

36
free

THE AUSTRALIAN NATIONAL UNIVERSITY
Centre for Economic Policy Research

DISCUSSION PAPERS

IMPROVING MINERAL TAXATION POLICY
IN AUSTRALIA

Craig Emerson and Peter Lloyd

Discussion Paper No. 36

October 1981

G

6 HC 8
A973

P.O. Box 4, Canberra 2600, Australia

The Centre for Economic Policy Research was established in 1980 as one of a number of University initiatives. It was provided with an annual grant for a period of five years and given a mandate to foster policy oriented studies of the Australian economy. The Centre intends to work closely with other economic research groups - both within the Australian National University and in other Australian universities. Within its means, the Centre stands ready to encourage research by academics with an interest in economic policy issues.

The Discussion Papers of the Centre are intended to make available to a wider audience a series of economic research studies. These studies will have either been commissioned by the Centre (for instance in conjunction with a conference held under the Centre's auspices) or undertaken by its research workers.

Discussion Papers will also be published where economic research work with relevance to policy has been undertaken by individual academics within the Australian National University - or where the Centre is able to act as a focal point for such research.

The Centre as such will not have any views on policy; individuals will.

IMPROVING MINERAL TAXATION POLICY
IN AUSTRALIA

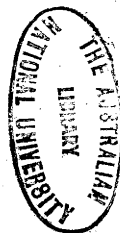
Craig Emerson and Peter Lloyd

Discussion Paper No. 36

October 1981

ISBN: 0 949838 36 5

ISSN: 0725-430X



IMPROVING MINERAL TAXATION POLICY IN AUSTRALIA

Abstract

Australian State governments have begun to increase royalty rates and other mineral taxes. The most instructive approach to taxation policy for the minerals sector is to set up a general model of mines which yields the optimal structure of taxes. A model of mine production under uncertainty is developed, following Leland. The optimal tax is a single tax with two parts, a bonus bid and conditional tax payments based on the ex post rent of the mine. The actual structure of taxes levied by State and Commonwealth governments is seen to be distinctly sub-optimal in several respects. Proposals to move the actual towards the optimal structure are made, recognising some of the constraints on information and the maximum acceptable rate of tax reforms. These proposals include a movement at the maximum feasible rate towards a single two-part tax, with the early introduction of open lump-sum bidding for new leases. In the process of moving towards the single two-part tax it is proposed that specific taxes be converted to ad valorem taxes, or ad valorem taxes to taxes based on annual profits, or that the ordinary income tax base and rates be changed to those of a tax on rent. Some combination of these changes should preferably be made simultaneously.

TABLE OF CONTENTS

DISCUSSION PAPER NO. 36

	<u>Page</u>	
ABSTRACT	(i)	
Introduction	1	
I. The Theory of Optimal Taxation	2	
II. The Actual Mineral Taxation Arrangements in Australia	12	
A. Overview of Taxation Arrangements for the Minerals Sector	12	
B. Royalties	15	
C. The Crude Oil Levy	21	
D. The Coal Export Duty	23	
E. Combined Commodity Taxes	24	
F. Company Income Tax	24	
III. How to Improve Australian Mineral Taxation Policy	26	
References	37	
Footnotes	40	
<u>TABLES</u>		
Table 1	Major Sources of Public Sector Revenue from the Minerals Sector, 1977-78	14
Table 2	State Mineral Royalty Bases for Selected Minerals, 1978-79	16
Table 3	Ad Valorem Equivalents of Royalty Receipts by State and Selected Mineral, 1978-79	19

IMPROVING MINERAL TAXATION POLICY IN AUSTRALIA

Abstract

Australian State governments have begun to increase royalty rates and other mineral taxes. The most instructive approach to taxation policy for the minerals sector is to set up a general model of mines which yields the optimal structure of taxes. A model of mine production under uncertainty is developed, following Leland. The optimal tax is a single tax with two parts, a bonus bid and conditional tax payments based on the ex post rent of the mine. The actual structure of taxes levied by State and Commonwealth governments is seen to be distinctly sub-optimal in several respects. Proposals to move the actual towards the optimal structure are made, recognising some of the constraints on information and the maximum acceptable rate of tax reforms. These proposals include a movement at the maximum feasible rate towards a single two-part tax, with the early introduction of open lump-sum bidding for new leases. In the process of moving towards the single two-part tax it is proposed that specific taxes be converted to ad valorem taxes, or ad valorem taxes to taxes based on annual profits, or that the ordinary income tax base and rates be changed to those of a tax on rent. Some combination of these changes should preferably be made simultaneously.

Introduction

In the last few years there have been suggestions that mining companies in Australia be taxed more heavily. With the resources boom in the 1980s the minerals sector can be expected to become an increasingly important source of public sector revenue.

Some economists and government officials have maintained that the rents received from mineral production should accrue in whole or at least in large part to the state which assigns the mining rights for these minerals on behalf of the population of the country. (For examples of this view see the papers in Smith (ed.), 1979). On the other hand the mining companies maintain that they require high profit rates because of the relatively high risks associated with mining activity, (see, for example, the Australian Mining Industry Council, 1981). In Australia the main proposal for taxing the rent generated by mining companies has been the Resource Rent Tax proposed by Garnaut and Clunies Ross (1975, 1979). Swan (1976) instead advocated the tax first proposed by Brown (1948). These proposals may be considered as tax reforms which were designed to increase the total tax receipts from mining activities and to decrease the distortions resulting from the use of royalties as the instrument of taxation. In the USA and Canada there has been considerable discussion of leasing as a vehicle of taxation (see Leland, 1978 and Reece, 1978, and references therein). More recently there has been some discussion in Australia of the advantages of using leasing policy (Dowell, 1978; Lloyd, 1981a; Porter, 1981). In the meantime some individual States have

begun to increase royalty rates and to introduce supplementary hidden taxes through the pricing of State-provided services.

In our view the most instructive approach to the question of taxation policy for this sector is to set up a general model of mining activities which yields the optimal structure of taxes on mineral production. Section (I) presents such a model. This Section follows Leland (1978) and hence the tax is called the Leland Tax. In Section (II) the actual structure of taxes is examined. Section (III) offers some suggestions for moving the actual structure of taxation towards the optimal one.

(I)

The Theory of Optimal Taxation

A mine is a production activity which extracts some mineral from a deposit in a tract of land. In Australia, unlike some other countries such as the USA, all mining rights are vested in the state, and almost all mining activities are operated by privately-owned companies. A company obtains from the government the exclusive right to mine the deposit by obtaining a lease over the tract. Until Section (II) the "government" may be taken to be the Commonwealth and State Governments combined. As a condition of the lease the company is committed to make payments to the government. Production takes place over multiple periods and under uncertainty with respect to output and input prices and the size of deposits. We endeavour to present a model which includes these features. The basic model is that of Leland (1978) with some modifications.

In a multi-period context the profits before tax of the company are the present value of its income stream during the lifetime of the mine, $(v_0, \dots, v_t, \dots, v_T)$, viz.

$$V = \sum_{t=0}^T v_t / (1+i)^t$$

$$= V(a, s) \quad (1)$$

where

$$v_t = p_t y_t - \sum_{j=1}^n a_{jt} w_{jt}$$

p_t and $(w_{1t}, \dots, w_{jt})$ are the prices of the output, y_t , and the inputs $(a_{1t}, \dots, a_{nt})$. $T \geq 0$ is the period of closure of the mine. V is also commonly referred to as the mineral rent. The rate of discount, i , is the company discount rate which is assumed constant. V is a random variable. s denotes all of the states of the world which may prevail. V is also a function of a vector of decision variables of the company, a . These are the inputs chosen in each period, $(a_1, \dots, a_k, \dots, a_K) = (a_{1t}, \dots, a_{jt}, \dots, a_{nt})$ before the state of the world is revealed.

We assume that the company cannot spread all production risks and therefore acts to maximise the expected utility of its net present value after tax from the mine, $E(U(Z))$. U is the utility function of the company. It is assumed to have a subjective probability distribution function of V and hence of Z .

In this paper all government revenues are called a tax. Thus the tax system includes the possibility that all or part of the total tax payments consist of a lump-sum payment in period 0. This is what is called a bonus bid in the USA and Canada. The total tax schedule is

$$G = P(a,s) + B(a) = G(a,s) \quad (2)$$

In general the tax schedule is a two-part tax. $P(a,s)$ is the part which is conditional upon the state of the world which is revealed, s , and upon the actions of the firm. It is expressed in terms of its present value. $B(a)$ is the bid part. The bid is made in the knowledge of the conditional payment schedule. Bidding is open to all comers.

The government is assumed to choose the tax schedule which maximises the expected utility of its tax receipts, $E(W(G))$. W is the utility function of the government. Formally the problem of the government is to choose that tax schedule so as to

$$\max_G \{E[W(G(a,s))]\}$$

subject to

$$E[U(V(a,s) - P(a,s) - B)] = U(0) \quad (3)$$

and

$$E[U'(\partial V / \partial a_k - \partial P / \partial a_k)] = 0 \text{ for all } j \text{ such that } a_k > 0$$

The first constraint results from the competitive bidding among firms and the second from the company's actions to maximise its bid.

The solution to this problem yields an optimal tax schedule in which the tax collected is some function of the company's actions and of the states of the world which are revealed

$$G^*(a,s) = B^*(a) + P^*(a,s) \quad (4)$$

(For the derivation of this tax see Leland 1978 and for some further discussion, see Lloyd, 1981b.) We shall refer to this tax as the Leland Tax.

The first aspect of the tax schedule is the effect of the tax on the incentives to the company. Tax payments which are conditional may provide a disincentive to the company since lower output may reduce these payments. Leland considered it in the form of the Pareto-optimality of the tax. A Pareto-optimal tax is one which maximises the welfare (expected utility) of the government for a given level of welfare (expected utility) of the company. Leland has proven that the tax schedule which is optimal for the government, G^* , is Pareto-optimal if and only if it does not affect the company's choice of actions at the margin. Thus the questions of the neutrality and the Pareto optimality of the government's choice of tax schedule are the same question. Moreover, he shows that the optimal tax is Pareto-optimal and neutral if the government can observe - at zero cost - both the company's action and the states of the world, or if it can observe only the states of the world, or if it can observe both a and $V(a,s)$ or some variable, $H(a,s)$, which is sufficient to observe the variable $V(a,s)$.

When the optimal tax is neutral it is possible to obtain a much stronger characterisation of the properties of the tax. Then the optimal conditional payment part, P^* , will vary when the actual ex post value of V varies, that is $P^* = P^*(V)$. While Leland does not discuss how to collect a tax on V in a multi-period setting a Brown Tax is a proportional tax on V (see Swan, 1976). A Brown Tax is a two-sided tax in that it applies to negative as well as positive values of the base, V . Its base can be used for a non-proportional tax on V . Further, a tax on V can be collected in other time configurations than that of the Brown Tax.

The second aspect of a tax schedule is the sharing of the risks of the enterprise between the two parties, the government and the company. Different tax schedules share risks to different extents. For example, a pure bonus bid means that all of the risks are borne by the company. At the opposite extreme all of the risks are borne by the government if it hires the company for a fixed fee to develop the tract or if it undertakes the development itself by means of a state corporation. The derivative of $G(V)$, $dG/dV = dP/dV$, is a local measure of the extent to which the risks are borne by the government. For neutral tax schedules Leland obtains

$$dP/dV = [1 + (R_g/R_f)]^{-1} \quad (5)$$

where R_g and R_f are the Arrow-Pratt coefficients of absolute risk aversion of the government and company respectively. Thus marginal rates of conditional tax payments lie in the closed interval $[0,1]$. Risk will be shared between the government and the company if both exhibit some finite degree of risk aversion. The share of risks borne

by the government at some V increases the less risk averse is the government relative to the company. The optimal tax schedule, $G^*(V)$, is concave, linear or convex at any V , according as the degree of risk aversion of the government is decreasing as a function of V at a lesser rate, at the same rate, or at a greater rate than that of the company.

Taxes other than the Leland Tax will be sub-optimal. For example, royalties will be sub-optimal because they will induce the firm to underproduce and because they do not share risks in the optimal way (Leland, 1978). An ordinary income tax is clearly sub-optimal because the tax base is a concept of annual income which does not correspond to V , the tax rate is proportional and it is invariant with respect to the distribution of V .

When considering the implementation of the optimal tax one might need to take into account aspects which have been omitted from the basic model above. We shall consider here only three aspects which are directly related to the process of changing tax regimes.¹

The first concerns the role of exploration. The Leland model may be interpreted as a model which yields the optimal tax when the lease grants the rights to extract a mineral only, the existence of the deposit if not its size and cost being known at this time as the result of public exploration or as the unintended byproduct of other mining activities. The second interpretation is that the lease grants the right to explore and the right to extract a deposit if found to the one lessee before exploration. (This would require a change in present Australian practice which separates the exploration and

extraction rights.) Such a lease poses the problem that the uncertainty of ultimate production may be very great before exploration begins and companies would be prepared to bid little for leases which might eventually yield large rents. Another alternative is for the government to undertake early exploration work itself or to contract it out, and to lease mineral-bearing tracts after deposits have been located. Some economists in the past have argued that this would greatly reduce the uncertainty of mining activities and would increase total government revenues from individual tracts and, further, that public disclosure of mineral discoveries made by or for the government would increase the social value of exploration discoveries (see Gaffney, 1967, p.378 and Crommelin and Thompson, 1977, pp. 149-162, 259, 262-63). By comparison a subsidy to private exploration leaves information gained at public cost in private hands.

The second aspect arises when proposals to increase or change the taxation of rents in the economy are confined to the mining sector. Mining companies in Australia have sometimes argued that this is discriminatory and that this discrimination will distort the pattern of investment and production in the economy away from the more heavily taxed mining activities to activities in other sectors. The absence of disincentive effects in the optimal Leland Tax above is conditional on an unchanging company interest rate, the opportunity cost of its capital investment. In the cases of multinational companies and national companies whose most profitable alternatives lie outside the mining sector, changes in taxes for the domestic mining sector alone would not affect the opportunity cost of their capital. Given the interest rate, the optimum nature of the tax schedule avoids excessive

rates of taxation which would induce sub-optimal levels of investment and production. Of course if rents due to monopolies or scarce resources in other sectors were also subject to rent taxation the opportunity cost of capital to mining activities is likely to be lower and the investment in mines more attractive. Thus it is the failure to tax rents elsewhere rather than the selective introduction of new taxes on the rents of mines which may lower investment in mines.

The third aspect is the absence of sovereign risk in the model. Any change in tax schedules may induce a fear that further changes are possible, especially for mines which turn out to be very profitable. Such a government-induced increase in uncertainty might shift the distribution of net present values downwards and result in lower production and rent collection than otherwise (for example, Garnaut and Clunies Ross, 1975 and Garnaut and Emerson, 1981). To analyse this problem it is necessary to distinguish between the two distinct sources of ex post rents which exceed the expected value of rents. First, high ex post rents of a mine may be the revelation of a point on the upper tail of the prior probability distribution of V . In this event, the government should not adjust the tax rates to capture more of the ex post profits of the mine. Any attempt to do so may induce greater uncertainty and lower the rent collected from all new mines. Second, a mine may be highly profitable because the market demand for the output increased during the life of the mine, causing the whole distributions of the exogenous output price and of the net present value to shift upwards. This yields unanticipated windfall gains to the company. The tax schedule $G^*(V(a,s),a)$ was fixed on the basis of the probability distribution of V at the time of leasing. If, at the

time of leasing, the profitability of the mine had been greater in the sense that the distribution of V shifts upwards (or more generally in a way which is preferred by the risk-averse company), the total tax liability should have been increased and in particular, unless the coefficient of absolute risk aversion does not decrease with V , the marginal rates of taxation of V should have been increased (Leland, 1978, Theorem III). This property of G^* can be extended to the case of a shift in the distribution of V during the life of the mine so that for the remainder of its life windfall profits do not accrue to the company. However, such action is a double-edged fiscal weapon. If the government adjusts tax rates to collect more rent when the unanticipated shift favours the company it should also adjust tax rates downwards when there is an unanticipated shift downwards in the distribution of V . There is also a danger that the government may increase the rates arbitrarily and in excess of the optimum, or it may confuse a high value of V drawn from the prior distribution with a shift of this distribution. It is probably better for the government to make no adjustments in the schedules for existing mines, recognising that it may set new schedules for new mines which are affected by shifts in the market and that some part of the higher rents of existing mines will accrue to the government in any event with positive marginal tax rates.

One other aspect of tax reform is that the optimal tax may not be implementable because of political constraints. Then the government must choose some tax with an observable base other than V . One needs to rank the different sub-optimal taxes. The ranking of each tax will depend on the rates of taxation as well as on the base of the tax. To

rank taxes one should choose the second-best tax schedule for each tax base. Since the second-best tax schedule may not be Pareto-optimal the schedule chosen should be that which maximises the welfare of the government rather than that of the company. Unfortunately, there is no such ranking of two or more instruments which holds generally. To prove this it suffices to take a simple case of the model in which there is only one period of production and the company's actions are unaffected by taxation. Now,

$$V = py - C \qquad C = \sum_k w_k a_k \qquad (6)$$

The optimal base is $V = v$. If the output variable is the only random variable, either a royalty based on the value of production or one based on the volume of production is actually first-best. This holds because, in this case, there is a one-to-one correspondence between either the value or the volume of production on the one hand and v on the other and hence there exists a tax schedule with either base which replicates exactly the optimal schedule $G^*(V)$. If, instead, output price is the random variable, or if both the price and output are random, the revenue-based royalty is first-best and ranks above the volume-based royalty which is second-best because the revenue-based royalty schedule can replicate the first best tax but the volume-based schedule cannot. If, instead, cost is the random variable the value-based and volume-based royalties are equal second-best. Finally, if all variables are random, only the tax based on v is optimal unless one variable, y or revenue, happens to be perfectly correlated with v . Similar but more complex possibilities arise with

multi-period production and/or endogenous actions by the company. Thus, although no ranking holds generally a ranking is possible in some circumstances and in these circumstances the ranking is according to the correlation of the base with that of the base of the optimal tax. For this reason there is a general presumption that the closer the base lies to that of the optimal tax base the higher the ranking of the tax, provided the appropriate schedule for each tax base is used. This holds because each lower ranking tax has a lower ability to differentiate with respect to V than those ranked above it. This result is the basis of our proposals in Section (III) for reform of the structure of mineral taxes in Australia.

(II)

The Actual Mineral Taxation Arrangements in Australia

This section examines the actual taxes on the minerals sector in Australia. The minerals covered are the metallic minerals and the energy minerals. While there have been many changes in taxation arrangements for the minerals sector in recent years, we will describe the present (mid-1981) arrangements, though regrettably the latest available data relate mainly to 1978-79.

A. Overview of Taxation Arrangements for the Minerals Sector

The existing fiscal regime for the minerals sector in Australia is a veritable hotch potch of separate taxes applied by both State and Commonwealth Governments. The State Governments apply what is from a

national perspective an exceedingly complex pattern of mineral royalties. The Commonwealth Government levies a tax on petroleum (the crude oil levy) in association with price controls on petroleum production, shares in State royalty collections from offshore petroleum production in Bass Strait and levies a tax on exports of coal. Mining company income is subject to Commonwealth Government income tax at the prevailing rate. Several State Governments have provided mining infrastructure (notably railways) at rates substantially in excess of cost, while other infrastructure, materials and services have been provided to mining companies at subsidised rates. In 1980 and 1981 there has been some discussion of allegedly large subsidies provided by the State Electricity Commissions of Victoria and New South Wales to aluminium smelters (see Dick, 1980 and Swan, 1981). The auctioning of mineral leases is little used in Australia, though there was one major case in 1981 where rights to mine the Winchester South coal deposit were allocated by the State Government in Queensland through a system of sealed tenders. The successful tender involved an additional royalty but no bonus bid.²

The discussion below omits the taxes implicit in the pricing of State-provided services because there is a wide divergence of estimates where some are available, and no estimates for most services. We do not even know whether the total implicit taxation receipts net of implicit subsidies are positive or negative.³

Of these various tax instruments, company income tax has in the past been the most important source of public sector revenue from the minerals sector (Table 1), though since 1977-78 it has been surpassed by the crude oil levy. State mineral royalties are a relatively minor

Table 1: Major Sources of Public Sector Revenue
from the Minerals Sector, 1977-78

	\$ million
State Government royalties	212.2
Crude oil levy	469.0
Coal export duty	100.2
Company income tax ^a	588.3
State Government profit on railway services	n.a.

Sources: Company income tax and State Government royalty statistics from Bureau of Mineral Resources, (1981); crude oil levy and coal export duty statistics from Treasury (1978).

^a Mining and quarrying.

source of revenue. So, too, is the coal export duty.

B. Royalties

Although royalties are not the most important of these sources of revenue they are, unlike company income tax, specific to mineral production and unlike the oil levy and coal export duty they apply in some form to all minerals produced in Australia. The pattern of royalties is complex. The states upon which they are conditional, which form the royalty base, vary. Some are based on the volume and some on the value of production or annual profits or a mixture of bases. The tax base and the rates of tax applied to the base vary across States and across minerals. The tax rates in some cases are constant and in others they are graduated. Often the tax base and rates vary within States for different deposits of the same mineral.

Table 2 summarises the differences in the tax bases. The exercise is confined to the eight most important mineral groups in Australia. The ex-mine value of production of these minerals accounted for about 80 per cent of the ex-mine value of all minerals produced in 1978-79 and some 90 per cent of the ex-mine value of all metallic minerals and fossil fuels produced in that year.⁴ Royalty bases which are described as mixtures of two bases represent a system in which both of the bases are used in the assessment of the royalty obligation and one of them is selected as being the relevant base depending on the assessed value of the royalty under each of the bases. For example, the royalty base may be ad valorem, subject to a minimum specific royalty.

Table 2: State Mineral Royalty Bases for Selected Minerals, 1978-79

State	Mineral							
	Black Coal	Oil & Gas	Iron Ore	Silver, Lead & Zinc	Bauxite	Copper	Tin	Nickel
New South Wales	Volume of output	Value of output	Volume of output	Profits	Volume of output	Profits	Value of output	Value of output
Western Australia	Volume of output	Value of output	Volume of value of output	Volume ^a of out-put	Volume of output	-	Volume of output	Value of output
Queensland	Volume/ value of output ^b	Value of output	Volume of output	Volume/ value of output	Volume/ value of output	Volume/ value of output	Value of output/ profits	Volume of output
Victoria	Volume of output	Value of output	Volume of output	Value of output	Volume of output	Value of output	Value of output	Value of output
Tasmania	Nil	- ^d	Value of output/ profits	Value of output/ profits	Value of output/ profits	Value of output/ profits	Value of output/ profits	Value of output/ profits
South Australia	Value of output	Value of output	Value of output	Value of output	Value of output	Value of output	Value of output	Value of output
Northern Territory	Value of output	Value of output	Value of output	Value of output	Volume of output/ profits ^c	Value of output	Value of output	Value of output

Source: Bureau of Mineral Resources.

^a Royalty specified for zinc only.^b Specific if consumed in the State; ad valorem if exported from the State.^c Specific, but related to profitability of operations for the Gove deposit; ad valorem for other deposits.^d Royalty rate not yet determined. Base will presumably be value of output/profits.

Even in cases where the royalty bases are the same for a given mineral in various States, the royalty rates vary quite markedly. For example, the specific rate on black coal production ranges from 2.5 cents per tonne in Western Australia to \$1.70 per tonne in New South Wales. And the ad valorem rates applied to petroleum production in the presently producing States vary from 5 per cent in Western Australia to 12.5 per cent (including the Commonwealth Government's share) in Victoria.

An examination of the royalty bases and rates in Australia indicates that the royalties are ad hoc, lacking a set of consistent underlying principles. The large variability among States in royalty bases and rates for the same mineral is compounded by such common practices, which vary across individual mines, as the reduction of royalty obligations for minerals consumed or processed within State boundaries and the abatement of royalties in periods of low profitability.

•

In view of the complexity of the royalty arrangements a useful step in their analysis is to calculate the ad valorem equivalent rate of tax for each mineral in each State. The ad valorem equivalent rate is the actual royalty payment expressed as a percentage of the ex-mine (or wellhead) value of output excluding the royalty payment. These rates are a convenient form of summary only. Classification of royalties by mineral and by State yields a two-way classification. The entries are themselves weighted averages of the ad valorem equivalent rates which actually apply to the outputs of individual mines. Moreover, the theory of the optimal tax

indicates that we should calculate net present value equivalent rates; that is, the royalty payment expressed as a proportion of the net present value of the mine. Unfortunately, this is not feasible as there are no data on the net present value of mines. The ad valorem equivalent rates express royalty rates in a form which reveals some deviations from the optimal taxes.

Surprisingly, the calculation of ad valorem equivalents of mineral royalties on a State by mineral basis has not been attempted before. We found the task to be a difficult one. The Australian Bureau of Statistics (ABS) conducts an annual census of mining establishments which includes the royalty payment and value of output of each mine but its disclosure rules have severely restricted the coverage of this data. Where data were not available from the ABS or State Governments, less direct methods of estimation have been used. Table 3 presents the results for the eight mineral groups. This table contains only three empty cells though ad valorem equivalents are quoted only for those minerals whose ex-mine value of output in the particular State exceeded \$1 million in 1978-79.

The final column in the table indicates the average of ad valorem equivalents for all minerals (including construction materials and other non-metallic minerals) in the respective States and the total of that column is the national average.⁵ In 1978-79 total mineral royalty receipts represented only 4.7 per cent of the reported ex-mine value of mineral production in Australia. The ad valorem equivalent of mineral royalty receipts by the Victorian Government, at 6.7 per cent, was considerably larger in 1978-79 than the corresponding

**Table 3: Ad Valorem Equivalents of Royalty Receipts
by State and Selected Mineral, 1978-79
(percentage)**

State	Mineral								
	Black Coal	Oil & Gas	Iron Ore	Silver, Lead & Zinc	Bauxite	Copper	Tin	Nickel	All minerals
New South Wales	3.4	-	-	9.0	-	<4.0 ^a	2.4	-	3.9
Western Australia	0.2 ^b	4.8	6.5		n.a. ^c	-	0.0 ^d	2.0 ^e	4.1
Queensland	4.4	9.2	-	n.a.	8.2 ^f	n.a.	0.7	5.0 ^g	4.5
Victoria	-	8.3	-	-	-	-	-	-	6.7
Tasmania	0.0	-	<3.5 ^h	<3.5 ^h	-	<3.5 ^h	<3.5 ^h	-	1.0
South Australia	2.5 ⁱ	5.8	2.5 ⁱ	-	-	2.5 ⁱ	-	-	2.8
Northern Territory	-	-	-	-	1.3 ^j	0.0	-	-	1.6
Commonwealth	-	3.1	-	-	-	-	-	-	3.1
Total	3.7	11.4						2.2	4.7

Sources: Australian Bureau of Statistics; Bureau of Mineral Resources; Australian Institute of Petroleum Ltd., various mining companies.

Notes: n.a. = not available.

- = value of production is zero or less than \$1 million.

^a On copper/zinc mining operations at Cobar the maximum marginal royalty is 8 per cent of accounting profits exceeding \$1.2 million. This rate corresponds to much less than 8 per cent ad valorem. Copper mining elsewhere in the State (apart from at Broken Hill) is subject to an ad valorem royalty of 4 per cent.

^b Specific royalty rate of 2.5 cents per tonne (AMIC 1979, 1) applied to total tonnage produced (ABS 1980, 6) and expressed as a percentage of ex-mine value of output (ABS 1980, 7).

^c If it is assumed that all bauxite was processed into alumina in Western Australia, the specific royalty rate on alumina would apply and the ad valorem equivalent would have been approximately 0.9 per cent in calendar year 1979, using data from BMR (1981 forthcoming, Part 4), assuming no price escalation. This rate on alumina is not comparable with the rates on bauxite in the other States.

- d Specific rate of 20 cents per tonne of concentrate (BMR, 1981 forthcoming, Appendix 2) applied to total tonnage produced (ABS, 1980, 6) and expressed as a percentage of ex-mine value of output (ABS, 1980, 7), giving an ad valorem equivalent of less than 0.1 per cent.
- e Royalty rate is 2 per cent of value of metal content sold (BMR, 1981 forthcoming, Appendix 2).
- f For calendar year 1979. Estimated from data provided by operating company.
- g For calendar year 1979. Implicit unit value of nickel ore = \$2.00, obtained from BMR (1981 forthcoming, Part 4). Specific royalty rate of 10 cents per tonne (BMR, 1981 forthcoming, Appendix 2) applied to implicit unit value, giving ad valorem equivalent of $0.10/2.00 = 5$ per cent.
- h The maximum royalty rate is 3.5 per cent (BMR, 1981 forthcoming, Appendix 2) of the ex-mine value of output including royalties. This means that maximum equivalent rate on the value excluding royalties is marginally greater.
- i An ad valorem royalty of 2.5 per cent is applied to value of output including royalties. See footnote h.
- j Data from Department of Mines and Energy (1981, 13-14).

figures for the other State Governments. This is largely explained by the facts that royalty collections from Bass Strait petroleum operations constituted a major share of the total mineral royalty receipts of the Victorian Government and the royalty rate on petroleum production is relatively high. The mineral royalty receipts of the other State Governments represented a small share of the ex-mine value of mineral output.

Looking now at the individual minerals, ad valorem equivalents of State royalties for the major minerals ranged from zero in the cases of black coal in Tasmania, copper in the Northern Territory and tin in Western Australia, to more than 9 per cent for oil and gas in Queensland and for silver, lead and zinc in New South Wales. There is considerable variation in each column of Table 3. This variation would be even larger if the ad valorem equivalents were to be calculated for individual mines.

C. The Crude Oil Levy

The Commonwealth Government's pricing and taxation arrangements for the petroleum industry have changed frequently since the beginning of the industry in Australia. From a period in which producers received prices above import parity, through another during which the situation was reversed, the arrangements have shifted since the mid-1970s to an incredibly complex system of price controls and taxes.

In August 1977 the Commonwealth Government introduced import parity pricing for part of Australia's crude oil production and a year later it introduced a requirement that all Australian crude oil be

priced to refiners at import parity. The intention of these arrangements was that producers not be allowed to retain the greater share of the windfall gains on crude oil extracted from existing fields as a result of the movement towards import parity pricing, but that they be encouraged to find and develop new fields through the application of world prices to any newly discovered oil. Consumers, on the other hand, were to be encouraged to conserve oil in response to the higher prices to them. The Commonwealth Government appropriates a large share of the rents that would have accrued to the producers of crude oil from existing fields by applying the crude oil levy, which is calculated so that the sum of the levy and the producer price equals the import parity price to refiners.

The exact pricing arrangements are complex and have clearly been designed with the production characteristics of particular existing Australian oil fields in mind.

Natural gas production is not subject to the crude oil levy, nor is liquefied petroleum gas (LPG) from fields that began producing after August 1977. LPG from fields producing before that date attracts the levy at the rate of 60 per cent of the margin by which the weighted average wholesale prices on exports and domestic sales exceed \$147 per tonne. Natural gas prices to producers have been controlled by the signing some years ago of long-term contracts with purchasers, among which have been State Government authorities, and by Federal Government restrictions on the export of natural gas. Consequently, natural gas producer prices are presently far below world levels (Hocking and Clarke 1980). These price controls are

equivalent to a specific royalty which, if the consumer price is below this world price, is returned to gas consumers.

D. The Coal Export Duty

Exports of coking coal are subject to a specific Commonwealth Government export tax. At present there are two rates: \$3.50 per tonne and \$1.00 per tonne. The higher rate applies to high-quality coking coals extracted from open-cut mines which were in production before 30 June 1980. The lower rate applies to all high-quality coking coal from underground mines and from open-cut mines with more than 60 metres overburden, coal from all new open-cut operations, including major expansions of existing mines, which commence production after 30 June 1981, and other coking coals. Exports of black coal after 18 August 1981 are also subject to the export duty at the rate of \$1.00 per tonne. The aim of the export duty is to appropriate a share of the increased rents from coal mining, particularly from the mines that were already clearly intra-marginal before the large increases in world coals prices in recent years. Since its introduction in 1975 the rate of the duty on coking coal has been lowered regularly and an increasing proportion of coal exports have been exempted from the duty.

The short history of the coal export duty is another example of the gradual awakening of governments to the presence of large rents which are taxable without greatly affecting output. But the fiscal obligations under the export duty on coking coal have been reduced over time through the Commonwealth Government yielding to political pressures.

E. Combined Commodity Taxes

Since royalties, the coal export duty, and the petroleum levy are all commodity taxes they may be aggregated. The data do not allow the total receipts from the export duty and the levy to be allocated to the individual States. In the case of coal the combined royalties and export duty amounted to 9.5 per cent of the ex-mine value of national production in 1978-79, compared with the equivalent tax rate of 3.7 per cent for that component due solely to royalties (from Table 3). In the case of oil and gas, the combined royalties and levy amounted to 159.5 per cent of the wellhead value of national production in 1978-79 compared with the tax rate of 11.4 per cent for that component due solely to royalties. Thus in both cases most of the commodity tax rate is due to the non-royalty component.

F. Company Income Tax

The income of all incorporated enterprises, mining and non-mining alike, in Australia is assessed for company income tax. Briefly, the income tax provisions affecting the tax base for the minerals sector are as follows. Exploration expenditure is deductible immediately and in full against net assessable income. Petroleum exploration expenditure is deductible against net assessable income derived from any source, whereas exploration expenditure on other minerals is deductible against net assessable income derived from mining activities only (though not necessarily against income from the mine

for which these expenditures were actually incurred).

Allowable capital expenditure is deductible over the lesser of the estimated life of the mine or 10 years, on a diminishing balance basis. This rate applies to capital expenditure incurred after 18 August 1981. It was raised from five years to six years in mind-1981 and to 10 years in August 1981. Again, allowable capital expenditure on petroleum mining is deductible against income from any source, whereas that on general mining is deductible against income from mining only. Capital expenditure on certain transport facilities (with the specific exclusion of railway rolling stock, road vehicles, ships and housing and welfare facilities located at ports) is deductible on a straight-line basis over 10 years. Expenditure on other capital goods which does not qualify as allowable capital expenditure must be written off at the generally prevailing tax depreciation rates for those goods. These rates are usually less favourable to the companies than the permissible rate of deduction of allowable capital expenditure.

On the cost of certain equipment ordered by 30 June 1978 and installed within one year of that date there is an investment allowance of 40 per cent of these costs in addition to the tax write-off mentioned above. The investment allowance on equipment ordered after the end of June 1978 and installed by 30 June 1986 is 20 per cent. The allowance on equipment ordered after 1 May 1981 is 18 per cent. Investment in mineral transport facilities does not qualify for the allowance.

Income earned by a bona fide prospector (whether individual or company) on the sale of mining rights to deposits of a number of specified minerals is exempt from income tax. Petroleum exploration is subject to concessions of its own: an income tax rebate of 27 cents in every dollar of share capital subscribed after 24 August 1977 in petroleum mining companies is allowable.

The rate of company income tax is constant and is presently 46 per cent. For comparison with the commodity taxes, this company income tax has in recent years been roughly equivalent to an ad valorem royalty of about 12 per cent, since the taxable profits of mining companies have been equal to about 25 per cent of the value of their production (BMR, 1981, pp.19, 43).

(III)

How to Improve Australian Mineral Taxation Policy

The structure of actual taxes outlined in Section (II) is highly differentiated by mineral and by State and by mines within individual States. The structure of optimal taxes outlined in Section (I) is also highly differentiated. Indeed the optimal tax is mine-specific. However, the pattern of differentiation of the actual structure deviates in many respects from that of the optimal tax.

Consider first the royalty arrangements and the other commodity taxes, the crude oil levy and the coal export duty. All commodity taxes are sub-optimal instruments of taxation because they have an

inappropriate tax base. Taxes based on the volume or value of production tax production at the margin and therefore have a disincentive effect on production. The coal export duty and royalties which are applied at equal rates for all mines within a State or within the nation have the further sub-optimal feature that they do not allow the mine costs of production as a deduction and they cannot therefore differentiate between mines so as to levy a higher rate for mines with equal prices but lower unit costs which yield higher rents to the producer. The same applies to royalties which are differentiated by buyer as with coal sales to State Electricity Commissions and sales to users within States.

Similarly, the company income tax (or royalties which are based on annual profits such as those which apply to production at Broken Hill and in Tasmania) is sub-optimal. The existing income tax arrangements for mining companies do not give rise to a tax based on net present value. The base of the Australian tax differs from that of the optimal conditional tax in three main respects. First, the optimal tax allows the immediate deduction of all exploration, capital and operating outlays, whereas the existing arrangements do not provide for the immediate deduction of capital expenditures. Second, in assessing the optimal tax negative net cash flows are carried forward at the investor's discount rate whereas the existing arrangements provide for their carrying forward without interest. Third, interest payments are not an allowable deduction in the optimal tax, but they are deductible in assessing company income tax. The net effect of these deviations from the optimum will vary substantially from mine to mine.

The granting of tax concessions to the petroleum industry which are not available to other mining industries and the exemption from income tax of income derived from the sale of mining rights to a selected list of minerals are arbitrary and discriminatory measures.

While there have been changes in recent years in the bases of taxes on the minerals sector we cannot discern any systematic movement towards the optimal base of net present value. This is true of company income tax, the crude oil levy and the coal export duty. With respect to royalties there has been no general trend away from specific and ad valorem bases to royalties based on profits. Tasmania, one of the smallest mineral-producing States, is the only one in which royalties based on (accounting) annual profits have been introduced with general application. The New South Wales Government's accounting profit-based royalty schemes for the Broken Hill and Cobar mines have been in place for some time, but the Government continues to apply specific and ad valorem royalties on mineral production elsewhere in the State. The Queensland Government has actually moved away from a royalty system based on accounting profits to an ad hoc array of specific and ad valorem royalties.

Looking now at rates of taxation we see that these also exhibit sub-optimal features. Royalty rates vary among States but not in a way which is systematically related to net present value. Within some States for some minerals there has been an increasing trend towards the negotiation of mine-specific royalty rates. This is a small movement towards the optimal structure in one respect. With respect to the risk-sharing feature of a tax, a royalty which is based on the

volume or value of production and whose rate is fixed yields a tax which is a concave function of the value of the mine (Leland, 1978, p.437 n.25) unless costs increase with mine output. This is sub-optimal except when the risk aversion of the government is decreasing at a lesser rate than that of the company. Similarly, the constant rate of company tax is sub-optimal in terms of risk-sharing except when the ratio of the coefficients of absolute risk aversion does not vary with income.

All of these features apply to taxes which have been fixed when the taxing authority and company had a certain subjective probability distribution of prices and hence the present value of the output which is taxed. Another set of questions apply to the taxes when the expectations of the government and companies change. This is especially important at present since the substantial increases in the prices of petroleum, coal and some other mineral products in recent years has produced substantial favourable shifts in the distributions of the present value of many mines. The optimal tax theory calls for an increase in tax rates on mines in this event. This is the carry over into the environment of uncertainty of the well-known proposition that windfall gains in an environment of certainty should not accrue to the mineral-extracting company. The gradual awakening of the Commonwealth and State governments to the existence of windfall gains for existing mines and the possibility of larger profits for new mines has led them to increase some rates but in a very piecemeal fashion. Company tax rates are tied to general considerations of levels of taxation which have little to do with the profits of the subset of companies which mine their outputs. There has been no general trend

towards increased State royalty rates on petroleum and coal production. The Western Australian and Queensland Governments have not raised the royalty rates on petroleum production. The Victorian Government has been able to raise the average royalty rate on the large crude oil production from the Bass Strait. While the Queensland Government has not increased the royalty rate on black coal production since 1974, it has been collecting a share of the rising value of this resource, albeit inefficiently, through its rail haulage charges. In New South Wales the royalty rate on black coal production was raised twice in the mid-1970s but not again until 1981. Production from the smaller black coal mines in the other States continues to bear little or no royalty. The important brown coal production in Victoria still bears a negligible royalty of 4 cents per tonne.

Indeed, one feature of the present tax structure has worked to reduce tax receipts as a percentage of the net present value during the period of rising mineral prices. Specific royalties and the coal export duty collect more than one-third of total royalty and coal export duty receipts. The receipts from a specific royalty decrease in ad valorem equivalent terms as the unit price increases unless the rates are constantly adjusted to maintain the initial ad valorem equivalent rate. The specific royalty on black coal in New South Wales is a good example. The royalty rate was raised twice during the mid-1970s but not again until 1981. During the period preceding each of the increases in the specific rate the ad valorem equivalent rate declined. In fact, the ad valorem equivalent rate was higher in the mid-1970s than in the late 1970s when rents had greatly increased.

Many of the distortions which might have resulted from these sub-optimal features of the present tax structure have probably not been substantial because of the low rates of taxation. Perhaps the most important feature of the actual structure is that the rates of tax are widely believed to be too low, even without allowing for recent mineral price increases. That is, it is believed that the net present value equivalent rates have generally been below the optimal rates and the taxes have collected less of the net present value (or "rent" or "profits") of mines than could have been collected. This seems very likely to us. Considering the revenue from royalties and other commodity taxes, it is apparent that the rates are low on all commodities except oil and gas and they collect a small proportion of the total rent from mining activities.⁶ The remaining tax instrument, the company tax, can collect only a small proportion of increases in rents associated with rising prices and profits because of the marginal rate on taxable company income of 46 per cent. The absence of a bonus bid is important also as it would collect significant additional revenue from the increase in rent for new mines. However, the extent of undertaxation will vary from mine to mine, and there may even be some less profitable mines which are presently overtaxed.

We now consider reforms of the actual structure of taxes which would seek to eliminate undertaxation and the costs of distortions without introducing overtaxation. Two preliminary comments are necessary. First, it will not be feasible, even in the absence of political constraints on tax reforms, to achieve exactly the optimal tax structure. Governments possess imperfect information concerning

the parameters which measure the risk aversion of the mining companies and the government and those which determine the distribution of the net present values of mines, and the model oversimplifies some aspects of production. But this does not preclude major basic improvements in the actual structure. The actual structure deviates in so many ways from the optimal that we can at least devise a new structure which qualitatively operates in the way of the optimal structure. Second, in Australia there is a fundamental difficulty in reforming taxes on mineral production because the authority to levy taxes of some form is divided between the State and the Commonwealth Governments. In large part this accounts for the problems of the present tax structure. Yet, economists can make one unambiguous recommendation in this regard. The tax system should first apply the optimal tax or as close to it as possible by means of a single integrated structure of taxes on all mines in Australia. Then these taxation revenues may be divided between the Commonwealth and the States in whatever way is decided politically. We eschew any consideration of the distribution of these revenues except to emphasise that the collection and the distribution of them may be separated. If the total taxation revenue is not determined in the best feasible way the result is clearly not Pareto-optimal since some State or the Commonwealth could receive more revenue without any other government receiving less. If the taxing authorities of a State and the Commonwealth, or perhaps of two different States vying for a mineral project, endeavour to maximise their individual government interests the outcome will inevitably be a distinctly sub-optimal structure of multiple taxes. Multiple taxes collect less revenue because they distort production and in some

instances competition among States has lowered rates of taxation. Currently the State and Commonwealth Governments are acting in this way. Such an outcome is an inexcusable folly for the nation. The States and the Commonwealth Governments should suppress their individual interests when determining the tax structure and squabble only over the distribution of the proceeds. In practice this distribution will be constrained as the major mineral-producing States are likely to insist upon receiving at least as much revenue as they could obtain under alternative arrangements.

The optimal tax is a single tax, though it consists of two parts. For mines already operating under existing leases the conditional part only would be revised. The tax is designed to replace all of the multiple taxes presently levied by State and Commonwealth Governments.

In practice the existence of two parts of the tax has advantages other than those discussed in Section (I). In the absence of perfect information concerning the parameters of risk aversion and the distribution of net present value of a mine, the presence of the bonus bid part has the advantage that for any specified schedule of taxes conditional on the value of the mine, competitive bidding would produce the maximum bid for new leases. For example, if the schedule of taxes on the value of the mine were set at rates below the schedule which is optimal with perfect information or if tax avoidance understates the base of the tax, some part of the present value of the optimal conditional revenues would be recouped through the bonus bid part because the sub-optimal conditional tax payments would increase the certainty value of the mine. On the other hand, if the

distribution of profits of the mine should shift favourably after the lease has been granted the bonus bid cannot be changed but the presence of the conditional tax part means that some of the increase in rent may be appropriated by the government. Provided, as we recommend in Section (I), the conditional tax rates are not subject to periodic revision, this single tax would overcome the risks of government-induced tax uncertainty which are present under the current system.

The replacement of company income tax (and other taxes) on mining companies alone poses a problem. Much of the discussion of the income tax provisions for the minerals sector (for example, Fitzgerald, 1974; IAC, 1976) has been devoted to comparing them with the provisions for other sectors in the Australian economy. There has been a presumption that on equity and efficiency grounds there should be no difference in the income tax arrangements between the mining and other sectors. But the mining sector differs from other sectors in one fundamental respect: mineral resources are publicly owned and generate rents. The single optimal tax recognises this by substituting a different concept of income as the base of taxation. However, no tax reform which is confined to one sector can remove all existing tax distortions. There are two choices here. One could retain the existing company income tax on mining companies and impose a Leland-type tax as a surtax, but this is administratively more complex and could not duplicate the optimal tax for all mines unless the surtax were two-sided. Alternatively, one could cease company income tax for mining activities. This would imply zero taxation of the capital component of income and hence this component would be treated

more favourably for mining activities than elsewhere as long as double taxation of the return to capital continues. Any such distortion is not likely to be substantial except for less profitable mines in which most of the income is a return to capital.

A single tax would cost less to administer than the present multiplicity of taxes based on mine production and income, provided of course that the State and Commonwealth governments could agree on the distribution of tax receipts net of administration costs.

The government should also consider participating directly in exploration activities rather than subsidising private exploration. As with taxation a nationally integrated system would be preferable to multiple State enterprises but this would again require Commonwealth-State co-operation.

It might be considered by the State and/or Commonwealth Government that the replacement of the present multiple tax structure by a single tax is too substantial. In this event the movement towards the optimal structure can be achieved in a piecemeal fashion. The introduction of open bidding for new leases, with the present structure of all (conditional) multiple taxes unchanged, would increase total revenue of the government without introducing any new distortions, or at worst it would leave revenue unchanged. If companies were prepared to develop a mine with higher rates of taxation they would be prepared to bid positive sums for the lease. In addition, the structure of the conditional payments for both new and existing leases could be reformed by changing the bases of these taxes to correspond more closely to that of rent. Thus specific taxes

could be converted to ad valorem taxes or ad valorem taxes to taxes based on annual profit or the ordinary company income tax base and rates could be changed to those of a tax on net present value. Or, better, some combination of these movements could be made simultaneously.

Overall the method of taxation of mineral rents through reliance on the two-part tax proposed in this paper would entail less distortions of mineral production and increased revenue to the public sector.

REFERENCES

- Australian Bureau of Statistics (1980), Mineral Production Australia 1978-79, Catalogue No.8405.0, Canberra, 27 May.
- Australian Institute of Petroleum Ltd. (1979), Oil and Australia: The Figures Behind the Facts, Melbourne.
- Australian Mining Industry Council (1979), "Australia - Selected Mineral Royalties", Canberra, (mimeo), 12 June.
- _____ (1981), "Resource Rent Taxation", Canberra, (mimeo).
- Brown, E.C. (1948), "Business-Income Taxation and Investment Incentives", in Income, Employment and Public Policy, Essays in Honor of Alvin H. Hansen, Norton, New York.
- Bureau of Mineral Resources (1981), Australian Mining Industry Annual Review 1979, General Review, (preprint), Australian Government Publishing Service, Canberra.
- _____ (1981 forthcoming), Australian Mining Industry Annual Review 1979, Australian Government Publishing Service, Canberra.
- Clarke, R., Hocking, D., Porter, M., Sieper, E. and Trengrove, R. (1981), "The Aluminium Industry in Australia in the 1980s", Centre of Policy Studies, Monash University, Melbourne, March.
- Crommelin, M. and Thompson, R. (eds.)(1977), Mineral Leasing as an Instrument of Public Policy, University of British Columbia Press.
- Dick, H. (1980), "Aluminium Smelters and the Price of Electricity: Who Really Pays?" University of Newcastle, (mimeo).
- Dowell, R. (1978), "Resources Rent Taxation", Australian Journal of Management, Vol.3, October, 127-46.

- Fitzgerald, T.M. (1974), The Contribution of the Mineral Industry to Australian Welfare,. Report to the Minister for Minerals and Energy, Australian Government Publishing Service, Canberra.
- Gaffney, M. (ed.)(1967), Extractive Resources and Taxation, The University of Wisconsin Press.
- Garnaut, R. and Clunies Ross, A. (1975), "Uncertainty, Risk Aversion and the Taxing of Natural Resource Projects", Economic Journal, 85, June, 272-287.
- _____ (1979), "The Neutrality of the Resource Rent Tax", Economic Record, 55, September, 193-201.
- _____ (1981 forthcoming), The Taxation of Mineral Rent.
- Garnaut, R. and Emerson, C. (1981), "Mineral Leasing Policy: Competitive Bidding and the Resource Rent Tax Given Various Responses to Risk", The Australian National University (mimeo.).
- Gungl, M. and Pilling, A. (1980), "Federal and Provincial Taxation of the Mining Industry", Coopers and Lybrand, Canada.
- Hocking, D. and Clarke, R. (1980), "Pricing, Export and Taxation Policy", paper presented at Conference on Natural Gas in Australia, Melbourne, 25 November.
- Industries Assistance Commission (1976), Petroleum and Mining Industries, Government Printer of Australia, Canberra, 28 May.
- Leland, H. (1978), "Optimal Risk Sharing and the Leasing of Natural Resources, with Application to Oil and Gas Leasing on the OCS", Quarterly Journal of Economics, 92, August, 413-438.
- Lloyd, P.J. (1981a), "How Do We Make a Resources Policy", Discussion Paper No.26, Centre for Economic Policy Research,-The Australian National University, Canberra, May.

- _____ (1981b), "The Optimal Tax on Mines", mimeo., Australian National University, Canberra, September, 1981.
- Mines and Energy, Department of (1981), Green Paper on Mining Royalty Policy for the Northern Territory, Darwin, February.
- Porter, M.G. (1981), "Financial Structure and Resource Development", Giblin Lecture, Section 24, 51st ANZAAS Congress, Brisbane, May.
- Reece, D.K. (1978), "Competitive Bidding for Offshore Petroleum Leases", The Bell Journal of Economics, 9, No.2, Autumn, 369-384.
- Smith, B. (1979), Taxation of the Mining Industry: Papers Presented to a Workshop on Mining Industry Taxation, Centre for Resource and Environmental Studies, Australian National University, Canberra.
- Swan, P.L. (1976), "Income Taxes, Profit Taxes and Neutrality of Optimizing Decisions", Economic Record, 52, June, 166-81.
- _____ (1981), "Pricing of Electricity to Alcoa at Portland, Victoria", Australian National University, (mimeo), March.
- Treasury, Department of the (1978), (1979), (1980), Budget Speech, Australian Government Publishing Service, Canberra, August.
- Utah Development Company (1981), Annual Review 1980, Brisbane.

FOOTNOTES

- * This paper has benefited from the comments of Richard Dowell, Ross Garnaut and Ben Smith. An earlier version of this paper was presented at an ANU seminar and at the Tenth Conference of Economists.

- ¹ Leland (1978) considered the complication of asymmetrical information to the government and the company. Monitoring costs are discussed by Shavell (1978) in a model which encompasses the Leland model. Lloyd (1981b) discusses the effects of introducing differences among bidding companies in their technologies or attitudes to risk. Reserve bids might be used in the absence of competition.
- ² The specific royalty in the successful tender was additional to both the present royalties and rail haulage charges. It is reported that one of the unsuccessful tenderers offered a bonus bid of \$35 million. See Clarke, et al. (1981, p.72).
- ³ One company, Utah Development Company, estimates that the profit included in the Queensland Government's rail freight charges to Utah alone was \$47 million in 1979 and \$54 million in 1980, which may be compared with its corresponding State royalty payments of \$22.7 million in each of 1979 and 1980 (Utah, 1980, p.6).

We can, also, state that these taxes are a poor proxy for taxes based on mineral rents. They are taxes on single inputs and as such introduce distortions in addition to those which apply to royalties based on output. By distorting the relative input prices from their opportunity costs they increase the real costs of production. They differentiate among commodities since one input such as electricity is a major essential input for some minerals but not for others. In the case of railway charges the revenues collected are retained by the Government Railways to offset the losses incurred on passenger traffic. Consequently there is little incentive to improve the efficiency of these services. We are indebted to Ross Garnaut for bringing this last point to our attention.

- ⁴ These figures are approximations because the value of neither bauxite nor nickel production is published separately by the ABS. However, it was possible to obtain estimates of the value of nickel production in calendar year 1979 from data contained in BMR (1981 forthcoming, Part 4). Bauxite was much more problematical, as there is no world market price for bauxite due to vertical integration in the industry. An estimate of the ex-mine value of Australian bauxite production in 1978-79 was obtained by deducting from the total ex-mine value of metallic minerals, as reported in ABS (1980, Table 2) the value of production of nickel and bismuth (also not published separately by the ABS) in 1979 obtained from BMR (1981 forthcoming, Part 4) and the value of all other metallic minerals (excluding bauxite) as reported in ABS (1980, Table 2).

- 5 This table and the discussion in the text relate to royalties paid to State and Commonwealth governments only. There are royalties paid to private individuals or companies who have assigned the rights to develop mines to other individuals or companies, and royalties paid to Aborigines in the Northern Territory. The former are clearly not a form of tax but the latter may be regarded as taxes which have been collected by the State through legislation and transferred to particular designated individuals. These latter payments are included in Table 3.
- 6 Gungl and Pilling (1980) have established that royalty rates are lower in Australia than Canada. However, the only relevant comparisons concern total taxation from all forms of taxes. Moreover, Australian tax rates should be set in relation to the ex ante distribution of lifetime rents from each mine and not by comparison with the rates of other countries, whether or not these latter rates are optimal for these other countries.