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Valuation of Natural Resources and Mineral Exploration

Australian valuation of subsoil natural resources

Prepared by Australian Bureau of Statistics[1]

Summary

This paper discusses the methods behind the valuation of subsoil natural resources in Australia. The Australian Bureau of Statistics has measured the value of Australia's natural resources for a number of years. The net present value approach is used to value these assets as there are insufficient transactions in subsoil natural resources in Australia to determine market prices. The valuation of subsoil natural resources in Australia is calculated separately to other mining industry statistics (even within national accounts). The current methodology ensures the results obtained from the subsoil natural resources valuation model and other ABS mining industry statistics align with each other.

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I. Introduction

1.   The Australian Bureau of Statistics (ABS) has measured the value of Australia's subsoil natural resources for a number of years. Estimates begin in 1988-89 and are published annually in the ABS publication, Australian System of National Accounts (cat no. 5204.0).

2.   This paper discusses the methods behind the valuation of subsoil natural resources in Australia.

II. Subsoil natural resources valuation

3.   Subsoil natural resources are included as a non-financial non-produced asset on Australia's national and sectoral balance sheets as published in *Australian System of National Accounts* (cat no. 5204.0). The valuation of subsoil natural resources in Australia is calculated separately to other mining industry statistics (even within national accounts). A comparison between the results obtained from the subsoil natural resources valuation model and other ABS mining industry statistics is constructed in the validation of results section of this paper.

4.   In the ABS there are 27 minerals that are included in the valuation of subsoil natural resources. These are based on *Australia's Identified Mineral Resources* (AIMR) as published by Geoscience Australia and include: antimony, bauxite, black coal, brown coal, cadmium, cobalt, copper, diamonds, gold, iron ore, lead, lithium, magnesite, minerals sands - ilmenite, rutile and zircon, nickel, petroleum products - crude oil, condensate, natural gas and LPG, platinum, rare earths, silver, tin, uranium and zinc. Data by mineral type is presented in *Australian System of National Accounts* (cat no. 5204.0) Electronic Table 62. Value of Demonstrated Subsoil Assets, by commodity.

III. Concepts

5.   Subsoil natural resources are defined in the System of National Accounts 2008 (SNA 2008) as:

"…those proven subsoil resources of coal, oil and natural gas, metallic minerals or non-metallic minerals that are economically exploitable given current technology and relative prices." (SNA 2008, para.12.17)

6.   The ABS has chosen the net present value (NPV) approach to value these assets as there are insufficient transactions in subsoil natural resources in Australia to determine market prices. This method is one of the approaches recommended in SNA 2008 and the System of Environment and Economic Accounts 2012 (SEEA 2012).

7.   SEEA 2012 is a framework for developing statistics about natural resources and ecosystems. It is designed to provide an environmental context for economic decision making. Data produced in line with SEEA 2012 enables an assessment of the impact of economic decisions on the environment and the impact of environmental policies on social and economic development.

8.   SEEA 2012 adopts a range of conventions (residence, unit definitions, sector and industry classifications, statistical geography and accounting structure) that are shared with SNA 2008 to make it easier to relate data derived from both frameworks. An example is relating land, energy and water use to industrial production, employment, capital investment and income generation.

9. Both the SEEA 2012 and SNA 2008 frameworks assist in attributing income to a mix of produced and non-produced assets that are used in the capital input mix in the productive process. SEEA 2012 shows that mining net operating surplus can be further decomposed into a return to non-produced assets ('rents' retained by general government owners), a return to produced assets (income retained by miners from rights to exploit minerals), and a measure of resource depletion (where depletion is analogous to consumption of fixed capital). These accounting relationships are demonstrated in Figure 1.

Figure 1
Relationship between gross operating surplus and capital services flows

Gross operating surplus	Consumption of fixed capital	Consumption of fixed capital
	Net operating surplus	Return to produced assets
		Return to non-produced assets
		Depletion

10. The SNA 2008 recognises economic rents accruing to miners from exercising rights to exploit natural resources. SNA 2008 states that:

"Suppose that a mining company knows the size of the deposit being mined, the average rate of extraction and the costs of extraction of one unit. After allowing for all intermediate costs, labour and the cost of fixed assets used, what is left must represent the economic rent of the natural resource. By applying this to the expected future extractions, a stream of future income can be estimated and from this, using the techniques already described, a figure for the value of the stock of the resource at any point in time." (SNA 2008, para.20.47)

11. SEEA 2012 further elaborates on estimating resource rents from natural resources in mining. SEEA 2012 states that:

"Resource rent is thus derived from standard SNA measures of gross operating surplus by deducting *specific subsidies, adding back specific taxes and deducting the user costs of produced assets (itself composed of consumption of fixed capital and the return to produced assets). As noted above, resource rent is composed of depletion and the net return to environmental assets."*[2] (SEEA 2012, para5.120)

IV. Methods

12. The NPV approach involves calculating the expected future net income flow generated by the asset, and then discounting that value by an appropriate discount rate over the expected life of the asset. This approach involves estimating the value of net income, gross output (price multiplied by quantity extracted) less costs (including a normal return on produced capital) over a year. The difference is taken to be the equivalent of economic rent. The future income flow is calculated for each year and discounted over the expected mine life to obtain a value in today's dollars. The ABS uses a five-year lagged average to smooth prices, costs and production.

13. Normal returns to produced capital are deducted from economic rent as it represents the returns from the resource only (and not returns on produced capital used to extract the resource). Normal returns on capital should include a reward to cover the cost of risk and

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[2] In Australia there are no significant specific subsidies or taxes attributable to the subsoil natural resource. In Figure1, specific taxes can be ignored.

uncertainty in exploration and development, and an overall long-term risk premium to cover price volatility and the general level of inflation.

14.   In the derivation of real (inflation adjusted) discount rates, the ABS has assumed that a company's decision to commit resources is significantly influenced by costs of borrowing. Consequently, the discount rate chosen has been aimed at reflecting the cost of capital, or the cost of borrowing, to the mining industry. A real rate of discount is appropriate because the future stream of income is expressed in current dollar terms, and the future income flow is calculated on the basis of current income and costs.

V.   Sources

15.   Geoscience Australia publishes annual estimates of economically demonstrated resources (EDRs) and domestic production of mineral resources in *Australia's Identified Mineral Resources* (AIMR) and *Australian Energy Resource Assessment*. EDRs equate to proven plus probable resources. EDRs are those resources that have a very high probability of existence, and are economically feasible to extract, given current technology and relative prices.

16.   Production costs are provided by a private consulting firm and are derived using company reported financial information from a sample set of mines and industry trends.

17.   Prices are derived from a number of publicly available resources, including the Australian Financial Review and the Department of Industry, Innovation and Science's quarterly publication *Resources and Energy Quarterly*.

18.   Data on normal returns to produced capital are derived by the ABS using national accounts capital stock estimates, an appropriate discount rate and extraction costs.

19.   The discount rate chosen is based upon the Reserve Bank of Australia's (RBA) large business variable lending rate as published in *Statistical Table F5 Indicator Lending Rates*.

VI.   Recent improvements

20.   There have been a number of initiatives in recent years to improve the quality of subsoil natural resources data. There was a methodological review of the subsoil natural resources valuation model for the 2011-12 release of *Australian System of National Accounts* (cat no. 5204.0). Assumptions regarding the normal return to produced capital were reviewed and updated mineral extraction cost data were included. These resulted in significant revisions to the value of the stock of subsoil natural resources on the balance sheet. The resulting improved methods are now available for inclusion in productivity measures.

21.   Mineral extraction costs are provided by a private consulting firm. Revisions to their data are due to a change in their methodology and the incorporation of the latest available company reported financial information. Due to the commercial sensitivity of the data provided, individual commodity costs that were previously published in *Australian System of National Accounts* (cat no. 5204.0) are no longer published.

22.   Normal returns to capital are included in economic rent to cover the cost of risk and uncertainty in exploration and development, and an overall long-term risk premium to cover price volatility and the general level of inflation. The normal rate of return to capital is used to mark up costs. Previously, the normal rate of return to capital was provided by a mineral economics consultancy firm, however, there were concerns that the rate was too

low. It is now derived using cost of extraction data (obtained from the consulting firm), mining industry capital stock estimates and an appropriate discount rate.

23.   The stock of Australia's subsoil natural resources was valued at $1 103.5 billion (AUD) as at June 30 2015. Subsoil natural resources are the fourth largest non-financial asset on the national balance sheet contributing approximately 10% to total non-financial assets in 2014-15. The current price value of subsoil natural resources has increased almost 60% since 2009-10. This increase in value is predominantly driven by price with volume estimates of subsoil natural resources increasing 8.5% over the same period.

VII.   Validation of results

24.   The ABS verifies the accuracy of the revised estimates of subsoil natural resources by comparing the results to other mining income data reported by the ABS. Estimates for the value of mining gross operating surplus (GOS) can be constructed from data published in *Australian System of National Accounts* (cat no. 5204.0). Theoretically, it should have the same result as that derived from the subsoil natural resources model, although in practice it does not, as the estimates are calculated using different data sources and have different scopes. Nevertheless, taking into account these differences, the results should be similar, which can be seen in Figure 2.

25.   Mining GOS estimates as shown in Table 1 can be modelled from data in the subsoil natural resources model. The data below includes the change made to the normal rate of return to capital and the updated extraction cost data.
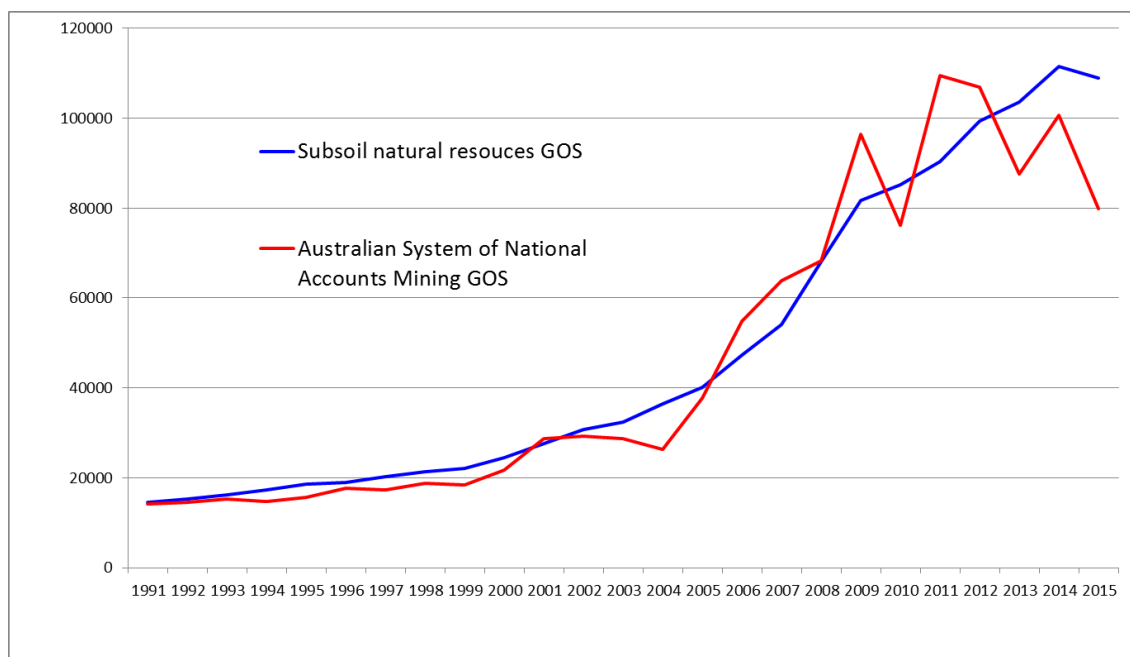
Table 1
Mining GOS derived from the subsoil asset estimates, 2009-10 to 2014-15, $m

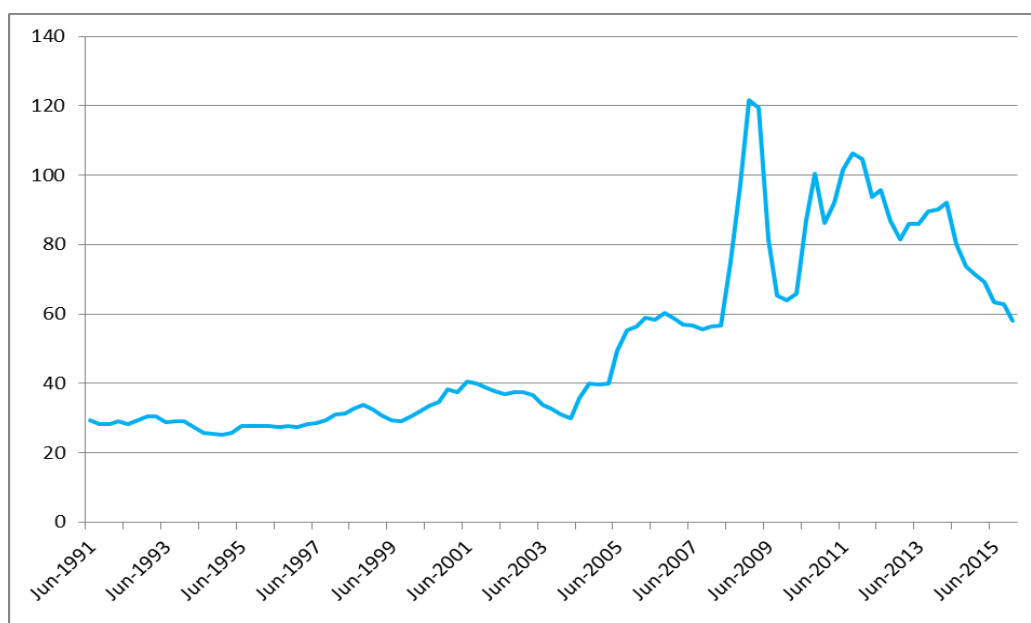|	*2009-10*	*2010-11*	*2011-12*	*2012-13*	*2013-14*	*2014-15*
Return to produced assets	19 114	21 231	24 615	25 032	23 569	23 251
plus Return to non-produced assets	35 067	36 522	37 726	36 286	40 111	33 592
plus Resource depletion	9 399	8 903	9 842	10 443	10 724	11 153
plus Consumption of fixed capital	21 671	23 749	27 181	31 868	37 171	41 007
Gross Operating Surplus	85 250	90 405	99 364	103 629	111 575	109 005

26.   The ABS publication *Australian System of National Accounts* (cat no. 5204.0) contains data on mining gross value added (GVA) and compensation of employees (COE) from which gross operating surplus (GOS) can be constructed. The scope of this publication is greater than the scope of the modelled subsoil natural resource GOS estimates, as it includes exploration and mining support services.

Figure 2
Mining GOS comparison ($billion), 1990-91 to 2014-15

27.   The other main differences are due to the subsoil natural resources model using five-year averages of prices, costs and production, which has subdued the volatility of subsoil natural resources GOS in recent years. P rice movements that the subsoil natural resources model has smoothed can be seen in Figure 3. Mining Industry Export Price Index from the ABS publication *International Trade Price Indexes* (cat no. 6457.0). Other differences are due to *Australian System of National Accounts* (cat no. 5204.0) estimates covering all minerals within the SNA 2008 production boundary, and the subsoil natural resources estimates only including the 27 minerals listed earlier.

Figure 3
ABS Mining Export Price Index, 1989-90 to 2011-12.2

VIII.   Conclusion

28.   In Australia subsoil natural resources are valued using the net present value approach as there are insufficient transactions in these assets to determine market prices. The stock of subsoil natural resources are calculated separately to other mining statistics.

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