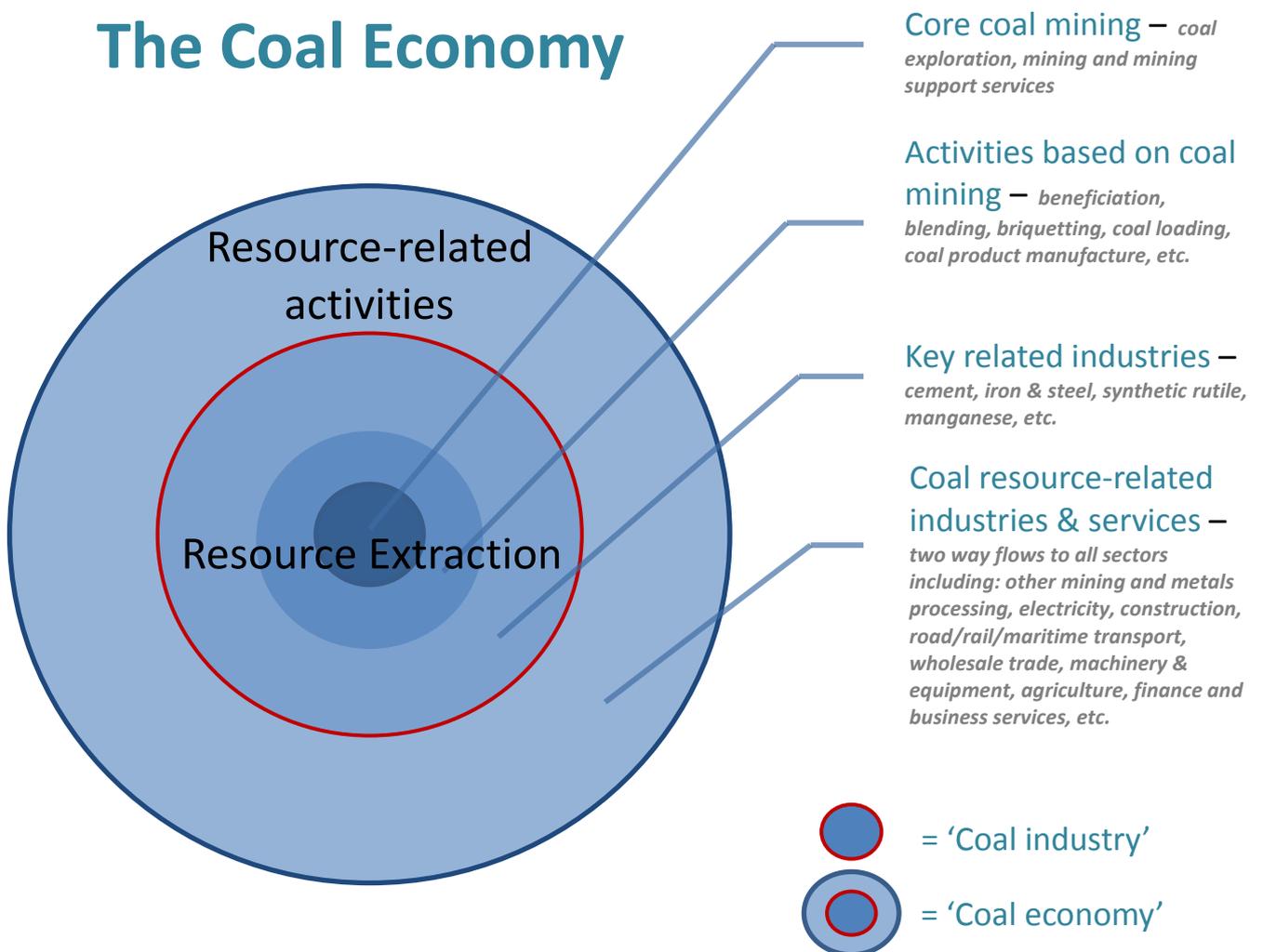The Australian Coal Industry

– Adding value to the Australian Economy

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The Coal Economy

Resource-related
activities

Resource Extraction

Core coal mining – *coal exploration, mining and mining support services*

Activities based on coal mining – *beneficiation, blending, briquetting, coal loading, coal product manufacture, etc.*

Key related industries – *cement, iron & steel, synthetic rutile, manganese, etc.*

Coal resource-related industries & services – *two way flows to all sectors including: other mining and metals processing, electricity, construction, road/rail/maritime transport, wholesale trade, machinery & equipment, agriculture, finance and business services, etc.*

= 'Coal industry'

= 'Coal economy'

Executive Summary

The coal economy is deeply embedded in the Australian economy with significant backward and forward linkages:

- The coal extraction industry made up 1.8 per cent of gross value added in 2011-12 up from 1.5 per cent in 2006-07.

- The 'coal economy' made up 3.1 per cent of gross value added in 2011-12 rising by 18.25 per cent since 2006-07. This is a supply-side measure.

- The broader 'coal economy', including both the supply-side and demand-side considerations, made up 4.2 per cent of gross value added in 2011-12.

- For every job created in coal mining 3.7 jobs are created nationally in the Australian economy making up a direct and indirect workforce of over 180,000 people in 2011-12.

- For every million dollars of output in coal mining the coal economy would see 3.2 jobs being created as a result of the extraction of coal and investment in new and improved capacity.

In February 2013 the Reserve Bank of Australia published a working paper that measured the size of the "resource economy". The Reserve Bank estimated that the resource economy accounted for 18 per cent of gross value added in 2011-12.

This paper complements the Reserve Bank analysis. We employ the same technique (input-output analysis) and data drawn from the Australian Bureau of Statistics to estimate the size of the Australian "coal economy" (that is, coal exploration and extraction and coal related activities).

Using the same approach as the Reserve Bank we find that the coal economy accounts for about 3.1 per cent of gross value added in 2011-12. That is nearly $43 billion. Given almost all of the black coal industry is located in NSW and Queensland and almost all brown coal mining is in Victoria, this activity is mostly located in those three states.

Over the past 30 years, coal has been one of Australia's major export industries. In fact, for most of that period it was the major export industry. Coal represents the main export earner for both Queensland and NSW.

Coal, however, is not just an export industry. What is particularly important is the relationship between coal and electricity generation. The modern Australian economy is highly dependent on access to reliable and cheap electricity. Coal mining and the coal economy underpin our prosperity.

We report that the coal economy has backward linkages from coal mining to Exploration and Mining Support Services, Construction Services, Coal mining itself, Finance, Petroleum and Coal Product Manufacturing, Rail Transport, Non-Residential Property Operators and Real Estate Services, Wholesale Trade, Transport Support services and storage and Professional, and Scientific and Technical Services.

Similarly the coal economy has forward linkages to Electricity Generation, Iron and Steel Manufacturing, Non Ferrous Metal Ore Mining, Iron Ore Mining, Coal mining itself, Cement, Lime and Ready-Mixed Concrete Manufacturing, Non Metallic Mineral Mining, Pulp, Paper and Paperboard Manufacturing, Basic Non-Ferrous Metal Manufacturing, Grain Mill and Cereal Product Manufacturing, Oil and gas extraction, and Rental and Hiring Services (except Real Estate).

It is clear that the coal economy is deeply embedded in the Australian economy.

The Reserve Bank paper forms part of a series of papers that attempts to provide a supply side model and understanding of the Australian economy. To that end it makes use of simple output multipliers. For their purpose this is entirely appropriate. A full and comprehensive understanding of the resource economy, and by implication the coal economy, requires an appreciation of both the supply side and demand side of the Australian economy. In addition to complementing the Reserve Bank research we also provide an estimate of the size of the demand side of the coal economy. When we undertake that analysis (using total output multipliers) the resource economy accounts for nearly a quarter of Australia's gross value added and the coal economy accounts for over four per cent of Australia's gross value added – almost $60 billion.

<div align="center">Summary Results</div>

	Simple Output Supply side only		Total Output Supply & demand side effects		Number of Employees	
	% Gross Value Added		% Gross Value Added			
	2006-07	2011-12	2006-07	2011-12	2006-07	2011-12
Coal industry	1.5	1.8	1.5	1.8	25,000	49,300
Coal economy	2.6	3.1	3.6	4.2	92,000	181,200
Resource economy	13.6	18.3	18.0	23.7	-	-

<div align="center">Source: ABS and author calculations
Number of employees as at August 2007 and August 2012.</div>

The employment data show how coal industry related activity in the broader economy (in areas such as business services, construction and energy intensive manufacturing) is significantly more labour-intensive than coal extraction. The last line in the table labelled 'Resource economy' reports that nearly a quarter of Australian prosperity can be attributed to mining and resource processing.

Introduction

In February 2013 the Reserve Bank of Australia (RBA) released a working paper that estimated the size of the Australian "resource economy" at "around 18 per cent of gross value added (GVA) in 2011/12".[1] In this paper we replicate the RBA method to determine that the size of the Australian "coal economy" is about 3.1 per cent of gross value added. This figure is about 18 per cent larger than its share in 2006-07 (2.6 per cent). We then trace out the full extent of the coal economy.

In the next section we describe the RBA study. We then report our own results looking just at the Australian coal economy. Employing Input-Output tables we are able to define the contribution coal makes to the Australian economy and the inter-relationships between coal activities and non-coal activities.

The RBA study

The RBA study is part of a much broader attempt to model the Australian economy as a three sector economy: Resource extraction, resource related activity, and non-resource activity. This would provide a richer understanding of the economy than the one-sector model that is currently employed for forecasting purposes. To that end the RBA paper builds on previous theoretical work undertaken by Treasury to model the size and growth of the resource economy, including interactions between the resource economy and the non-resource economy.[2]

It is important to understand that the RBA study is a methodological contribution to a model building exercise of the supply-side of the Australian economy. This allows the RBA to come up with a measure of the size of the resource economy from a supply-side perspective.

The RBA provides a robustness test of their modelling that is set out on pages 33 and 34 of the paper. There they show that their measure of the resource economy *less* the interaction with the non-resource economy is equal to the Australian Bureau of Statistics estimate for Gross Value Added of the mining industry.[3] The innovation of the RBA paper isn't that they can replicate Gross Value Added but rather that they can understand the interaction between the mining industry and the rest of the economy.

The difference between the ABS Gross Value Added measure for the mining industry and the RBA estimate of the resource economy is the production weighted simple output multipliers that can be estimated from ABS Input-Output tables.[4]

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[1] Vanessa Rayner and James Bishop, 2013, Industry dimensions of the resource boom: An input-output analysis, *Reserve Bank of Australia Research Discussion Paper*, RDP 2013-02.

[2] Michael Kouparitsas, 2011, A Framework for Forecasting Sectoral Output Using Final Expenditure Forecasts, *Draft Australian Treasury Working Paper*.

[3] ABS Cat. 5204.0 Table 5. Gross Value Added measures the contribution of each individual industry to the overall economy. Note the sum of industry GVA does not quite add up to GDP, which includes various other components including the imputed contribution of owner occupied dwellings.

[4] For a full discussion of Input-Output tables see William McLennan, 1989-90, Introduction to Input-Output Multipliers, ABS Cat. 5246.0. For a previous application of that methodology to coal mining see our 2011 Minerals Council of Australia paper "Costing of The Greens' economic policies".

Using their method the RBA estimates the resource economy is comprised of resource extraction making up 11.5 per cent of gross value added (with coal mining making up 2.5 per cent) and resource-related activity making up 6.5 per cent of gross value added.

Our estimates of the production weighted simple multipliers for the Mining industry are set out in table one below. For their purposes the RBA are only interested in the (production weighted) simple multipliers that will provide them with an understanding of the supply-side of the economy. That is entirely appropriate. It does, however, mean that the demand side of the economy is not included in their estimate of the size of the resource economy. In all our analysis we report both simple multipliers and total multipliers that will allow us to estimate both the supply-side size of the coal economy and total (supply and demand) size of the coal economy.

Table One: Production-weighted Mining Industry Output Multipliers.

	2006-07	2007-08	2008-09	Average
Simple Output Multiplier	1.8078	1.7341	1.7859	1.7759
Total Output Multiplier	2.3357	2.2643	2.3086	2.3029

Source: Author calculations.

Under simplifying assumptions it is possible to show the growth of the resources economy over the past twenty years by applying the average production-weighted simple output multiplier to the ABS gross value added for the mining industry. That exercise is shown in figure one below. The size of the resource economy following this exercise is 18.29 per cent of Gross Value Added in 2011-12.

Figure One: Simple Estimate of the Size of the Resources Economy.
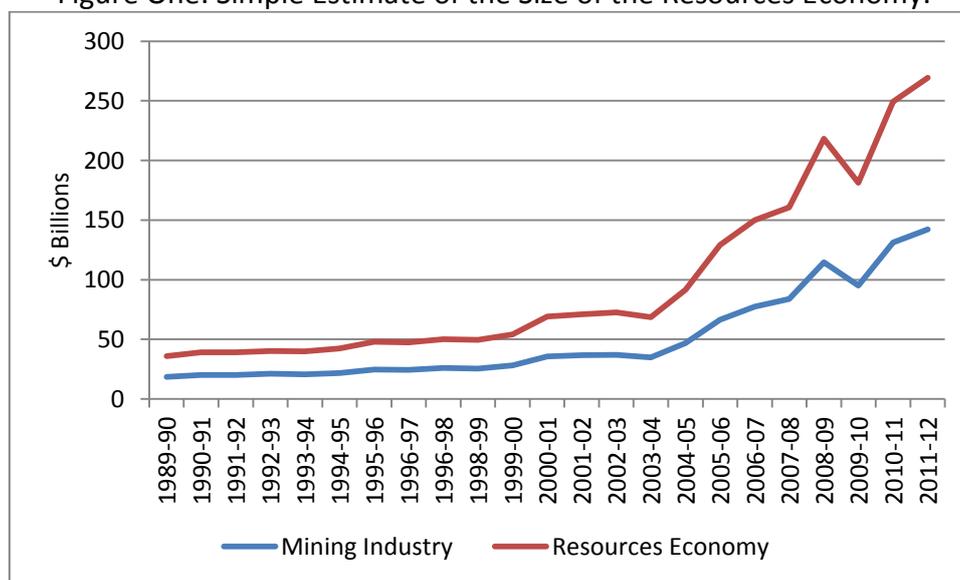
Source: ABS Cat. 5204.0 Table 5 and author calculations.

In this exercise we have applied a constant multiplier to estimate the size of the resources economy. The RBA have calculated time-varying multipliers – but to the extent that the multipliers are reasonably stable over time the results would not change much. In any event, it has only been in recent years that the ABS has made Input-Output tables available on an annual basis.

What is important for our purposes in that we understand and can replicate the RBA method.

The Australian Coal Economy

1.   Size. In the first instance we have calculated the simple output multiplier and total output multiplier for the coal industry for 2006-07, 2007-08 and 2008-09. The result of this exercise is shown in table two.

Table Two: Coal Mining Output Multipliers.

	2006-07	2007-08	2008-09	Average
Simple Output Multiplier	1.8503	1.7834	1.5181	1.7173
Total Output Multiplier	2.5685	2.4914	1.9388	2.3329

Source: Author calculations.

It is immediately apparent that the coal mining output multiplier in 2008-09 has declined relative to 2006-07 and 2007-08. This is likely due to volatility in coal exports in that year. This is in contrast to the output multipliers for the mining industry where the multipliers have remained quite stable. We report results using time-varying multipliers and the average of the multipliers. Due to the drop-off in 2008-09 we favour using the average of the multipliers to demonstrate the size of the coal economy. To the extent that the RBA have made use of the time-varying multipliers it is likely that they have under-estimated the size of the coal economy. This is not meant as a criticism of their approach – this is a problem that bedevils all empirical research that relies on lagged data.

The challenge that we face is in establishing the coal mining share of total mining output. The ABS report gross value added data for coal mining at chain volume measures but not at current prices. This means that we must estimate the coal mining share of the mining industry gross value added at current prices. We do this by making use of the coal mining share of the mining industry gross value added at chain volume measures. We then apply the coal mining simple output multiplier to arrive at a share of overall gross value added. Table three shows our results.

Table Three: Estimates of the Size of the Coal Economy.

	Simple Output Multiplier	Coal Economy (%GVA)	Average Simple Output Multiplier	Coal Economy (%GVA)
2006-07	1.8503	2.84	1.7173	2.63
2007-08	1.7834	3.05	1.7173	2.94
2008-09	1.5181	3.15	1.7173	3.57
2009-10	*1.5181*	2.48	1.7173	2.80
2010-11	*1.5181*	2.71	1.7173	3.06
2011-12	*1.5181*	2.75	1.7173	3.11

Source: Author calculations.

Table three shows the results of two separate analyses. First we employ the time-varying simple output multipliers that we calculated for 2006-07, 2007-08 and 2008-09 to calculate the size of the coal economy for those years. We then use the latest output multiplier (2008-09) to calculate the size of the coal economy for 2009-10, 2010-11 and 2011-12. We have italicised the simple output multiplier in those years to demonstrate the assumption that the (time-varying) multiplier remains constant after 2008-09. Using the time-varying simple output multiplier we find that the coal economy comprises about 2.75 per cent of gross value added in 2011/12. That figure is slightly lower than it was in 2006-07; however, it is down on 2008-09.

When we apply a constant simple output multiplier (the average of the three years that we estimated) to the data we find that the coal economy comprises 3.1 per cent of gross value added up from 2.6 per cent in 2006-07.

The RBA estimate the size of the coal extraction industry to be 2.5 per cent of gross value added in 2011-12. If we apply the time-varying simple output multiplier we can estimate the size of the coal economy to be 3.75 per cent of gross value added – slightly higher than the estimates we report in table three.[5]

2.   Scope. The ABS Input-Output tables provide inter-industry flows. This allows us to report the inter-relationships between coal mining and the rest of the Australian economy.[6] Coal mining and its interrelationship are what we define as the "coal economy".

We will begin our analysis by considering the question: If an industry were to increase its production by the value of $100 what would be required from the coal mining industry? The top ten industries (including coal itself) are shown in table four. Coal mining makes use of coal within its own production – this own supply is shown in the table in italics.

Table Four: Top Ten Industries Dependent on Coal.

Industries highly dependent on Coal	Production of Coal Required ($)
Electricity Generation	20.837
Iron and Steel Manufacturing	6.835
Non Ferrous Metal Ore Mining	3.239
Iron Ore Mining	2.611
Coal mining	*1.466*
Cement, Lime and Ready-Mixed Concrete Manufacturing	0.944
Non Metallic Mineral Mining	0.664
Pulp, Paper and Paperboard Manufacturing	0.503
Basic Non-Ferrous Metal Manufacturing	0.328
Grain Mill and Cereal Product Manufacturing	0.268
Oil and gas extraction	0.221

Source: ABS Cat. 5209 Table 6.

We now turn our attention to the question: If the coal industry were to increase its production by the value of $100 what would be required from the rest of the economy? The top ten industries are shown in table five. Again the interaction with coal itself is shown in italics.

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[5] We prefer to report the estimates based on the ABS gross value added figures. There is a large deviation in the Reserve Bank estimate for mining gross value added and the ABS estimate for gross value added in 2011-12. This is not an unusual occurrence with recent data that is often subject to revision. The RBA discusses that discrepancy at pages 34 – 35 of the paper.

[6] Here we are constrained by the ABS industry definitions. See ABS Cat. 1292.0 for a discussion of the *Australian and New Zealand Standard Industrial Classification*. Coal mining activities do not necessarily neatly fall within ABS classifications.

Table Five: Top Ten Industries Stimulated as a Result of a $100 Increase in Coal Output.

Industries that Coal relies on	Coal Requires ($)
Exploration and Mining Support Services	5.299
Construction Services	1.472
Coal mining	*1.466*
Finance	1.355
Petroleum and Coal Product Manufacturing	1.325
Rail Transport	1.258
Non-Residential Property Operators and Real Estate Services	1.252
Wholesale Trade	1.220
Transport Support services and storage	1.106
Professional, Scientific and Technical Services	1.071
Rental and Hiring Services (except Real Estate)	0.985

Source: ABS Cat. 5209 Table 6.

Tables four and five show the extent to which coal mining has an impact on the broader Australian economy. It is this broader economy that we define as being the coal economy.

What is particularly striking is the relationship between coal and electricity generation – to the extent that the modern Australian economy is highly dependent on access to reliable and relatively cheap electricity coal mining in particular, and the coal economy in general, underpins our prosperity.

3.   Employment effects. In addition to output multipliers it is possible to generate employment multipliers. The employment multipliers are a function of production. We also calculate so-called Type 1B employment multipliers that estimate the number of jobs created in the broader economy for every additional job created in a specific industry. The Type 2A employment multipliers estimate the employment effects of a particular industry including consumption effects. We show the employment multipliers for coal mining in table six. The first thing to notice is that the multipliers have declined quite substantially over the three year period we have calculated them. This is a similar result to what we saw in table two and again very likely due to the volatility in coal exports at that time with the rapid onset of the Global Financial Crisis.

Table Six: Coal Mining Employment Multipliers.

	2006-07	2007-08	2008-09	Average
Simple Employment Multiplier	3.9031	3.4899	2.2129	3.2020
Total Employment Multiplier	7.0655	6.4597	3.9373	5.8208
Type 1B Employment Multiplier	3.5856	3.4790	3.9627	3.6757
Type 2A Employment Multiplier	6.4907	6.4396	7.0504	6.6602

Source: Author calculations.

For every million dollars of output in coal mining the coal economy would see 3.2 jobs being created on average. This number is quite small when converted to a proportion of the Australian workforce and can be explained by the fact that the coal mining industry itself is capital intensive and is not a large employer *per se*. Even so, it suggests that the coal economy employs a workforce that is more than three times greater than the number employed in coal extraction. That reflects the fact that the employment generated in coal related activities is more labour-intensive and complements those people directly employed in coal extraction and coal mine investment.

The Type 1B employment multiplier suggests that Coal mining has a large impact on the coal economy. According to the ABS there were 46,200 individuals with full-time jobs in coal mining in February 2013.[7] An average Type 1B multiplier of 3.7 predicts over 170,000 jobs in the coal economy. Figure two shows our estimates of the employment in the coal economy.

Figure Two: Estimate of Employment in the Coal Economy.
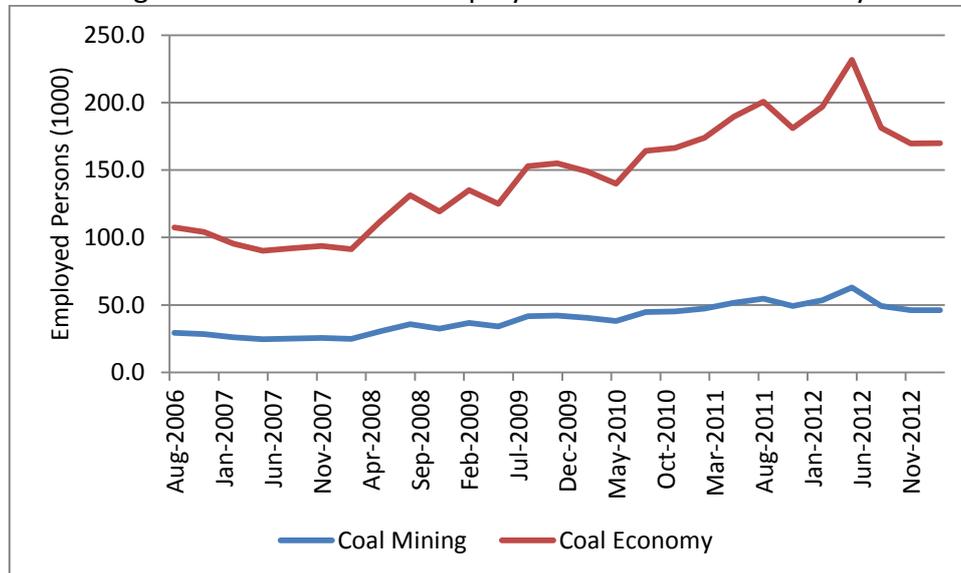
Source: ABS Cat. 6291.0.55.003 Table 6 (original data) and author calculations.

4.   Impact on the economy. The RBA paper is attempting to model the supply side of the Australian economy. To that end they have only calculated the impact of the resource economy on the supply side of the economy, excluding consumption expenditure. The simple multiplier calculates, "The total amount of output induced by the requirement from all industries to produce output to satisfy the demand for an extra dollar of output from an industry".[8] If we want to understand the total impact an industry has on the entire economy, and not just the supply side, we need to examine the total output multiplier. This the ABS defines as being, "The total amount of output induced by the requirement from all industries to produce output to satisfy the demand for an extra dollar of output from an industry, *and* by the spending of the extra wages and salaries earned (from producing the additional output) by householders (consumers)" (emphasis added).[9]

On this criterion the resource economy and coal economy make a still larger contribution to the overall Australian economy. We have shown the total output multipliers in tables one and two above. If we apply the average total output multiplier to the mining industry data, then in 2011-12 the resource economy was actually 23.7 per cent of gross domestic product. Nearly a quarter of Australian prosperity can be attributed to mining. On the same basis (see table seven) the coal economy comprised 4.2 per cent of Australian gross domestic product in 2011-12.

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[7] ABS Cat. 6291.0.55.003, table 06.
[8] McLennan, 1989-90, as above, pg. 18.
[9] McLennan, 1989-90, as above, pg. 18 – 19.

Table Seven: Estimates of the Total Size of the Coal Economy.

	Total Output Multiplier	Coal Economy (%)	Average Total Output Multiplier	Coal Economy (%)
2006-07	2.5685	3.94	2.3329	3.57
2007-08	2.4914	4.26	2.3329	3.99
2008-09	1.9388	4.02	2.3329	4.84
2009-10	*1.9388*	3.16	2.3329	3.80
2010-11	*1.9388*	3.46	2.3329	4.16
2011-12	*1.9388*	3.51	2.3329	4.22

Source: Author calculations.

Similarly the total employment effect of the coal economy is much larger than a multiplier of 3.7 suggests. With a Type 2A multiplier of 6.7 the coal economy supports over 300,000 jobs.

Conclusion

In this paper we have employed the RBA method used recently to estimate the size of the Australian resource economy to estimate the size of the Australian coal economy. The RBA have made use of estimates of production weighted simple output multipliers to estimate the size of the Australian resource economy at about 18 per cent of gross value added. We first replicate that result and then show that the equivalent size of the Australian coal economy is about 3.1 per cent of gross value added.

We suggest the RBA has under-estimated the total contribution the resources economy makes to the Australian economy. The recent RBA paper is a methodological contribution to a supply-side modelling exercise. To that end the RBA employs simple output multipliers that abstract from consumption effects. To gauge the impact of the resources economy to the overall Australian economy we should include both supply side and demand side effects. When we undertake that exercise, we find that the resources economy contributes nearly a quarter of Australia's gross domestic product. On that basis the Australian coal economy contributes over four per cent to Australian gross domestic product.

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Sinclair Davidson is a Professor in the School of Economics, Finance and Marketing at RMIT University and a Senior Fellow at the Institute of Public Affairs. He has been published in academic journals such as the *European Journal of Political Economy*, *Journal of Economic Behaviour and Organization* and the *Cato Journal*. His opinion pieces have been published in *The Age, The Australian, Australian Financial Review, Daily Telegraph, Sydney Morning Herald*, and *Wall Street Journal Asia*.

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