STATE TAXATION OF THE IRON ORE INDUSTRY
IN WESTERN AUSTRALIA*

by

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Abstract

As a contribution to the debate over the taxation of the extractive industries, this paper provides estimates of the short run and long run price elasticities of supply for iron ore in Western Australia. Using these estimates, an increase of 1% in the average royalty rate on iron ore is shown to result in a short run decline of 0.61% in the output of iron ore, and a long run decline of 4.36%.

It is concluded that raising tax revenue by *ad valorem* royalties on iron ore leads to a substantial distortion of output, especially after accounting for indirect effects.

INTRODUCTION

Taxation of the extractive industries has been a controversial issue among economists and politicians for some time now. The major aspect of this debate concerns the relative desirability of various taxation arrangements, with the relative merits of the Resource Rent Tax (R.R.T.), as proposed by Garnaut and Clunies Ross (1975), of particular concern. Perhaps the best review of the main theoretical issues involved, including both those relating to the relative efficiency of the R.R.T., and those relating to the appropriate Federal-State financial arrangements, is given by Emerson and Lloyd (1983).^{1/} Their proposals for mineral taxation reform reflect the widely held view that, on theoretical grounds, a movement away from the present mixed system of specific, *ad valorem* and profits taxes towards a more unified tax system based on economic rent "would entail less distortions of mineral production and increased revenue to the public sector".^{2/}

1. One notable shortfall is their discussion of the issue of exploration and the R.R.T. which has been a significant feature of recent debate. See, for example, Esso Australia Ltd. (1984), Campbell and Lindner (1985).

2. Emerson and Lloyd (1983, p. 243).

But agreement on the theoretical disadvantages of the present system of mineral taxation has been countered by criticism of the practical application of a theoretically superior tax system like the RRT. For example, Esso Australia Ltd. (1984) state: "It is a tax theory never designed for the complex ownership, partnership and multi-government situation prevailing in Australia" (p. 1). Furthermore, a dearth of empirical evidence relating to the present tax system has meant there is little empirical support for the theoretical view regarding its inferiority on efficiency grounds.^{3/}

It seems to us that what is needed at this point is more empirical evidence to support the theoretical consensus about the disadvantages of the present mineral taxation system. This would help clarify the need for changes to be made to this system and thereby contribute to a resolution of disagreement. The aim of this paper is to provide some such empirical evidence, in our case set in the particular context of Western Australia's iron ore industry.

The plan of the paper is as follows. Section I discusses the existing system of iron ore royalties in Western Australia, and describes the importance of these royalties to the W.A. government's revenues. Section II outlines the model used to derive the estimating equation. Section III discusses the data used in estimation. Section IV presents the results of the estimation. Section V concludes the paper with a discussion of the implications of the results obtained.

3. The two empirical studies of Australian mineral taxation that we have been able to find are Barnett and Anderson (1983) and I.A.C. (1975).

SECTION I: EXISTING IRON ORE ROYALTY PAYMENTS

(a) The Present Structure

State royalties on iron ore are levied by a combination of *ad valorem* and specific taxes at the following rates:

Export "lumps":	7.5 per cent f.o.b. revenue, minimum 60 cents per tonne.
Export "fines":	3.75 per cent f.o.b. revenue, minimum 30 cents per tonne.

Ore used in Australia: 15 cents per tonne.

These royalties were established by agreements negotiated separately with each company and ratified by State Parliament. It can be seen from the above that the mining companies face a specific royalty on export "lumps" and "fines" for prices of up to \$8 per tonne, and an *ad valorem* royalty for higher prices. With domestic use of iron ore an insignificant proportion of total output, export royalties represented 5.5% of the value of output in 1981-82.

(b) Importance to State Government Revenue

Iron ore royalties have been an important source of revenue for the State government since 1966 (see Table A in Appendix 2). In the late sixties and early seventies iron ore royalties grew rapidly in real terms, making a peak contribution of 9.6% of all State taxes and charges in 1970-71 (see Table 1, column (6)). However, in column (3) of Table 1 it can be seen that despite a nominal growth in iron ore royalties in all years except 1981-82, real growth performance has been uneven since the early seventies. The real value of iron ore royalty income in 1982-83 was 16.7% less than that in

1973-74. Therefore, it is clear that iron ore royalties have not provided the State government with a stable source of real revenue.

The declining real value of iron ore royalties and the increasing value of other mineral production in Western Australia have resulted in iron ore royalties contributing a smaller proportion of both State revenue and total mineral royalty collections. In 1982-83 iron ore royalties contributed only 5.9% of C.R.F. revenue and 67.7% of all mineral royalties - down from 91% in 1973-74 (see Table 1, columns (5) and (6)).

TABLE 1
ROYALTY PAYMENTS

Year	(1) All Royalties (\$M)	(2) Iron Ore Royalty (\$M)	(3) Growth (Real) (%)	(4) State Revenue on C.R.F. (\$M)	(5) (2) as % of (1)	(6) (2) as % of (4)
1966-67	2.6	2.4	-	121.3	90.2	2.0
1967-68	6.2	4.9	100.9	138.1	79.3	3.5
1968-69	11.0	9.0	77.7	148.5	82.1	6.1
1969-70	15.7	13.1	37.6	176.9	83.4	7.4
1970-71	22.3	19.0	35.9	196.8	85.1	9.6
1971-72	25.2	22.4	10.2	243.9	88.9	9.2
1972-73	27.7	24.7	2.9	273.2	89.2	9.0
1973-74	33.6	30.6	9.4	333.4	91.0	9.2
1974-75	39.4	35.7	-2.3	419.4	90.6	8.5
1975-76	43.1	38.2	-7.7	497.2	88.7	7.7
1976-77	51.6	44.6	4.5	561.8	86.4	7.9
1977-78	54.5	44.8	-8.2	626.1	82.3	7.2
1978-79	57.8	48.5	0.4	689.2	83.9	7.0
1979-80	66.7	52.4	-2.1	787.8	78.6	6.6
1980-81	78.3	60.2	4.2	906.0	76.8	6.6
1981-82	81.3	59.4	-10.5	1023.2	73.0	5.8
1982-83	102.4	69.4	5.0	1183.2	67.7	5.9
1983-84	110.6*	71.0*	-4.3	1380.0*	64.2	5.1

* Estimates made at the time of the 1983-84 budget. The actual figures are not yet available.

Sources: (1), (2): Western Australia, *Auditor General's Report* (various years).

(3): Calculated as described in Appendix 1.

(4): Western Australia, *Consolidated Revenue Fund: Estimates of Revenue and Expenditure* (various years).

SECTION II: THE MODEL

The model is based on two behavioural assumptions. The first is that the representative firm's desired level of output in period t is that which maximises profit (π):

$$\pi_t = p_t \cdot q_t^* - s_t \cdot q_t^* - c(q_t^*) , \quad (1)$$

where: q_t^* = desired output in period t ,
 s_t = royalty per unit of output in period t ,
 $c(q_t^*)$ = cost function,
 p_t = price in period t .

It is further assumed that price is exogenously determined by competitive market conditions. Qualifications to this assumption will be discussed in section III. In addition, note that the firm's royalty has been assumed to be a specific tax. Such a specific tax could alternatively be represented as its *ad valorem* equivalent (see Emerson and Lloyd (1983)).

In the absence of an *a priori* preferred specification, the cost function is specified as having the following exponential form:

$$c(q_t^*) = a \cdot q_t^{*b} , \quad (2)$$

where: $b > 1$.

Substituting (2) into (1), the first order condition for profit maximisation is, therefore, given by:

$$p_t - s_t = a.bq_t^{*b-1}. \quad (3)$$

By taking logarithms in (3) desired output in period t can be represented in linear form as:

$$\log q_t^* = (-\log a.b + \log(p_t - s_t))/(b - 1), \quad (4)$$

which we rewrite as:

$$\log q_t^* = b_0 + b_1 \log R_t, \quad (5)$$

where: $b_0 = (-\log a.b)/(b - 1),$

$b_1 = 1/(b - 1),$

$R_t = (p_t - s_t).$

The second behavioural assumption is based on the Nerlove stock adjustment principle.^{4/} In this case, although we have a model in which the desired level of output in period t depends on the value of R in period t , the actual adjustment of output to the desired level in that period is assumed to be only gradual due to technological, administrative and industrial relations constraints.^{5/} This gradual adjustment assumption may be represented by the following equation:

4. See Nerlove (1958). This approach has also been used in similar empirical work. See, specifically, I.A.C. (1975).

5. It may be argued that, in this case of gradual adjustment of actual output, desired output should be a function not just of current net revenue, but also of expected near future net revenues. In specifying desired output as an explicit function only of current net revenue, we are implicitly specifying current net revenue as the firm's best estimate of near future net revenues. The appropriateness of this specification clearly depends on the extent to which changes in current net revenue are expected to be maintained into the near future. In the case of Western Australian iron ore, this in turn relates principally to the price renegotiation features of long-term contracts.

$$q_t/q_{t-1} = c(q_t^*/q_{t-1})^\beta, \quad (6)$$

where: c = some constant embodying long term growth plans,

β = the coefficient of adjustment (<1).

By taking logarithms in (6), this adjustment process may be represented in linear form as:

$$\log q_t - \log q_{t-1} = b_3 + \beta(\log q_t^* - \log q_{t-1}), \quad (7)$$

where: $\log q_t - \log q_{t-1}$ = actual (log) change in output,

$\log q_t^* - \log q_{t-1}$ = desired (log) change in output,

$$b_3 = \log c.$$

By substituting (5) into (7) and including a disturbance term (μ_t), we obtain the following estimating equation:

$$\log q_t = (\beta b_0 + b_3) + (\beta b_1) \log R_t + (1 - \beta) \log q_{t-1} + \mu_t. \quad (8)$$

Equation (8) shows (in logarithmic form) that output in a particular period depends partly on the level of output in the previous period and partly on the net-of-royalty price of iron ore.

The coefficients to be estimated using this equation are:

$(\beta b_0 + b_3)$: a constant term, the sign of which
is *a priori* indeterminate,

(βb_1) : the coefficient of the price
variable, *a priori* positive,

$(1 - \beta)$: the coefficient of lagged output,
a priori positive.

Moreover, the logarithmic form in (8) implies that βb_1 can be interpreted as the short run price elasticity of supply and b_1 the long run elasticity. Note that b_1 is calculated using the coefficient of $\log q_{t-1}$:

$$b_1 = \beta b_1 / 1 - (1 - \beta) . \quad (8)$$

SECTION III: DISCUSSION OF THE DATA

(a) Costs

Implicit in (8) is the assumption of a constant marginal cost curve over time. This may be considered unlikely in view of continued mining company claims of increased costs of inputs. However, to the extent that increased wage and fuel costs have been offset by improved productivity and efficiency, this assumption may be considered reasonable.^{6/}

Also implicit in (8) is the assumption that marginal cost conditions are constant across firms, but again the assumption may be defended. Hamersley Iron and Mt. Newman Mining, which together represent 90% of capacity, are companies with very similar scale, equipment and mining techniques so that the difference in their marginal costs would be minimal. We feel that these costs would also not be significantly different from those of the smaller producers.

(b) Price

The world market for iron ore is complex. Approximately three-quarters of Western Australian iron ore is shipped to Japan on the basis of long-term contracts. There is also a substantial "free" market for iron ore in which price is negotiated on a "spot" basis. In addition, some iron ore producers are supplying other subsidiaries of the same corporate group, with these supplies valued at an internal "transfer" price.

6. That the companies have undertaken such technical improvements is suggested in the Booth, Connell-Hatch (1983) report on the industry. For example: "As a general rule the major producers are highly capitalized and utilize or have subsequently invested in automation and computer based control systems to improve efficiency and productivity" (p. 64).

Whether or not traded prices can be considered to have always been determined on a competitive basis is open to question. Initially price was determined in an oligopolistic setting, although the market has recently become much more competitively structured. The prices in contracts that have been negotiated recently in relation to Australian iron ore may be considered to approximate closely competitive prices due to the "contestable" nature of the world iron ore market, specifically the continued prospect of the Japanese expanding their Brazilian purchases.

Nevertheless, each company typically faces a different set of prices for a variety of reasons. These include different contract terms and periods; different quality characteristics of each company's ore; and different requirements of customers. In seeking to specify a representative price for iron ore, our procedure was to derive price data by dividing the total value of output in the industry for each year by the tonnage of output in that year to give an "average" price facing iron ore producers (see Appendix 2 for details).

(c) Royalties

As detailed in Section I, royalties on domestically consumed iron ore are levied at 15 cents per tonne, while exported lumps are taxed at 7.5% and exported fines at 3.75% (where price exceeds \$8 per tonne). This means that total royalties paid by the industry, or even by a company, may vary simply because of a change in the proportion of lumps and fines shipped, or because of a change in the export share.

As with the price variable, in seeking to specify a representative tax on iron ore, our procedure was to derive an average measure of the royalty burden per tonne by dividing total royalties paid each year by the tonnage of output in that year (see Appendix 2 for details).

(d) Net Revenue

The net revenue per tonne received by iron ore producers was calculated as the difference between price and royalty, themselves calculated as described in (b) and (c) above. These values were deflated using the C.P.I. to give the values of R_t used in the estimation (see Appendix 2 for details).^{7/}

(e) Sample Period

Data for the estimation procedure cover the period from 1961-62 to 1981-82 (see Appendix 2 for details).

7. The C.P.I. may not be the most appropriate deflator, however alternative indices were not available over the whole of the sample period.

SECTION IV: RESULTS

Using the method of Ordinary Least Squares, the estimated equation is as follows (t-statistics are in brackets):

$$\log q_t = 0.84 + 0.61 \log R_t + 0.86 \log q_{t-1}$$

(4.19) (6.09) (39.13)

$$R^2 = .9914 \qquad d.w. = 1.31 \qquad F = 1102.3.$$

All coefficients are significant at the 5% level. The Durbin-Watson statistic lies between the significance values at the 5% level so that the test for the presence of serial correlation is inconclusive at this level. At the 1% level, however, the null hypothesis of zero autocorrelation is not rejected.^{8/}

Since

$$\beta b_1 = 0.61$$

we can use (8) to calculate

$$b_1 = 4.36.$$

In other words, our results estimate the short run price elasticity of supply to be 0.61 and the long run elasticity to be 4.36.

8. It should be noted that the Durbin-Watson statistic is an unreliable indicator of serial correlation in situations where there is a lagged dependent variable. The Durbin "h" statistic, which is reliable in this instance, is unreliable for small samples. Nevertheless, its value, calculated to be 1.31, means that the null hypothesis of zero autocorrelation is not rejected at the 5% level.

SECTION V: CONCLUSION AND IMPLICATIONS

Our results have estimated the short run price elasticity of supply of iron ore in Western Australia to be 0.61. It follows from this that a 1% reduction in net revenue per ton (equivalent to an increase in the average royalty rate from 5.5% to 6.5%) would result in a reduction of output by 0.61% and, combining the two, a fall in revenue to producers of 1.61% in the short term. For the government, the increase from 5.5% to 6.5% represents an 18.18% increase in the royalty rate. Due to the reduction in output, however, there would be an increase of only 17.57% in royalty receipts.

Given time to adjust fully their output levels, producers are seen to be more responsive to changes in net revenue, with the long run price elasticity of supply estimated to be 4.36. Therefore, the same increase in the royalty rate would result in a 4.36% reduction in output and a 5.36% fall in the revenue of producers. Moreover, this larger fall in output in the longer term means that an 18.18% increase in the royalty rate would result in an actual growth of royalty receipts to the government of less than 14%.

In the wider context of the Australian economy, the iron ore industry makes a direct contribution of about 1% of Gross Domestic Product (1980-81). In the particular context of Western Australia, where the industry is concentrated (approximately 90% of Australian production), this contribution represents a considerable 9% of Gross State Product.^{9/} Furthermore, via forward and backward linkages, the industry also makes a major indirect contribution to the Western Australian economy which has been estimated as three times as strong as the direct effect and concentrated mainly on local industries.^{10/} It follows that an

9. Based on experimental estimates for 1980-81 contained in Burrell, Daniel, Johnson and Walters (1984).

10. See Fraser (1984).

increased *ad valorem* royalty rate, through its impact on the output of the iron ore industry, would also have a substantial adverse effect on the level of economic activity in Western Australia, and to a lesser extent, Australia. This, in turn, must have an adverse effect on general tax receipts, both State and Federal. Therefore, although our results suggest the State government would be able to increase royalty receipts by increasing the royalty rate on iron ore, any consequent increase in overall tax receipts may be considerably diminished by the associated indirect effects.

As a result of these considerations, our conclusion is that the use of increased *ad valorem* royalty taxation of the iron ore industry as a means of raising tax revenues would lead to a substantial distortion of output and, especially after accounting for indirect effects, would raise considerably less tax revenue than might be anticipated.

APPENDIX 1

Calculation of Real Growth Rates

Implicit Price Deflators were used to bring all figures to 1979-80 values. Implicit Price Deflators were used in preference to the Consumer Price Index because they capture a much wider range of prices. The I.P.D. used was that for Gross National Expenditure as this captures the widest range of price changes. A continuous series of deflators is available with 1979-80 as a base year from 1969-70 to 1982-83. I.P.D.'s for 1983-84 were not available at the time of writing. Deflators prior to 1969-70, back to 1966-67 only, are available with 1974-75 as the base year. These were calculated in 1979-80 values simply by multiplying by the 1974-75 deflator in 1979-80 values. A strategic approximation for the 1983-84 deflator was made by using the C.P.I. rise for 1983-84 of 6.9%. In the six years prior to 1983-84 changes in the G.N.E. deflator differed little from the change in the C.P.I.

Source: Quarterly Estimates of Income and Expenditure,
Australian Bureau of Statistics, 5206.0, Table 3.

Implicit Price Deflators

Year	I.P.D.	% Change	% Change [*] C.P.I.
1966-67	32.0	-	
1967-68	33.1	3.4	
1968-69	34.0	2.7	
1969-70	35.8	5.3	
1970-71	38.3	7.0	
1971-72	41.0	7.0	
1972-73	43.8	6.8	
1973-74	49.6	13.2	
1974-75	59.3	19.6	
1975-76	68.8	16.0	
1976-77	76.8	11.6	
1977-78	84.1	9.5	9.5
1978-79	90.6	7.7	8.2
1979-80	100.0	10.4	10.1
1980-81	110.1	10.1	9.4
1981-82	121.3	10.2	10.4
1982-83	135.1	11.4	11.5
1983-84	144.4	6.9+	6.9

* Six states

+ Estimate

APPENDIX 2

Table A

Year	(1) Output ('000t)	(2) Value ('000\$)	(3) Royalties ('000\$)
1961-62	1,404	2,394	192
1962-63	1,391	2,362	198
1963-64	1,368	2,320	191
1964-65	1,866	3,157	192
1965-66	4,278	16,323	347
1966-67	9,280	50,170	2,380
1967-68	15,743	91,298	4,945
1968-69	23,701	140,075	9,028
1969-70	34,576	195,074	13,085
1970-71	46,417	279,478	19,027
1971-72	52,666	316,387	22,449
1972-73	64,434	332,520	24,676
1973-74	82,404	392,903	30,582
1974-75	90,659	552,803	35,706
1975-76	86,092	619,802	38,249
1976-77	88,999	698,159	44,635
1977-78	84,942	797,323	44,848
1978-79	78,845	823,780	48,498
1979-80	91,519	992,868	52,430
1980-81	89,209	953,784	60,154
1981-82	82,524	1,079,814	59,350

Sources: (1), (2): Australian Bureau of Statistics,
Western Australian Yearbook (various years).

(3): Western Australia, Auditor General's Report
(various years).

Table B

Year	(1) Price (P) (\$/t)	(2) Tax (S) (\$/t)	(3) P-S	(4) C.P.I.	(5) Net Revenue (R)
1961-62	1.71	0.14	1.57	89.6	1.75
1962-63	1.71	0.14	1.56	89.8	1.74
1963-64	1.70	0.14	1.57	90.6	1.72
1964-65	1.69	0.10	1.59	94.0	1.69
1965-66	3.82	0.08	3.74	97.4	3.84
1966-67	5.41	0.26	5.15	100.0	5.15
1967-68	5.80	0.31	5.49	103.3	5.31
1968-69	5.91	0.38	5.53	106.0	5.22
1969-70	5.64	0.38	5.26	109.4	4.81
1970-71	6.02	0.41	5.61	114.6	4.90
1971-72	6.01	0.43	5.58	122.4	4.56
1972-73	5.16	0.38	4.78	129.8	3.68
1973-74	4.77	0.37	4.40	146.6	3.00
1974-75	6.10	0.39	5.71	171.1	3.34
1975-76	7.20	0.44	6.76	193.3	3.50
1976-77	7.84	0.50	7.34	220.0	3.34
1977-78	9.39	0.53	8.86	240.9	3.68
1978-79	10.45	0.62	9.83	260.6	3.77
1979-80	10.85	0.57	10.28	286.9	3.58
1980-81	10.69	0.67	10.02	313.9	3.19
1981-82	13.08	0.72	12.36	346.5	3.57

Sources: (1): Derived from Table 1 Value/Output.
(2): Derived from Table 1 Royalties/Output.
(3): (1)-(2).
(4): A.B.S., Consumer Price Index.
(5): (3)/(4) × 100.

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