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HAVE MINING ROYALTIES BEEN BENEFICIAL TO AUSTRALIA?

By

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Abstract

The 'Henry tax review', Australia's Future Tax System (2010), recommended that royalties be abolished and replaced by a resource rent tax. Regarding abolition, AFTS drew on KPMG Econtech (2010a), a report commissioned by Treasury to investigate the efficiencies of a wide range of Australian taxes, using MM900, a proprietary CGE model. That report estimated that the average excess burden (AEB) of royalties and crude oil excise was 50 per cent, and the marginal excess burden was 70. This may have led some policy advisers and commentators to conclude that royalties, considered separately from the excise, are the most inefficient of all (non-corrective) imposts. We argue that the KPMG Econtech long run comparative static framework was inappropriate for policy purposes. By ignoring that mining is largely foreign owned, the model missed a large 'rectangle' of gain—which we calculate using a partial equilibrium model. Also, the modellers assumed stationary minerals prices, apparently those of 2004-05: the subsequent doubling of mineral prices halves the estimate of AEB. More fundamentally, the finding that royalties harm Australia implies that a rise in the terms of trade also harms Australia. Thus, KPMG Econtech overstated the excess burden of royalties; in fact, royalties are likely to have been beneficial.

Keywords: Excess burden; Henry tax review; mining royalties; foreign ownership; KPMG Econtech

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1. Introduction

When the first Rudd government announced the Resource Super Profits Tax (RSPT), it made four supporting claims:

- The resources were owned by all Australians;
- The miners were making super profits, after existing taxes and State royalties;
- Royalties were very inefficient—so inefficient that the Henry review of Australia's Future Tax System (AFTS) recommended abolishing royalties and imposing a form of the 'Brown' tax;
- The RSPT would have no excess burden.[1]

Subsequently, the Gillard government resiled from the RSPT and imposed the Minerals Resource Rent Tax (MRRT) on iron ore and black coal (and incidental coal seam gas).

The claim that royalties were very inefficient was made in KPMG Econtech (2010a), a major piece of research commissioned by the Treasury for AFTS, using a model called MM900 to estimate the effects of a wide range of Australian taxes (see also 2010b). The report concluded that royalties and the crude oil excise, taken together, were the most inefficient major tax group, with an average excess burden (AEB) of 50 cents and marginal excess burden (MEB) of 70 cents: see Table 1. These findings were accepted, maybe welcomed, by Treasury and the first Rudd government (see, for example, DWEER 2010) and the Gillard government. It is curious that such a dramatic claim, as it applied to royalties, did not elicit much critical attention from economists and that virtually nothing has been published by way of independent expert appraisal of the whole report.

Insert Table 1 here

Although the KPMG Econtech estimates were for royalties and crude oil excise taken together, some policy advisers and commentators seem to have assumed, incorrectly, that KPMG found royalties to be the most inefficient of all non-corrective taxes. For what it is worth, our effort to disentangle the KPMG Econtech estimate suggests that the AEB for royalties alone, using MM900, would be around 20 per cent.[2] This would put royalties into the low to medium range of average excess burden and thus not the most obvious candidate for complete abolition.

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[1] On the excess cost of rent taxes, see Ergas, Harrison and Pincus (2010) and Swan (2011).

[2] The calculation assumes that the AEB of royalties-plus-excise, in KPMG Econtech (2010a), is the revenue-weighted average of the AEB estimates of the two imposts; that AEB is proportional to the tax rate, in the usual partial-equilibrium expression (see the Appendix); and that the supply elasticity for mineral products subject to royalties, was the same as for crude oil. Then we have $AEB(royalties) \approx AEB\ (both)/[\{R_2/R\}\{1 + (R_2/R_1)(t_2/t_1)\}]$, where the subscript 1 refers to royalties and 2 to crude oil, and no subscript, to both together; revenue is denoted by R and tax rates by t. The crude excise rate was around five times the average royalty rate; in 2006-07, royalty revenues were about equal those from the excise. (ABS 1301.1 2010)

Moreover, we suggest that the modelling by KPMG Econtech for Treasury does not provide an adequate basis for policies on mining taxation and royalties.

KPMG Econtech adopted a long run, comparative static framework in which Australian households own all real assets used in Australian mining (and in all industries)—there are no foreign shareholders to bear any burden; there is no direct foreign investment. Moreover, no burden falls on non-resident financiers in their model, since foreign capital was assumed to be in perfectly elastic supply. However, a considerable portion—over 80 per cent—of the burden of royalty revenue payments falls (legally) on non-residents shareholders of the Australian-based mining operations. We use a partial equilibrium model to estimate that the final incidence on foreign shareholders is about 25 per cent of the public revenue involved. The assumption that there are no foreign shareholders seems sufficient to make the KPMG Econtech model a precarious basis for changes in policy on royalties, crude oil excise, resource rent taxes and company tax.

It is generally agreed that a rise in the terms of trade boosts Australian real incomes. The 'story' goes as follows: Australian production mix is more intensive in minerals than is the Australian consumption bundle (via input-output relations); a rise in world mineral prices increases Australian export earnings; the foreign exchange rate rises; imports become cheaper; real incomes rise (Gregory 2011). Notice that this 'story' contradicts any claim that the net effect of a rise in mineral prices is negative for real incomes, due to the flow through of higher mineral prices into the prices of consumption items that embody minerals (like transport equipment). Now, this beneficial sequence does not depend on the cause of the rise in export prices and the terms of trade. To the extent that royalties discourage output and exports of products facing somewhat elastic export demand, royalties drive up the terms of trade. Thus, royalties would be expected to generate a gross benefit, which could only be overbalanced by substantial excess burden 'triangles'. To the extent that royalties means that mineral output is smaller, royalties reduce the demand for Australian labour and an excess burden on the supply side. Our partial equilibrium model confirms the intuition that both the supply-side and the consumer-side triangle are very small in relationship to the revenue rectangle. Specifically, we argue against accepting the KPMG Econtech estimate that the cost of living rise due to royalties and crude oil excise is larger than the public revenues they generate.

We offer two illustrations of the dangers of using a long run comparative static model as the basis of policy advice.

Most Australian royalties on high value mineral are *ad valorem*, and so royalty revenue rises somewhat proportionally with prices. KPMG Econtech's database year was 2009-10, but they removed the huge rise in mineral prices since 2004-05.[3] We argue below that this adjustment approximately halved the revenue attributed to royalties (and the crude oil excise, because oil prices also rose sharply). Therefore, this adjustment greatly inflated the estimate of AEB, which is the ratio of excess burden to revenue—the numerator is largely invariant to mineral prices, but the denominator is roughly proportional. To choose the prices of one year as the basis of

[3] 'This normalised economy abstracts from the strength of Australia's mining exports and terms of trade growth since 2004/05' (KPMG Econtech 2010a: 42).

the AEB calculation may suit some modelling purposes; but it would have been useful if the modellers had reported a sensitivity analysis of their most dramatic conclusion. (No sensitivity analysis of any kind was reported in KPMG Econtech 2010a or 2010b.)

The KPMG Econtech (2010a) estimate of the beneficial effects of abolishing royalties completely does not depend on assuming anything was put in their place: the simulation merely abolished royalties.[4] Their long run comparative static model generates steady state equilibria: the present value of a policy change is given by the change in steady state economic welfare. Such a model does not any capture transient effects, even those of considerable policy relevance. Mineral prices rose unexpectedly and hugely, and are likely to be higher than the long-term average for over a decade. In the short run, the elasticity of supply of minerals is very low. Therefore, in a period of unexpected and large rises in mineral prices, more royalty revenues are collected, with trivial effect of output and trivial excess burden. Royalties and company taxation may not be the best combination of imposts to capture the benefits of the price rises; but to accept that is not to accept that royalties actually harmed the Australian economy and that their abolition in 2004-05 would, by itself, have benefitted Australians.

Section 2 examines the modelling in KPMG Econtech (2010a), and discusses why we are unwilling to accept the KPMG Econtech (2010a) estimated that a rise in the cost of living, induced by royalties and crude excise, overshadowed the benefits of royalties. We also speculate about what, other than foreign shareholding, could account for the huge gap between our and their estimates. Section 3 uses a partial equilibrium model to estimate the effects of royalties on mining generally, and on black coal and iron ore specifically. Conclusions are in Section 4. The appendix presents derivations, data and sources.

2. KPMG Econtech's CGE modelling

MM900 is a large computable general equilibrium model, with 109 industries and almost 900 separate products, and 19 taxes or levies. It is a comparative static model—it computes prices, quantities, revenues and so on, as though the economy had fully adjusted to the 'shock' that caused it to deviate from the initial solution. In MM900, financial capital was provided from domestic savings, assumed proportional to income; and via foreign capital, assumed in perfectly elastic supply. The labour market clears through flexible wages; and the labour-leisure trade-off means that labour supply has some elasticity, but quite small. Foreign balance is maintained through a flexible exchange rate. World prices respond to variations in Australian exports; and production for domestic absorption cannot be transformed one-to-one into production for export.[5] The database year is 2009-10, although unspecified adjustments were made for the global financial crises and to offset some of the effect of the boom in export prices between 2004-05 and 2009-10.

[4] KPMG Econtech (2010b) simulates the abolition of royalties, the imposition of a resource rent tax, and cuts in company taxes. However, the cumulative effect will be roughly additive in the effects of each change considered in isolation.

[5] This assumption is hard to reconcile with long-run comparative statics.

To estimate incidence and average excess burden, KPMG Econtech shocked their model by setting a levy or tax to zero; the new equilibrium was computed, and compared with the equilibrium in which the levy or tax was imposed. In the simulations for the MEB, the rate of impost was reduced by 5 per cent (of itself). After the removal or reduction in a tax, a lump sum transfer from the private sector balanced the public sector accounts. The transfer was from households, who were assumed to have owned all Australian-based assets and labour. Excess burden was measured as the compensating variation in income necessary to restore the utility of the representative household.

There is an important methodological point to make. The KPMG Econtech counterfactual appropriately compared an economy in which miners paid all general taxes and no royalties, with the equilibrium when the miners paid all general taxes and also paid royalties:

> *To estimate the excess burdens, the effective tax rate is altered and the changes in welfare and tax revenues are compared. This is done using the following simulations. The marginal excess burden of crude oil excise and royalties is estimated by simulating a small (5 per cent) increase in the effective crude oil excise and royalty rate. To estimate the average excess burden of crude oil excise and royalties, these taxes are abolished (by setting the effective tax rates to 0 per cent) (2010a: 96).*

The supply curve in our Figure 1, below, likewise incorporates the effects of all general taxes: payroll tax and company tax and the like.[6] If the mining industry were to be relieved of these, then the Productivity Commission would report the resultant 'tax-expenditures' as industry-specific assistance—mineral output would then exceed the 'ideal' or constrained-optimal level, absent reasons of externalities and the like. (The constraint is that government needs revenue and imposes a variety of taxes on industry generally as the principal means.) The question to be asked of the model relates only to the effects of special imposts on mining, imposed on top of the general taxes that all industries pay.

In building a large model on a limited budget, PKMG Econtech used the Procrustean technique: every industry shared the same elasticities of factor substitution in a common CES production structure (see Turner et al. 2012). Thus, it can scarcely be expected that the modelling would be as satisfactory and results as reliable for industries, like mining, with unusual features. Firstly, mining uses natural resources. KPMG Econtech in effect made them costlessly renewable—fixed in quantity and with a stationary real price (compare Hotelling 1931, Farzin 1992). This raises important issues for CGE modelling: strictly, if the stock of resource were fixed as of

[6] When the first version of this paper was presented at ACE12, discussants (temporarily) convinced us that we had made a serious mistake, by computing MEB of royalties by using a supply curve that already incorporated other taxes. We had computed excess burden of a single impost, a royalty, rather than of an aggregate of taxes, the total rate of which considerably exceeded the royalty rate; and it was pointed out that, in partial equilibrium, EB rises with the square of the total tax burden—which is correct but irrelevant to our paper. It would be relevant to a paper examining the effects of imposing an excise tax at the same rate on all industries, on top of existing general taxes; or, possibly, comparing the effects of imposing no general taxes on mining, with the effects of imposing two alternatives: all the general taxes and no royalties, or all the general taxes plus royalties.

2009-10, then either all expansion of output is at the intensive margin—quite contrary to fact—or some resource was not used in 2009-10 and therefore had a marginal product and rent of zero.[7] Here we note that recent experience (see Appendix) and general considerations of resource specificity suggest a relatively elasticity low of supply.[8] Secondly, for black coal, oil and gas, iron ore, and non-ferrous metals, KPMG Econtech (2010a) found excess returns were being earned by 'Owners of non-land fixed factors of production e.g. natural resources' (2010a: 35-36 and Table 3.1).[9] This seems hard to reconcile with their conclusion that royalties fall heavily on non-rents—an issue to which we return.

To supplement the summary of AEB and MEB (in table 1 above), KPMG Econtech report provided a series of tables, 5.1 through 5.30, headed "Incidence of…Taxes" reporting changes in total after-tax private income and its main elements. Table 2 summarises that information for royalties and crude oil excise.[10]

Insert Table 2 here

Before focussing on lines 2 (revenue) and 4 (CPI rise), we comment on line 1, nominal after-tax income. Although KPMG Econtech reported royalties and crude oil excise together, as tables 1 and 2 show, it is not clear whether or not the two imposts were treated identically in MM900. Under the system of national accounting (ABS 5506.0), if the oil excise were to be removed, gross operating surplus (GOS) does not change (before general-equilibrium effects). In contrast, because a royalty is not a tax, if royalties were forgiven, the GOS of the miners would rise, as rent is transferred between the private productive sector and the public sector. If MM900 treated the removal of royalties exactly as for the removal of an excise (and we have been unable to clarify this point), then it overstated the change in private post-tax income by the amount of the transferred royalty payment. Royalty payments in 2004-05 were $2.3b (Commonwealth Grants Commission 2011: Box 5.1); as Table 2 shows, this is greater than the excess burden of $1.7b shown in line 5, so that AEB would become minus 15 per cent (a benefit). Alternatively, using our partial equilibrium model, we estimate that producers bore over 80 per cent of the incidence of the $2.3b of royalties, that is, $1.8b. Removing $1.8b from KPMG Econtech's estimate of AEB of royalties and crude oil excise reduces it from 50 to around zero.

The first order effect of re-setting minerals prices to 2004-05 is on public revenue, line 2. To a first approximation, line 2 is the revenue from imposing the two industry-specific imposts. The total of revenue from royalties and the crude oil excise in 2009-10 was closer to $7b than the $3.4 used in table 3 (KPMG Econtech 2010a: 95 and ATO Taxation Statistics 2007-08, table 13.2); and $3b more in 2010-11. Our

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7 In MM900, there is no heterogeneity in the quality of a specific resource. It is not clear if the model recognised locational rents.

8 If a relatively small non-mining industry were exempt from payroll tax (say), its output would rise, drawing more labour, capital and land from large national pools, all elastically supplied to the specific industry. But for mining, for each output type there is a specific resource in perfectly inelastic supply. Moreover, there is a limit on substitution: no amount of labour and capital can produce more than a tonne of minerals from less than a tonne of ore.

9 Presumably, this phrase is shorthand for ''Owners *of entitlements to access* non-land fixed factors of production e.g. natural resources'.

10 We are grateful to a referee for correcting our earlier interpretation of this table: see Pincus 2012.

understanding is that CGE estimates of the change in private incomes (line) 1 and of the rise in CPI (line 4) are largely invariant to the level of mineral prices. The first is a 'real' number, with the numeraire being the nominal wage. The CPI rise is the percentage increase due to the imposition of royalties and crude oil excise and these products have a relatively small (direct and indirect) weight in the CPI. Thus we suspect that the reduction in mineral prices, which KPMG Econtech imposed on their database of 2009-10, may well have doubled their estimate of AEB for royalties and crude oil excise.[11]

Notice that the largest cost to Australian households from royalties, $3.8b (line 4), came from a rise in the cost of living relative to the nominal wage. There is no discussion of the mechanism in the report. Presumably, royalties on black coal and iron ore reduce output and drive up their world prices[12], as well as the prices of products that use the minerals, including imports. However, to conclude that a rise in black coal and iron ore prices harms the living standards of Australians would be to deny the generally accepted proposition that Australia gains from a rise in its terms of trade (Gregory 2011). Australian production is more intensive in coal and iron ore than is Australian consumption (directly and indirectly), and so rises in their world prices would be expected to improve Australian real incomes, unless accompanied by extraordinarily large excess burden 'triangles'.

Nor is it easy to reconcile the KPMG Econtech finding with the theory of the optimal trade tax. KPMG Econtech's remarked (p. 71) that 'the theoretical "optimal" tariff was around 11% (based on the average export demand elasticity of around – 10).' The actual tariff averaged about 3% (Lloyd 2007). By Lerner's symmetry theorem, removal of import tariffs of 3% should have the same effect as the removal of an export tax of 3%; and any export tax less than 8% would move trade taxes closer to the optimum. Averaged across all exports, royalties were around 3%.[13] Royalties must have had effects very close to export taxes: in 2007-08, 85 per cent of royalties come from oil and gas, coal and iron ore; the shares of the outputs exported were 68, 93 and 98 per cent (ABS 1301.0 2009-10: 18.16 and 18.18). So it is surprising that KPMG Econtech found that removing the tariff of 3 per cent (with the royalties still in place) reduced economic welfare by a negligible amount of $0.2b, whereas removing the royalties of 3 per cent (with the tariffs still in place), improved economic welfare by a considerable $1.7b. The argument can be refined,[14] but the inference is still the same—something seems seriously amiss with the KPMG Econtech modelling of royalties.

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[11] In contrast, Independent Economics (2012), in estimating the excess burden of horizontal fiscal equalisation for the South Australian Government, boosted mineral prices above their database levels, in order to achieve a more typical result. See also Fitzgerald and Murphy (2010).

[12] In MM900, crude oil has an export demand elasticity of – 12. The excise was around 30 per cent; if the supply elasticity were unity and 50 per cent continued to be exported, the model suggests that Australian crude excise drives up world oil price by 2.5 per cent, which is hard to accept. (Infinitely elasticities can cause model instability.)

[13] Mineral exports, which accounted for around 40% of all exports, were burdened with a royalty regime averaging about 7% in 2009-10, while other exports paid zero, for a weighted average of about 3%.

[14] In MM900, import prices are exogenous; major mineral products and crude have export demand elasticity of - 6; all other exports have an export demand elasticity of – 12. Therefore, the optimal set of trade taxes in MM900 comprises zero tariffs and two export taxes of about 20% for minerals and 9% for all other exports.

To avoid confusion, we reiterate the framework of the MM900 simulation: table 2 reports the estimated effects on the welfare of Australians of removing royalties (and the excise) completely; *nothing was assumed to be put in the place of royalties*: no *ex ante* auction for mining rights, no resource rent tax. So the table says that Australian households would gain up to $1.7b, by giving mining rights away (say, by lottery). However, this would generate a secondary market in rights. An example is a private royalty arrangement that Clive Palmer negotiated, under which Citic Pacific is to mine 6b tonnes of magnetite, pay Palmer's firm *ad val.* royalties and then pass the mine over to Palmer (*Australian Financial Review*, 31 March 2012: 50).

This contract involves non-residents; however, KPMG Econtech (2010a) assumed that Australians own all real productive factors in the database:

> *A key observation is that Australian households are simultaneously consumers and producers. Households derive welfare from their consumption of goods and services, which in turn, depends on their income as owners of factors of production, including labour, capital, land and other fixed factors…It follows that distinguishing between the incidence on consumers and producers would not be a meaningful analysis (p. 24).*

Only if Australian households owned all Australian assets would there be no purpose in distinguishing consumers from producers.[15] In reality, the legal obligation to pay royalties and taxes is with companies. If foreign ownership were taken into account (Connolly and Orsmond 2011), the KPMG Econtech estimates of the benefit to Australian households would be understated and the AIEB overstated by approximately 80 per cent of the revenue, or $2.8b: the net benefit to Australians from royalties and the crude excise would be $1.1b.[16]

KPMG Econtech implicitly assumed that the Australian mining industry would be just as extensive and just as productive if the Australian government had forbidden direct foreign investment: the nature of foreign investment—equity or portfolio—is epiphenomenal. However, a large literature shows that the form of foreign investment does matter. In particular, direct foreign investment is a vehicle through which technical and organisational knowledge is transferred, to an extent not generally true for portfolio investment. (A similar remark applies to all industries with some degree of foreign equity or property holdings.)

In their model, there is no such asset as production knowledge that can be owned by foreigners, and command a factor reward. This is consistent with the following:

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[15] It could be argued that the long run framework means that all contracts are re-negotiable and so the ultimate burden of royalties must fall on the ultimate owners of the resource, the households of Australia. Keynes's scepticism about policy relevance of 'the long run' does come to mind. Dasgupta and Heal (1979: 363-5) derives the level and escalation of royalties that do not distort output choices, which, presumably, would be those discovered by a competitive market for rights.

[16] In the Haig-Simons' framework, selling sub-soil assets does not add to income; but in standard national accounting, no deduction is made for the diminution of resource stocks and so sale to foreigners does increase GDP. However, even in the Haig-Simons' world, permitting sales of mining rights to foreigners would be expected to boost the 'price', which is a benefit.

> *Resource royalties and crude oil excise are applied to the output of mining industries rather than to the profits derived from the natural resources used in mining industries. However, these natural resources, as fixed factors, still bear some of the incidence of these taxes. In the same way as company tax, the mobility of capital means that it will not bear the incidence of resource royalties and crude oil excise. When some of the capital in mining industries is withdrawn, this reduces the productivity of natural resources, leading to lower rents from those natural resources (KPMG Econtech 2010a, 9, 10).*

The only route in MM900 by which foreigners could bear some tax incidence is via effects of taxes on world prices paid by customers (which doubtless their model captured). This is because there is no direct foreign investment, and financial capital bears no tax incidence in MM900: Australia is assumed to be a price-taker with respect to capital inflows, and domestic savings are assumed unresponsive to returns (being a fixed proportion of income). However, if the miners were earning excess profits, then why would a royalty drive financial capital away (as this quotation claims)?

3. A partial equilibrium model

The purpose of our partial equilibrium model is to provide a better understanding of the mechanisms through which royalties affect economic welfare, and to quantify them. In particular, we evaluate the sizes of the revenue rectangles provided by suppliers and demanders, and by Australians and non-residents, and relate them to the excess burden triangles. Because it is a 'real' model—the numeraire is a unit of mining output—it cannot be used to estimate the induced rise in the cost of living.[17]

The basis of our model is Figure 1, showing the supply and demand curves for Australian mining output. The demand curve is the horizontal sum of the demand of Australians plus the excess demand of the rest of the world. A royalty shifts the supply curve up to S' and drives a wedge between the price received by the Australian suppliers and that paid by demanders.

Insert Figure 1 here

A royalty is a price for access to a resource. There exists a level and time-profile of the positive access charge that are non-distorting (Dasgupta and Heal, 1979: 263-5).[18] Therefore, the analysis of the economic effect of royalties bears some similarity to the analysis of price control or monopoly: given the nature of the royalty type in place, economic inefficiency varies with the deviation of the royalty from its non-distorting path, and not with royalty rate itself. In contrast, given the nature of the distorting tax, the size of economic inefficiency depends on the tax rate itself. As we cannot

[17] Haig and Wood (1974) used the input-output and the basket of the CPI to estimate the effects of rises in wages and import prices on the cost of living, without general equilibrium modelling.

[18] The non-distorting royalty is also what an efficient competitive market for access would deliver.

incorporate this nicety into a static model, we simply assume that the optimal royalty level is zero (as did KPMG Econtech).

In Figure 1, areas are labelled in bold letters: **A**, **a**, **B**, **b**. The total burden on demanders is (**A** + **a**); the total burden on suppliers is (**B** + **b**). Royalty revenue, R, is equal to (**A** + **B)**, of which **A** falls on demanders and **B** on suppliers. For the world as a whole, therefore, the excess burden on demanders is **a**, and on suppliers is **b**. As usual, the triangles are equal to half the square of the relevant change in price, times the relevant elasticity.

We are, however, interested in the excess burden on Australians. The essential element is that the revenue that non-Australians contribute is not returned to them, but is distributed to Australians (as a lump sum). Formally, the appendix derives the average incremental excess burden on Australians as shown in equation (7) below. We have inserted the word 'incremental' to distinguish the concept of AEB used here from some others—we are considering the addition of industry-specific royalties to the general tax burden borne by all industries including mining. The excess burdens are converted to 'averages' by dividing them by the royalty revenue itself.

$$AIEB = c.AIEB_{D*} + (1 - f\pi)AIEB_{S*} - (1 - c)\delta - f\pi\sigma \qquad (7)$$

The first two terms of (7) are what Australians bear of the AIEB burdens from the demand-side triangle **a** and the supply-side triangle **b**; the third and fourth terms are the proportions of revenue borne by non-residents on the demand side and supply side respectively (that is, their shares of rectangles **A** and **B**). The average incremental excess burdens of royalties on the world-as-a-whole on the demand and supply sides are denoted $AIEB_{D*}$ and $AIEB_{S*}$ respectively. The share of output not exported is denoted c; f is the fraction of ownership held abroad; π is the share of profits in price; the price wedge borne on the demand and supply side, δ and σ respectively, depend on the supply elasticity and the overall demand elasticity. The parameter values and source for mining as a whole, and for black coal and iron ore separately, are given in the Appendix.

Table 3 provides a sensitivity analysis. We note that first two terms of (7), relating to the excess burden triangles, when apportioned between Australians and non-Australians, rarely sum to over + 5 per cent of revenue, and never over + 8 per cent. In contrast, the sum of the last two terms is consistently around about – 30 per cent (columns 1 – 4) or above (cols 5 and 6): the non-resident shares of the revenue rectangle on the demand side and supply side dominate.

Insert Table 3 here

For export demand, we applied the simple average of -6, what KPMG Econtech assumed for black coal, iron ore and some other major products, and -12, for other mining. Column 3 shows a small effect from rejecting the counterfactual of adding mining royalties to the general taxes paid. The results are relatively insensitive to the supply elasticity (cols 1 and 2; raising the elasticity to 2 makes little difference).

When we eliminate foreign shareholding, this wipes off about 25 percentage points (col.1 compared with col. 6). This is the most important result of the modelling, as it relates to a sharp difference between our approach and that of KPMG Econtech. Note that the argument about foreign shareholdings also applies to resource rent taxes. Ergas, Harrison and Pincus (2010) argued that resource rent taxation must have a disincentive effect; and Treasurer Swan (2011) agreed. If the burden of paying rent taxes falls heavily on non-residents, then resource rent taxes may also produce the reverse of excess burden. Similar remarks apply to the company tax—around half of the shares of Australian-based companies are owned abroad.

Our model indicates that royalties benefit Australia, and maybe considerably so. The benefit disappears, if we ignore non-resident shareholding; assume almost perfectly elastic export demand; and adopt a methodologically incoherent tax counterfactual. But even then, something substantial is required to explain the vast gap between our findings and those of KPMG Econtech (2010a).

A deficiency of our partial-equilibrium model is that it does not capture the effects of royalties on the cost of living. Consider iron ore. Australia exports almost all of its production, so the partial-equilibrium model would show very little adverse effect on the Australian customers; however, Australians consume products that embody iron and steel, directly or indirectly, and royalties raise their prices. We have not attempted to estimate these effects. However, if the KPMG Econtech estimate of the cost of living rise, $3.8b were accepted, then we can deduct it from the excess benefit derived from column 1. Earlier, we noted that in 2009-10 royalties and the crude oil excise revenue was more than $7b. Thus col. 1 implies an excess benefit of 0.31 times $7b, or $2.2b, which would yield an adjusted AIEB of 31 per cent, which is the closest we can come to the KPMG Econtech estimate of 50 per cent. We note, however, that the partial-equilibrium model suggests that royalties raise the world price of minerals by about 1.2 per cent (that is, 7 per cent of the share falling on demand, which is about 17 per cent for col. 1). It seems most unlikely that a 1.2 per cent rise in their prices would increase the CPI rise by the 0.5 per cent lift estimated by KPMG Econtech.

4. Conclusions

Our partial equilibrium model suggests that foreign shareholders bear around one quarter of royalty payments that fall on suppliers, and foreign customers bear up to one fifth of royalty payments that fall on demanders. Even if the first benefit is ignored, the second is many times larger than the usual excess burden triangles. Our model ignores cost-of-living effects, which we do not attempt to estimate. However, we are hesitant in accepting KPMG Econtech's estimate of the cost of living increase, which is so large as to negate the benefit, to a major exporting country, of higher world prices for its main mineral exports; and which assumed that the Australian excise lifts world crude oil prices.

Were the KPMG Econtech (2010a) estimate of AEB of 50 per cent to be adjusted to royalties only, it may fall to as low as 20 per cent.

KPMG Econtech (2010a: 58) explained the large excess burden by pointing out that royalties, like an excise tax, reduce supply; but also by postulating a displacement of financial capital when royalties depress the return to mining capital. But the

displacement of capital assumes that the miners were not earning excess profits in the form of resource rents—contrary to what KPMG Econtech asserted. If the miners were earning excess profits as resource rents, why would a fall in the return to mining capital act to drive capital away from the industry?

Moreover, trade theory suggests that a country would benefit from a rise in the export prices of mineral products if, like Australia, it had an output mix more intensive in minerals than is its consumption mix. Concomitantly, the theory of the optimal trade tax is hard to reconcile KPMG Econtech's finding that removal of the (3 per cent) tariff would produce a small efficiency gain, but removal of royalties (then around 7 per cent), a close substitute for a tailored set of export taxes, would cause great harm.

In their large proprietary CGE model, KPMG Econtech (2012a) may have substantially overstated the excess burden of royalties, because of how they modelled resource rents, their size and their distribution. A significant overstatement (around 25 per cent) came from their assuming away the extensive foreign ownership of mining companies. This may suit long run comparative statics; if so, it makes long run comparative statics unsuitable for policy purposes.

Royalties are a traditional means by which the ultimate owners of exhaustible resources attempt to capture resource rents. To the extent that royalties perform that task well, they cause little by way of reduction in output and, thus, a small reduction in the demand for mobile factors of production: the excess burden triangles would be small. However, both their and our approaches assume that the optimal royalty is zero and so the supply elasticity comes into play.

By assuming a specific supply curve, KPMG Econtech necessarily prejudged the crucial question and determined the extent to which royalties fell on resource rents and on mobile factors (and GE effects would magnify the latter impact into the excess burden). The less elastic is supply, the smaller will be the effect of an output reduction on producer surpluses, other than on resource rents—and a change in rents, by definition, has no excess burden. The claim that the miners were making excess profits, by way of retained resource rents, is hard to reconcile with their conclusion that a large burden of royalties fell elsewhere than on resource rents (see table 3). High resource rents—as asserted by KPMG Econtech, the Henry tax review and the Rudd and Gillard governments—suggest relatively inelastic supply. For reasons spelled out, we think that supply is not very elastic in the long run, and very inelastic in the short run, during which royalties may deliver policy relevant benefits. However, not to be prejudicial, we adopted a unitary supply curve (with sensitivity for 0.1 and 2). The value of the elasticity is not reported in KPMG Econtech (2010a).

KPMG Econtech asserted that the mining companies were earning excess profits by way of retained resource rents. However, KPMG Econtech found that the final incidence of royalties and crude oil excise is largely on the non-rent incomes of Australian households.

One way to reconcile these two assertions is that what KPMG Econtech observed were quasi-rents, not the pure rents that their model required. KPMG Econtech looked at the data for 2009-10 and found rates of return in excess of 'normal'. Had they looked at the rate of return for those mines in operation a decade or more earlier—and

these made up the vast majority of those operating in 2009-10, KPMG Econtech probably would have found very low rates of return after royalties. Even in the 2000s, according to Parham (2012: Figure 4.1), the internal rate of return to mining never exceeded about 18%, and averaged about 13%. Companies that invested in Australian mines decades ago took huge risks. When the investment began, Japan was the main customer, and Japan's chief exports were textiles; China was nowhere to be seen in the world market for coal and iron ore. Very few governments, very few investors, very few public servants in Treasuries, and very few economic modellers foresaw that a huge rise in Chinese demand would cause a huge rise in natural resources prices.[19] To take a spot check of rates of return and find them excessive is to risk confusing pure rents with quasi-rents. The methodological difficulty in using computable general equilibrium to model industries that can earn large quasi-rents—windfalls, if you like—is that the modeller has to assume that the data on outputs and costs reflect equilibrium; or else, create a factitious long run, equilibrium dataset.[20]

The other possible reconciliations are that, by modelling royalties as though they were excise taxes, KPMG Econtech mistakenly treated the transfer of royalty revenue from the private to the public sector not as a transfer of rent, but as a fall in output; or that (implausibly) they missed the incidence of royalty payments on non-resident customers.

If their table 5.9 for incidence (table 2 above) were crudely but generously adjusted for foreign ownership, then it would more than halve the 50 per cent AIEB that KPMG Econtech found; an alternative adjustment reduces it to about zero. If, instead, they have misattributed a royalty rent transfer as excess burden, as we speculate, then the excess burden of royalties again disappears. Without a large 'terms of trade' effect, and with no foreign ownership, such a finding would be surprising: although the optimal level of royalties is not zero, actual royalties do discourage or defer marginal mining activities. Nonetheless, given that KPMG Econtech asserted that these industries earned substantial resource rents after royalties; and given the importance of their surprising findings, a more convincing explanation of a high excess burden was required than was offered.

[19] This brief account of history draws on Ergas, Harrison and Pincus (2010).

[20] KPMG Econtech may have incidentally boosted their estimates of AEB and MEB by adjusting the mineral outputs downwards, to offset the rise in prices between 2004-05 and their database year, 2009-10.

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Appendix

Part A: Deriving Average Incremental Excess Burden of a Royalty with Exports and Foreign Ownership

Notation:

1. Arc elasticity of supply in the range OQ_1 to OQ_0 is η
2. Arc elasticity of the sum of domestic and export demand in the range is ε (taken for convenience as a positive number)
3. Pre-tax price is P_0, normalised to unity
4. Royalty is specific (dollars per tonne) at rate τ; post-tax supply price is equal to $1 - \sigma\tau$; post-tax demand price is $1 + \delta\tau$
5. The *ad val.* tax rate on post-tax supply price is t: $\tau = \mathrm{t}/(1 + \sigma\mathrm{t})$
6. Pre-tax output is $0Q_1$, post-tax output is $0Q_2$, denoted Q_1 and Q_2 respectively
7. Revenue is $R = \tau Q_1 = tQ_1/(1 - \sigma t)$
8. Domestic market share in output is c.
9. Foreigners own a share f of the profits, and earn no other factor income from Australian mining
10. The share of profits in price is π.

In Figure 1, areas are labelled in bold letters: **A**, **a**, **B**, **b**. The excess burden falling on Australians can be read off Figure 1:

$$EB = c(\boldsymbol{A} + \boldsymbol{a}) + (1 - f\pi)(\boldsymbol{B} + \boldsymbol{b}) - R \tag{1}$$

Using **A** + **B** = R, we have:

$$EB = c\boldsymbol{a} + (1 - f\pi)\boldsymbol{b} - (1 - c)\boldsymbol{A} - f\pi\boldsymbol{B} \tag{2}$$

The first two terms of (2) are the Australian parts of the excess burden on the demand and the supply sides respectively, and are evaluated by the usual formula for the area of a triangle:

$$\boldsymbol{a} = (\sigma\tau)^2\varepsilon Q_1/2 = \sigma^2\tau Q_1\varepsilon/2; \boldsymbol{b} = \delta^2\tau\eta Q_1/2 \tag{4}$$

The last two terms of (2) denote the burden of revenue incident on foreigners, via the demand and supply sides, and they benefit Australians. By inspection, we have $\boldsymbol{A} = \delta R = \delta\tau Q_1$ and $\boldsymbol{B} = \sigma R = \sigma\tau Q_1$.

Therefore, excess burden is

$$EB = \left\{\frac{c\sigma^2\tau\varepsilon}{2} + \frac{(1-f\pi)\delta^2\tau\eta}{2} - (1 - \mathrm{c})\delta - f\pi\sigma\right\}\tau Q_1 \tag{5}$$

The average incremental excess burden is found by dividing (5) by R = τQ_1:

$$AIEB = \frac{c\sigma^2\tau\varepsilon}{2} + \frac{(1-f\pi)\delta^2\tau\eta}{2} - (1 - \mathrm{c})\delta - f\pi\sigma \tag{6}$$

Conventionally, when the economy suffers an excess burden, AEB is presented as a positive number, as in '50 cents per dollar of revenue'.

Note that the elasticities are not invariant to the size of $0Q_0$, and so none of the terms in (6) are constants. The first two terms in (6) have scalars, c and $(1 - f\pi)$, being the share of output consumed by Australians, and the share of factor incomes going to Australians. The other elements, $\sigma^2\varepsilon\tau/2$ and $\delta^2\eta\tau/2$, are the average excess burden triangles for the world as a whole. Denoting these as $AIEB_{D*}$ and $AIEB_{S*}$, we have

$$AIEB = c.AIEB_{D*} + (1 - f\pi)AIEB_{S*} - (1 - c)\delta - f\pi\sigma \quad (7)$$

The last two terms in (7) are the shares of royalty revenue paid by non-resident consumers and factors of production, respectively.

When all factors are Australian-owned, $f = 0$, as in KPMG Econtech (2010a), and we have

$$AIEB_{f=0} = c.AIEB_{D*} + AIEB_{S*} - (1 - c)\delta \quad (8)$$

The market-clearing equality of supply and demand requires that $Q_0Q_1 = t\sigma\eta Q_1 = t\delta\varepsilon Q_1$; and that $\delta + \sigma = 1$. Therefore, we have:

$$\sigma = \eta/(\eta + \varepsilon);\ \delta = \varepsilon/(\eta + \varepsilon). \quad (9)$$

To derive ε, we denote the elasticities of domestic and foreign demands as ε_c and ε_f respectively. Then, because domestic and foreign demand sum to output, we have

$$\varepsilon = c\varepsilon_c + (1 - c)\varepsilon_f$$
(10)

Marginal Excess Burden

Marginal excess burden is usually defined as the difference between the change in excess burden and the change in revenue, when a tax is increased marginally (e.g., Creedy 2003). However, this difference is denominated in dollars, whereas KPMG Econtech (2010a) reported MEB in percentage terms (or cents in the dollar). Thus, KPMG Econtech (2010a: 19) reported what is usually called the marginal cost of public funds, MCF, which is the ratio of the change in excess burden to the change in revenue. It echoes their calculation of AEB as the ratio of the excess burden to revenue generated, when a tax is removed completely. The counterpart in our partial equilibrium model would be to differentiate the expression of excess burden, (5). The result contains terms in the non-constant elasticities, which we could not evaluate, using only the numerical values in Part B below.

Part B: Parameters used in estimating the tax burden on mining

This presents the numbers used in the calculations and their sources.

TABLE A
DATA AND SOURCES, MINING INDUSTRY, VARIOUS YEARS

	Symbol	Value	Description	Source
1	c	0.5, 0.25 and 0.03	Share of output not exported (by quantity, 2007-08), mining, black coal and iron ore	Referee (ABS Input-Output table); ABS 1301.0 2009-10: 18.16, 18.18
2	f	0.83	Fraction of mining equity owned abroad (mining generally)	Connolly and Orsmond (2011)
3	π	0.35	Share of profits in output (2007-08)	ABS 1301.0 2009-10: 18.11
4	η	1	Supply elasticity in the long run	Assumed
5	ε_c	1	Elasticity of Australian demand	Assumed
6	ε_f	9 and 6	Elasticity of export demand, extractive industry; MRRT liable	KPMG Econtech (2010a), Table C.3
7	ε	4.8 to 5.8	Overall demand elasticity	Equation 8
8	σ	83%	Share of royalty incident on suppliers (col.1 of table 3)	Equation 7
9	δ	17%	Share of royalty incident on demanders (col. 1 of table 3)	Equation 7
10	t	7%	Royalty rate: average *ad val.*	Grants Com. 2010: 8.3
11		6.2%	Company tax rate in excise-equivalents	See below
12		2.0%	Payroll tax rate in excise-equivalents	See below

Notes
Line 3: profit share. ABS 2006, Table 2.5 reported profit margin on sales (before tax and interest) in 2004-05 as 33.3%; that had risen to 38.3 % by the next report, for 2010-11.

Line 4: supply elasticity. KPMG Econtech provided insufficient information to permit outsiders to calculate their supply elasticity. (KPMG Econtech did not assume a constant elasticity.) We computed the 'general-equilibrium elasticity' as the ratio of the percentage rise in output to that in the producer price, following the simulated removal of royalties. The numerator is 7.5% (KPMG Econtech 2010a: 134). Thus, a royalty of 7% yields a 'GE' supply elasticity of 1.1.
Minerals price soared remarkably for almost a decade, and are forecast to remain at least twice their pre-boom levels. Between 2008 and 2012, ore production rose about 75% (*Aust. Fin. Rev*. 24 January 2013: 1); and was projected to rise by another 50 or 60 per cent in the next few years. However, a number of ore projects have been recently cancelled or postponed.

Line10: average royalties from CGC, 2010, Table 8.3. The Commonwealth claimed that miners were paying around 20 per cent of their profits as royalties in 2008-09 (http://www.mining-tax.com.au). Using a profit share of 35 per cent (line 3 above), we have 0.35x0.20 =0.07. The States have raised their royalty rates since the imposition of the Minerals Resource Rent Tax, expecting that most of the burden would fall on the Commonwealth, since royalties are credited against MRRT obligations.

Lines 11 and 12: company and payroll taxes. ABS Taxation Statistics (2007-08: Table 8) showed a ratio of net company tax to total income for mining of 5.0%. Export prices rose between 2004-05 and 2007-08, which would presumably raise the ratio of tax to income; but the boom in mining investment would tend to lower it. ('Total income' includes interest and dividends received.) For 2007-08, it was reported that miners paid around 14 per cent of gross operating surplus in company taxes (*Australian Financial Review*, 7 May 2012: 53). Payrolls accounted for about 40% of mining costs, with the tax levied at about 5%, for an excise equivalent of 2%. Thus, company and payroll taxes were around 8% of sales. Thus, these plus royalties give a total tax burden of 15% of sales.

FIGURE 1
SUPPLY AND DEMAND, WITH A ROYALTY

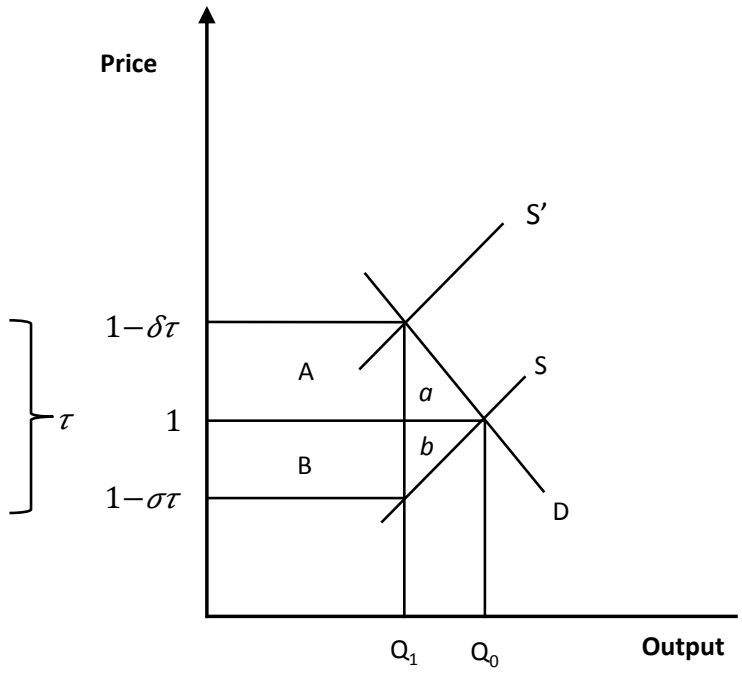

TABLE 1
KPMG ECONTECH ESTIMATES OF AVERAGE AND MARGINAL EXCESS BURDENS

Tax	AEB	MEB
Tobacco excise	-23	-8
Import duties	-7	-3
Petroleum resource rent tax	0	0
Municipal rates	1	2
GST	6	8
Land taxes	6	8
Alcohol excise and WET	7	9
Fuel taxes	10	15
Stamp duties other than real property	18	18
Luxury car tax	9	20
Labour income tax	16	24
Conveyancing stamp duties	31	34
Motor vehicle registration	32	37
Motor vehicle stamp duties	38	38
Corporate income tax	23	40
Payroll tax	22	41
Insurance taxes	47	67
Royalties and crude oil excise	50	70
Gambling taxes	54	92

Source: KPMG Econtech 2010a, Table A.
Note: Footnotes in the original have been omitted. The report indicated that the numbers for gambling maybe over-estimates because the negative social costs of gambling were not taken into account (KPMG Econtech 2010a: 81).

TABLE 2

SUMMARY OF INCIDENCE OF ROYALTIES AND CRUDE OIL EXCISE ($b)

1	Change in private nominal after-tax income	-1.3
2	Royalty revenue, as a nominal transfer to households[1]	+3.4
3	Net effect on household nominal income (= 1 + 2)	+2.1
4	Loss[2] due to CPI rise of 0.5	-3.8
5	Net effect on household real income = excess burden (= 3 + 4)	-1.7

Source: KPMG Econtech (2010a) tables A and 5.9.
Note 1. The label is as given in the source, but clearly revenue from the oil excise is included. Also, the revenue number is the endogenous variation in the total of all tax and royalty revenues when the oil excise and royalty rates are set at zero.
Note 2. Dollar number derived by us as balancing item, but it checks approximately against ABS national accounts.

TABLE 3
AVERAGE INCREMENTAL EXCESS BURDEN OF MINING ROYALTIES. SENSITIVITY ANALYSIS

	1	2	3	4	5	6
c: Fraction not Exported	0.5	0.5	0.5	0.5	0.25	0.03
ε_f: Export Demand Elasticity	-9	-9	-9	-9	-6	-6
f: Foreign Share-Holding (%)	83	83	83	0	0.83	0.83
t: Tax Rate (%)	7	7	15	7	0.07	0.07
η: Elasticity of Supply	1	0.1	1	1	1	1
AIEB (%)	-31	-29	-28	-6	-35	-37
					Black Coal	Iron Ore

Source: Authors' calculations. The spreadsheet is available on request. Parameters are given in the Appendix.