Value-adding Australian Oil and Gas Industry

The Australian Petroleum
Production & Exploration
Association Ltd (APPEA)

Value-adding: Australian
Oil and Gas Industry

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pwc

Executive summary

Australia's oil and gas industry plays an important role in the prosperity of Australia's economy through its value-add, employment, scale of technology, and tax contribution.

To understand its relative contribution to the Australian economy, APPEA has engaged PwC to prepare a policy paper that examines the economic importance of the oil and gas industry to the Australian economy and national incomes.

Key findings

- The substantial increase in demand for industrial material inputs has caused non-rural commodities prices to increase substantially. Higher commodity prices have substantially lifted our terms of trade with substantial benefits to Australia.

- The terms of trade is the relationship between export and import prices. The terms of trade is an important driver of resource re-allocation in the economy.

  – When one sector of the economy experiences higher returns (such as the resource sector), freely mobile factors of production (capital and labour) tend to move in response to those higher factor returns (wages and the return on capital) away from lower return sectors (the manufacturing sector for example).

- The oil and gas sector is a high returning sector that is attracting substantial investment, generating significant value relative to its inputs and growing rapidly. The continued shift of resources from sectors with lower ratios of the value of outputs to inputs (value-add) is good for the economy.

  – While the oil and gas extraction sector contributes around 2 per cent to national output, with value-added of approximately $32 billion in 2012-13 (Table 1), its contribution to the Australian economy is similar to that made by the agricultural industry which employs around 325,000 people.

  – For every dollar of domestic production, the oil and gas sector value-adds 70¢ to Australian output. This compares to an average of 49¢ for every dollar of production for all other industries.

  – Continued strong demand both domestically and internationally will see estimated growth in the industry be higher than the rest of the Australian economy over the next decade. This will see the dramatic expansion of output providing a substantial boost to national income and taxation revenue.

  – By 2029-30, when production (on the basis of current and forthcoming capacity) and prices are expected to stabilise, the industry's total economic contribution is projected to be around 2.6 per cent of national output or approximately $67 billion. That is an increase of over 0.5 percentage points in the industry's current contribution to the national economy.

  – Under current capital expenditure projections, the oil and gas sector will employ over 35,000 people by 2029-30.

- Some commentators have been concerned that the expansion of the oil and gas (and resources) sector poses some risks due to reduced diversification of the economy. In this paper we model a scenario where the terms of trade deteriorate to a lower level than currently estimated by the Treasury. Even with this deterioration we show that the economy continues to grow strongly with an annual growth rate of 2.8 per cent demonstrating that any lack of diversification risk is manageable given the adjustment mechanisms within the economy.

– Additionally, at current production levels, natural gas reserves will last at least 60 years, implying that capital investment in the sector can remain productively utilised over the long term and not be stranded.[1]

Table 1 Value-add of oil and gas industry to 2029-30

	NPV (2012-30)	2012-13	2019-20	2029-30
Direct value-add ($bn)	294	32	53	67
Indirect value-add ($bn)	94	10	17	21
Total value-add ($bn)	388	43	70	88
Direct value-add % GDP		2.12%	2.81%	2.62%
Total value-add % GDP		2.80%	3.72%	3.47%

Source: PwC estimates.

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[1] If we were to include **all identified gas resources** from APPEA's key statistical publication (http://www.appea.com.au/wp-content/uploads/2014/04/Key-Stats_2014_A4-print.pdf), at current production levels, gas reserves could last up to three times as long as highlighted in the paragraph above.

Contents

1   Introduction

In response to strong demand for energy, particularly in the Asia-Pacific region, the Australian oil and gas industry is in the midst of an unprecedented phase of investment involving some of the largest projects ever undertaken in this country. This new capacity will dramatically expand operational output over the next two decades, providing a substantial boost to national income and taxation revenue. On the back of current investments, Australia is set to challenge Qatar as the world's largest exporter of liquefied natural gas (LNG) over the next decade, strengthening economic linkages within our economy and region.

Most efficient allocation of resources to maximise oil and gas industry value-add to the Australian economy

Against this backdrop of an increasing importance of oil and gas to the Australian economy, PwC was commissioned by APPEA to analyse the current and future value-add of the oil and gas industry. In particular, PwC was asked to examine the following key aspects:

- the contribution of the oil and gas industry to value-add and aggregate economic performance;[2]

- oil and gas industry's forward and backward linkages with the rest of the Australian and international economies; and

- the relative scale of investment and application of technology between the oil and gas industry and other industries in Australia.

1.1   Report structure

This report is structured as follows:

Chapter 2 provides a quantitative description of the current pattern of value-add in the economy and provides a brief overview of the resources boom in Australia and how this has influenced the oil and gas sector. This includes the current value chain of the oil and gas industry in terms of its forward and backward linkages, its share of the economy in terms of value-add production, investment, employment, exports and imports, prices, capital intensity production and the tradability of industries.

Chapter 3 develops a baseline built on existing information on the future path of the Australian economy and the oil and gas industry to 2029-30. This includes the evolution of the oil and gas industry and macroeconomic and industry projections to 2029-30. The Treasury's economic forecasts and terms of trade projections underpinning the 2014-15 Budget are included in the baseline.

Chapter 4 provides a sensitivity analysis of the aggregated terms of trade and more specifically, oil and gas prices, on the structure of the Australian economy. These figures are compared against Treasury's aggregate terms of trade projections and consensus oil and gas price estimates to analyse the impact to the Australian economy.

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[2] This indicates an economy should produce goods and services that are of high demand and high value to generate higher incomes for domestic residents after accounting for any negative externalities. In technical terms, this is similar to Kaldor-Hicks studies of efficiency, by shifting resources in the economy from low value-add to high value-add to generate higher incomes for the economy.

Chapter 5 provides some concluding remarks about the significance of the oil and gas industry to the Australian economy and the implications of an adverse terms of trade shock to illustrate the resilience of the economy with a higher share of resources devoted to the oil and gas sector.

2 Current pattern of value-add

One measure of the importance of an industry is its contribution to Australian economic growth. The size of the Australian economy is typically described in terms of gross domestic product (GDP), and the structure and performance of the economy in terms of industry gross value-added (GVA).

Well performing economies allocate resources to the highest value activities. The difference between the value of inputs purchased by a sector and the value of the outputs is a measure of the increased value created by a particular sector. When the returns to a particular sector rise it is generally desirable for more resources to flow to that sector as the opportunities for value creation increase.

GDP is an estimate of the total market value of goods and services produced in Australia, in a given period, after deducting the cost of goods and services used in the process of production (intermediate consumption), but before deducting the allowances for the consumption of fixed capital (depreciation). This measure avoids double counting goods and services produced at successive stages of production. Movements in the volume measures of GDP and industry GVA (from which the direct effects of price changes have been removed) are key indicators of economic growth.[3]

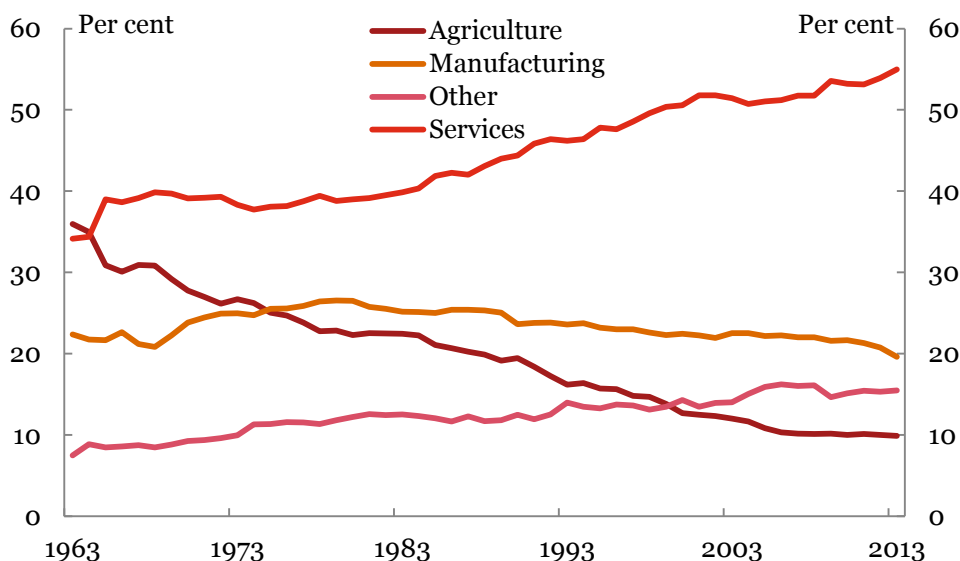## 2.1 Current pattern of value-add in the Australian economy

This section outlines the current pattern of value- add in the Australian economy. As is outlined in this section there are two broad stories as to what has driven the evolution of value-add in the Australian economy. First, there is a longer term trend which is evident across most major economies of declining importance of agriculture and manufacturing and increased importance of the services sector. Second, in the Australian case, the impact of the very substantial terms of trade increase associated with the resources boom has also had a significant impact on the distribution of value-add.

With respect to long-term trends, global trade and capital flow barriers declined in the years following the Second World War allowing developing economies opportunities to move from agricultural and non-rural commodity exports to expand into labour-intensive and lower-value-add exports (such as manufactured goods). As emerging economies became more integrated with the rest of the economy, many developed economies shifted resources away from low-value manufactured or agricultural goods and into higher-valued adding industries. As economies record higher rates of growth and per capita incomes increase, the demand for consumption of goods and services increases. As this occurs, economies tend to transition to higher productivity and more service-orientated industries (see Figure 1).

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[3] ABS (2012),
http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1301.0~2012~Main%20Features~Value%20of%20goods%20and%20services%20produced%20by%20Australian%20Industry~240

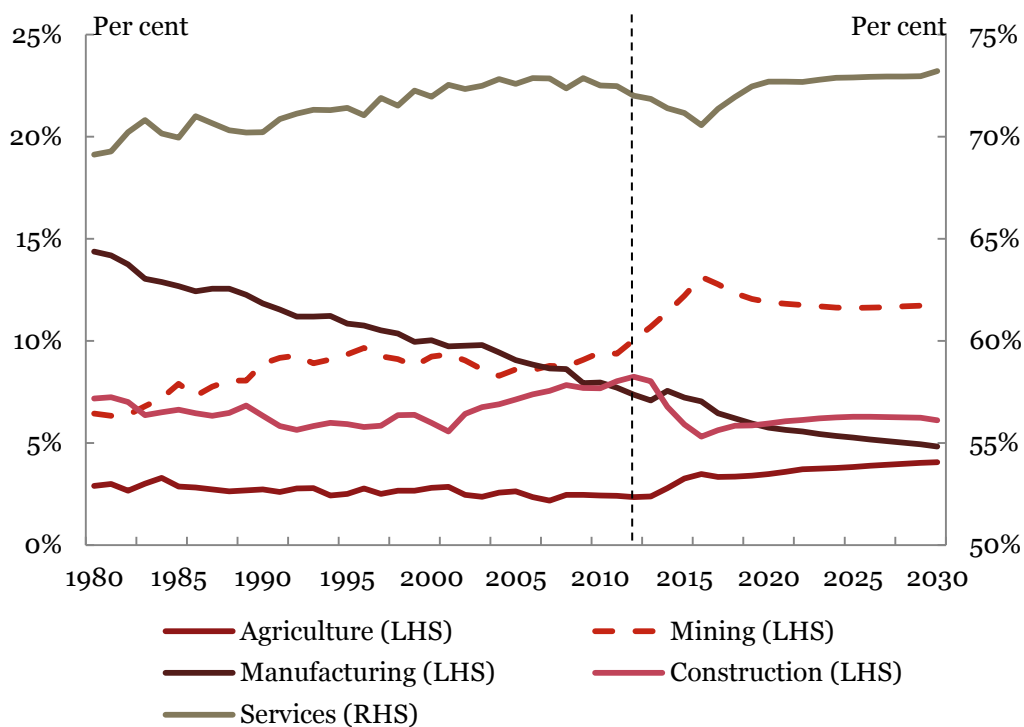**Figure 1 Industry share of total output for middle income economies**

Source: World Bank Development Indicators

Similar to other advanced economies over the past 50 years, the structure of the Australian economy has changed significantly. Industries such as agriculture and manufacturing have declined in significance as service orientated industries (e.g. financial and insurance services) become a larger proportion of economic output.

The current Australian industry composition is dominated by the services sector with over 70 per cent of industry output coming from services orientated industries. Australia's economy is expected to continue its long-term trend towards services and to see continued decline in the proportion of output from the manufacturing sector. The services share in the economy has increased from around 60 per cent in 1970s and is expected to be 75 per cent by the end of 2030. In addition to strong services sector growth, Australia's abundance of natural resources and strong export demand from Australia's major trading partners has driven strong growth in the resources sector (including oil and gas) over the past decade. The resources sector's share of the economy is expected to almost double from 7 per cent in the 1970s to approximately 12 per cent by the end of 2030 (see Figure 2).

Figure 2 Industry share of total Australian output*

*Aggregate mining industry, including oil and gas sector.

At the beginning of the mining boom in 2003-04, the mining sector was Australia's 11th largest industry (4.4 per cent of total output)

With an increased proportion of output in the economy attributable to the resources sector, developments in global commodity markets can have significant impacts on national output. Chapter 4 applies a sensitivity analysis by applying a negative shock to non-rural commodity prices to illustrate the impact on both economic growth and resource allocation.

At the beginning of the first phase of Australia's resources boom, the manufacturing sector was the largest producing industry in Australia (11.9 per cent of output), followed by financial and insurance services (7.8 per cent) and the construction industry (7.1 per cent). In comparison, the mining sector was Australia's 11th largest industry, comprising of 4.4 per cent of national output (see Figure 3).

Figure 3 Industry share of Australian output (2003-04)[4]

Industry	Per cent
Manufacturing	11.9
Financial and insurance services	7.8
Construction	7.1
Public administration and safety	6.2
Health care and social assistance	5.9
Professional, scientific and technical services	5.9
Retail trade	5.4
Wholesale trade	5.4
Transport, postal and warehousing	5.1
Education and training	4.8
Mining	4.4
Information media and telecommunications	3.9
Agriculture, forestry and fishing	3.4
Administrative and support services	3.2
Electricity, gas, water and waste services	2.7
Rental, hiring and real estate services	2.6
Accommodation and food services	2.6
Other services	2.3
Arts and recreation services	1.1

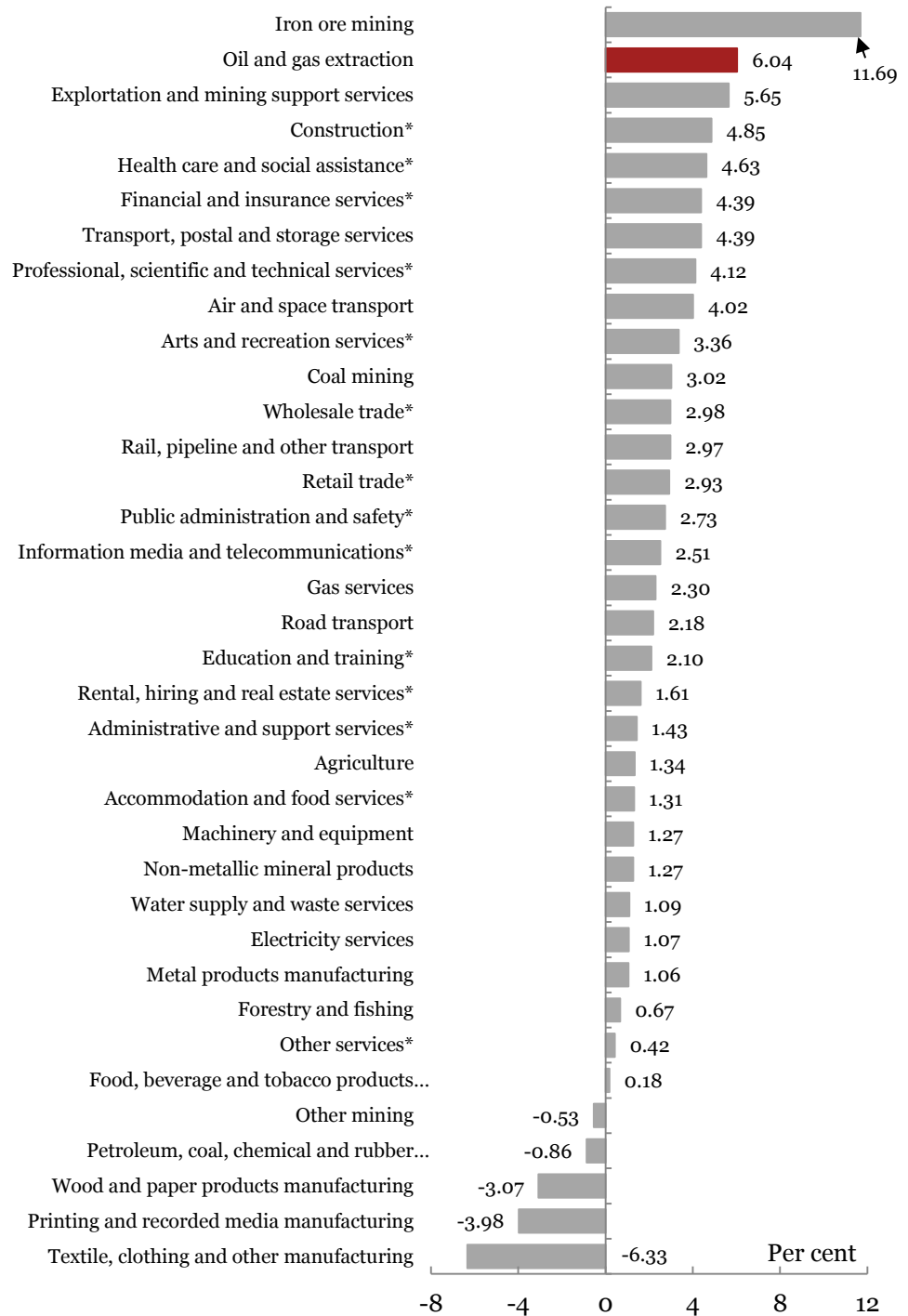Source: ABS catalogue number 5204.0

However, with increased activity in the mining sector driven by increased demand for non-rural commodity resources in the Asian region, resource allocation in the economy moved towards the mining sector over the past decade. While mining and construction output increased strongly in response to the mining boom, the agriculture and manufacturing sectors share of the economy continued its 30-year decline. Over the past decade, annual average growth has been strongest in iron ore mining (11.7 per cent), oil and gas extraction (6 per cent), exploration and mining support services (5.7 per cent) and construction (4.9 per cent). The lowest growth rates were in the manufacturing sector, with textile and clothing (-6.3 per cent), printing and recorded media (-4 per cent) and wood and paper product manufacturing (-3.1 per cent) recording the weakest average growth rates (see Figure 4).

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[4] The ABS does not provide a current price estimate of sub-divisional industry output over time (i.e. oil and gas extraction). Therefore we cannot compare industry shares of output between time periods at the sub-divisional level. Further information can be found on page 16 of http://www.bea.gov/papers/pdf/NABEspeakernotes.pdf.

Current price estimates of sub-divisions can be calculated from detailed input-output tables from 2001-02 to the latest edition in 2009-10. However, there are two shortcomings of using this method:

1) The latest input-output table released last year is only for fiscal year 2009-10 (a point where oil and gas investment only just started to increase strongly). Using these figures would then understate the current share of the oil and gas sector in the economy.

2) The ABS released the latest Australian and New Zealand Standard Industrial Classification in February 2006. This review replaced the 1993 edition and reflected substantial review of each industrial classification which included extensive consultation with industry and government agencies. Therefore comparing input-output tables based on the 1993 edition with the latest table using the 2006 edition could provide discrepancies in the results.

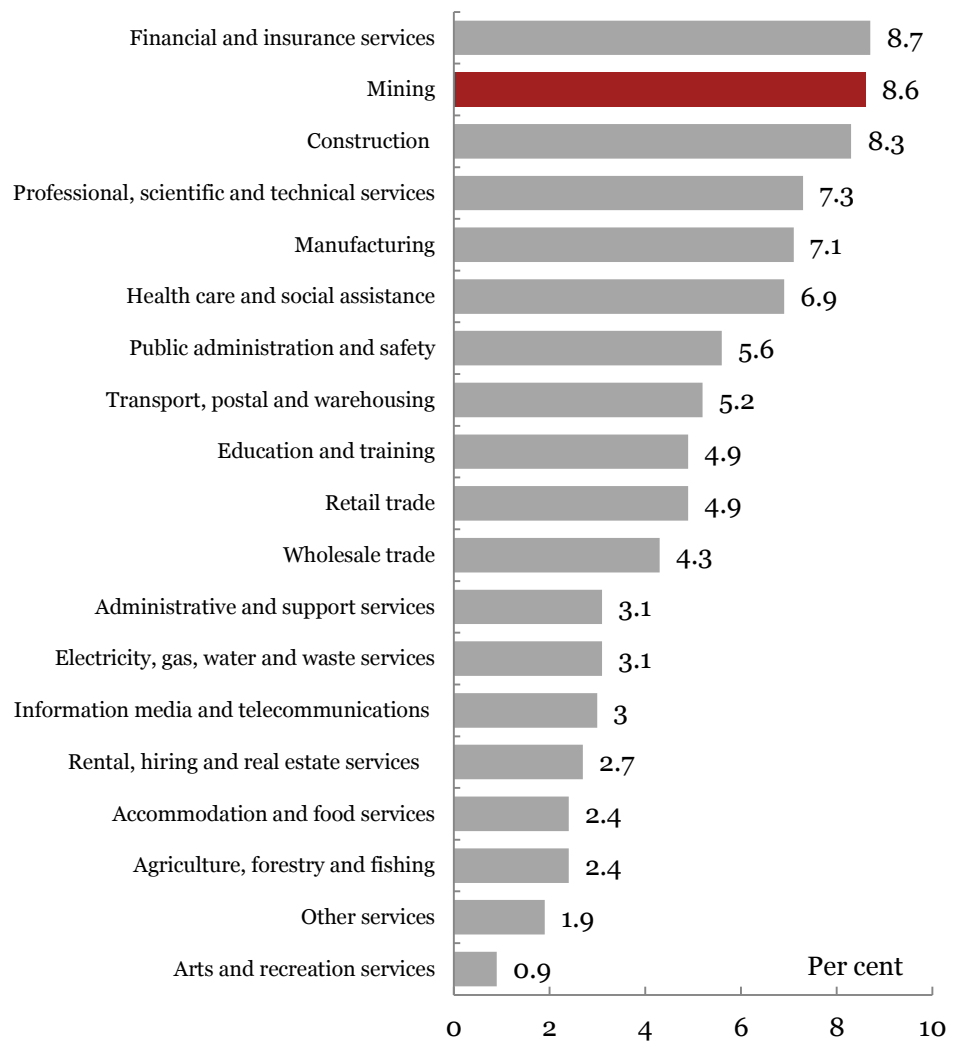**Figure 4 Average annual growth rate of industries (including sub-industries) (2003-04 to 2012-13)[5]**

Industry	Per cent
Iron ore mining	11.69
Oil and gas extraction	6.04
Explortation and mining support services	5.65
Construction*	4.85
Health care and social assistance*	4.63
Financial and insurance services*	4.39
Transport, postal and storage services	4.39
Professional, scientific and technical services*	4.12
Air and space transport	4.02
Arts and recreation services*	3.36
Coal mining	3.02
Wholesale trade*	2.98
Rail, pipeline and other transport	2.97
Retail trade*	2.93
Public administration and safety*	2.73
Information media and telecommunications*	2.51
Gas services	2.30
Road transport	2.18
Education and training*	2.10
Rental, hiring and real estate services*	1.61
Administrative and support services*	1.43
Agriculture	1.34
Accommodation and food services*	1.31
Machinery and equipment	1.27
Non-metallic mineral products	1.27
Water supply and waste services	1.09
Electricity services	1.07
Metal products manufacturing	1.06
Forestry and fishing	0.67
Other services*	0.42
Food, beverage and tobacco products...	0.18
Other mining	-0.53
Petroleum, coal, chemical and rubber...	-0.86
Wood and paper products manufacturing	-3.07
Printing and recorded media manufacturing	-3.98
Textile, clothing and other manufacturing	-6.33

[5] The majority of industries are not disaggregated any further. The following industries have been split into their sub-division level: **agriculture, mining, manufacturing** and **electricity, gas, water and waste services.**

* Denotes aggregated industry that is not further classified.

Figure 5 Industry share of Australian output (2012-13)[6]

Today, the mining sector is Australia's second largest industry behind financial and insurance services, with a total value-add to the economy of $122 billion

Industry	Per cent
Financial and insurance services	8.7
Mining	8.6
Construction	8.3
Professional, scientific and technical services	7.3
Manufacturing	7.1
Health care and social assistance	6.9
Public administration and safety	5.6
Transport, postal and warehousing	5.2
Education and training	4.9
Retail trade	4.9
Wholesale trade	4.3
Administrative and support services	3.1
Electricity, gas, water and waste services	3.1
Information media and telecommunications	3
Rental, hiring and real estate services	2.7
Accommodation and food services	2.4
Agriculture, forestry and fishing	2.4
Other services	1.9
Arts and recreation services	0.9

Source: ABS catalogue number 5204.0

Figure 3 and Figure 5 illustrate industry shares of output for 2003–04 and 2012–13 respectively. While in 2003-04, the manufacturing sector was the largest industry in Australia, in 2012-13, the financial and insurance sector contributed the largest share of output (8.7 per cent). This was closely followed by the mining industry (8.6 per cent), construction (8.3 per cent) and professional, scientific and technical services (7.3 per cent).

Between 2003–04 and 2012–13, the largest increase in industry GVA as a share of total output was for mining (up 4.2 percentage points) and professional, scientific and technical services (up 1.4 percentage points). The largest fall in industry share of GDP in the period was manufacturing which fell by 4.8 percentage points (see Figure 6).

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[6] See footnote in Figure 3.

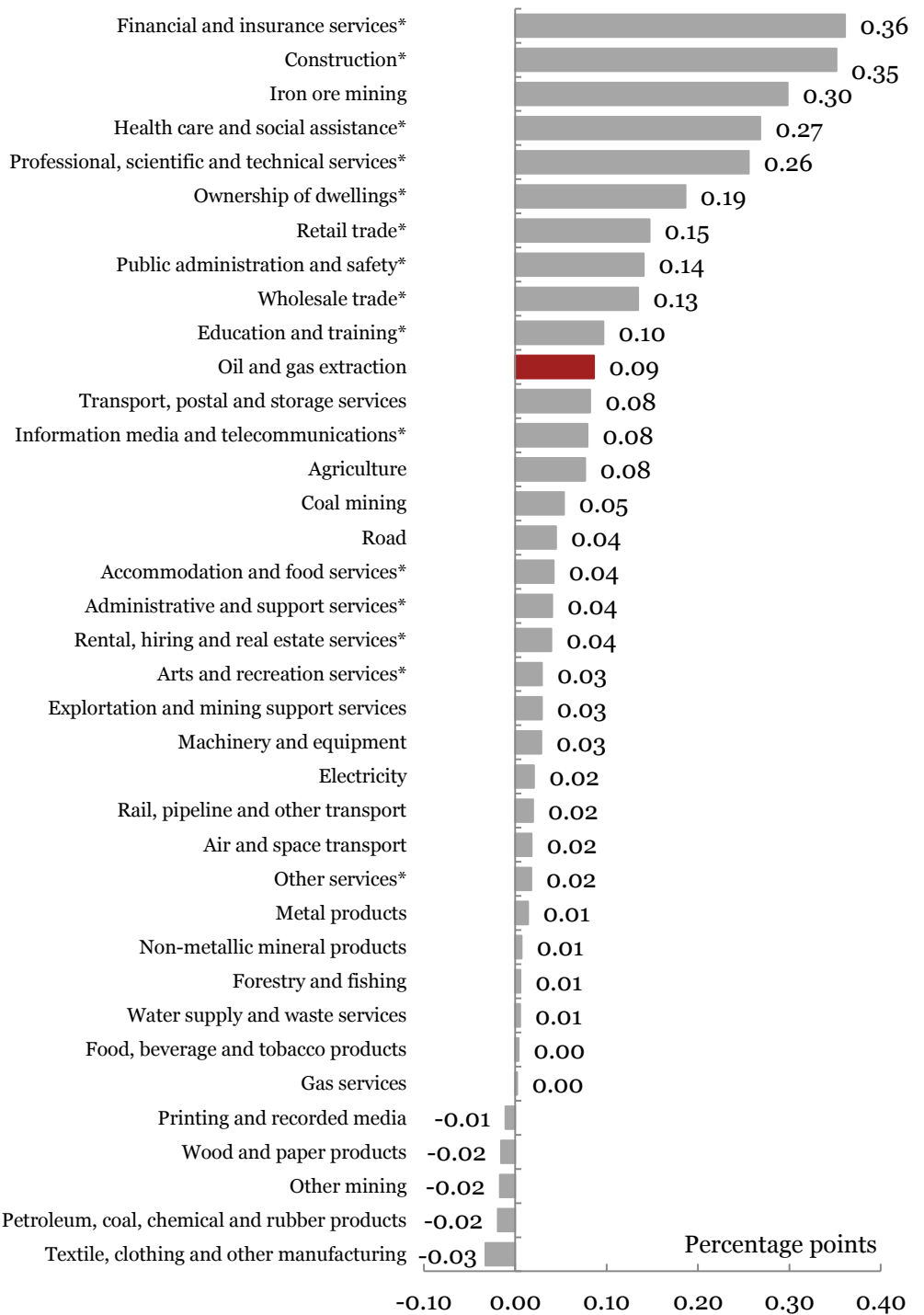**Figure 6 Difference in industry shares of total output (2012-13 to 2003-04)**

Industry	Percentage points
Mining	4.2
Professional, scientific and technical services	1.4
Construction	1.2
Health care and social assistance	1
Financial and insurance services	0.9
Electricity, gas, water and waste services	0.4
Education and training	0.1
Transport, postal and warehousing	0.1
Rental, hiring and real estate services	0.1
Administrative and support services	-0.1
Arts and recreation services	-0.2
Accommodation and food services	-0.2
Other services	-0.4
Retail trade	-0.5
Public administration and safety	-0.6
Information media and telecommunications	-0.9
Agriculture, forestry and fishing	-1
Wholesale trade	-1.1
Manufacturing	-4.8

Source: ABS catalogue number 5204.0

While average annual growth rates provide an indicator of the broad underlying industry behaviour over several years, these averages smooth the annual movements in the series and mask the highest and lowest movements. In terms of year-on-year changes, some fast growing industries in this period showed fluctuating trends of GVA throughout the decade (e.g. financial and insurance services pre and post-GFC).

With high growth in mining investment and production over the past decade, the mining sector was the largest contributor to growth. Over the period from 2003-04 to 2012-13, the mining sector contributed an annual average of 0.4 percentage points to economic growth. This includes: 0.3 percentage points from iron ore mining, 0.09 percentage points from oil and gas extraction and 0.05 percentage points from coal mining (see Figure 7). After mining, financial and insurance services, construction and health care and social services were the other major contributors to growth. While still a major industry over the past decade, output in the manufacturing sector has been sluggish with a negligible contribution to gross value added. Positive contributions from machinery and equipment and metal products were partially offset by negative contributions from textile, petroleum and wood and paper product manufacturing.

Figure 7 Average annual contribution to gross value added (2003-04 to 2012-13)[7]

Industry	Percentage points
Financial and insurance services*	0.36
Construction*	0.35
Iron ore mining	0.30
Health care and social assistance*	0.27
Professional, scientific and technical services*	0.26
Ownership of dwellings*	0.19
Retail trade*	0.15
Public administration and safety*	0.14
Wholesale trade*	0.13
Education and training*	0.10
Oil and gas extraction	0.09
Transport, postal and storage services	0.08
Information media and telecommunications*	0.08
Agriculture	0.08
Coal mining	0.05
Road	0.04
Accommodation and food services*	0.04
Administrative and support services*	0.04
Rental, hiring and real estate services*	0.04
Arts and recreation services*	0.03
Explortation and mining support services	0.03
Machinery and equipment	0.03
Electricity	0.02
Rail, pipeline and other transport	0.02
Air and space transport	0.02
Other services*	0.02
Metal products	0.01
Non-metallic mineral products	0.01
Forestry and fishing	0.01
Water supply and waste services	0.01
Food, beverage and tobacco products	0.00
Gas services	0.00
Printing and recorded media	-0.01
Wood and paper products	-0.02
Other mining	-0.02
Petroleum, coal, chemical and rubber products	-0.02
Textile, clothing and other manufacturing	-0.03

Source: ABS catalogue number 5206.0

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[7] The majority of industries are not disaggregated any further. The following industries have been split into their sub-division level: **agriculture, mining, manufacturing** and **electricity, gas, water and waste services.**

While the manufacturing sector is still a significant proportion of the economy at the aggregate (20 industry) divisional level, it is worth comparing industries at the sub-divisional level. Using 2011-12 (current price) figures, five major sectors can be further disaggregated to their sub-divisional level (see Table 2).

While oil and gas extraction is 2 per cent of output in 2011-12, it is still higher than each sub-component of manufacturing. The highest share of output in the manufacturing sector is food, beverage and tobacco and machinery and equipment (1.8 per cent and 1.6 per cent respectively).

Table 2 Industry share of Australian output (2011-12)

	2011-12	% of output
Agriculture	29,047	2.1
Forestry and fishing	4,678	0.3
Agriculture, forestry and fishing	33,725	
Coal mining	25,275	1.8
Oil and gas extraction	27,749	2.0
Iron ore mining	51,886	3.7
Other mining	18,975	1.4
Exploration and mining support services	10,234	0.7
Mining	134,119	
Food, beverage and tobacco products	24,482	1.8
Textile, clothing and other manufacturing	5,391	0.4
Wood and paper products	6,299	0.5
Printing and recorded media	3,812	0.3
Petroleum, coal, chemical and rubber products	19,481	1.4
Non Metallic Mineral products	5,587	0.4
Metal products	18,185	1.3
Machinery and equipment	21,655	1.6
Manufacturing	104,892	
Electricity	22,941	1.6
Gas	1,303	0.1
Water supply and waste services	13,764	1.0
Electricity, gas, water and waste services*	38,008	
Construction*	114,785	8.2
Wholesale trade*	61,808	4.4
Retail trade*	66,880	4.8
Accommodation and food services*	34,920	2.5
Road	22,493	1.6

	2011-12	% of output
Air and space transport	6,533	0.5
Rail, pipeline and other transport	10,093	0.7
Transport, postal and storage services	31,971	2.3
Transport, postal and warehousing*	71,090	
Information media and telecommunications*	42,129	3.0
Financial and insurance services*	117,656	8.4
Rental, hiring and real estate services*	37,662	2.7
Professional, scientific and technical services*	97,303	7.0
Administrative and support services*	42,547	3.1
Public administration and safety*	77,644	5.6
Education and training*	66,807	4.8
Health care and social assistance*	90,840	6.5
Arts and recreation services*	11,858	0.9
Other services*	27,763	2.0
Ownership of dwellings*	120,208	8.6
Total industry gross value added	**1,392,644**	**100**

Source: ABS catalogue number 5204.0

* Denotes aggregated industry that is not further classified.

2.2 Drivers of the mining boom since 2003-04

Rapid growth in emerging Asian economies over the past decade in particular, has seen an increase in demand for Australian commodity exports (see Figure 8).

Figure 8 Value of Australian non-rural commodity exports

Source: ABS catalogue number 5368.0

With a strong increase in commodity demand from emerging markets and global supply unable to respond adequately, commodity prices increased to record highs resulting in Australia's terms of trade reaching record levels.

Figure 9 GDP of selected Asian economies

Source: The Conference Board Total Economy Database™ (January 2014) and IMF World Economic Outlook Database (April 2014) forecasts.

Demand for Australian resources increased strongly over the past decade, driven by strong economic growth in emerging economies (see Figure 9). Increased commodity prices and investment activity saw factors of production in the economy flow towards the resources sector (e.g. mining related construction activity). Increased capital expenditure in the resources sector saw mining capital expenditure in Australia reach record levels to be almost $95 billion by the end of 2012-13 (see Figure 10). Over the past five years, the major driver of mining capital expenditure has been in the oil and gas sector, which has partially offset the decline in iron ore and coal mining capital expenditure over the past year.

Figure 10 Capital expenditure in the mining sector

Source: ABS catalogue number 5625.0

2.3   Oil and gas sector in Australia

As highlighted in the section above, strong growth in output in Australia's major trading partners over the past two decades has increased demand for Australian energy and resources (including oil and gas).

With the price received by Australian LNG exporters almost tripling over the past decade (see Figure 11) and emerging markets expected to be the predominant driver of growth in energy demand over the next 30 years (see Figure 12), investment and exploration expenditure in the sector have increased strongly.

Figure 11 Regional gas prices (2003-2013)

Source: World Bank Commodity Price Data (The Pink Sheet)

Figure 12 Energy demand by region (2005-2040)

Source: U.S. Energy Information Administration (EIA, 2013)

Exploration expenditure (both onshore and offshore) is over 6½ times the size of two decades ago, driven by strong increases in both offshore and onshore exploration. Western Australia and Queensland (to a lesser extent) experienced the

greatest increase in exploration expenditure over the period. While exploration expenditure remains historically elevated, the number of wells drilled per dollar of offshore expenditure has fallen significantly over the past five years (see Figure 13).

Figure 13 Annual offshore exploration expenditure and drilling activity

In addition to strong exploration expenditure, the pipeline of mining investment projects remains strong. There are currently over 14 oil and gas projects at the committed stage with a value of almost $200 billion, 8 projects at the feasibility stage with a value of over $42.5 billion and a further 8 publicly announced projects with a value of around $30 billion. Of all committed resource and energy projects, oil and gas projects now account for over 85 per cent of investment in Australia.

With strong investment in the sector, proven natural gas reserves have increased significantly over the past 30 years to increase six-fold and be around 3.5 trillion cubic metres. At current production levels (around 60 billion cubic metres in 2012-13) this would imply natural gas reserves will last at least 60 years.[8] While proven gas reserves are at record highs and account for publicly announced gas projects, further investment in both conventional and unconventional extraction technologies can provide further upside to proven gas reserves. Importantly, the size of proven reserves should imply that the significant investment in capital in the sector can remain productively utilised over the long term and not be stranded or left idle.

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[8] This is an estimate by PwC based on current gas production levels for 2012-13 (from the Bureau of Resource and Energy Economics) and no change to proven gas reserves from the end of 2013. In reality, increases in exploration expenditure should result in increased quantities of proven reserves over time (occurring at declining marginal rate). If we were to include **all identified gas resources** from APPEA's key statistical publication (http://www.appea.com.au/wp-content/uploads/2014/04/Key-Stats_2014_A4-print.pdf), at current production levels, gas reserves could last up to three times as long as highlighted in the paragraph above.

Figure 14 Australian natural gas proven reserves

With increased capacity over the past decade, the size and scale of the oil and gas sector has changed significantly, with employment in the sector growing by over 14,000 persons and output by almost $14 billion (see Table 3).

Table 3 Key characteristics of the oil and gas sector

	2003-04	2012-13	Difference**
Gross value added ($bn)*	18.5	32.3	13.8
Direct employment	6,200	20,400	14.1
% of total employment	0.07	0.18	0.11
Exports ($bn)	9.5	28.0	18.6
Petroleum	6.6	12.7	6.0
Gas	2.8	15.4	12.5
% of total goods exports	8.7	11.3	2.7

2.4   Oil and gas extraction value chain

While the oil and gas sector has increased strongly over the past decade, it also uses a number of other Australian industries output through its supply chain. In 2009-10, the oil and gas sector's gross value added was over $23 billion and it used almost $10 billion of intermediate inputs (approximately 0.4 per cent of total industry supply).

Figure 15 illustrates that goods and services from other Australian industries represent the majority of inputs to domestic oil and gas extraction ($8.8 billion of $9.9 billion). Principal materials are: oil and gas' own use (23 per cent), exploration and mining support services (8 per cent), petroleum and coal manufacturing (3 per cent), specialised and other machinery equipment (3 per cent), and heavy and civil engineering construction (12 per cent).

Figure 15 Oil and gas industry value-add chain (2009-10)

While the oil and gas sector added over $23 billion of value-add to the Australian economy, industries related to the sector added another $4 billion to the economy.

Source: ABS catalogue number 5209.0

In using almost $10 billion of domestic inputs, the industry also created an additional $4 billion of value-added to the economy indirectly through its demand of inputs from other sectors of the economy (see Figure 16).
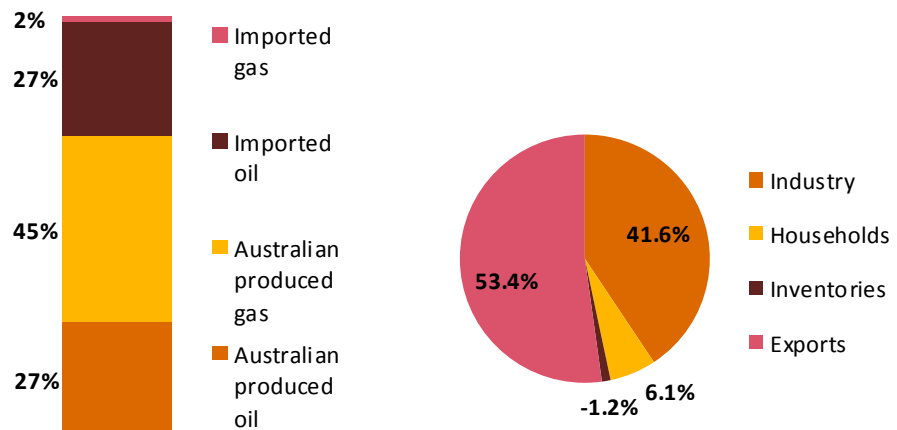
Figure 16 Oil and gas industry value-add chain (2009-10)

Source: ABS catalogue number 5209.0

Of the $46 billion supply of oil and gas in the Australian economy, around 30 per cent is imported (vast majority is refined petroleum) and 70 per cent is produced domestically. Across the economy, for every $1 of oil and gas produced domestically, 53.4 cents is exported, 41.6 cents are used by domestic industry and around 6 cents are used in the household sector (see Figure 17).

Figure 17 Composition of Australian oil and gas supply

Source: ABS catalogue number 5209.0

For every $1 of production in the oil and gas sector, 70 cents of value is added. This compares to 75 cents and 71 cents in education and health care respectively.

Of the 41.6 cents used in the domestic industry, the vast majority is used in the manufacturing sector (see Table 4). The manufacturing sub-industry that uses around 85 per cent of the manufacturing industry's oil and gas consumption is the petroleum and coal product manufacturing sector. This sector is mainly engaged in manufacturing asphalt, tar and various solvents.

Table 4 Total industry breakdown

Manufacturing	23.6 cents
Mining	9.4 cents
Utilities	3.5 cents
Wholesale trade	2.1 cents
Transport	1.1 cents
Other	1.9 cents
Total industry	**41.6 cents**

Source: ABS catalogue number 5209.0
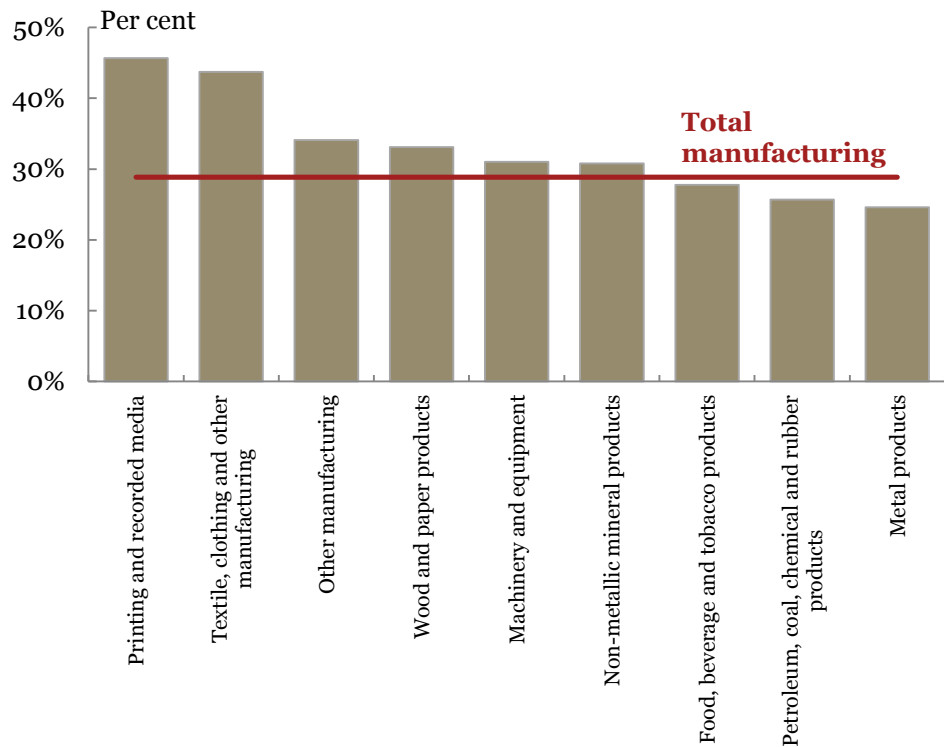
2.5 Value-added per unit of production

In 2009-10, the oil and gas sector provided over $23 billion of value-add to the economy, using around $8.8 billion of domestic inputs. On average, for every $1 of production by Australian industry, 49 cents of value-add is created in the economy. This compares to 75 cents in education and training, 71 cents in financial and insurance services and 70 cents in the oil and gas extraction sector. The oil and gas sector has a higher ability to add value to the Australian economy through its large scale capital and skilled labour. The industry with the lowest value-add per unit of supply is the manufacturing industry, which adds less than 30 cents for every $1 of supply used (see Figure 18 and Figure 19).

Figure 18 Value-added per unit of production

Value-added is the efficiency of the sector in turning a unit of input into an output

Source: ABS catalogue number 5209.0 and PwC estimates

Figure 19 Value-added per unit of production in the manufacturing industry

These sentiments are echoed in a recent Deloitte Access Economics report[9], which found that while manufacturing's share of industry gross value added is still high, its value-added as a share of total production is low given it consumes a significant number of outputs from other sectors of the economy to use as its inputs to production.
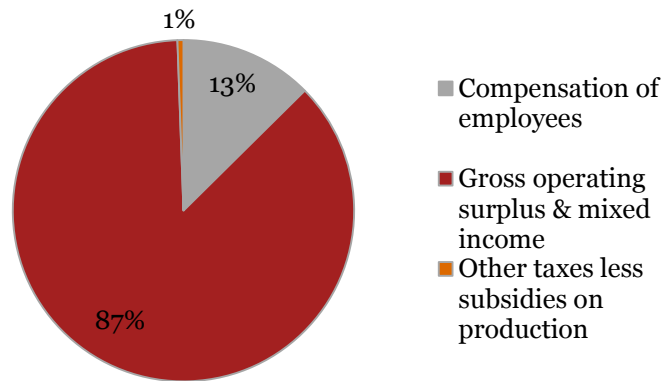
Of the $23 billion of value-add from the oil and gas industry, almost 90 per cent is driven by returns on capital (as shown by gross operating surplus), with the balance being provided by labour (compensation of employees) and to a lesser extent other taxes and subsidies (see Figure 20).

Given, the high capital use in the oil and gas sector, the capital share of gross value added is almost double the total industry share (87 per cent vs 46 per cent) and the balance attributable to labour is significantly smaller than the aggregate economy (13 per cent vs 51 per cent) (see Figure 21).

While the oil and gas sector has a high proportion of value added attributable to returns on capital, the mining industry (including oil and gas extraction) is amongst the highest paying industries in the economy (see Figure 22).
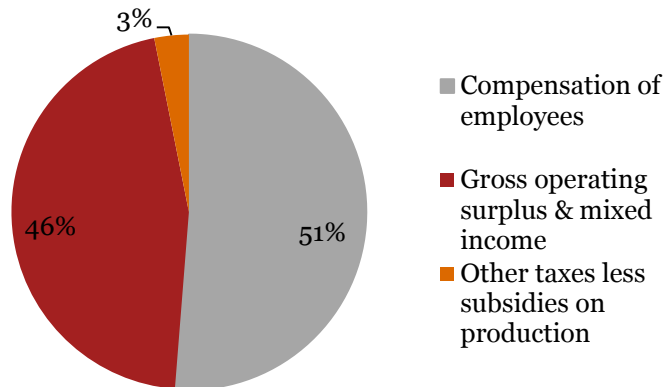
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[9] http://pdf.aigroup.asn.au/Deloitte%20Gas%20Market%20Transformations%20-
%20Manufacturing%20Impacts%20Report%20-%20web%20final%20-%20July%2014%202014.pdf

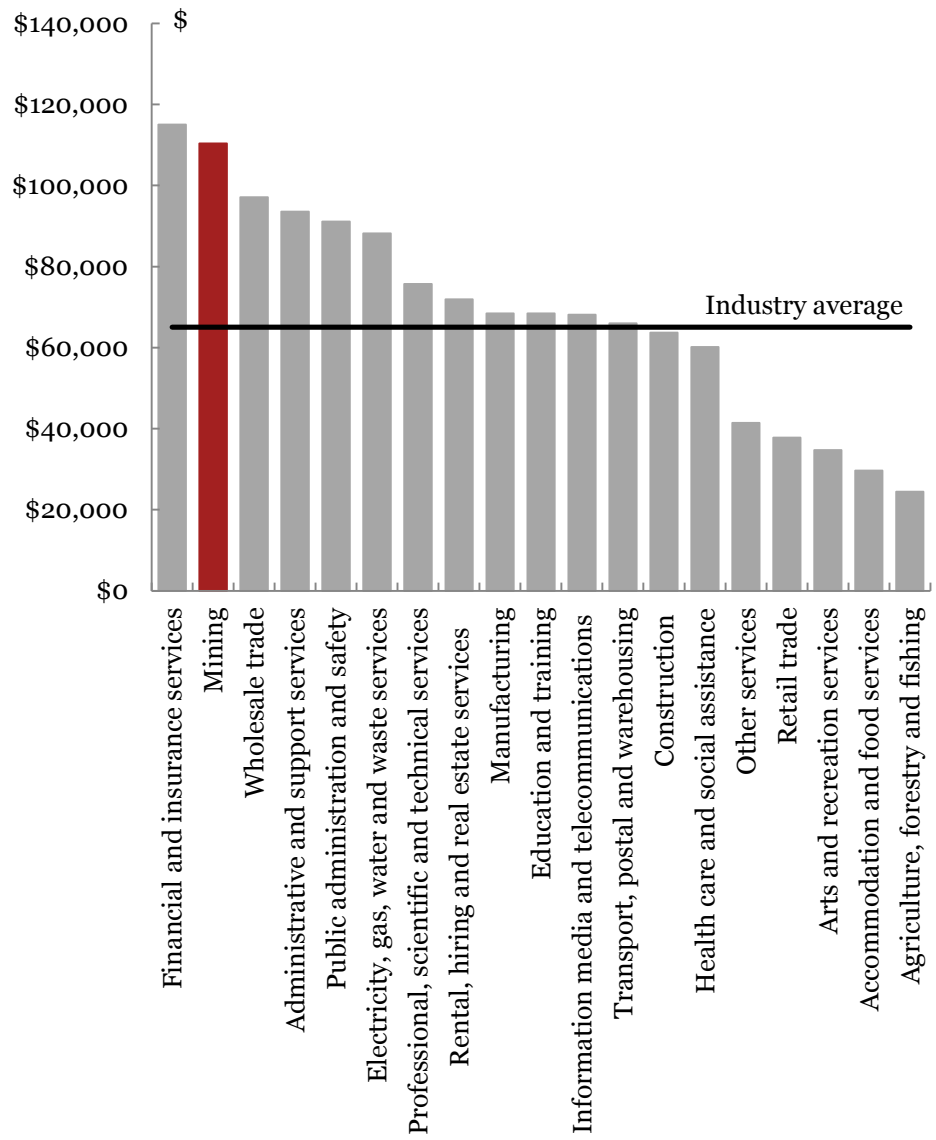**Figure 20 Oil and gas extraction breakdown of value added (2009-10)**

Source: ABS catalogue number 5209.0

Figure 21 Total industry breakdown of value added for all sectors (2009-10)

Source: ABS catalogue number 5209.0

Figure 22 Average compensation per employee by industry (2012-13)

Source: ABS catalogue number 5204.0 and 6291.0.55.003

3   *Australian economy and industry to 2029-30*

This chapter outlines a base case or business as usual scenario for the evolution of the Australian economy to 2029-30. The purpose of developing a base case is to estimate the future contribution of the oil and gas industry to the Australian economy from current production level expectations. This provides a quantitative description of the evolution of value-add over the past ten years and anticipated changes in the pattern of value-add over the next decade.

The base case scenario tells a story of an Australian economy that will continue to grow based on official projections and anticipated production levels, generating output and income growth. It is also a story of ongoing and substantial structural transformation driven by demographic change, the unwinding of an elevated terms of trade, uneven productivity growth across industries, and continued trend changes in consumer preferences. While aggregate growth is projected to be strong, growth across sectors and industries vary, with the strongest growth in the oil and gas and related sectors over the coming decade.

The economy-wide model used is the MONASH Multi Regional Forecasting Model (MMRF). PwC's MMRF model[10] is based on the Victoria University suite of CGE models (previously MONASH models), and are kept updated with the latest ABS data. The MMRF model is a highly detailed representation of national and regional economies, with sophisticated economic relationships linking industry sectors, consumers, governments, investors, and foreign trade. These industry sectors are complemented with databases that provide a comprehensive representation of the Australian economy and industries. This model is widely used by the Treasury and Productivity Commission for policy evaluations. More details of MMRF model are provided in **Appendix A**.

3.1   *Base case assumptions*

PwC has used the following base case assumptions to 2029-30:

- Australian Bureau of Statistics forecasts for demography;

- Treasury forecasts for the economy and the aggregate terms of trade;

- World Bank forecasts for commodity prices; and

- Coal, oil and gas production forecasts from the Bureau of Resources and Energy Economics (BREE).

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[10] We applied PWC's version of the Monash Multi Regional Forecasting Model (MMRF) for economic modelling of the Australian economy to 2029-30.
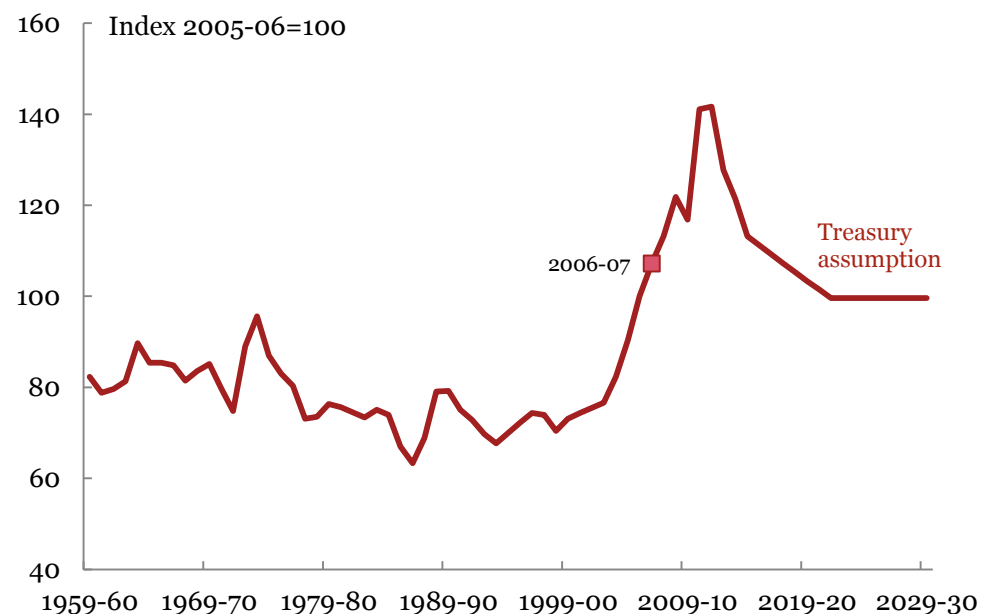
3.2 Terms of trade forecasts in the base case

In the base case, the terms of trade projections are consistent with the Treasury's forecasts to 2029-30.

Treasury's long term terms of trade forecasts are based on the detailed price and volume forecasts for Australia's major export categories, including global demand and supply models for the three major bulk commodities (iron ore, metallurgical coal and thermal coal). Based on 2014-15 Budget forecasts, Australia's terms of trade in the base case are expected to fall over the rest of the decade before settling around levels recorded in 2006-07[11] (see Figure 23).

PwC have used Treasury's terms of trade forecasts in the base case given the numbers underpin official Budget documents and the methodology is well documented and publicly available.

Figure 23 Terms of trade forecasts in base case

Australia's terms of trade in the base case are expected to fall over the rest of the decade before settling around levels recorded in 2006-07

Sources: ABS catalogue number 5206.0, Treasury and PwC.

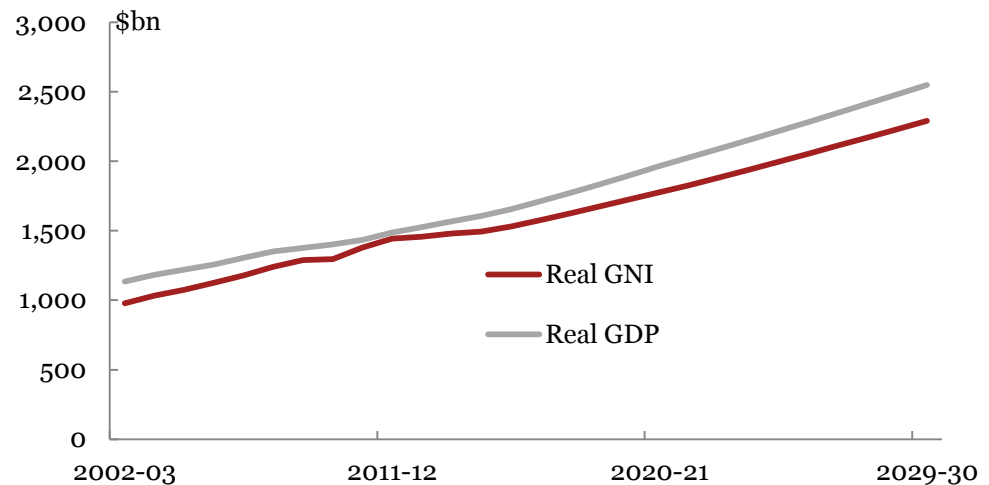## 3.3 Australian macro economy to 2029-30

Real Gross Domestic Product (GDP) and Real Gross National Income (GNI) forecasts to 2029-30 are provided in Figure 19. GDP is a measure of the value of production in Australia and is the most common measure of the size of the economy. GNI is a better measure of welfare because it also accounts for that part of domestically generated income that accrues to non-residents. It also accounts for foreign generated income that accrues to domestic residents.

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[11] Bullen, Kouparitsas and Krolikowski (2014), Long-run forecasts of Australia's terms of trade, Treasury Working paper, 2014-01.
http://www.treasury.gov.au/~/media/T`reasury/Publications%20and%20Media/Publications/2014/Long%20run%2 0forecasts%20of%20Australias%20terms%20of%20trade/Documents/PDF/long_run_tot.ashx

In the base case scenario, Australia's GDP is forecast to grow at an average annual rate of 3 per cent to 2029-30 (close to current trend rate). By 2030, GDP is projected to increase by 67 per cent to be $3 trillion from current levels of $1.5 trillion (see Figure 24).

Given a large proportion of domestic income accrues to overseas residents, Australia's real GNI is expected to grow slightly lower than GDP at an annual average rate of 2.7 per cent per annum to 2029-30. This is driven by a lower terms of trade and slowing labour force growth as the effects of an ageing population begin to slow growth towards the end of 2025.

Figure 24 Real GDP and Real GNI levels ($bn) in the base case

Source: ABS and estimates based on PwC assumptions and MMRF model, 2011-12 prices

While output in the economy continues to grow at trend, services and mining-related industries continue to dominate growth in the forecast period. The oil and gas extraction industry and the information and communication industry have the highest average annual rate of growth (both 4.4 per cent), followed by business and public services (4 per cent and 3.8 per cent respectively).
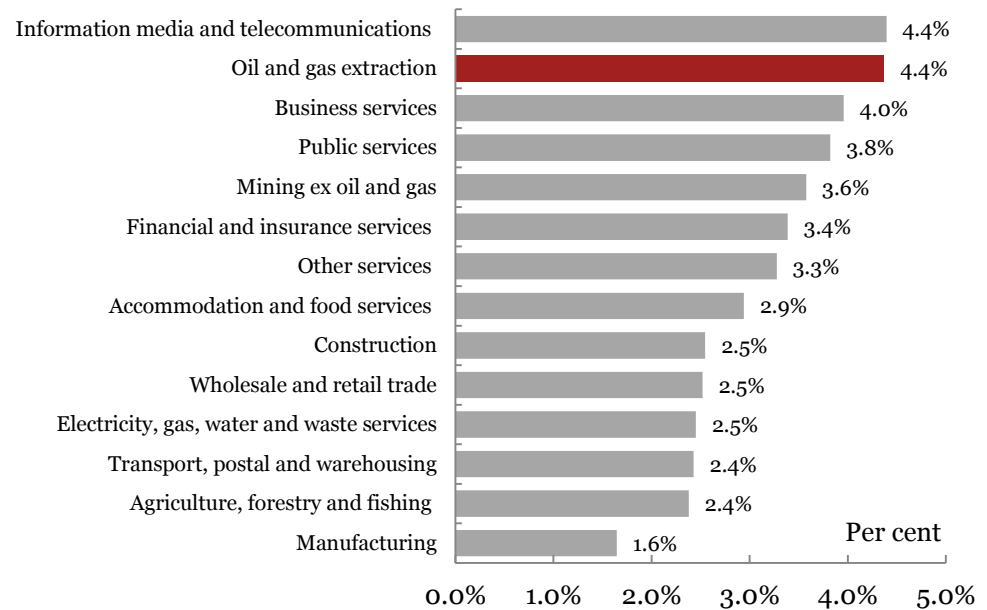
Figure 25 shows the annual average growth rate in GVA (in real terms) for individual industries between 2012–13 and 2029–30. While oil and gas and the rest of the mining industry continue to grow strongly, average annual growth rates are lower than the decade after the first phase of the mining boom from 2003-04. Over this time period, the mining industry (in aggregate) increased at an annual average rate of 5½ per cent.

This is supported by Figure 26 which shows the change in the share of industry gross value added between 2012-13 and 2029-30. Between 2003-04 and 2012-13, the mining sector's share of industry output increased by 4.2 percentage points. However, over the two decades to 2029-30, the sector is only expected to increase by a further 1.2 percentage points to be around 12 per cent of total industry output. The deceleration in mining's contribution to growth over the next 15 years is expected given the strength witnessed over the past decade, coupled with the easing in global commodity prices as increased capacity from commodity exporting countries continue to come online. While the mining sector continues to grow (albeit at a lower rate), the manufacturing industry's share of industry output falls by 1.4 percentage points as the services share of the economy continues to increase (see Figure 26). This remains consistent with the structural change in advanced economies towards higher value-adding industries.

Figure 25 Average annual growth rate of industries between 2012-13 and 2029-30
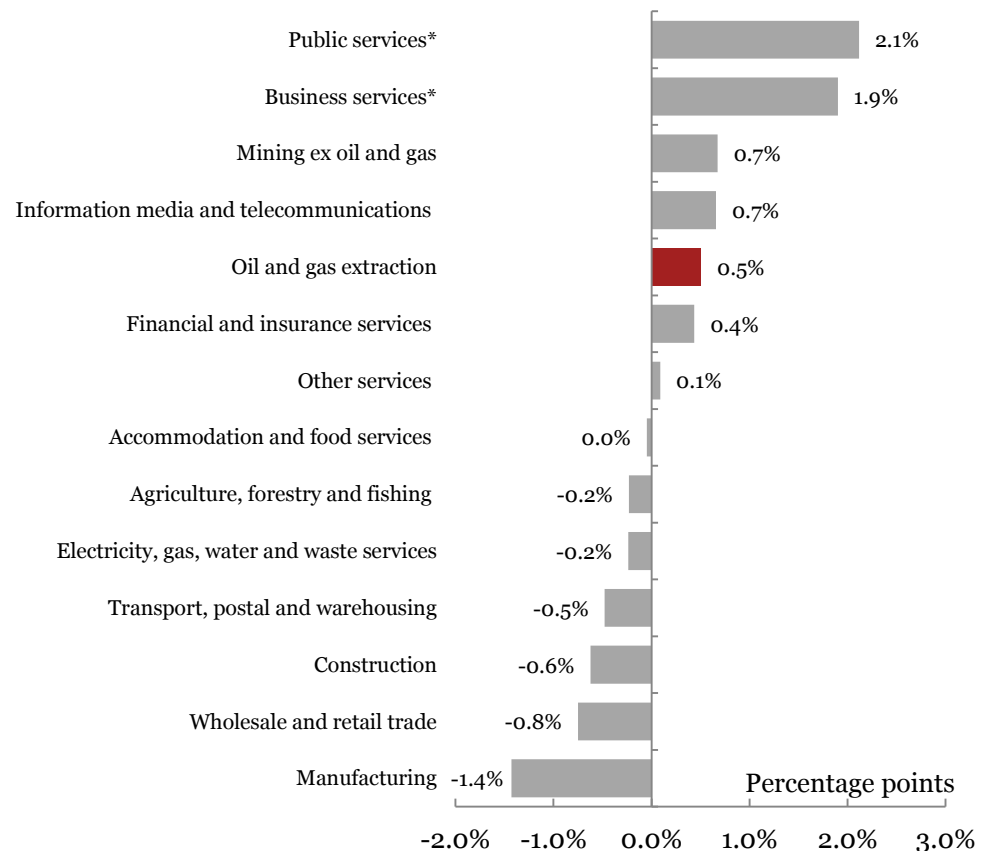
Along with information media and telecommunications, the oil and gas sector is estimated to be one of the fastest growing sectors in the Australian economy between 2012-13 and 2029-30.

Industry	Per cent
Information media and telecommunications	4.4%
Oil and gas extraction	4.4%
Business services	4.0%
Public services	3.8%
Mining ex oil and gas	3.6%
Financial and insurance services	3.4%
Other services	3.3%
Accommodation and food services	2.9%
Construction	2.5%
Wholesale and retail trade	2.5%
Electricity, gas, water and waste services	2.5%
Transport, postal and warehousing	2.4%
Agriculture, forestry and fishing	2.4%
Manufacturing	1.6%

Source: ABS and estimates based on PwC assumptions and MMRF model, 2011-12 prices

Figure 26 Change in share of gross value added between 2012-13 and 2029-30

Industry	Percentage points
Public services*	2.1%
Business services*	1.9%
Mining ex oil and gas	0.7%
Information media and telecommunications	0.7%
Oil and gas extraction	0.5%
Financial and insurance services	0.4%
Other services	0.1%
Accommodation and food services	0.0%
Agriculture, forestry and fishing	-0.2%
Electricity, gas, water and waste services	-0.2%
Transport, postal and warehousing	-0.5%
Construction	-0.6%
Wholesale and retail trade	-0.8%
Manufacturing	-1.4%

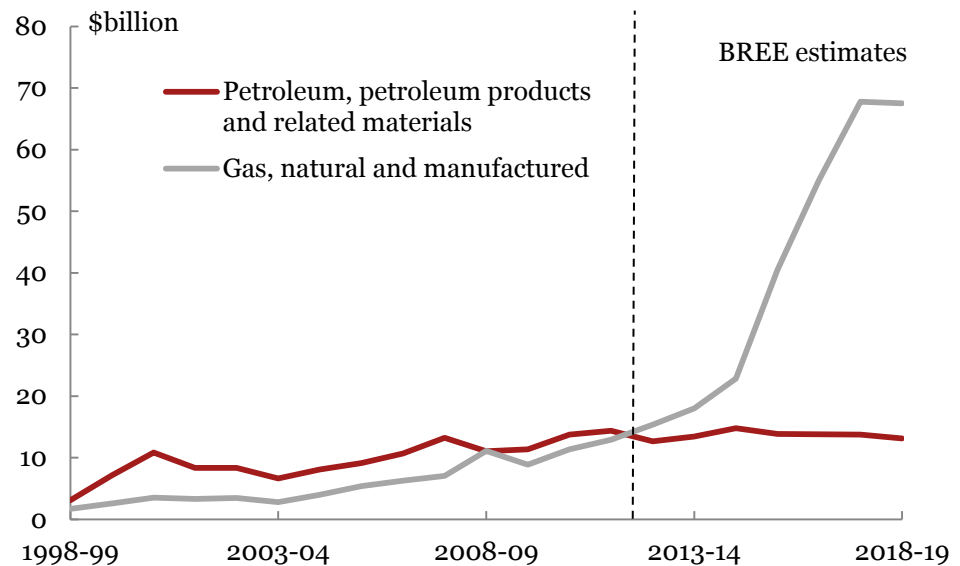Source: ABS and estimates based on PwC assumptions and MMRF model, 2011-12 prices

*__Public services__ include public administration and safety, education and training, health care and social assistance. __Business services__ include rental, hiring and real estate services, professional, scientific and technical services and administrative and support services.

With increased capacity coming online in the next few years, the value of gas exports is expected to increase to almost $70 billion by 2018-19.

The oil and gas sector continues to play an important role in the Australian economy. As noted earlier in the report, the oil and gas industry's production profile directly represents around 2 per cent of current gross domestic product (GDP), with value-added of approximately $32 billion in 2012-13. Despite the record increase in production associated with new LNG projects, a significant level of exploration expenditure will still be needed given the average offshore expenditure per well is over 15 times the cost of a decade ago. While further exploration expenditure will be required to create more output from the oil and gas sector, at current projected investment levels, the total forward contribution of the combined oil and gas and exploration sectors is projected to double to approximately $53 billion in 2019-20 and $67 billion in 2029-30 (see Table 5).
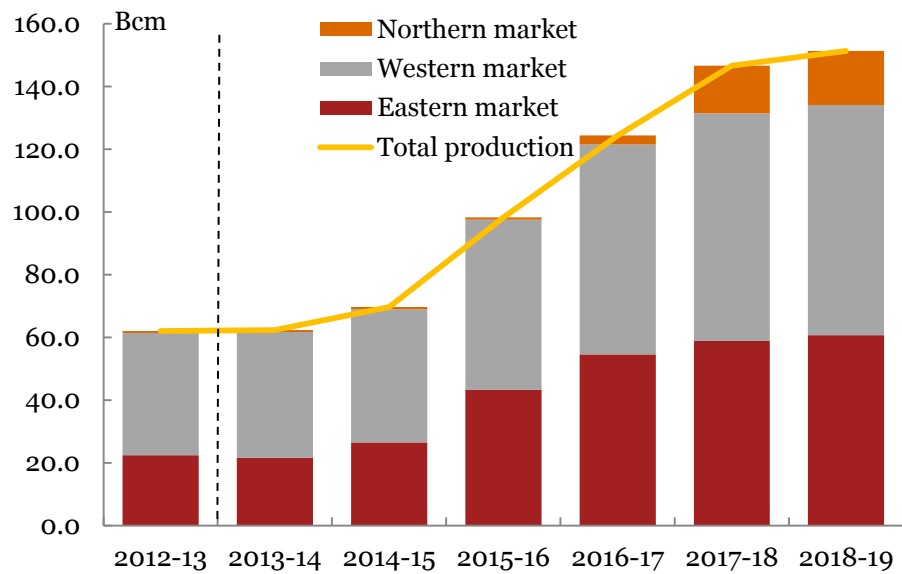
Driving strong value-add from the industry is an increase in gas exports over the next decade. The value of natural gas exports is expected to reach around $60-70 billion by the middle of 2019 (see Figure 27) and production is expected to double over the next five years from 62 billion cubic metres to around 150 billion cubic metres. The increase in production is expected to be driven by the east and west coast major projects and to a lesser extent the northern market (see Figure 28).

Figure 27 Value of petroleum and gas exports (1998-99 to 2018-19)

Source: ABS catalogue number 5368.0 and BREE Resources and Energy Quarterly estimates

Figure 28 Australian gas production by region (2012-13 to 2018-19)

In 2030, when production (on the basis of current and forthcoming capacity) and prices are expected to stabilise, the oil and gas industry's total economic contribution is projected to be around 2.6 per cent of the Australian economy. However, after accounting for its inter-linkages with the rest of the economy the sector is projected to be around 3.5 per cent of national output (see Table 5).

Table 5 Value-add of oil and gas extraction industry to 2029-30

	NPV	2012-13	2019-20	2029-30
Direct value-add ($bn)	294	32	53	67
Indirect value-add ($bn)	94	10	17	21
Total value-add ($bn)	388	43	70	88
Direct value-add % GDP		2.12%	2.81%	2.62%
Total value-add % GDP		2.80%	3.72%	3.47%

4 Terms of trade scenario

The first part of this report has provided significant information on the contribution of the oil and gas sector to the Australian economy both to date and under the base case expectation to 2029-30. The oil and gas sector clearly makes a very substantial contribution to economic activity over this period. Some commentators have raised concern that while such an expansion may be beneficial in the presence of a high terms of trade, the economy may be exposed if there were a substantial adverse movement in the terms of trade. These commentators have sometimes argued that there should be a premium put on diversifying the economy to protect against such risks.

The first observation to make is that even in the base case scenario there is an expectation of some unwinding of the terms of trade from its historical peak. Even with such an unwinding there are clearly significant benefits to the economy associated with the expansion of the oil and gas sector.

The second observation is to consider a scenario in which the terms of trade deteriorate even more significantly than captured in the base case. This section considers such a scenario. The results in this section indicate that even with an adverse movement in the terms of trade real economic activity continues to grow strongly.

The **terms of trade scenario** has been calibrated as follows:

In this scenario, an assumption is made that the terms of trade unwinds faster than the Treasury's assumption (which was to gradually decline to its 2006-07 level by around 2017-18 and remain at this level to the end of 2029-30). This section investigates channels through which the terms of trade can affect the composition of the economy, particularly the value-add of the oil and gas industry and its related industries.

The aim of this scenario is to assess the economic risks associated with the price sensitivities on the Australian economy and the importance of diversification of the economy.

A brief literature on the terms of trade and economic welfare is provided in **Appendix B**.
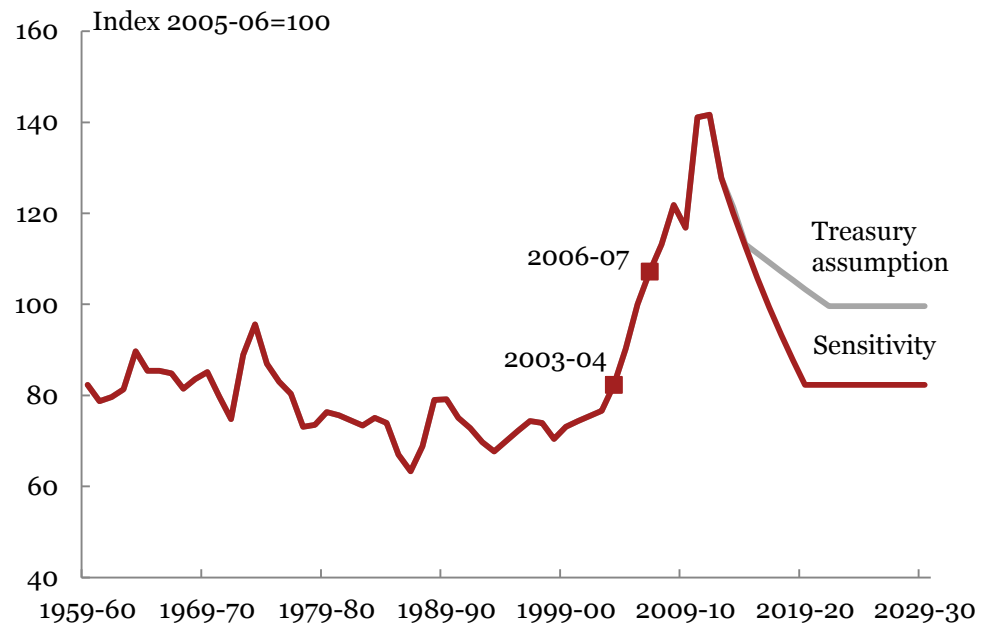
4.1 Terms of trade scenario

As mentioned above, Treasury assumes that the level of the terms of trade reaches 2006-07 levels by 2022-23 and remains constant after that period. PwC has used this assumption in our base case modelling (as discussed previously).

Against the base case, PwC have developed a model scenario that assumes the terms of trade unwinds faster than the Treasury's assumption, by 2019-20. PwC modelling assumes the higher terms of trade experienced in 2011-12 unwinds to its 2003-04 level (pre-boom levels) by 2019-20 as shown in Figure 29. The source of this shock is not defined, however, it could include a slowdown in global growth or a major shock to one of Australia's key trading partners (China, Japan, Korea). This faster unwinding scenario can impose costs on the allocation of resources and mobility of resources between the sectors. This scenario is motivated by previous

analysis by Gillitzer and Kearns (2005)[12] and statistical evidence that suggests terms of trade movements are often unwound.

This section focuses on the effects of the lower terms of trade scenario on both GNI and GDP and how these effects flow through the economy.

Figure 29 Terms of trade scenario

Source: PwC assumption against Treasury's base case

4.2   Macroeconomic impacts

A terms of trade shock over 17 per cent, is estimated to lower nominal GDP by 9 per cent by the end of 2029-30.

In the model, a significant reduction in the level of the terms of trade (17.4 per cent lower than the base case), causes nominal GDP to be 9 per cent lower by the end of 2029-30 and gross national income to be around 8.6 per cent lower (see Figure 30). While the shock to employment is significant over the short-term, some of these job losses are partially offset, as resources re-allocate to other industries in the economy (see Table 6).

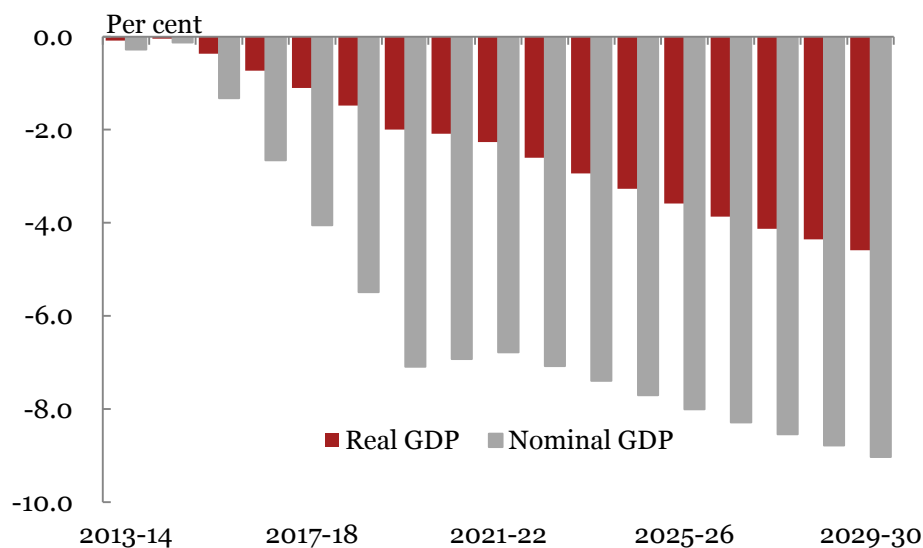**Table 6 Key macroeconomic impacts between the terms of trade scenario and the base case***

	Unit	2017-18	2021-22	2025-26	2029-30
Real GDP	%	-1.1	-2.3	-3.6	-4.6
Nominal GDP	%	-4.1	-6.8	-8.0	-9.0
GNI	%	-4.2	-6.5	-7.7	-8.6
Employment	%	-1.0	-0.5	-0.4	-0.3
Terms of trade	%	-0.4	-16.8	-17.4	-17.4

* Deviation from baseline between the shock scenario and the baseline.
Source: PwC estimates

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[12] http://www.rba.gov.au/publications/rdp/2005/2005-01.html, Long-term patterns in Australia's terms of trade, Research Discussion paper, Reserve Bank of Australia.

Figure 30 Macroeconomic impacts (percentage change from baseline)

A negative shock to the global economy could potentially lower global energy demand and therefore Australia's terms of trade. An example of this shock could be a slowdown in economic growth in China, with Chinese demand for our natural resources slowing as industrial production activity slows. However, given the majority of Australian gas contracts are longer term (with some agreements 15-20 years in duration), the impact of a negative shock to gas prices could prevent the full impact flowing through to Australian gas exporters and the broader economy. Long-term gas contracts (defined as 4 years or longer) are generally linked to the price of crude oil (and sometimes other energy substitutes) and provide buyers with long-term energy security and sellers looking for stability in making large and long-term investment decisions.

While 70 per cent of Asian LNG contracts are long term, this has come down from over 85 per cent less than a decade ago (see Figure 31). This trend is expected to continue as the price paid by Asian LNG importers is significantly higher than spot prices in the Middle East and Europe.

Figure 31 Proportion of Asian LNG by contract length

Source: 'The LNG Industry 2006-20013' - The International Group of Liquefied Natural Gas Importers

In addition to longer term contracts (relative to other Australian non-rural commodities), the majority of Australian LNG projects are partly owned by major LNG buyers from the Asian region (Japan, Korea, China and Malaysia) (see Table 7). This provides long-term demand stability for future gas production, as major users of Australian gas have an active interest in the success of each operation.

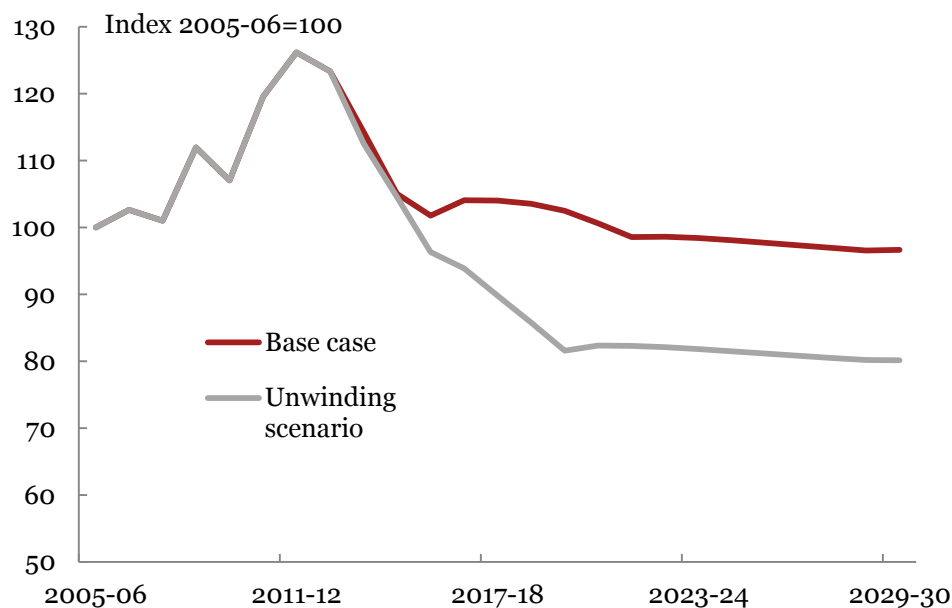**Table 7 Example of joint venture arrangements on major Australian oil and gas projects**

Project	Joint venture share of project
Gorgon (WA)	Chevron (47.3%) ExxonMobil (25%) Shell (25%) Osaka Gas (1.25%) Tokyo Gas (1%) Chubu Electric Power (0.417%)
Pluto (WA)	Woodside (90%) Tokyo Gas (5%) Kansai Electric (5%)
Australia Pacific LNG (QLD)	Origin (37.5%) ConocoPhillips (37.5%) Sinopec (25%)
Gladstone LNG (QLD)	Santos (30%) PETRONAS (27.5%) Total (27.5%) KOGAS (15%)

Source: Company annual reports.

4.3 Real exchange rate

The nature and extent of a shock to the terms of trade depends importantly on the behaviour of the exchange rate, since the terms of trade determines how income gains are shared. A fall in the terms of trade as a result of a decrease in the price of Australia's commodities provides a contractionary impact through the economy via lower national income (as discussed previously in this report).

Figure 32 Real exchange rate impact

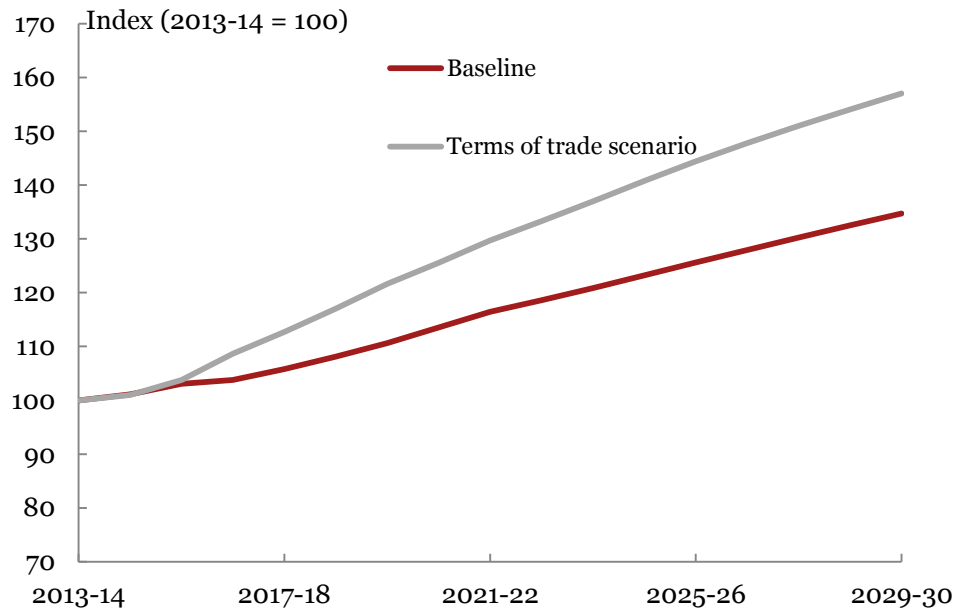Source: PwC estimates based on the MMRF model

In line with the projections for the terms of trade in the base case, the real exchange rate is expected to depreciate across the forecast period before settling around 2023-24 onwards. With a 17 per cent shock to the terms of trade against the baseline (to be around its 2003-04 level), the real exchange rate is expected to depreciate around 12.9 per cent than what was forecast in the base case (see Figure 32).

With a depreciation in the real exchange rate, output of trade exposed sectors of the economy is expected to improve by around 22 percentage points from 2013-14 to 2029-30

A depreciation of the real exchange rate increases the attractiveness of domestic goods against imported goods which alleviates pressure on import competing industries of the economy (e.g. domestic residents decide to travel within Australia, rather than travel internationally). The depreciation of the real exchange rate also alleviates competitive pressure on export orientated sectors of the economy such as agriculture, manufacturing and tourism. In the baseline scenario, the trade exposed sectors of the economy were forecast to grow by 35 per cent between 2013-14 and 2029-30. With a reduction in the real exchange rate, output in these sectors is expected to grow by 57 per cent over the same period (see Figure 33).

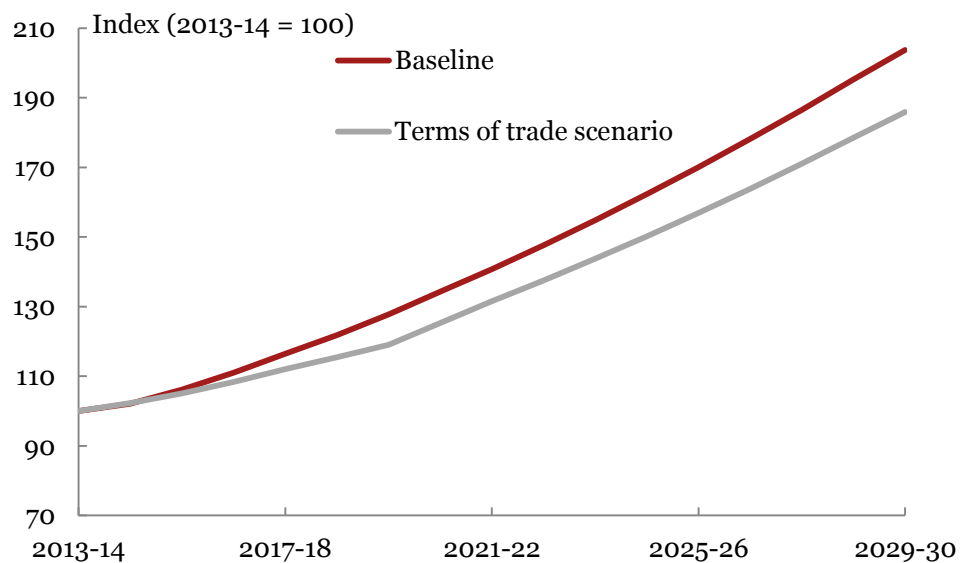**Figure 33 Output of trade-exposed sectors of the economy***

*includes agriculture, manufacturing and tourism.

Source: PwC estimates based on the MMRF model

4.4 Gross domestic product, gross national income and industry output

As highlighted earlier in section 3, Australia's nominal GDP is expected to increase from around $1.5 trillion in 2012-13 to to reach around $3 trillion by 2029-30. However, in the terms of trade shock scenario, the model suggests nominal GDP will be 9 per cent lower (see Figure 34).

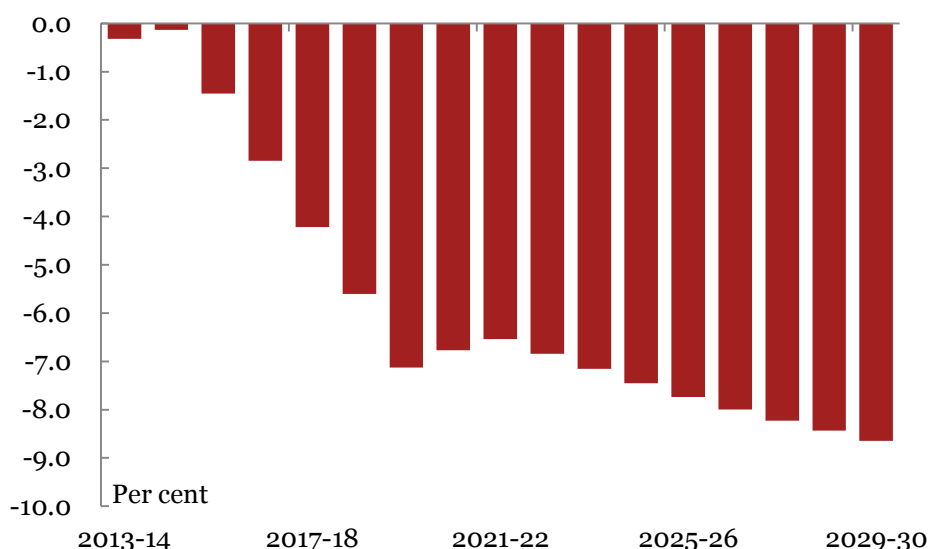**Figure 34 Nominal GDP impact between baseline and terms of trade scenario**

Source: PwC estimates based on the MMRF model

Australia's GNI per person, a measure which captures changes to what an average Australian can buy or save, continually grows, but will be lower under the terms of trade shock scenario.

In the base case, supported by a higher terms of trade level, GNI per person increases by around 28 per cent from 2012-13 to 2029-30. This translates to an increase from today's levels (in 2012-13 dollars) of around $56,000 per person to about $71,000 per person in 2029-30. In the terms of trade shock scenario, where the terms of trade level reaches its 2006-07 level by 2018-19, Australia's GNI per person increases by around 18 per cent from 2012-13 to 2029-30 (a 10 percentage point decrease). As referred to earlier in chapter 4, by the end of 2029-30, GNI is 8.5 per cent lower in the terms of trade shock scenario than in the base case (see Figure 35).

Figure 35 Percentage difference in Gross National Income (terms of trade shock vs. base case)
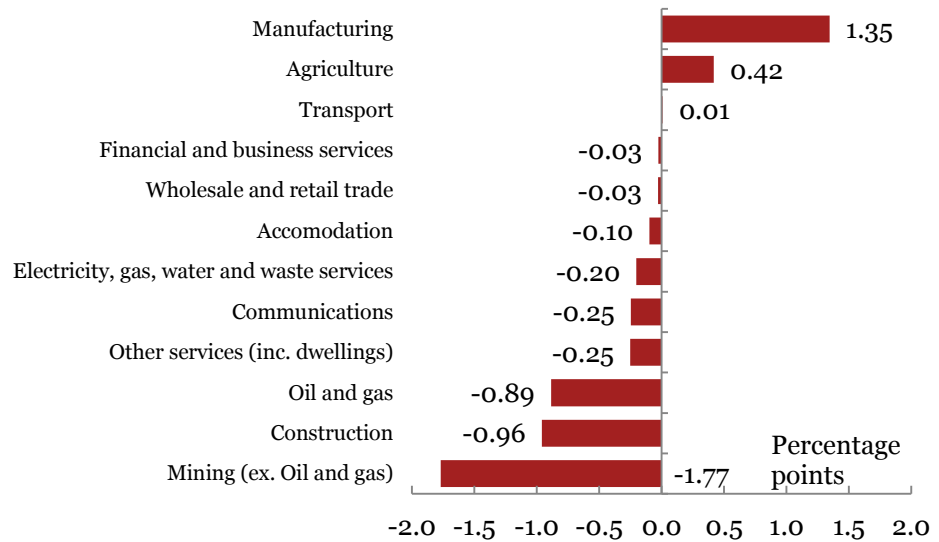

Source: PwC estimates

An increase in export prices relative to import prices enables a larger volume of imports to be purchased with a given volume of exports, thus increasing the real purchasing power of domestic production. The increase in purchasing power flowing from a rise in the terms of trade can be illustrated by comparing real GDP with real GNI. Over the year to 2030, growth in real GNI exceeded that in real GDP by around 6 percentage points.

The industries hit heaviest after the terms of trade shock are mining (excluding oil and gas extraction), construction and oil and gas sectors, which see their average annual growth rate over the 20 years to 2029-30 fall by over 2 percentage points for mining and almost 1 percentage point for construction. However, as the real exchange rate depreciates, average annual output in the trade exposed sectors of manufacturing and agriculture increase by 1.4 percentage points and 0.4 percentage points respectively (see Figure 36).

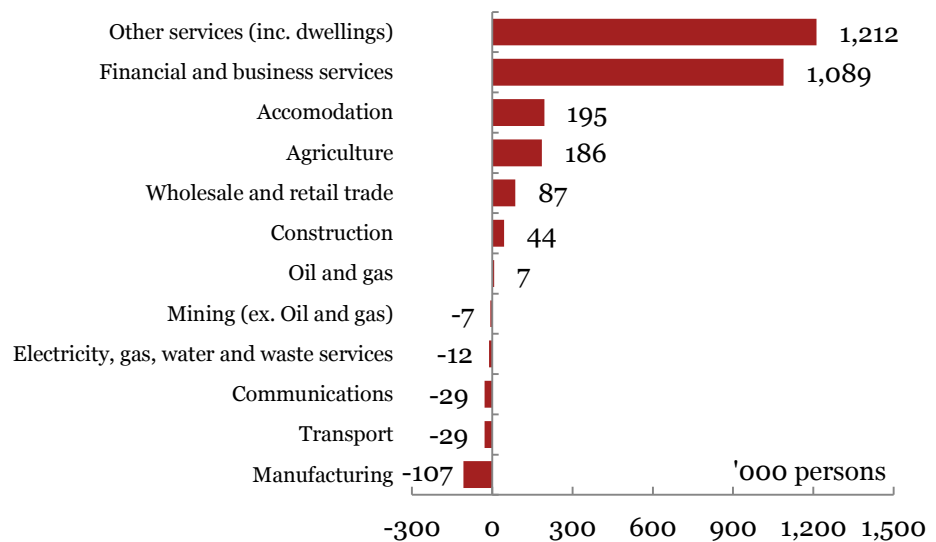**Figure 36 Percentage point difference in annual average output growth (terms of trade shock vs. base case)**

Industry	Percentage points
Manufacturing	1.35
Agriculture	0.42
Transport	0.01
Financial and business services	-0.03
Wholesale and retail trade	-0.03
Accomodation	-0.10
Electricity, gas, water and waste services	-0.20
Communications	-0.25
Other services (inc. dwellings)	-0.25
Oil and gas	-0.89
Construction	-0.96
Mining (ex. Oil and gas)	-1.77

Source: PwC estimates

4.5 Labour market

In the base case scenario, Australian employment is expected to increase by almost 2.6 million persons. The increase in employment is forecast to be driven by the services industries, while the manufacturing industry continues its long-term structural decline. Employment in the oil and gas sector is expected to increase by 7,000 persons by the end of 2029-30, while non-oil and gas extraction employment is expected to decline slightly as it reaches its peak in the middle of this decade (see Figure 37).

Figure 37 Growth in employment by industry under baseline scenario (2012-13 to 2029-30)

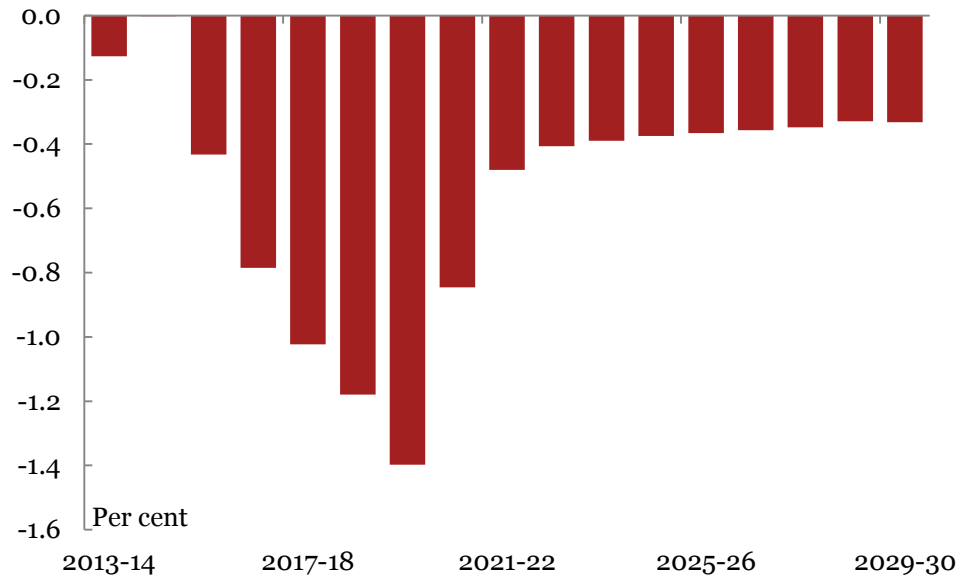| Industry	'000 persons
Other services (inc. dwellings)	1,212
Financial and business services	1,089
Accomodation	195
Agriculture	186
Wholesale and retail trade	87
Construction	44
Oil and gas	7
Mining (ex. Oil and gas)	-7
Electricity, gas, water and waste services	-12
Communications	-29
Transport	-29
Manufacturing	-107

Source: PwC estimates

While the terms of trade shock has a negative impact on employment, some of these job losses are offset by increased employment in other sectors of the economy.

As a result of a lower terms of trade in the shock scenario, real wages and employment are forecast to fall relative to the base case over time. However, as output and employment decline in industries impacted by the terms of trade shock (mining and construction), some of this lost labour finds employment in other sectors of the economy. While the level of employment is around 1.4 per cent lower in 2019-20 (at the peak of the shock), the employment difference begins to evaporate as labour is absorbed into other sectors of the economy (see Figure 38).
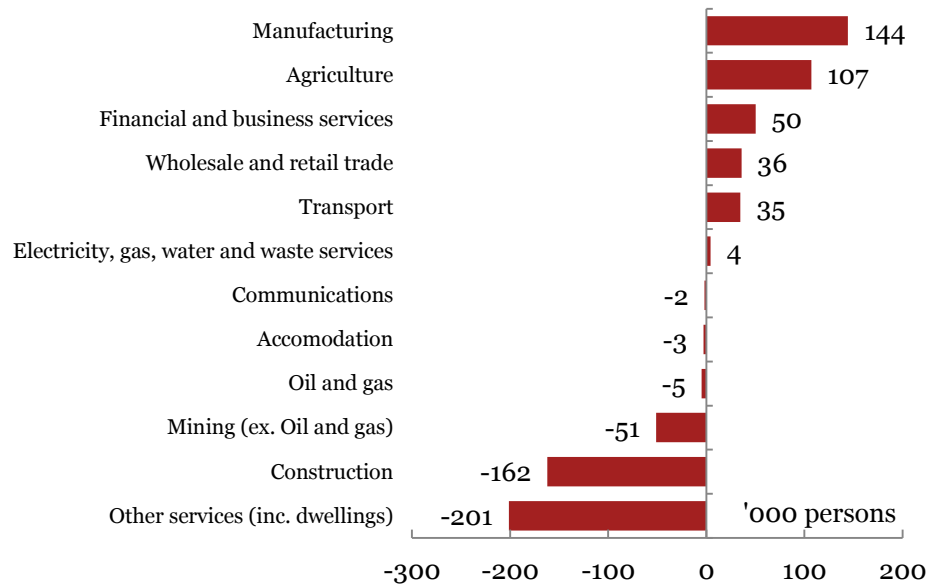
Figure 38 Change in total industry employment from base case to terms of trade scenario

Source: PwC estimates

By sector, the terms of trade shock has the largest employment impact on the other services, construction and the mining industry. These industries lose 415,000 jobs by the end of 2029-30. However, as highlighted above, this is partially offset by increased employment in trade-exposed sectors such as manufacturing, agriculture and to a lesser extent, financial and business services (see Figure 39) as the real exchange rate adjusts.

Figure 39 Level difference in industry employment in 2029-30 (terms of trade shock vs. base case)
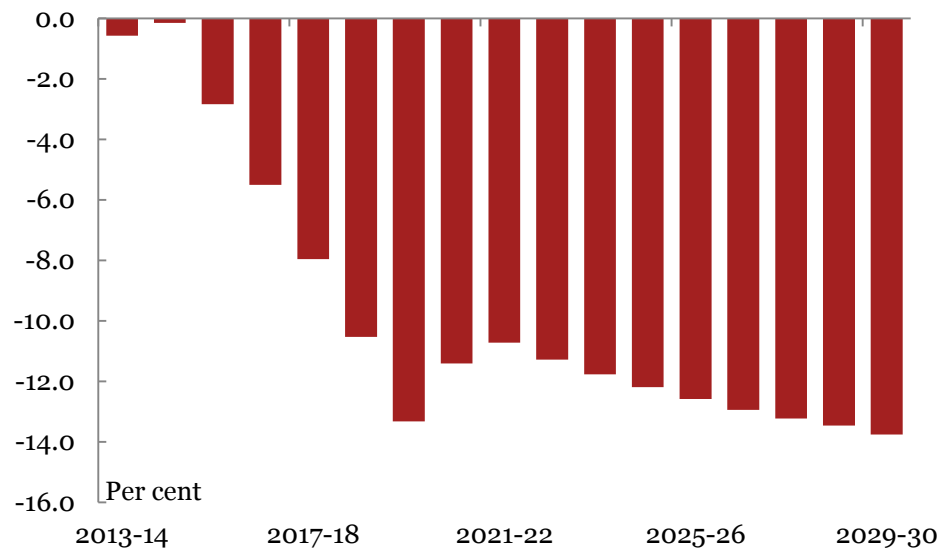
Industry	'000 persons
Manufacturing	144
Agriculture	107
Financial and business services	50
Wholesale and retail trade	36
Transport	35
Electricity, gas, water and waste services	4
Communications	-2
Accomodation	-3
Oil and gas	-5
Mining (ex. Oil and gas)	-51
Construction	-162
Other services (inc. dwellings)	-201

Source: PwC estimates

4.6   Investment and capital

The shock to the terms of trade is estimated to reduce aggregate investment in the economy by 14 per cent by the end of 2029-30.

With a decline in the terms of trade (driven by a fall in Australian commodity export prices), mining investment is projected to fall as the return on mining capital falls. Our modelling suggests aggregate investment will be 14 per cent lower by the end of 2029-30 driven by reduced investment in mining and construction (see Figure 40).

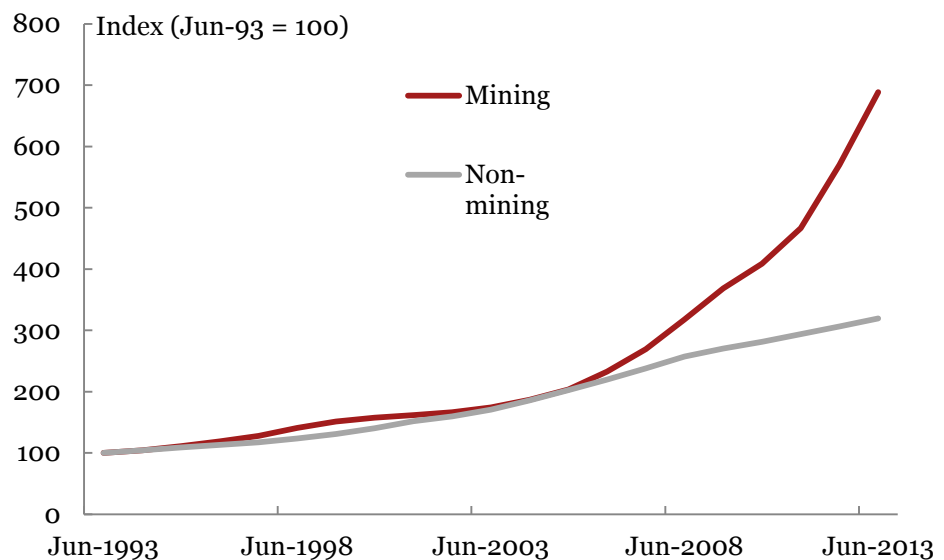**Figure 40 Percentage difference in investment (terms of trade shock vs. base case)**

Source: PwC estimates

With reduced investment, the economy-wide capital stock will be lower, as investment replaces depreciation of capital at a slower rate. In the long run, the

capital-stock decreases by 5.2 per cent, which implies an increase in the ratio of labour to capital of around 4.2 per cent.

However, in reality, the change in aggregate investment across the economy is hard to determine. While the terms of trade are elevated, the mining sector is investing more than other sectors of the economy (see Figure 41). With increased competition for capital, other sectors of the economy may no longer be undertaking required replacement investment.

Figure 41 Mining and non-mining net capital stock

Source: ABS catalogue number 5204.0

The net effect of the impact on investment from a terms of trade shock depends on the size of the investment response in mining and related sectors (which in turn will depend on expectations about the future direction of commodity prices), the relative size of the different industries, the capital intensities of each industry and the domestic economic outlook.

4.7   Summary

Even with deterioration in the terms of trade, we show that the economy continues to grow strongly with an annual growth rate of 2.8 per cent, demonstrating that any lack of diversification risk is manageable given the adjustment mechanisms within the economy.

While GDP, employment and the terms of trade are lower in the shock scenario, employment and output growth are expected to remain positive over the projection period. Over the period from 2013-14 to 2029-30, the baseline forecasts real GDP will grow at an annual average rate of just over 3 per cent. While lower under the shock scenario, real GDP is still estimated to grow at an annual average rate of 2.8 per cent (slightly below trend growth of 3 per cent). Similarly, while nominal GDP is expected to grow at around 4½ per cent per year in the baseline, under the shock scenario, growth is expected to moderate slightly to 4 per cent per year.

As highlighted earlier in the report, over the first five years of the shock, employment growth is projected to moderate slightly as resources in the economy adjust to the fall in the terms of trade and real exchange rate. However, as conditions in trade exposed sectors of the economy improve, employment growth in these sectors partially offsets weaker employment growth in the mining and construction sectors. The overall impact on employment growth is expected to be negligible with only a slight difference in the average annual growth rate over the period.

These results illustrate, even with current rates of growth in the resources sector, the Australian economy is expected to remain resilient to negative shocks to the terms of trade. While a larger-than-expected fall in the terms of trade lowers the rate of growth in the economy, growth is expected to remain positive over the estimation period (albeit slightly below trend).

Table 8: Selected economic growth rates (baseline vs terms of trade shock)

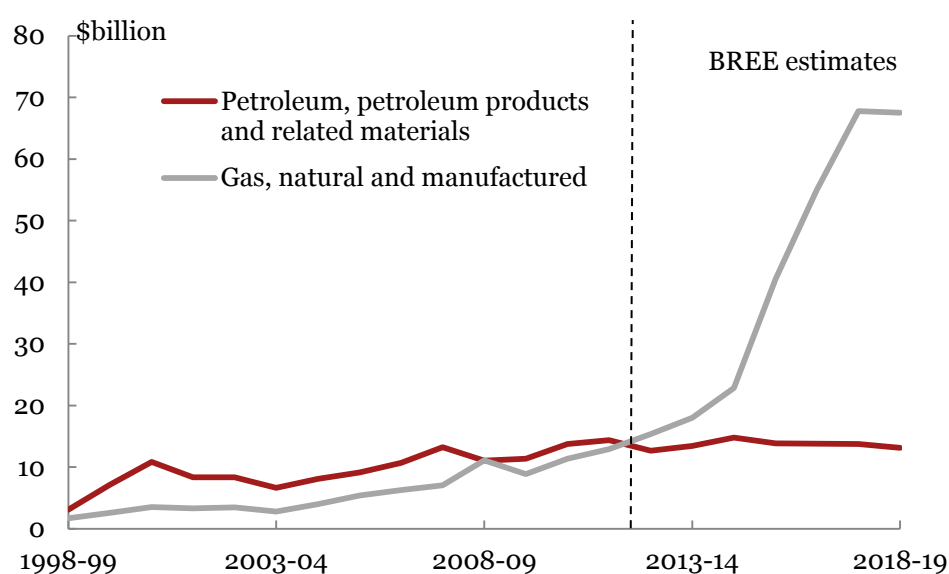|		2013-14	2017-18	2021-22	2025-26	2029-30	2013-14 to 2029-30 average growth rate
Real GDP							
Baseline	%	3	3.5	3.2	2.9	2.7	3.1
Shock	%	2.7	3.1	3.1	2.6	2.4	2.8
Nominal GDP							
Baseline	%	2.7	4.9	4.8	4.8	4.4	4.4
Shock	%	2.4	3.4	5.0	4.4	4.1	3.9
Employment							
Baseline	%	1.9	1.2	1.1	1.1	1.1	1.2
Shock	%	1.8	1.0	1.5	1.1	1.1	1.2
Terms of trade							
Baseline	%	-5.0	-1.8	-1.8	-	-	-1.4
Shock	%	-6.1	-6.1	-	-	-	-2.5

Source: PwC estimates.

5   Conclusion

The Australian oil and gas industry is in the midst of an unprecedented phase of expansion, with employment, investment and output in the sector increasing significantly over the past decade. Over the next decade, output in the sector is expected to more than double as increased capacity comes online over the next few years.

As increased capacity comes online, the value of Australian gas exports is expected to quadruple over the next five years to reach almost $70 billion by the end of 2018-19 (see Figure 42).

Figure 42 Value of petroleum and gas exports (1998-99 to 2018-19)

The sector is expected to become a larger share of the economy over the next two decades, shifting from around 2.1 per cent of total output to around 2.6 per cent by the end of 2029-30. Over this period, the sector is expected to generate over 7,000 direct jobs and add almost $390 billion of value-add to the economy (see Table 9).
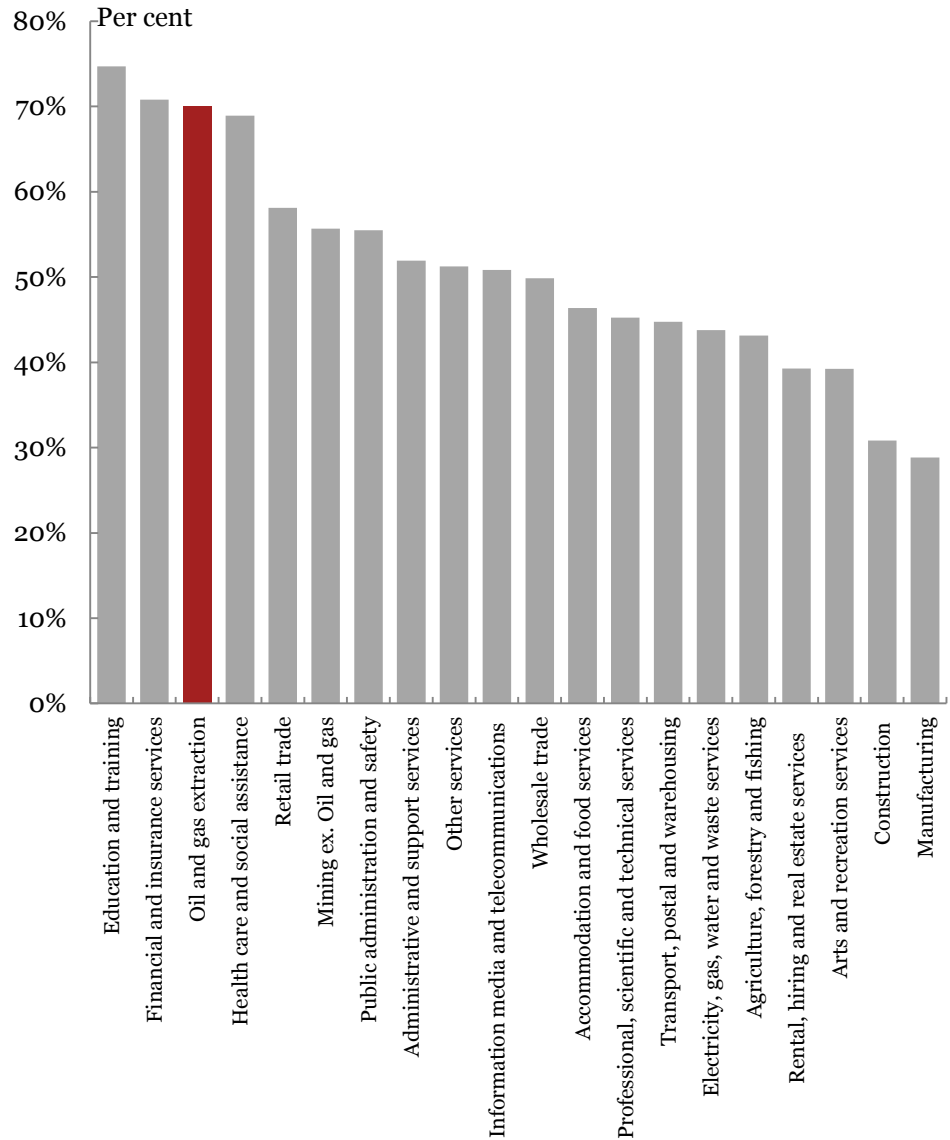
Table 9 Value-add of oil and gas extraction industry to 2029-30

	NPV (2012-30)	2012-13	2019-20	2029-30
Direct value-add ($bn)	294	32	53	67
Indirect value-add ($bn)	94	10	17	21
Total value-add ($bn)	388	43	70	88
Direct value-add % GDP		2.12%	2.81%	2.62%
Total value-add % GDP		2.80%	3.72%	3.47%

While the sector's share of total output is relatively small, the industry remains one of the highest value-adding industries in the Australian economy (behind education and training and financial and insurance services). For every dollar of domestic production, the oil and gas sector value-adds 70¢ to Australian output, this compares to an average of 49¢ for every dollar of production across all other Australian industries (see Figure 43).

Figure 43 Value-added per unit of production

Source: ABS catalogue number 5209.0 and PwC

As the oil and gas sector becomes a larger share of the economy, the industry becomes susceptible to external shocks to global commodity prices. However, given the majority of Australian gas contracts are longer term, the impact of a negative shock to oil and gas sector is less significant than other sectors in the mining industry.

PwC have applied a sensitivity analysis, to measure the impact of a decline in the terms of trade (in addition to the forecast decline from Treasury). Our modelling suggests the additional shock to the terms of trade will have a cumulative negative impact on the economy of approximately 9 per cent by 2029-30 and growth in the

oil and gas industry will slow as investment decisions are scrapped or delayed in line with a fall in oil and gas prices in the international economy.

However, as the real exchange rate adjusts, output and employment will increase in trade-exposed sectors of the economy, which will offset some of the decline in output from the mining and mining-related sectors of the economy. Even in the presence of the terms of trade shock, the economy averages growth in real GDP of 2.8 per cent per year (slightly below trend growth of 3 per cent).

Appendices

Appendix A   Value-Added

The term 'value-add' has a different interpretation across a number of stakeholder groups (including businesses, statisticians and economists). Value-add is the difference between the price of the finished product or service and the cost of inputs involved in producing the product or service. Therefore, value-added is the increase in value that the firm or industry creates by undertaking the production.

The Australian Bureau of Statistics (ABS) defines gross value-added as the value of output at basic prices[13] minus the value of intermediate consumption at purchaser prices[14], which is the sum of:

- **Compensation of employees (COE)** - this component consists of the value of entitlements earned by employees from their employers for services rendered during the accounting period. It covers wages and salaries received by employees in cash and in kind, changes in provisions for future employee entitlements such as super contributions (return to labour);

- **Gross operating surplus (GOS) and mixed income (GMI)** - the operating surplus accruing to all enterprises (corporate and unincorporated), from their operations in Australia. It is calculated before deduction of consumption of fixed capital (depreciation), dividends, interest, royalties and land rent, and direct taxes payable, but after deducting the inventory valuation adjustment (return to capital); and

- **Other taxes less subsides on production (net production taxes)** - other taxes and subsidies on production include: taxes and subsidies related to the payroll or workforce numbers.

Gross value-added is a measure of the contribution to gross domestic product (GDP) made by an individual producer, industry or sector. This concept of value-add is used in this study to understand the Australian oil and gas industry's contribution to the Australian economy. This is a widely used concept by statistical agencies across the world and provides a solid indicator for comparative purposes.

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[13] The amount receivable by the producer from the purchaser for a unit of a good or service produced as output, minus any tax payable plus any subsidy receivable on that unit as a consequence of its production or sale, it excludes any transport charges invoiced separately by producer. Basic prices valuation of output removes the distortion caused by variations in the incidence of commodity taxes and subsidies across the output of individual industries

[14] http://www.abs.gov.au/AusStats/ABS@.nsf/Glossary/5204.0

Appendix B Analysing the terms of trade impacts

The terms of trade are an important determinant of economic welfare since it influences the quantity of foreign goods that can be purchased with a given amount of domestic production. Changes in this key relative price variable can have a major influence on the economy in terms of consumption, savings and investment. While movements in the level of the terms of trade affect real income, significant terms of trade volatility can affect economic efficiency. For example, when producers incorrectly estimate the extent and duration of a change in the terms of trade, investment and resource allocation decisions are likely to be inefficient.

B.1   Analysing terms of trade impacts

Theoretical literature on the impact of the terms of trade can be grouped into two broad groups. One class of models is macroeconomic in nature and concerned with the behaviour of broad macroeconomic aggregates. A second class is microeconomic in nature and stresses the effects of terms of trade shocks on different sectors of the economy. In both cases, the key channel through which the terms of trade affect the economy is via the exchange rate.

B.1.1 Macroeconomic impacts

Early analysis in macroeconomic literature is based on the framework of static Keynesian saving and investment functions (Laursen and Metzler 1950, Harberger 1950). Later studies are based on neoclassical models, typically involving dynamic optimization (Obstfeld 1982, Sen and Turnovsky 1989). According to these studies, terms of trade shocks alter permanent income, and intertemporal relative prices and hence affect consumption, saving and investment.

The impact of the terms of trade on investment in economic models depends on how the external economic environment is assumed. Unlike earlier studies, the saving rate is treated as exogenous in the current model and the capital account is mainly determined by the investment response. The real exchange rate is endogenous and adjusts to equate demand and supply of Australian currency to maintain balance of payment equilibrium. The real exchange rate in the model will restore balance on the external accounts in response to a terms of trade shock.

More recent empirical work in the Australian context suggests that the terms of trade increases domestic production and a floating exchange rate provides an important adjustment mechanism to the external shocks that move the terms of trade (Jääskelä and Smith 2011).
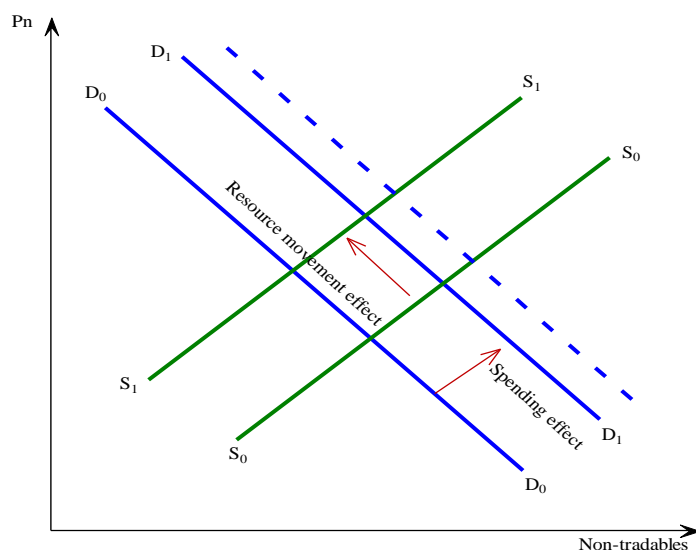
B.1.2 Sectoral impacts

The microeconomic literature mainly focused on the effects of the terms of trade on the structure of the economy (Gregory 1976, Corden and Neary 1982, Corden 1984, Bruno and Sachs 1982). At a microeconomic level, the economy is modelled as consisting of three sectors — mining sector or booming sector, non-resources tradable sector (mainly agriculture and manufacturing) and the non-tradable sector (mainly services). Prices of tradable goods are set in the world market.

As shown in Figure 44, there are two key channels through which the terms of trade can affect the industry structure of the economy: the spending effect and the resource movement effect.

The spending effect occurs when increased domestic income from mining production leads to higher domestic aggregate demand (shifting the demand curve from D0 to D1).

Figure 44 Spending and resource movement effect

Source: Based on Corden (1984), p. 361.

Increased demand for non-tradable goods (mainly services) leads to higher consumer prices and higher output of non-tradable goods. This will increase wages in the economy since the services sector is more labour intensive relative to the mining and manufacturing sectors. Increased wages (with no change in output), will reduce profit in the non-resource tradable sector (which includes manufacturing), where prices are fixed at international levels. If the spending effect dominates, the share of service sector output increases while the share of manufacturing sector output decreases.

The resource movement effect takes place when a boom in the mining sector attracts capital and labour from other parts of the economy, including from the non-resource tradable sector and the non-tradable sector. This raises the marginal product of mobile factors of production relative to fixed factor capital. Increased labour employed draws resources out of others sectors, giving rise to various adjustments in the rest of the economy (one mechanism of this adjustment being the real exchange rate).

The resource movement effect tends to reduce output in the rest of the economy that is in the non-resource tradable sector (shifting supply curve from S0 to S1). In particular, the reduced output in the non-tradable sector causes the price of non-tradable outputs to rise relative to the price of tradable outputs even further. This will lead to further appreciation of the real exchange rate.

If the mining sector uses a relatively low amount of resources drawn from elsewhere in the economy this effect is negligible and the major impact of the boom comes instead from spending effect.

The impact of the terms of trade on sectoral shares depends on whether the spending effect dominates or the resource movement effect dominates. If the spending effect dominates, the non-tradable sector expands (which means the services share of the economy increases and the manufacturing sector share of the economy declines). If the resource movement effect dominates, there will be a fall in output share of the non-tradable services sector and a rise in the mining share of the economy.

In summary, terms of trade changes alter relative prices in the economy including the price of traded goods relative to the price of non-traded goods. When relative prices change, the allocation of resources within the economy also changes.

The empirical evidence on the effect of the terms of trade on manufacturing varies. Ismail (2010) studied the impact of oil price shocks using detailed, disaggregated sectoral data for manufacturing across a number of countries. This study finds that the effects are larger if the economy is more open

to capital flows and has relatively less exposure to capital intensive manufacturing sub-sectors. The effects of the terms of trade in the Australian context are also discussed in McKissack et.al. (2008).

Box 1 provides an empirical relationship between the terms of trade and the exchange rate.

Box 1: Empirical relationship between the terms of trade and the exchange rate

There is robust empirical evidence that terms of trade increases cause nominal and hence real appreciations of the Australian dollar.

Key Australian studies on the terms of trade have tended to focus on the relationship between the terms of trade and real exchange rate. Gruen and Wilkinson (1991) concluded that there is a long-run stable relationship between the terms of trade and the real exchange rate over the period 1969 – 1990, where they estimated that a one per cent change in the terms of trade causes a change in the real exchange rate of between 0.82 per cent and 1.08 per cent. Blundell-Wignall et al. (1993) identified a positive correlation between the terms of trade and the real exchange rate of around 0.8 over the period 1983 – 1993. Bleaney (1996) examined the relationship between the annual average exchange rate and relative price of exports from 1900 – 1991 and concluded that there was a significant positive correlation though the real exchange rate does not display the downtrend that has been observed in the price of primary commodities (and the terms of trade). Wren-Lewis (2004) predominantly focused on the New Zealand exchange rate, with parallel analysis undertaken on the Australian exchange rate for comparisons. This study shows that a 10 per cent increase in all export prices led to a 5 per cent increase in the $A TWI, a 10 per cent increase in food export prices leads to a 1.1 per cent increase in the $A TWI and a 10 per cent increase in metal prices leads to a 0.7 per cent increase in the $A TWI.

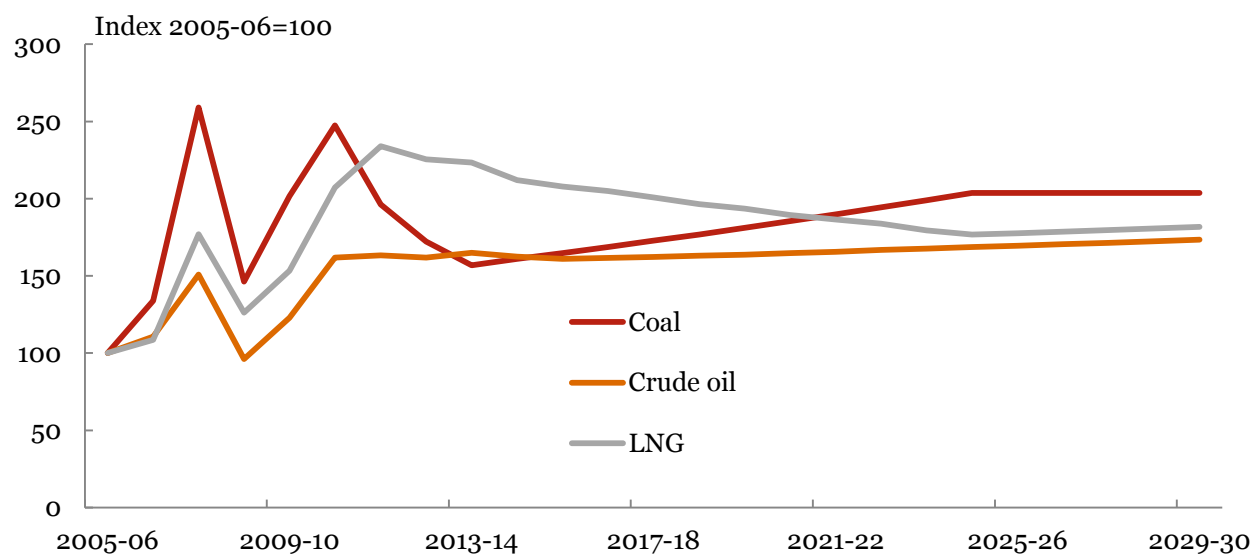In summary, the terms of trade and the real exchange rate had displayed a positive correlation.

Appendix C Commodity forecasts

Coal, oil and gas price forecasts in the base case

The following coal, oil and gas export prices are used in the base case (see Figure 45).

- Coal prices are taken from the World Bank ($US/MT)[15]

    – Coal (Australia), thermal GAR, f.o.b. piers, Newcastle/Port Kembla from 2002 onwards , 6,300 kcal/kg (11,340 btu/lb), less than 0.8%, sulfur 13% ash; previously 6,667 kcal/kg (12,000 btu/lb), less than 1.0% sulfur, 14% ash

- Average crude oil prices are taken from the World Bank ($/BBL).

    – This is the average spot price of Brent, Dubai and West Texas Intermediate, equally weighed.

- Gas prices are taken from the World Bank ($/MMBTU).

    – Natural gas LNG (Japan), import price, cif, recent two months' average.

Figure 45 Coal, oil and gas export prices in the base case

Source: World Bank – The Pink Sheet (July 2014)

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[15] The World Bank Commodity Price data, The Pink Sheet. Updated on 03 July 2014.