income-tax purposes.

Assuming no unrecouped losses, the before-tax RRT royalty would have a symmetrical effect on the before-tax *NPV* probability distribution (as in Figure 2). With a project which is marginal after tax but before royalties, the threshold rate with the before-tax RRT royalty would have to be set at least equal to the before-tax discount rate to ensure that the expected after-tax *NPV* of the project was not reduced below zero by the royalty. However, because the non-neutrality of the company tax scheme affects projects with different characteristics differently, there is no one before-tax threshold rate which would ensure that no royalties were paid on projects marginal after tax.[24]

In contrast, with an after-tax RRT royalty (and no unrecouped losses), the expected after-tax *NPV* of a project marginal after tax would be maintained at zero after the royalty with the threshold rate set at the appropriate post-tax rate. The case studies in Table 2 illustrate this point. With a threshold of 15 per cent (or less) any project with an after-tax rate of return of 15 per cent or more will pay royalties with an after-tax RRT. However, with the before-tax RRT, there is no fixed relation between the before royalty rate of return and the required limiting threshold rate.

The non-neutrality of the existing company tax scheme would also influence the administration of threshold rates over time. Increasing the company tax rate applying to all industries would result in a general effect on discount rates used to screen investment decisions. This would, in turn, require the limiting threshold rates for both the RRT royalty schemes to be adjusted accordingly.

In contrast, any changes to the existing income-tax scheme which would affect the relation between the before-tax and after-tax net present values only within the industry subject to a RRT royalty would mean that the limiting threshold rate would have to be changed with a before-tax royalty but not with the after-tax version. For example, if the write-off period for capital expenditure in the industry was reduced, some previously sub-marginal projects would become marginal after tax and some projects above the margin would not be subject to royalty payments under a before-tax RRT royalty scheme. Ideally, the threshold rate of the before-tax RRT royalty would need to be reduced to ensure that only projects marginal after tax paid no royalties. Such changes in the income-tax scheme which increased the after-tax *NPV* would automatically result in increased royalty payments with the after-tax RRT royalty because of the fixed after-tax threshold rate while projects marginal after-tax would continue to pay no royalties.

The inevitability of unrecouped losses and their skewing effect on the *NPV* probability distribution would also influence the determination of the appropriate threshold and royalty rates with both the RRT royalty schemes. As shown earlier, this skewing effect means that the royalty rate and the threshold rate are inter-related. Consequently, with increasing royalty rates, the threshold rates may have to be increased in order to avoid excessive distortions at the margin in the industry subject to the royalty.

[24] This assumes that the ideal limiting threshold rate is required.

Summary and Conclusions

Royalty schemes currently used in Australia to raise revenue in the mining and petroleum industries reduce the expected after-tax *NPV* of potential projects by skewing the *NPV* probability distribution negatively by an amount which depends on the individual project characteristics. In contrast, a royalty scheme in the form of a Brown Tax applied to marginal projects either before or after company tax would have a symmetrical effect on the *NPV* probability distribution. This effect is independent of the characteristics of the individual project and depends only on the royalty rate. This Brown Rent royalty then would not greatly affect the screening of marginal projects nor the ranking of projects above the margin.

On neutrality grounds then, either the before or after-tax Brown Rent royalty is preferable to the royalty schemes currently used in Australia.

Investment screening decisions based on the expected *NPV* criterion are not affected by the substitution of a Resource Rent Tax type of royalty for the ideal Brown Tax type provided that, (i) sufficient income is generated (or is available) to deduct fully losses being carried forward with interest, and (ii) the threshold rate for interest determination corresponds to the appropriate discount rate. Basing the Resource Rent royalty on a company basis rather than a project basis would minimize the possibility of unrecouped losses and reduce the importance of selecting the appropriate threshold rate for loss carry forward under this scheme. However, small less-profitable companies would be relatively disadvantaged by a company-based scheme.

The inevitability of unrecouped losses with a project-based scheme means that a Resource Rent royalty also skews the *NPV* probability distribution negatively making the threshold rate and royalty rate inter-dependent. However, in contrast to the existing royalty schemes, the Resource Rent royalty would generally affect the *NPV* distribution in a predictable way. Therefore, with appropriate threshold and royalty rates a Resource Rent royalty would not affect investment-screening decisions markedly and would also be preferable to existing royalty schemes.

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