REPORT PREPARED FOR THE PORT HEDLAND INDUSTRIES COUNCIL

AN ECONOMIC STUDY OF PORT HEDLAND PORT

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SUMMARY OF RESULTS

The Port of Port Hedland ('the Port') is one of Australia's most important pieces of economic infrastructure. In 2016-17, the Port facilitated some 500.9 million tonnes (MT) of trade, the vast majority of which (494.6 MT) was iron ore produced by companies operating in the Pilbara region. This trade volume makes the Port the largest bulk export terminal in the world.

ACIL Allen has been engaged on behalf of the Port Hedland Industries Council (PHIC) to conduct an economic study on the Port of Port Hedland, in order to understand:

- the value of the Port of Port Hedland and the trade through the Port to the Pilbara, Western Australian and Australian economies; and
- the potential economic and social costs that would result if approvals for further expansions of the Port were not granted, and total iron ore exports remained unchanged over the next ten years.

Economic Contribution of Port of Port Hedland

In order to estimate the economic value of the Port, ACIL Allen has combined the income, expenditure and employment of the Port of Port Hedland and associated entities that utilise the Port for trade into a single group called the Port Hedland Port Supply Chain. This allowed ACIL Allen to present the results of this study as a single contribution/impact, and importantly protect the confidentiality of information provided by the Port and its users.

Using ACIL Allen's Input-Output models of the town of Port Hedland, the Pilbara Region, Western Australia, and Australia, the economic value of the Port Hedland Port Supply Chain was determined in each region on the basis of its contribution to real wages and salaries, real output, and real employment. ACIL Allen was also able to estimate the taxation and royalty payments made by the Port Hedland Port Supply Chain to both the Commonwealth and Western Australian Governments.

Overall, ACIL Allen has found that in 2015-16 the Port Hedland Port Supply Chain generated significant economic value to the town of Port Hedland, the Pilbara Region, Western Australia and Australia.

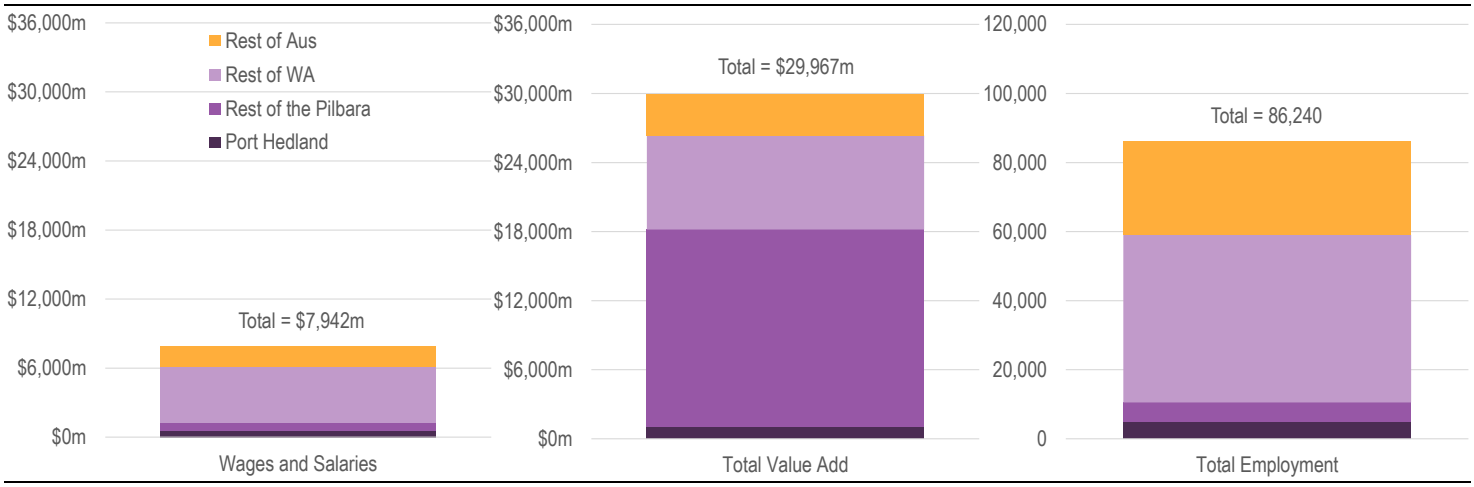
- **Port Hedland**: it is estimated that the activities of the Port Hedland Port Supply Chain accounted for more than $1 billion, or one-fifth of all economic output produced in the town in 2015-16. Further, almost 5,000 FTE jobs or just under half of total employment in town is directly the result of these activities, and more than $250 million or 60 per cent of total wages and salaries are the result of the activities of the Port Hedland Port Supply Chain.
- **Pilbara Region**: it is estimated that the activities of the Port Hedland Port Supply Chain accounted for $18.3 billion, or 47 per cent of total economic output produced in the Pilbara region in 2015-16. Further, 10,510 FTE jobs are also supported by the Port Hedland Port Supply Chain in the region, accounting for 16 per cent of total employment. Of this amount, more than two thirds is the result of

indirect employment, highlighting the degree to which the activities of the Port Hedland Port Supply Chain flow on to other parts of the Pilbara Region's economy.

— **Western Australia**: it is estimated that the activities of the Port Hedland Port Supply Chain generated $18.5 billion in direct economic output in the Western Australian economy in 2015-16. This accounted for 7.6 per cent of the economic output produced in the Western Australian economy in the financial year. Ranked against all industries, the Port Hedland Port Supply Chain would be the third largest industry in the State, behind only Mining and Construction in 2015-16. Including the indirect economic impacts, the Port Hedland Port Supply Chain generated $26.4 billion to the State's economy, which in turn supported just over 59,000 FTE jobs – or around one in every 20 FTE jobs in the State.

— **Australia**: it is estimated that the activities of the Port Hedland Port Supply Chain contributed $30 billion in economic output to the Australian economy in 2015-16, or 1.9 per cent of GDP. This level of economic contribution supported a total of 86,240 FTE jobs, of which 86 per cent were the result of the flow on impacts of the activities of the Port Hedland Port Supply Chain across the Australian economy.

FIGURE ES 1 ECONOMIC CONTRIBUTION OF THE PORT HEDLAND PORT SUPPLY CHAIN IN AUSTRALIA, 2015-16, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

— **Taxes and Royalties:** it is estimated that the Port Hedland Port Supply Chain directly paid $2.3 billion in taxation receipts to the Western Australia Government and a further $2.4 billion to the Commonwealth in 2015-16. The majority of this flowed to the State through royalties ($1.9 billion) and to the Commonwealth through company taxes ($1.8 billion) and personal income tax ($606 million). In the context of the Western Australian Government, ACIL Allen estimates the Port Hedland Port Supply Chain accounted for 8.2 per cent of the State's General Government revenue in 2015-16.

Economic Impact of Future Growth in Port Capacity

In this study, ACIL Allen undertook an economic impact assessment on the opportunity for economic income, output and employment associated with potential expansion of iron ore export capacity through the Port over the next ten years. To do this, ACIL Allen first developed a reasonable baseline assessment of potential future iron ore export growth through the Port in two phases:

— a short term forecast (2016-17 to 2021-22) based on the publicly available forward guidance of the Port's major users; and

— a medium term projection (2022-23 to 2026-27) based on consultation with the PPA in relation to the potential capacity of the Port.

ACIL Allen has adopted a conservative iron ore price assumption over the forecast period to reflect the difficulty in accurately predicting future prices.

Based on this approach, ACIL Allen forecasts iron ore exports through the Port will increase from 495.6 MT in 2016-17 to 613.7 MT in 2021-22, which equates to annual average growth of 4.4 per cent over the five year period (which compares against growth of 16.1 per cent annual average growth in the five years to 2016-17). Following 2021-22, it is assumed iron ore exports from the Port reach the Port's ultimate capacity of 700 MT by 2026-27, at a constant rate of 2.7 per cent per annum.

Real Income

ACIL Allen estimates that the potential real income increase associated with the Port Hedland Port reaching its projected export capacity of 700MT is a cumulative $37.2 billion over the ten years ending 2026-27. The average potential annual increase in real income increases in line with the growth in iron ore exports – from $1.3 billion in 2017-18 to $5.6 billion in 2026-27.

Real Output

ACIL Allen estimates that the potential real output increase associated with the Port Hedland Port reaching its projected export capacity of 700MT is a cumulative $32 billion over the ten years ending 2026-27. The average potential annual increase in real output increases in line with the growth in iron ore exports – from $1.2 billion in 2017-18 to $4.8 billion in 2026-27.

The potential increase in real output is concentrated in the Pilbara region ($29.8 billion), as it is the region in which the value of iron ore exports is realised. For the Pilbara region, the average potential annual increase in the region's output is equivalent to 7.4 per cent of the Pilbara economy's GRP in 2015-16.

Real Exports

ACIL Allen estimates that the potential increase in real exports associated with the Port Hedland Port reaching its projected export capacity of 700MT is a cumulative $33.2 billion over the ten years ending 2026-27. The average potential increase in exports in Western Australia over the study period represents approximately five per cent of Western Australia's total exports in 2015-16.

Employment

ACIL Allen estimates that the potential increase in real employment associated with the Port Hedland Port reaching its projected export capacity of 700MT is an average of 5,377 FTE jobs per annum over the ten years ending 2026-27.

The majority of the potential impact on jobs occurs in the rest of Western Australia (potential increase of 3,838 FTE jobs on average per annum or 71 per cent), with some 28 per cent (potential increase of 1,500 FTE jobs on average per annum) occurring in the Pilbara, and the remaining one per cent (potential increase of 39 FTE jobs on average per annum) occurring in the Rest of Australia. The potential impact on the Pilbara region is most pronounced, with the number of FTE jobs added per annum equivalent to three per cent of its current workforce.

Real Taxation

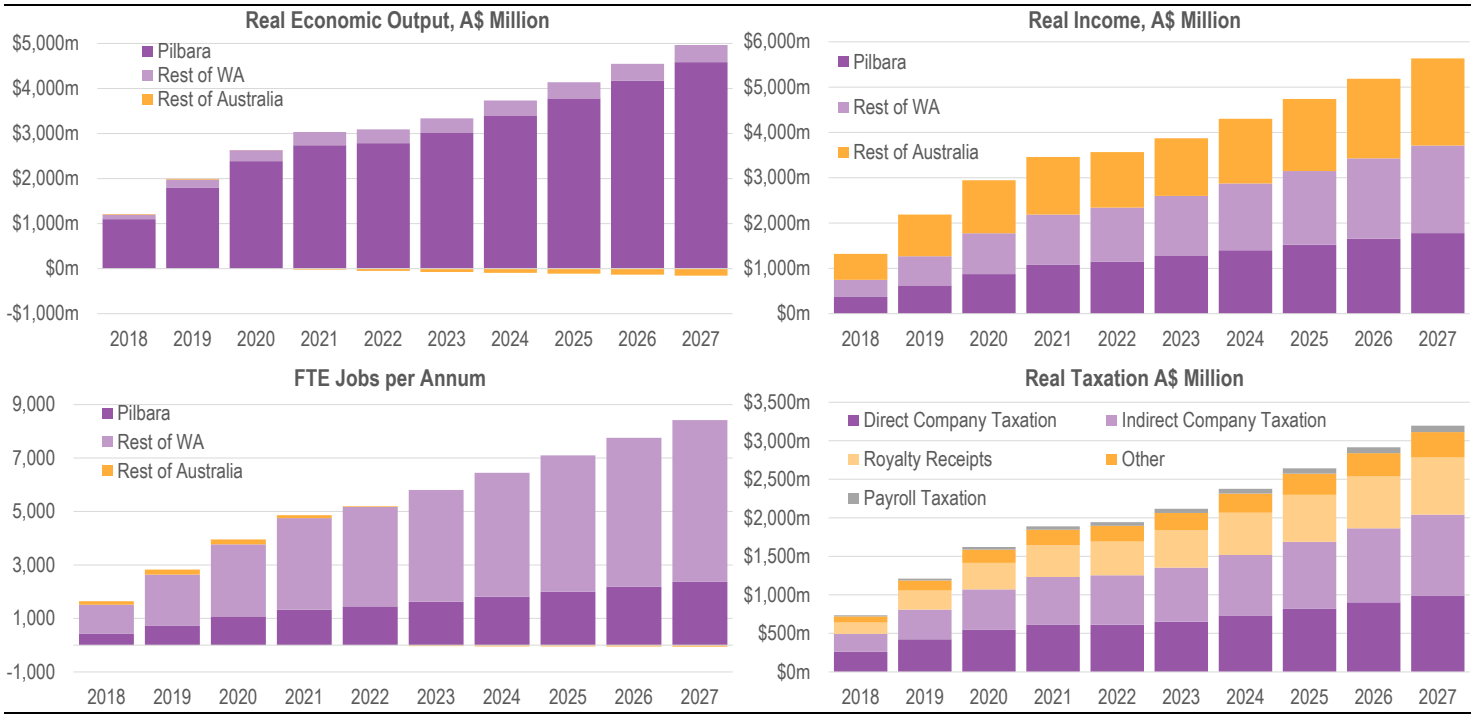
ACIL Allen estimates that the potential increase in real taxation and royalty receipts associated with the Port Hedland Port reaching its projected export capacity of 700MT is an a cumulative $20.6 billion over the ten years ending 2026-27. The average potential annual increase in real taxation and royalty receipts increases in line with the growth in iron ore exports – from $734 million in 2017-18 to $3.2 billion in 2026-27.

The majority of the potential impact on taxation receipts is attributed to Australian company taxation receipts, with direct and indirect company tax receipts potentially $13.3 billion higher over 10 years under the scenario where exports at the Port are not capped. The remaining potential impact on taxation receipts is attributed to:

- Western Australia Royalty receipts, which are potentially $4.6 billion higher over 10 years;
- Australian other tax receipts, which are potentially $2.2 billion higher over 10 years; and
- Western Australia Payroll tax receipts, which are potentially $508 million higher over 10 years.

The Commonwealth Government will be a significant beneficiary of the growth in iron ore exports out of the Port, with an average annual increase in taxes paid of $2.1 billion per annum over the study period. For the Western Australia Government, the growth in iron ore exports out of the Port will increase its taxation and royalties take on average by $516 million per annum over the study period.

FIGURE ES 2 ECONOMIC IMPACT OF GROWTH IN PORT HEDLAND PORT EXPORTS



SOURCE: ACIL ALLEN CONSULTING

Summary Results

TABLE ES 1 SUMMARY OF ECONOMIC IMPACT, REALISING THE POTENTIAL OF PORT HEDLAND PORT, REAL TERMS, A$ MILLION

	Total	Average	Discounted (7%)
	Projected cumulative gain in real economic income		
Pilbara	$29,760m	$2,976m	$19,548m
Rest of Western Australia	$2,901m	$290m	$1,926m
Total Western Australia	**$32,661m**	**$3,266m**	**$21,474m**
Rest of Australia	-$612m	-$61m	-$350m
Total Australia	**$32,049m**	**$3,205m**	**$21,123m**
	Projected cumulative gain in real output		
Pilbara	$11,719m	$1,172m	$7,653m
Rest of Western Australia	$12,352m	$1,235m	$8,039m
Total Western Australia	**$24,071m**	**$2,407m**	**$15,693m**
Rest of Australia	$13,126m	$1,313m	$8,731m
Total Australia	**$37,197m**	**$3,720m**	**$24,424m**
	Projected average gain in employment		
	Total	Average	Peak (Year)
Pilbara	14,996	1,500	2027
Rest of Western Australia	38,379	3,838	2027
Total Western Australia	**53,375**	**5,337**	**2027**
Rest of Australia	394	39	2019
Total Australia	**53,769**	**5,377**	**2027**
	Projected cumulative gain in real taxation		
Royalties (WA)	$4,651m	$465m	$3,027m
Payroll tax (WA)	$468m	$47m	$302m
Total WA	**$5,119m**	**$512m**	**$3,239m**
Company tax (AU)	$6,554m	$655m	$4,327m
Other Company tax (AU)	$6,503m	$650m	$4,250m
Other (AU)	$2,499m	$250m	$1,641m
Total Australia	**$20,676m**	**$2,068m**	**$13,547m**

Note: totals can be subject to rounding errors

SOURCE: ACIL ALLEN CONSULTING

1 INTRODUCTION

1.1 Our engagement

The Port of Port Hedland ('the Port') is one of Australia's most important pieces of economic infrastructure. In 2016-17, the Port facilitated some 500.9 million tonnes (MT) of trade, the vast majority of which (494.6 MT) was iron ore produced by companies operating in the Pilbara region. This trade volume makes the Port the largest bulk export terminal in the world.

The Town of Port Hedland is one of the State's largest regional population centres, with a resident population of 14,500 in 2016.[1] The Port, which lies adjacent to what is known as the "West End" portion of the Port Hedland town site, was originally gazetted in 1896, and has grown significantly larger in recent years as a result of growing demand from China for natural resources to fuel growth – including iron ore.

ACIL Allen Consulting (ACIL Allen) has been engaged on behalf of the Port Hedland Industries Council (PHIC) to conduct an economic study on the Port of Port Hedland, in order to understand:

- the value of the Port of Port Hedland and the trade through the Port to the Pilbara, Western Australian and Australian economies; and
- the potential economic and social costs that would result if approvals for further expansions of the Port were not granted, and total iron ore exports remained unchanged over the next ten years.

ACIL Allen will undertake this engagement through the provision of two discrete modelling activities:

- an economic contribution study, which will estimate the contribution that the Port of Port Hedland makes to the Town of Port Hedland, the Pilbara, Western Australia and national economies in a representative year; and
- an economic impact assessment, which will estimate the future economic impact of constraining the Port's iron ore capacity.

ACIL Allen has developed the inputs used for the modelling task with the assistance relevant industry stakeholders, including the Pilbara Ports Authority (PPA) and major iron ore producers that utilise the Port. ACIL Allen has independently verified these inputs, and made assumptions using publicly available information where there were identified gaps in the data.

1.2 Methodology

To complete this study, ACIL Allen has undertaken two modelling tasks: an economic contribution study and an economic impact assessment. The economic contribution is used to estimate the

[1] ABS. 2017. *ABS Census 2016: Town of Port Hedland*. Accessed online at http://www.stat.abs.gov.au/

proportion of the local, State and national economies are accounted for by activities associated with the Port. These findings provide the starting point for the economic impact assessment.

A brief outline of these two tasks is below.

1.2.1 Economic contribution study

An economic contribution study takes the financial and employment data of entities in a given year to determine the overall size and scope or "footprint" of the entities on the economy. An entity's contribution is calculated on the basis of its direct activities (such as profits generated, expenditure incurred, wages paid to employees) and indirect activities (such as flow on impacts from payments made to suppliers, goods and services purchased from employees) to determine the full extent of the flow on economic contribution.

To do this, ACIL Allen has received data from the PPA and users of the Port on:

- total revenue;
- total expenditure (excluding wages), by key categories where available; and
- total wages paid.

Where possible, this data has been allocated by geographic locations to enable ACIL Allen to model the impact of activities at a regional level.

ACIL Allen converts this data into an economic accounting framework known as an Input-Output table,[2] which is produced by the Australian Bureau of Statistics (ABS) and refined by ACIL Allen using its own expertise.

In this engagement, ACIL Allen received information from the major users of the Port, and the Port itself, and conducted the economic contribution study at the local (Port Hedland and Pilbara region), State (Western Australia) and national (Australia) level. The results of the economic contribution study are located in Section 3.

1.2.2 Economic impact assessment

An economic impact assessment is conducted using ACIL Allen's *Tasman Global* Computable General Equilibrium (CGE) model. Further details on *Tasman Global* are found in Appendix A. This modelling tasks articulates the potential future economic impact of the difference between two economic scenarios; typically a baseline assessment and a change to the baseline.

In this study, ACIL Allen has undertaken an economic impact assessment on the opportunity for economic income, output and employment associated with potential expansion of iron ore export capacity through the Port over the next ten years. To do this, ACIL Allen first developed a reasonable baseline assessment of potential future iron ore export growth through the Port in two phases: a short term forecast (2016-17 to 2021-22) based on the publicly available forward guidance of the Port's major users, and a medium term projection (2022-23 to 2026-27) based on consultation with the PPA in relation to the potential capacity of the Port. The deviation from this scenario was to assume that the Port's export capacity was capped at 2016-17 levels for the full forecast period, leading to lost iron ore exports and an associated economic impact.

For the purposes of this study, the economic impact of the growth of Port Hedland Port has only considered the future growth of iron ore exports, as this was the basis of ACIL Allen's engagement. As a result, this does not include other growth opportunities, such as the lithium industry, live cattle trade, or the development of an offshore industry supply base.

The full explanation of this scenario is outlined in Section 4, and the results of the economic impact assessment are outlined in Section 5.

[2] See Section 1.3 for a definition of Input-Output Tables.

1.3 Glossary of terms and abbreviations

Compensation of employees	The total remuneration, in cash or in kind, payable by an enterprise to an employee in return for work done by the employee during the accounting period. It is further classified into two sub-components: wages and salaries; and employers' social contributions. Compensation of employees is not payable in respect of unpaid work undertaken voluntarily, including the work done by members of a household within an unincorporated enterprise owned by the same household. Compensation of employees excludes any taxes payable by the employer on the wage and salary bill (e.g. payroll tax).
Economic footprint	*A measure of the total economic activity in the production of new goods and services* Economic footprint is a broader measure of the economy in that it includes the final value of goods and services produced (GDP/GSP/GRP), as well as the value of the intermediate consumption within the region to produce the goods and services, and imports from outside the region.
Employment	The number of full time equivalent job years created as a result of a project or expenditure in the economy, which includes direct and indirect (flow-on) employment.
Exchange rate	The exchange rate is expressed as the AUD/USD exchange rate unless otherwise stated and is denoted as $ or A$ throughout the document.
Exports	The value of goods exported and amounts receivable from non-residents for the provision of services by residents.
Gross Operating Surplus	*A measure of the gross income less expenditure on intermediate inputs and wages* Gross Operating Surplus (GOS) is an economic measure of the income earned by the capital employed by a project or economy. It is typically calculated as a residual factor of total income earned by a project less expenditure on intermediate inputs and wages paid. It is different to accounting profit as it includes a number of the deductions and other outflows a company would typically remove from the measure of its profitability; it also includes all taxes payable to governments.
Gross product or real economic output	*A measure of the size of an economy* Gross product is a measure of the output generated by an economy over a period of time (typically a year). It represents the total dollar value of all finalised goods and services produced over a specific time period and is considered as a measure of the size of the economy. At a national level, it is referred to as Gross Domestic Product (GDP); at the state level, Gross State Product (GSP); while at a regional level, Gross Regional Product (GRP).
Gross Income	*A measure of the income derived from production in an economy* Gross Income is the income earned as a result of the production of goods and services in a region or economy. In differs from measures of production as it is the ultimate measure of the "return" on production in the form of Gross Operating Surplus and Wages and Salaries which accrue to the resident population of a particular region. At a national level, it is referred to as Gross National Income (GNI); at the state level, Gross State Income (GSI); while at a regional level, Gross Regional Income (GRI).

Gross Value Added	*A measure of the value of goods and services produced in an industry or sector of an economy.* Gross Value Added (GVA) is the output of an industry or sector minus intermediate consumption. GVA therefore represents the value of all goods and services produced, minus the cost of all inputs and raw materials used to produce that good or service. Unlike Gross Product, GVA does not include the value of taxes minus subsidies.
Imports	The value of goods imported to a region and amounts payable to non-residents for the provision of services to residents.
Input-Output Tables	Input-Output (I-O) tables capture the direct and indirect effects of expenditure by capturing, for each industry, the industries it purchases inputs from and also the industries it sells its outputs to. For example, the I-O model for Western Australia captures purchases from and sales to industries located in Western Australia, as well as imports from outside of Western Australia.
Job years	Real employment is measured in job years. A job year is employment of one full time equivalent (FTE) person for one year. Alternatively in can be expressed as one 0.5 FTE person for two years.
Net present value (NPV)	The value of a future stream of income (or expenses) converted into current terms by an assumed annual discount rate. The underlying premise is that receiving, say, $100 in 10 years is not 'worth' the same (i.e. is less desirable) than receiving $100 today. For the purposes of this study, NPV calculations have been made based on a discount rate of 4 per cent and 7 per cent.
Port Hedland Port Supply Chain	For the purposes of this study, ACIL Allen has combined the income, expenditure and employment of the Port of Port Hedland and associated entities that utilise the Port for trade into a single group we have called the Port Hedland Port Supply Chain. This allows us to present the results of this study as a single contribution/impact, and protects the confidentiality of information provided by the Port and its users.
Purchasing Power Parity (PPP)	Purchasing Power Parity (PPP) represents the theoretical value of a nation state's economic output adjusted for currency effects and the purchasing power of a standard unit of exchange. It ultimately reflects the underlying competitiveness of a country's economy.
Real and nominal dollars	Nominal dollars are dollars that are expressed in the actual dollars that are spent or earned in each year, including inflation effects. Real dollars have been adjusted to exclude any inflationary effects and therefore allow better comparison of economic impacts in different years. Over time, price inflation erodes the purchasing power of a dollar thereby making the comparison of a dollar of income in 2063 with a dollar of income in 2016 invalid. Adjusting nominal dollars into real dollars overcomes this problem. All values are expressed in real dollar terms with a base year of 2016, unless otherwise stated.
Real income	*A measure of the welfare of residents in an economy through their ability to purchase goods and services and to accumulate wealth* Although changes in real economic output are useful measures for estimating how much the output of the economy may change due to a change in policy, changes in real income are also important as they provide an indication of the change in economic welfare of the residents of a region through their ability to purchase goods and services.

Real income measures the income available for final consumption and saving after adjusting for inflation. An increase in real income means that there has been a rise in the capacity for consumption as well as a rise in the ability to accumulate wealth in the form of financial and other assets. The change in real income from a development is a measure of the change in the economic welfare of residents within an economy.

State Final Demand / domestic economy *A measure of the value of goods and services in an economy*

The aggregate obtained by summing government final consumption expenditure, household final consumption expenditure, private gross fixed capital formation and the gross fixed capital formation of public corporations and general government. It is conceptually equivalent to the Australia level aggregate domestic final demand.

Working age population

All usual residents of Australia aged 15 years and over except members of the permanent defence forces, certain diplomatic personnel of overseas governments customarily excluded from census and estimated population counts, overseas residents in Australia, and members of non-Australian defence forces (and their dependants) stationed in Australia.

LIST OF ACRONYMS

Abbreviation	Full name
ABS	Australian Bureau of Statistics
AUD/ A$ or $	Australian dollars (default unless otherwise specified)
Billion	Billion measured by $1x10^9$ (or 1,000 million) as per the US convention
CAPEX	Capital expenditure
CGE	Computable General Equilibrium (model)
CO2	Carbon dioxide
CPI	Consumer Price Index
FIFO	Fly in-fly out work practice
FOB (shipping)	Free on Board
FTE	Full Time Equivalent
FY	Financial year
GDP	Gross Domestic Product
GRP	Gross Regional Product
GSP	Gross State Product
GST	Goods and Services Tax
GVA	Gross Value Added
Million	Million measured by $1x10^6$ (or 1,000 thousand) as per the US convention
MT	Million tonnes
MTPA	Million tonnes per annum
NPV	Net Present Value
OPEX	Operational expenditure
PAYE	Pay as you earn income tax
PPP	Purchasing Power Parity
USD or US$	United States dollars
WPI	Wage Price Index

1.4 Structure of this report

This report outlines the inputs, methodology, assumptions and findings of the study. The report is structured as follows:

— **Section 1** (this section) contains the introductory information and context for this engagement, including a brief outline of the methodologies ACIL Allen has employed and a glossary of key terms and abbreviations used.

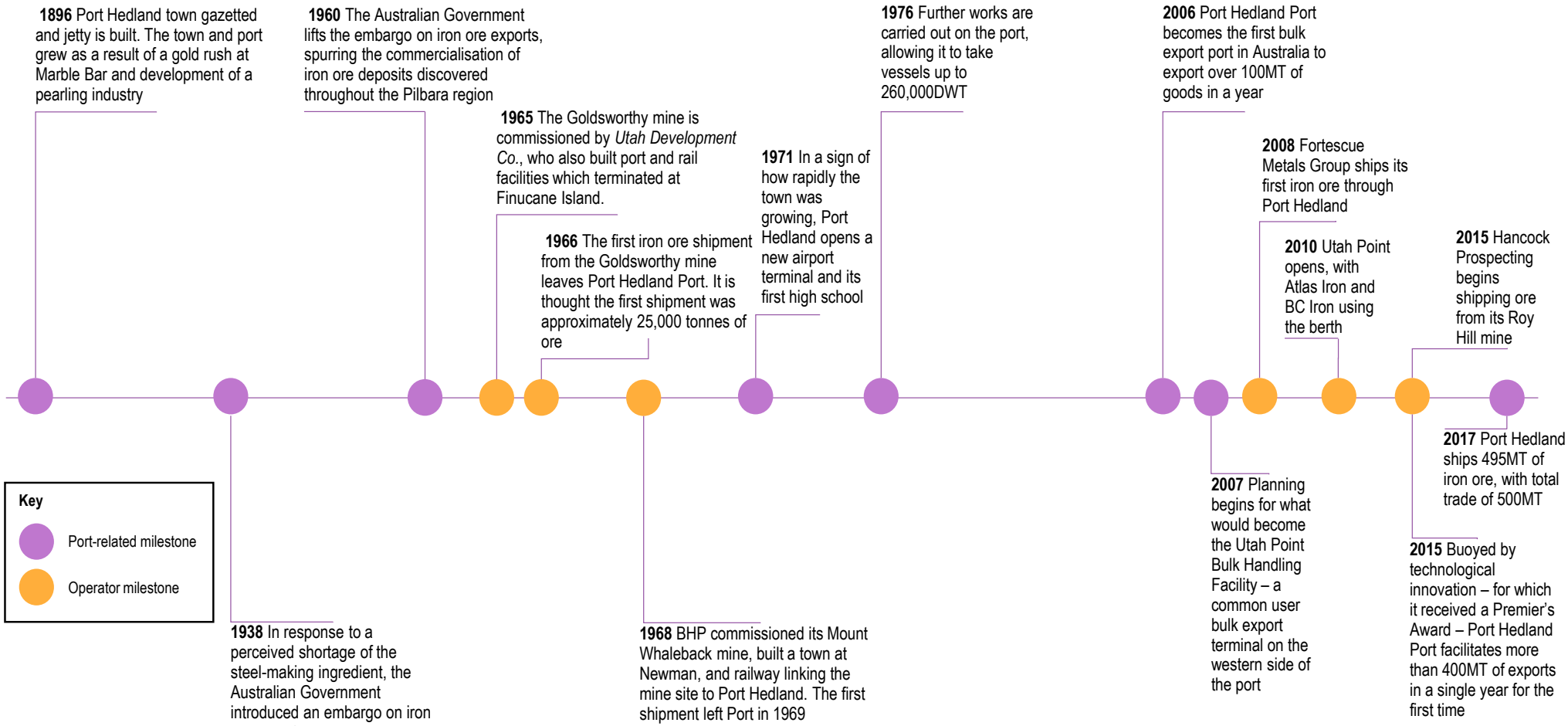
— **Section 2** contains a brief history of the Port of Port Hedland, including key developments and important historic milestones, in order to provide important contextual information on the scale and pace of growth of the Port in recent years.

— **Section 3** contains the findings of the Economic Contribution Study of the Port and its major operators. The results are presented by geographical location: the Town of Port Hedland, the Pilbara, Western Australia and total Australia. The results are presented as direct (the first round contribution to income, expenditure and employment) and indirect (the flow on contribution across the economy) contribution.

— **Section 4** outlines ACIL Allen's scenarios for future growth of the Port: a growth scenario, where exports of iron ore from the Port progressively grow over time, reaching the Port's capacity by 2026-27; and a capped scenario, where the Port's capacity is capped at 2016-17 levels. This section outlines all of the assumptions used to derive these scenarios, including a brief assessment of the market structure and outlook for seaborne iron ore.

— **Section 5** contains the findings of the Economic Impact Assessment of future growth scenarios for the Port from 2016-17 to 2026-27. The two scenarios analysed are an unconstrained forecast, where the Port is able to grow to its capacity by 2026-27, and a constrained forecast, where the Port's iron ore export capacity is capped at 2016-17 levels. The results are presented as potential economic output at the local (Pilbara), State (Western Australia), and national (Australia) levels in the form of real income, real output, real exports, employment, and real taxation.

PORT OF PORT HEDLAND: KEY MILESTONES 2



3 THE CONTRIBUTION OF PORT HEDLAND TO THE LOCAL, STATE AND NATIONAL ECONOMIES

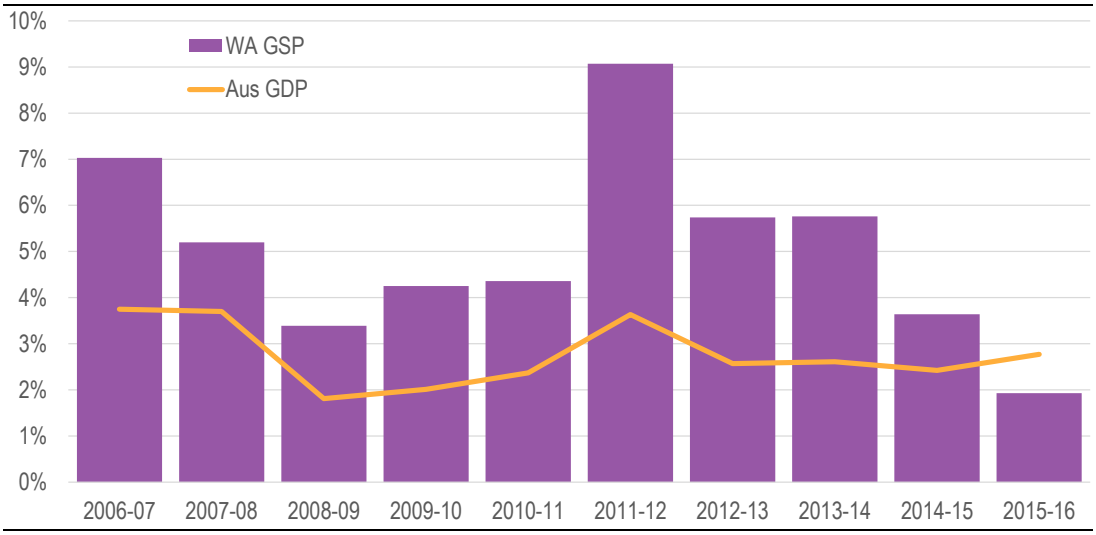
This chapter of the report provides an overview of current economic conditions in the Pilbara and Western Australian economies, and outlines the results of the economic contribution study modelling undertaken for this engagement.

3.1 Economic Overview

3.1.1 Current economic conditions

On the back of an investment driven resources boom, the Western Australia economy has expanded significantly over the past decade. Total annual output produced in the State's economy is now 52 per cent larger than it was in 2006-07, with annual economic growth averaging 4.8 per cent. By contrast, annual growth in the national economy has averaged just 2.7 per cent since 2006-07 (see **Figure 3.1**), which has meant that over this period, the Western Australia economy has grown its share of the national economy from 12.7 per cent of Australia's GDP in 2006-07 to 15.4 per cent by 2015-16.

FIGURE 3.1 WESTERN AUSTRALIA GROSS OUTPUT, ANNUAL PERCENTAGE CHANGE



SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 5220.0

Much of the growth in Western Australia over the past decade can be attributed to the Pilbara region, with its rich resources base making it an investment hot-spot for major resources companies as

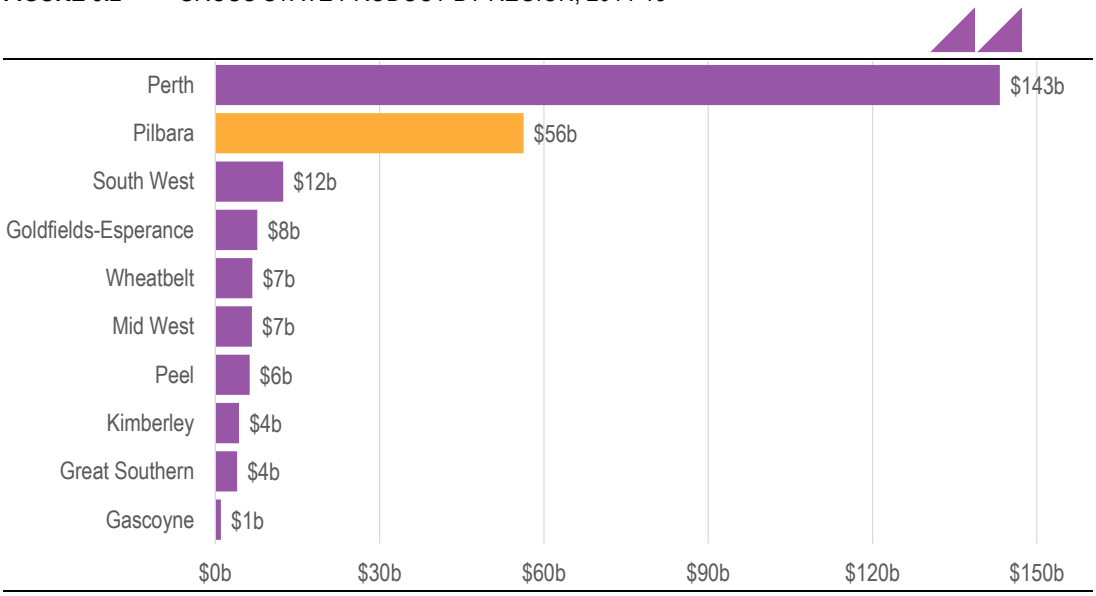
commodity prices surged. Some of the major Pilbara projects that have either been completed over the past decade, or are nearing completion, include:

- Hancock Prospecting's US$10 billion Roy Hill iron ore project;
- Fortescue Metals Group's full mine, rail and port developments spanning two main mining regions (Chichester Hub and Solomon Hub);
- Woodside's US$14.9 billion Pluto LNG project;
- Rio Tinto's various mine expansions and port investments, totalling US$9.8 billion over the period;
- Chevron's $US54 billion Gorgon LNG and $US34 billion Wheatstone LNG projects; and
- BHP Billiton's $US7.4 billion Jimblebar iron ore project and Port Hedland Port expansion.

Further investment into the region has also been provided by the Western Australia Government, most notable through its $1.7 billion "Pilbara Cities" initiative funded through *Royalties for Regions.*[3]

The impact that these investments have had on the Pilbara economy is clearly demonstrated by Gross Regional Product (GRP) estimates produced by ACIL Allen for all Western Australia regions in 2014-15, which show that the Pilbara is the State's largest regional economy (see **Figure 3.2**), and was responsible for 23 per cent of Western Australia's Gross State Product (GSP) in 2014-15.[4]

FIGURE 3.2 GROSS STATE PRODUCT BY REGION, 2014-15



SOURCE: ACIL ALLEN CONSULTING

The Pilbara is the State's largest regional economy, generating $56 billion in output in 2014-15

Growth in the Western Australia and Pilbara economies has slowed significantly since 2014-15 as the construction phase of major resources projects approached completion. For the Pilbara, this has been highlighted by a weaker jobs market, a falling population, and a rapid decline in property values; while for Western Australia, the Western Australia domestic economy shrunk in size, a softer labour market emerged, and measures of wealth retracted from all-time highs (see **Figure 3.3**, overleaf).

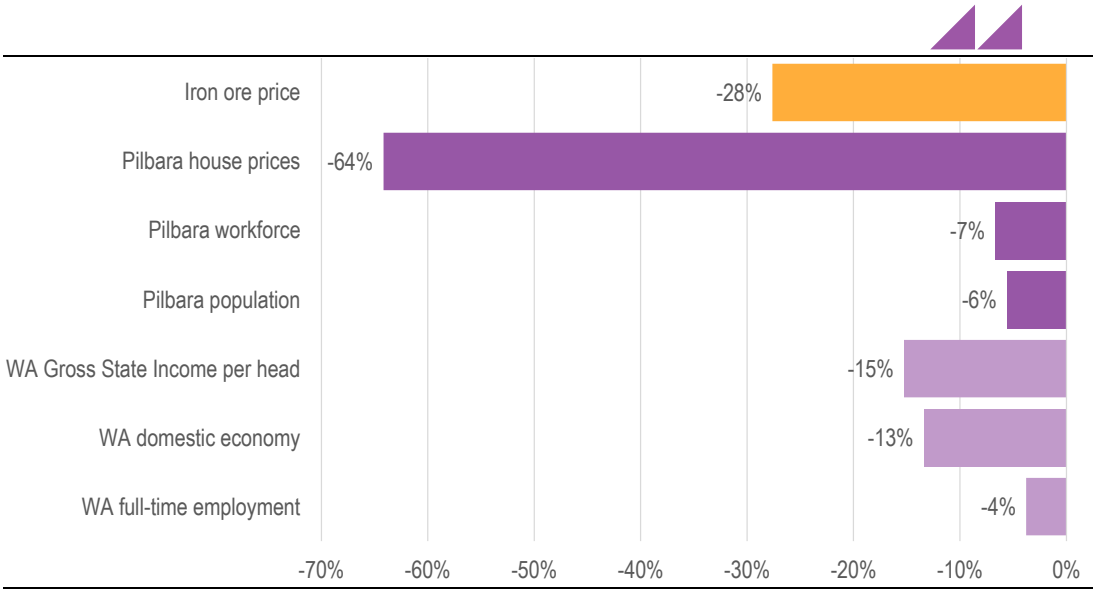
There are now signs that the transition in the Western Australia economy has almost run its course. Full-time employment in the Western Australia economy has increased each month since the beginning of 2017, and the unemployment rate has fallen from a high of 6.4 per cent in March to 5.4 per cent by July 2017.

A similar labour market story has emerged in the Pilbara, with employment increasing by 5.4 per cent over the 12 months to 49,800 in March 2017 as a number of mining operations phase into production.

The following subsections describe in greater detail the industry composition, and labour market and population trends of the Western Australia and Pilbara economies.

[3] Royalties for Regions is a State Government policy introduced in the 2008-09 which channels 25 per cent of the State's royalty income (up to $1 billion per annum) into a special purpose fund to be spent on projects and programs in regional Western Australia.
[4] Latest data available for regions other than Pilbara.

FIGURE 3.3 THE UNWINDING OF THE RESOURCES CONSTRUCTION BOOM, PERCENTAGE CHANGE BETWEEN 2014 AND 2016



Note: Iron ore price, Pilbara house prices, Western Australia domestic economy, Pilbara workforce and Western Australia full-time employment percentage changes are for between December 2013 and December 2016,;Western Australia Gross State Income per head percentage change is for between 2013-14 and 2015-16, and Pilbara population percentage change is for between June 2014 and June 2016.

SOURCE: ACIL ALLEN CONSULTING, ABS CATALOGUE 5220.0, 5242.0, 3218.0 & 6202.0, DEPARTMENT OF EMPLOYMENT SMALL AREA LABOUR MARKETS MARCH 2017, AND CORELOGIC

3.1.2 Industry output

The mining industry accounted for 77 per cent of the Pilbara economy in 2015-16

The mining sector is both Western Australia and the Pilbara's most dominant industry. In Western Australia, it is responsible for just above one quarter of total GSP, while in the Pilbara, it responsible for over 77 per cent of GRP in 2014-15.

In Gross Value Added terms, just under 45 per cent of the mining industry's total output in Western Australia occurs in the Pilbara region, which demonstrates the importance of the Pilbara region in the broader context of the Western Australia economy.

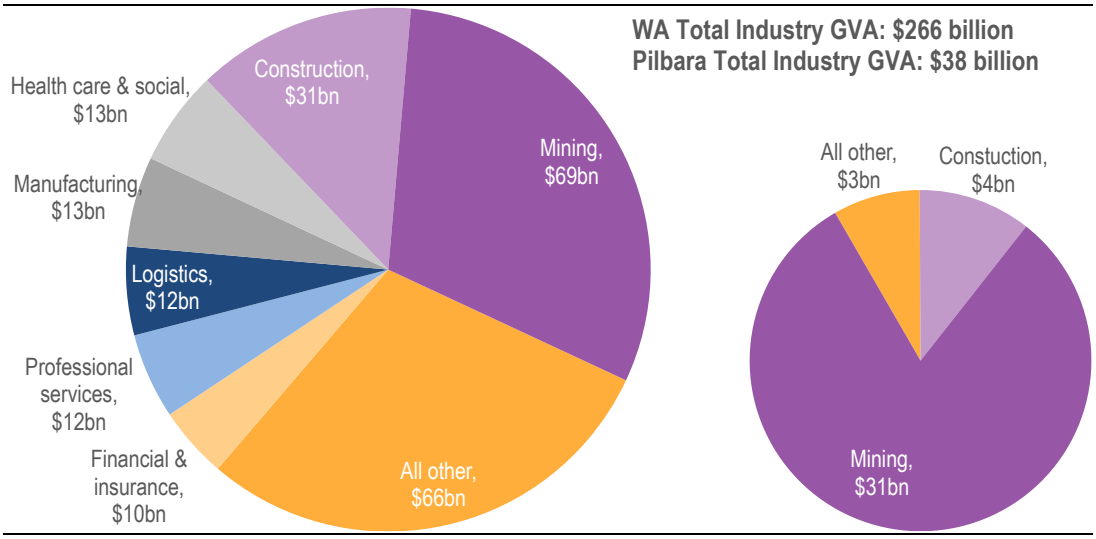
The construction sector, which in recent years has directly leveraged off the expansion needs of the mining sector, is the second largest industry in both Western Australia and the Pilbara, being responsible for just over 10 per cent of GRP in the Pilbara, and 12 per cent of GSP in Western Australia in 2014-15. Of the remaining industries, only transport, postal and warehousing contributes more than one per cent of GRP in the Pilbara (2.1 per cent in 2014-15).

Due to its higher population base, the Western Australia economy is better supported by services based industries when compared to the Pilbara, with:

- health care and social assistance industry responsible for 5.2 per cent of GSP;
- transport, postal and warehousing industry responsible for 4.8 per cent of GSP;
- professional services industry responsible for 4.7 per cent of GSP;
- financial and insurance services industry responsible for 3.9 per cent of GSP;
- education and training industry responsible for 3.3 per cent of GSP; and
- retail trade industry responsible for 3.2 per cent of GSP.

These industry output trends are shown below in **Figure 3.4**.

FIGURE 3.4 INDUSTRY GROSS VALUE ADDED, WA AND PILBARA 2015-16,SHARE OF TOTAL



SOURCE: ACIL ALLEN CONSULTING AND ABS CAT. 5220.0

3.1.3 Labour market

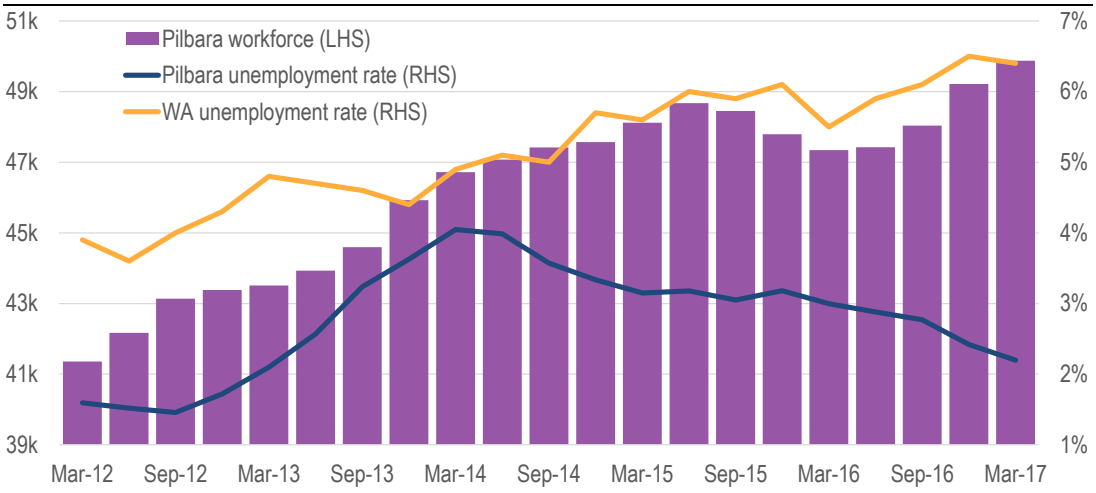
The Pilbara region had a workforce of just under 50,000 people by March 2017, which is some 20 per cent higher than it was just five years ago. This increase has come despite the workforce shrinking in size between June 2015 and December 2016 as the resources industry reduced its workforce in order to remain competitive in a subdued price environment.

Given the remote location of many mine sites in the region, the size of the region's workforce is likely to be greater than estimated, with regular Australian Bureau of Statistics ('ABS') labour force surveys only including Fly-In Fly-Out (FIFO) employees as part of the Pilbara workforce when their usual place of residence is reported as in the Pilbara region. While there are no official statistics available, it was suggested by the Chamber of Minerals and Energy in a recent Parliamentary Inquiry that '*around 60 per cent of the resources sector who do work in operations do fly in, fly out, whereas around 80 per cent of those working in the resources sector doing construction do fly in, fly out*.'[5]

Unemployment in the Pilbara region is very low relative to Western Australia, as highlighted in **Figure 3.5** below. Notably, the Pilbara region's unemployment rate has trended down, reaching a low of 2.2 per cent by March 2017.

[5] Parliament of Western Australia Legislative Assembly. 2015."*The impact of FIFO work practices on mental health Final Report*." Page 8.

FIGURE 3.5 SIZE OF PILBARA WORKFORCE AND UNEMPLOYMENT RATE, WA COMPARISON



SOURCE: ACIL ALLEN CONSUTLING, ABS CAT. 6202.0 AND DEPARTMENT OF EMPLOYMENT SMALL AREA LABOUR MARKETS MARCH 2017

The dominance of the resources sector in the Pilbara region is highlighted by industry employment statistics, which show that at the 2011 Census,[6] over 50 per cent of all workers[7] in the region were employed by the mining industry. Comparatively, the latest data from the ABS shows that the mining sector is the State's seventh largest employer (just under seven per cent of the State's total workforce).

Other major industries of employment in the Pilbara region at the time of the 2011 Census were the:

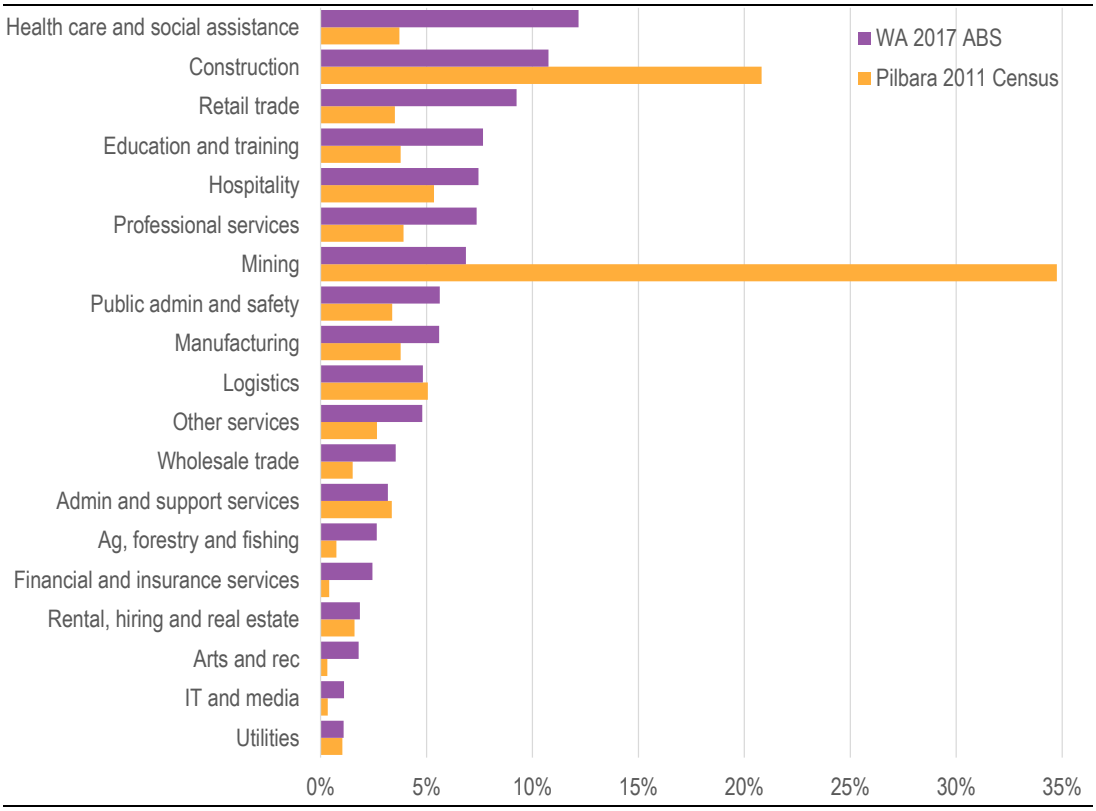
- construction industry, which employed 32 per cent of workers in the region;
- accommodation and food services industry, which employed eight per cent of workers in the region; and
- transport, postal and warehousing industry, which employed eight per cent of workers in the region.

Employment in the Western Australia economy as a whole is more diverse, with the health care and social assistance industry being the largest employer (12 per cent of the total workforce), followed by the construction industry (11 per cent of the total workforce), and the retail trade industry (nine per cent of the total workforce).

These industry employment trends are shown below in **Figure 3.6** below.

[6] Results from the 2016 Census data will be available in October 2017.
[7] On a place of enumeration basis

FIGURE 3.6 INDUSTRY OF EMPLOYMENT, WA AND PILBARA, SHARE OF TOTAL



SOURCE: ACIL ALLEN CONSULTING, 2011 CENSUS AND ABS CAT. 6203.0

3.1.4 Population

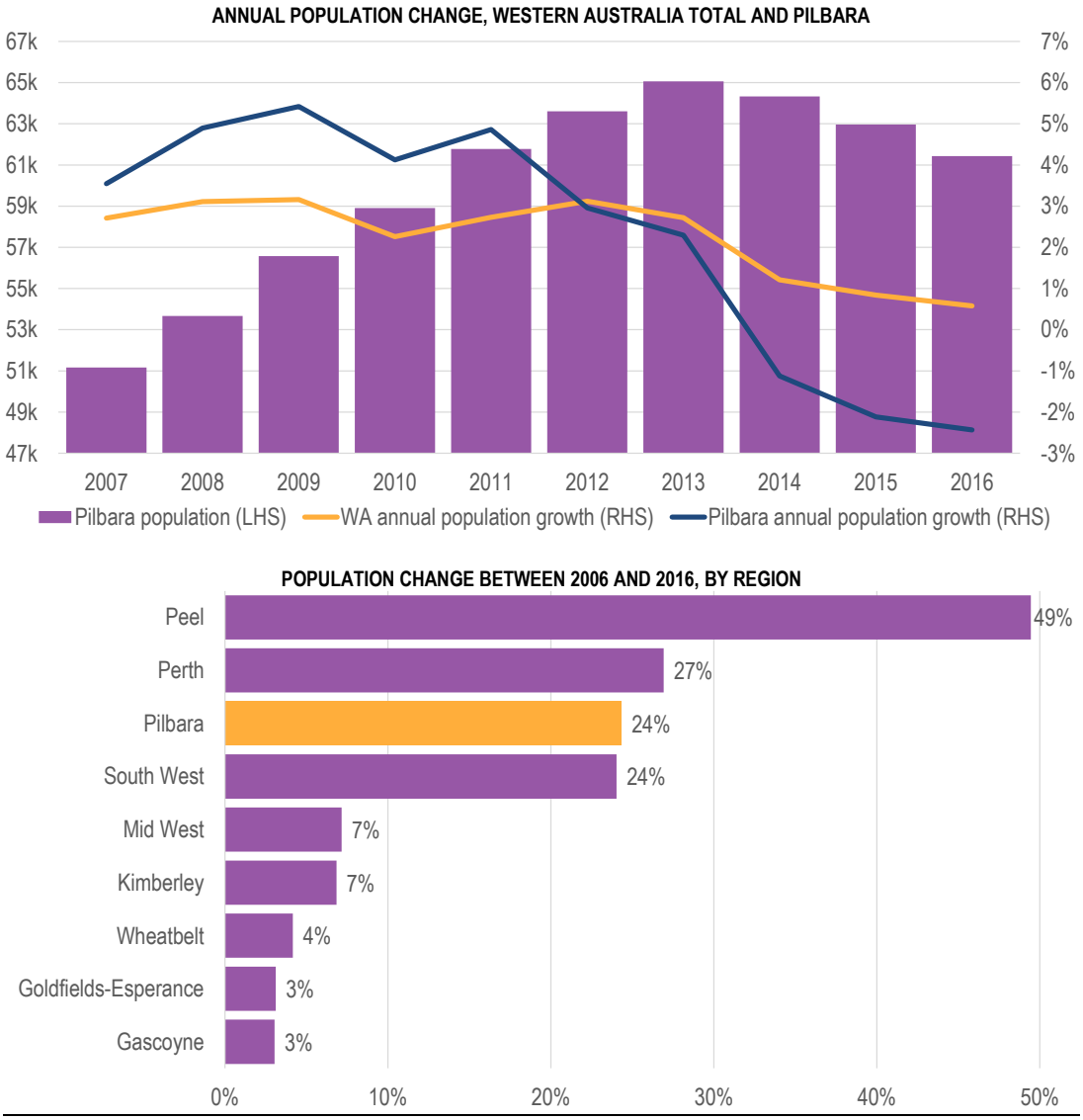
The population of the Pilbara region fell to 61,500 persons in 2016 (from a historic high of 65,000 in 2013), as the construction of a number of major resources projects neared completion.

Despite slowing since 2013, the Pilbara region has still experienced population growth of 24 per cent (at an average annual rate of 2.2 per cent) since 2006, making it the fastest growing Western Australia region over the past 10 years outside the Perth and Peel regions.

Across the State as a whole, the population has increased at the same rate as the Pilbara region since 2006, averaging growth of 2.2 per cent per annum over this period.

These population trends are shown below in **Figure 3.7**.

FIGURE 3.7 POPULATION TRENDS



SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 3101.0 & 3218.0

3.2 The contribution of the Port of Port Hedland to the local and State economies

The results below articulate the economic contribution the activities associated with the Port made to the economic output and employment of the Town of Port Hedland, Pilbara, Western Australian and Australian economies in 2015-16. ACIL Allen received information on the income, expenditure and wages paid by BHP, FMG, Roy Hill and PPA for the 2015-16 financial year to complete the economic contribution study. Collectively, ACIL Allen will refer to the subjects of this contribution study as the Port Hedland Port Supply Chain.

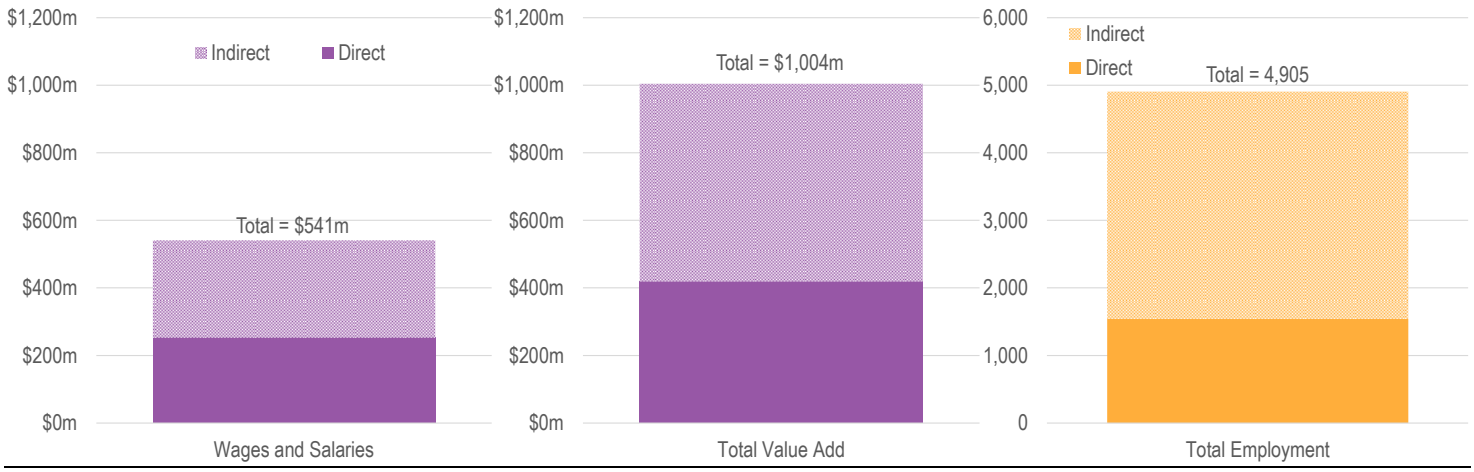
The results for economic output are presented on the basis of where activity occurs, whereas the results for income and employment are presented on the basis of where people live rather than where they work. This allows the contribution study to highlighting the scale of the contribution that the Port Hedland Port Supply Chain makes to the local, State and national economies.

3.2.1 Economic Contribution

The Town of Port Hedland

The Port Hedland Port Supply Chain accounted for $418.4 million in direct economic output in the Town of Port Hedland in 2015-16. This was approximately 8.7 per cent of the economic output produced in the town of Port Hedland in the financial year. The activities of the Port Hedland Port Supply Chain in Port Hedland generated $585.9 million of indirect economic output in the Town, meaning the total economic contribution exceeded $1 billion ($1.004 billion) in 2015-16. All told, this represented approximately 21 per cent of total economic output produced in Port Hedland in the year (**Figure 3.8**).

FIGURE 3.8 ECONOMIC CONTRIBUTION OF THE PORT HEDLAND PORT SUPPLY CHAIN IN PORT HEDLAND, 2015-16, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

The economic multiplier of local expenditure by the Port Hedland Port Supply Chain is estimated to be 2.4, meaning every dollar of expenditure made in the area generated flow on expenditure of $1.40. This is a significant result given a typical multiplier would indicate flow on expenditure of less than $1.00 for every dollar spent. This implies that the Port Hedland Port Supply Chain is critical to the underlying structure of the Port Hedland economy.

The Port Hedland Port Supply Chain is critical to the structure of the Port Hedland economy

This level of activity supported approximately 5,000 FTE jobs (4,905) in the Town of Port Hedland, which in 2015-16 was just under half of total employment (10,989) in the region.[8] The reason for the seemingly large discrepancy between output and employment contribution in the local area is the way in which value added is calculated in ACIL Allen's modelling. Much of the value adding activities associated with the Port Hedland Port Supply Chain occur at the mine head, which is accounted for in the "Rest of Pilbara" region (i.e. outside of Port Hedland). By contrast, as employment is calculated on a place of residence basis, the contribution study is capturing the fact that a significant share of those employed by the Port Hedland Port Supply Chain are residents of Port Hedland.

This is also reflected in the wages and salaries component of the contribution study. ACIL Allen estimates that direct wages and salaries paid into the Port Hedland region are $252.4 million in 2015-16, equivalent to approximately 60 per cent of total direct economic contribution to the region. By contrast, wages and salaries paid in the broader Pilbara region are equivalent to just 3.7 per cent of total direct economic contribution.

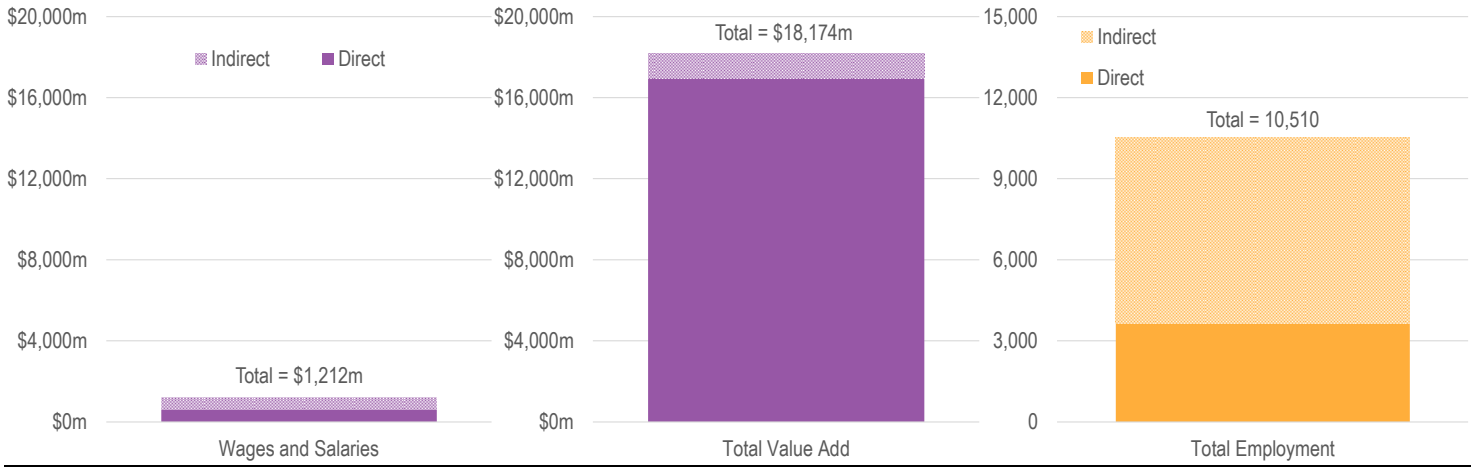
Pilbara

The Port Hedland Port Supply Chain accounted for $16.9 billion in direct economic output in the Pilbara region in 2015-16. This was approximately 45 per cent of the economic output produced in the Pilbara region in the financial year. The activities of the Port Hedland Port Supply Chain in Port

[8] Department of Employment. 2017. *Small Area Labour Markets, March 2017 update*. Accessed online at http:///www.employment.gov.au/

Hedland generated an additional $1.2 billion of indirect economic output in the region, a relatively low amount driven by the fact the direct expenditures of the mining industry (the Port Hedland Port Supply Chain, other iron ore miners, and the oil and gas industry) account for 77 per cent of Gross Value Added in the region (see Section 3.1.2). The total economic contribution of the Port Hedland Port Supply Chain is estimated to be $18.3 billion, or 47 per cent of total economic output produced in the Pilbara region in the year (refer to **Figure 3.9**).

FIGURE 3.9 ECONOMIC CONTRIBUTION OF THE PORT HEDLAND PORT SUPPLY CHAIN IN THE PILBARA, 2015-16, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

The Port Hedland Port Supply Chain accounted for 47 per cent of the Pilbara region's economy in 2015-16

The Port Hedland Port Supply Chain supported 10,510 FTE jobs in the Pilbara region in 2015-16, accounting for 16 per cent of total employment. Much of this is indirect employment (6,861 FTE, more than two thirds of the total), an indication of the significant role the activities of the Port and its operators play in the Pilbara region more broadly. ACIL Allen estimates the Port Hedland Port Supply Chain contributed $1.3 billion to the Pilbara region in wages and salaries, with the flow on benefit to consumer spending from this worth approximately $363.9 million.

Western Australia

The Port Hedland Port Supply Chain accounted for $18.5 billion in direct economic output in the Western Australian economy in 2015-16. This was 7.6 per cent of the economic output produced by the Western Australian economy in the financial year (refer to **Figure 3.10**).

FIGURE 3.10 ECONOMIC CONTRIBUTION OF THE PORT HEDLAND PORT SUPPLY CHAIN IN WESTERN AUSTRALIA, 2015-16, A$ MILLION

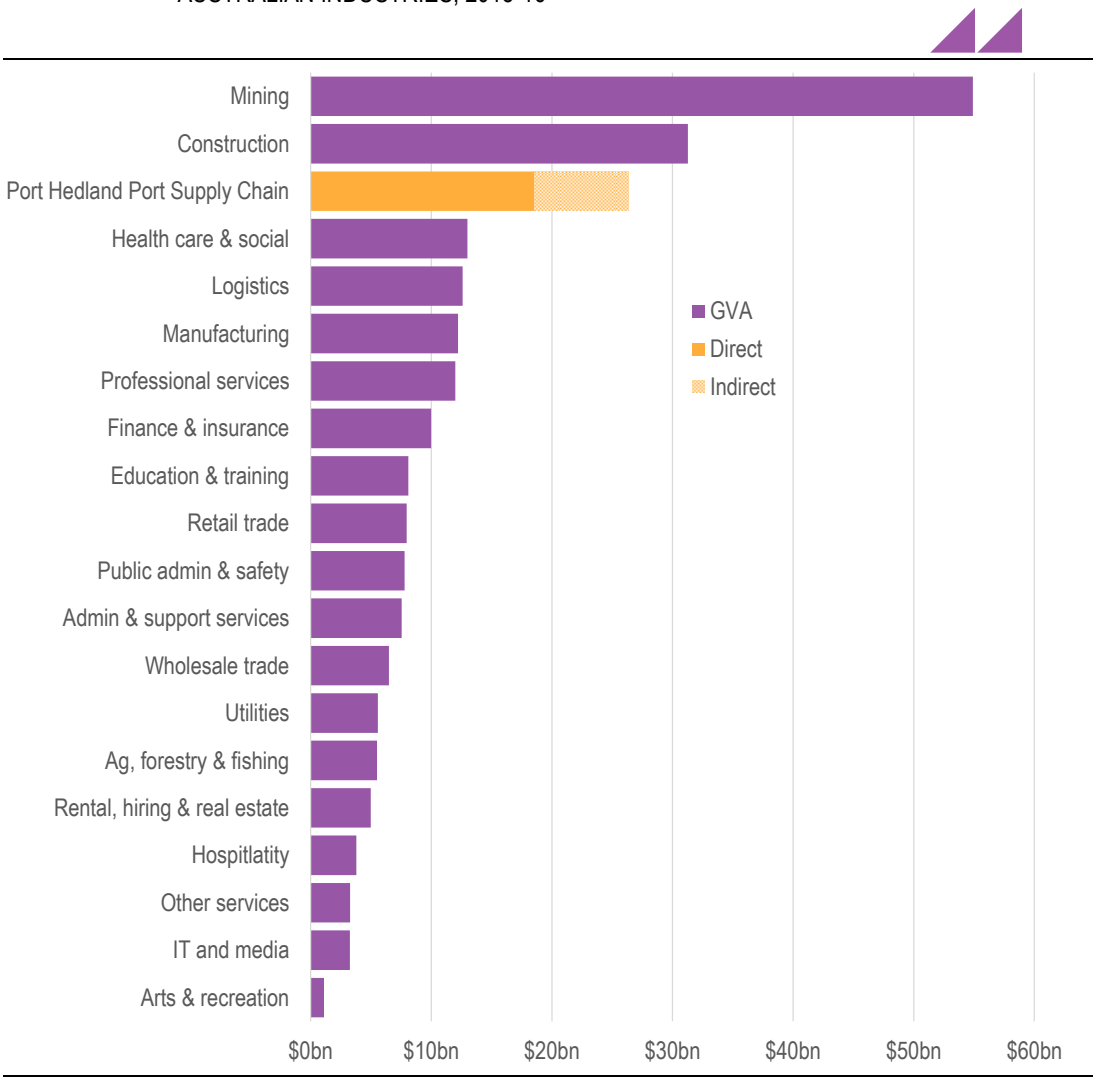
SOURCE: ACIL ALLEN CONSULTING

If the Port Hedland Port Supply Chain was its own industry under the ABS definition of an industry, it would be the third largest industry in the State behind the overall Mining industry ($69.9 billion, 28.1 per cent of the State's economy) and Construction industry ($30.5 billion, 12.4 per cent) (**Figure 3.11**).

If the Port Hedland Port Supply Chain was its own industry, it would rank as the State's third largest industry in 2015-16

The indirect economic contribution of the Port Hedland Port Supply Chain to the Western Australian economy was $7.8 billion, yielding a multiplier of 1.42. The total economic contribution of the Port Hedland Port Supply Chain to the Western Australian economy is $26.4 billion – almost as much as the State's entire construction industry.

FIGURE 3.11 SIZE OF PORT HEDLAND PORT SUPPLY CHAIN RELATIVE TO OTHER WESTERN AUSTRALIAN INDUSTRIES, 2015-16



SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 5220.0

The Port Hedland Port supports around one in every 20 FTE jobs in Western Australia

This level of economic contribution supported just over 59,000 (59,015) FTE jobs in the Western Australian economy – or around one in every 20 FTE jobs in the State. Significantly, 47,062 (80 per cent) of these jobs are on an indirect basis, indicating the extent to which the Port Hedland Port Supply Chain supports the broader Western Australian economy. Similarly, of the $6.3 billion of wages and salaries contributed by the Port and its operators, 67 per cent was on an indirect basis.

Australia

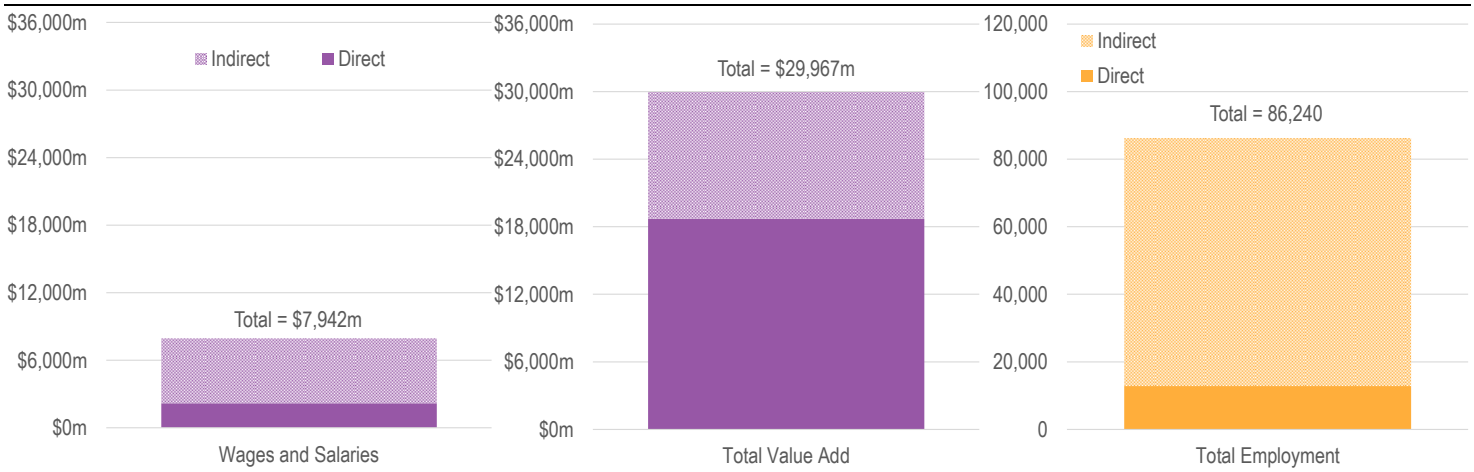
The Port Hedland Port Supply Chain alone contributed $30 billion in economic output to the Australian economy in 2015-16. This is equivalent to 1.9 per cent of GDP, or approximately three quarters of the

total annual economic output of Australia's agriculture, forestry and fisheries industry (refer to **Figure 3.12**). Excluding Western Australia, the Port Hedland Port Supply Chain directly contributed $193.9 million to the national economy, and contributed a further $3.4 billion on an indirect basis.

This contribution does not include the taxes and charges which ACIL Allen estimates accrued to the Commonwealth Government as a result of the activities of the Port and its operators.

This level of economic contribution supported a total of 86,240 FTE jobs, with 12,850 of these direct and 73,390 of them indirect. The Port Hedland Port Supply Chain contributed $8.1 billion in wages and salaries, with the vast majority of this (73 per cent) on an indirect basis.

FIGURE 3.12 ECONOMIC CONTRIBUTION OF THE PORT HEDLAND PORT SUPPLY CHAIN IN AUSTRALIA, 2015-16, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

3.2.2 Contribution to Taxes and Royalties

As part of its economic contribution study modelling, ACIL Allen is able to derive estimates of a number of taxes and charges that have been collected by State and Commonwealth Governments in a given financial year. These taxes include:

- Goods and Services Tax (GST);
- Import duties; and
- Payroll tax.

ACIL Allen has also collected information from relevant operators to allow it to calculate other lines of taxes and charges paid that are not typically estimated as part of an economic contribution study. These include:

- Royalties paid (direct);[9]
- Dividends collected by the State Government from the Port's operations;[10]
- Company tax paid (direct);[11] and

[9] ACIL Allen received information on the value of royalties paid to the Western Australian Government by the State's major iron ore producers, and estimates royalties paid on other commodities where royalties are payable. Estimates were derived using information gathered from PPA and the Department of Mines, Industry Regulation and Safety.

[10] ACIL Allen apportioned the revenue, expenditure and wages paid by PPA to the Port of Port Hedland and other operations on the basis of the share of trade (in tonnes) facilitated by Port Hedland Port as a share of total PPA trade. ACIL Allen then applied the State Government's current policies as they relate to Government Trading Enterprise dividends and income tax equivalents to arrive at the estimate.

[11] ACIL Allen receive information on the value of company tax paid by the State's major iron ore producers, and scaled this up on a per revenue tonnes basin to arrive at the estimate.

— Personal income tax paid on wages and salaries (direct).[12]

These estimates are presented in **Table 3.1**, with the method for calculating estimates where required are found in the footnotes found on the previous page and below.

TABLE 3.1 CONTRIBUTION OF THE PORT HEDLAND PORT SUPPLY CHAIN TO REVENUES OF THE WESTERN AUSTRALIA AND COMMONWEALTH GOVERNMENTS, 2015-16, $M

Line of taxation	Western Australia Government	Other States	Commonwealth	Total
Goods and Services Tax	$56m	$5m	N/A	**$61m**
Import duties	N/A	N/A	$2m	**$2m**
Payroll tax	$193m	$9m	N/A	**$202m**
Royalties	$1,921m	N/A	N/A	**$1,921m**
Dividends and other payments from the Port	$101m	N/A	N/A	**$101m**
Company tax paid	N/A	N/A	$1,797m	**$1,797m**
Personal income taxes	N/A	N/A	$606m	**$606m**
Total	**$2,271m**	**$14m**	**$2,405m**	**$4,689m**

SOURCE: ACIL ALLEN CONSULTING

The Port Hedland Port Supply Chain accounted for 8.2 per cent of the State's General Government revenue in 2015-16

In total, ACIL Allen estimates that the Port Hedland Port Supply Chain directly paid $2.3 billion in taxation receipts to the Western Australia Government and a further $2.4 billion to the Commonwealth in 2015-16. The majority of this flowed to the State through royalties ($1.9 billion) and to the Commonwealth through company taxes ($1.8 billion) and personal income tax ($606 million).

In relation to the revenue flows to the Western Australia Government, ACIL Allen estimates the Port Hedland Port Supply Chain accounted for 8.2 per cent of the State's General Government revenue in 2015-16.

[12] ACIL Allen calculated the average FTE salary of the wages and salaries paid to direct employees of the relevant entities. Using the ATO tax tables, and an estimate of the average allowable deduction as a share of total income tax withholding (according to Federal Budget paper), ACIL Allen calculated an effective average tax rate of 27.7 per cent would be payable on this per FTE value. ACIL Allen then applied this ratio to the total wages and salaries directly paid by the Port and operators

4 THE FUTURE GROWTH OF PORT HEDLAND PORT

This chapter of the report provides an overview of the history and outlook for the iron ore industry as it relates to the Port, including an assessment of the likely growth of the Port's iron ore exports which form the basis of the inputs into the economic impact modelling undertaken in Section 5.

4.1 Recent trends in iron ore market

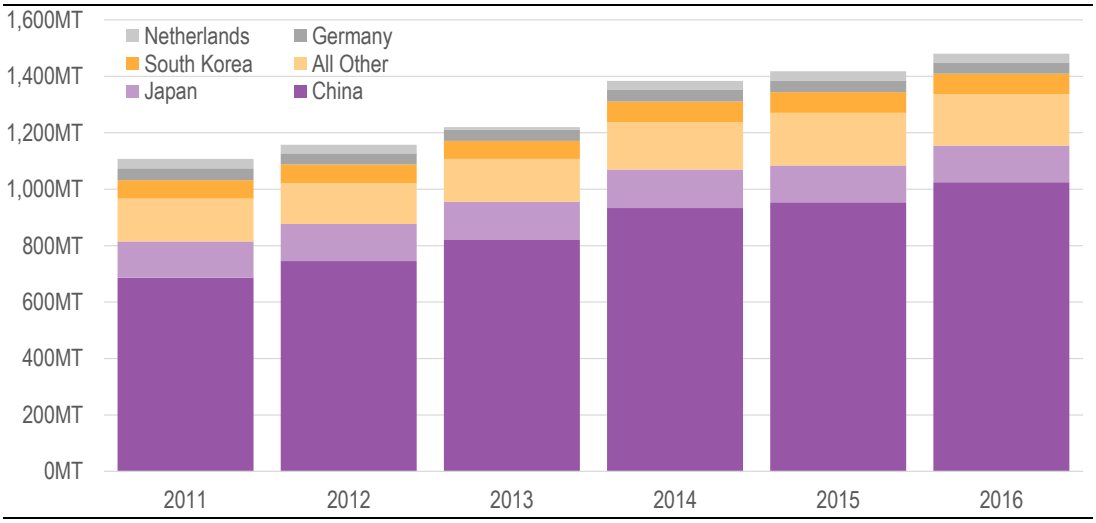
4.1.1 Historic market overview

The following section provides a brief historic overview of the of the seaborn iron ore market.

Global demand for iron ore

Global demand for seaborn iron ore has been driven by China over the past five years, accounting for on average 66 per cent per year. China's demand for seaborn iron ore has increased by 49 per cent over the past five years, from 687 million tonnes in 2011 to 1,025 million tonnes in 2016 (refer to **Figure 4.1**).

FIGURE 4.1 GLOBAL DEMAND OF SEABORN IRON ORE, BY COUNTRY, MILLION TONNES



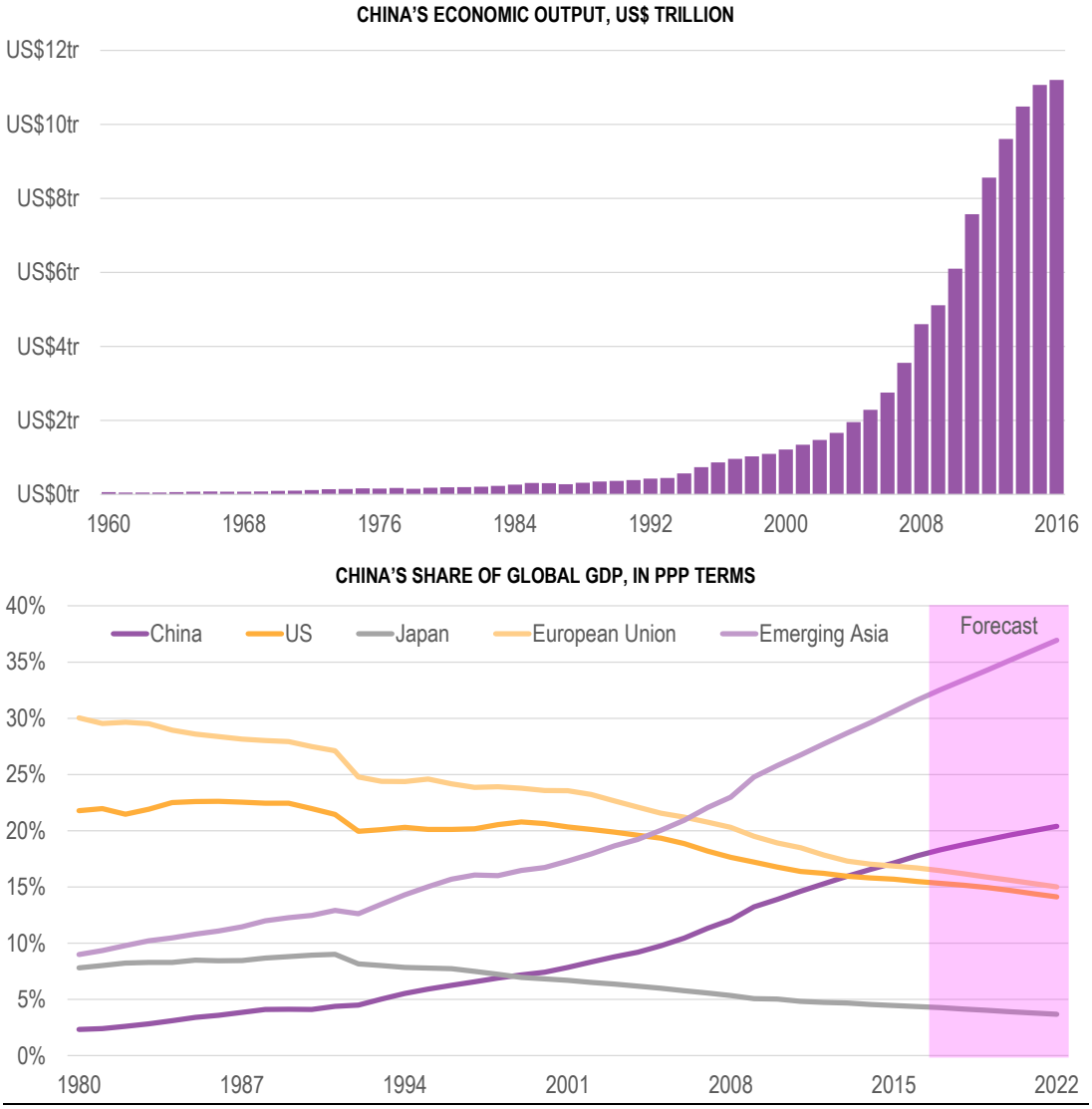
SOURCE: ACIL ALLEN CONSULTING, SNL METALS AND MINING

Chinese demand for iron ore has been driven by the rapid expansion of the Chinse economy over the past decade and a half. China's development was historically driven by industrial sectors (such as

mining, manufacturing, agriculture and exports), and this has resulted in large demand for steel from Chinese steel mills.

The Chinese economy has roughly doubled in size every eight years since the early 2000s, increasing its share of global economic output in purchase power parity (PPP) terms to the largest in the world (refer to **Figure 4.2**). China has been the major driver of global economic growth, however, smaller developing countries in Asia have and will continue to be drivers of global growth (refer to **Figure 4.2**).

FIGURE 4.2 CHINESE ECONOMIC GROWTH



SOURCE: ACIL ALLEN CONSULTING, IMF, WORLD BANK

Global supply of iron ore

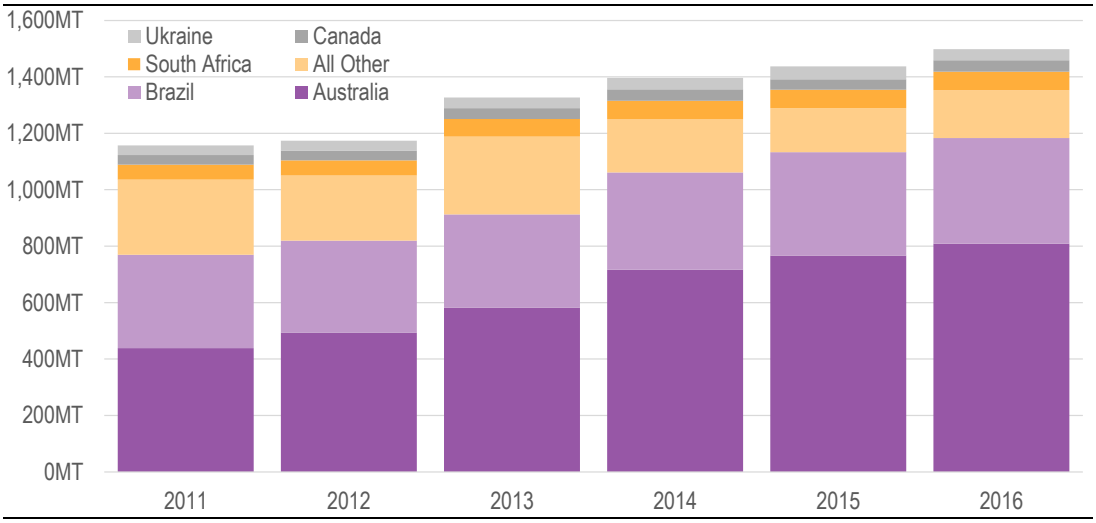
In response to a significant increase in demand for steel, Chinese steel mills began sourcing iron ore from the global market, as the existing Chinese iron ore producers could not keep pace with the growth in demand.

Since 2011, the seaborn iron ore market has grown by 29 per cent, from 1,150 million tonnes to just under 1,500 million tonnes in 2016 (refer to **Figure 4.3**, overleaf). Growth has been led by the rapid expansion of the iron ore industry in Australia and Brazil.

Growth in the Australian market has been the most profound of any major producing nation, growing from a country that exported just under 450 million tonnes in 2011 to over 800 million tonnes in 2016 (growth of 85 per cent).

Australia's growth has been driven by major investment projects undertaken by some of the world's largest mining companies (BHP (then BHP Billiton), Rio Tinto, FMG and Hancock Prospecting), along with significant investment by junior mining companies (Atlas Iron, BC Iron, Mineral Resources and others). This has seen the Australian iron ore industry displace supplies from the rest of the world, which has declined by 36 per cent over the past five years.

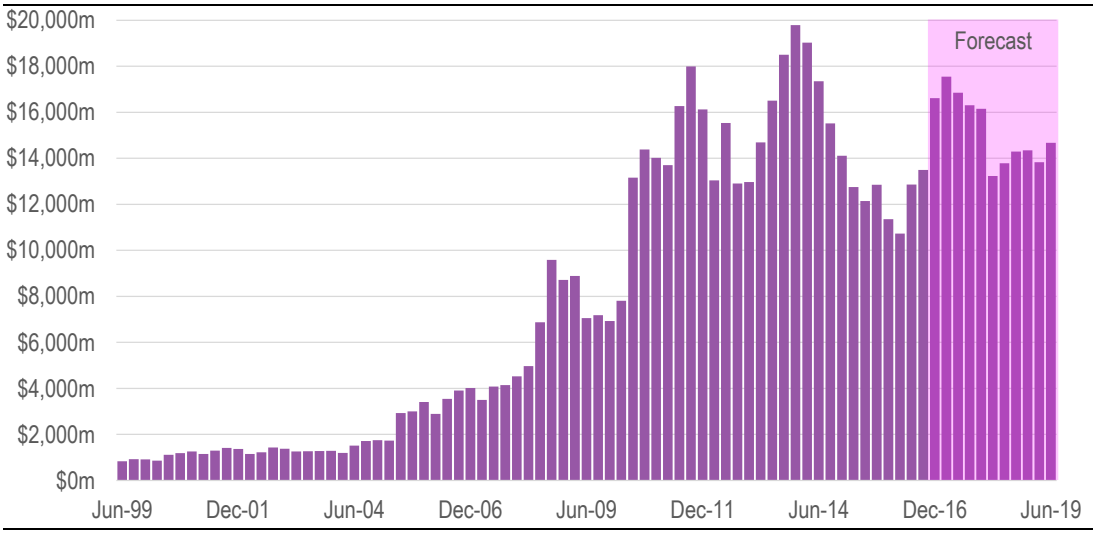
FIGURE 4.3 GLOBAL SUPPLY OF SEABORN IRON ORE, BY COUNTRY, MILLION TONNES



SOURCE: ACIL ALLEN CONSULTING, SNL METALS AND MINING

Over a similar period of time, the value of Australia's iron ore exports have increased significantly, growing from $1.3 billion in December 2000 to a peak of $19.8 billion in December 2014. While Australia's supply to the seaborn market has continued to grow over the past five years, the value of Australia's supply has risen sharply and then decreased sharply, due to the volatility of the spot price for iron ore (refer to **Figure 4.4**).

FIGURE 4.4 VALUE OF AUSTRALIAN IRON ORE EXPORTS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING, ABS, DEPARTMENT OF INDUSTRY, INNOVATION AND SCIENCE

Prices

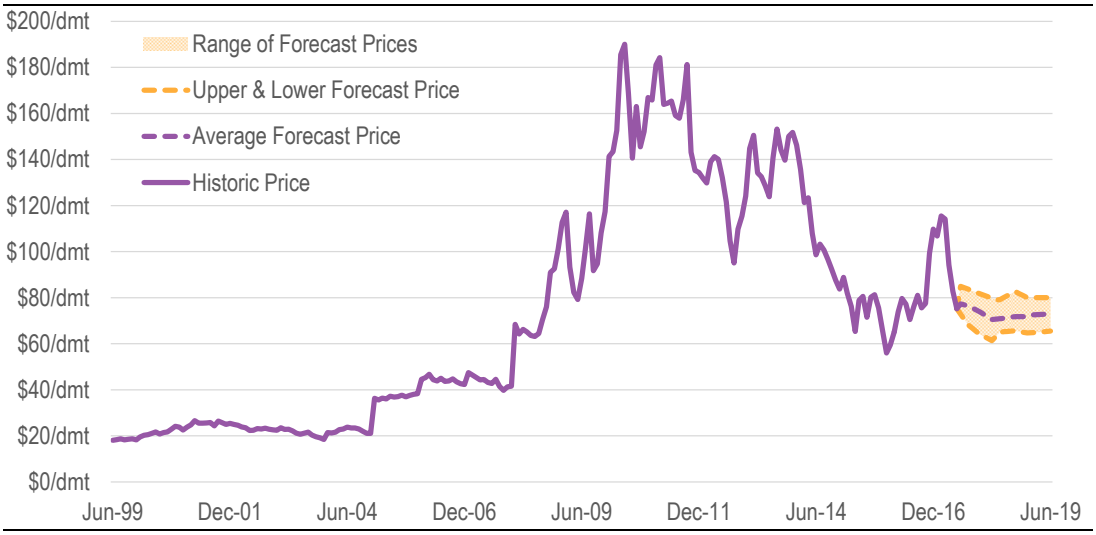
Over the past decade, the price of seaborn iron ore has been driven by demand and by supply at different points in time.

The price of seaborn iron ore reached a high of A$190 per dmt in May 2010 (refer to **Figure 4.5**), and was largely driven by demand from Chinese steel mills in response to fiscal stimulus by Chinese Authorities. As the market adjusted to increased demand, additional supply was introduced to the seaborn market, particularly from Brazil.

As the supply of seaborne iron ore continued to increase, prices adjusted downwards. This adjustment reached a turning point in January 2016 when the seaborn iron price reached a low of A$59 per dmt. However, since then, many of the high cost producers that were able to operate in the market under higher prices were now no longer profitable.

More recently, the price of seaborne iron ore rose to a multi-year high of A$115 per dmt in February 2017 on the back of a temporary stimulus-induced increase in Chinese demand. Since then the price has settled back at around A$75 per dmt in June 2017. The short term outlook for seaborn iron ore prices is for the benchmark price to average around A$75 per dmt, with the upper range of forecast prices averaging above A$80 per dmt and the lower range above A$60 per dmt (refer to **Figure 4.5**).

FIGURE 4.5 HISTORIC AND FORECAST IRON ORE PRICES, A$/DMT



Note: US$/dmt iron ore prices were converted to A$/dmt using historic exchange rates from the RBA or by assuming a constant US$0.75 exchange rate. Forecast prices include: Western Australia Treasury (2017-18), Office of the Chief Economist (June 2017), SNL Consensus (July 2017), Citi Group (July 2017), NAB Corporation (August 2017).

SOURCE: ACIL ALLEN CONSULTING; RBA; WA TREASURY; THE STEEL INDEX VIA THE IMF; DEPARTMENT OF INDUSTRY, INNOVATION AND SCIENCE, SNL METALS AND MINING VIA S&P GLOBAL MARKET INTELLIGENCE

4.1.2 Market outlook

The following section provides a brief outlook for the seaborne iron ore market.

Demand

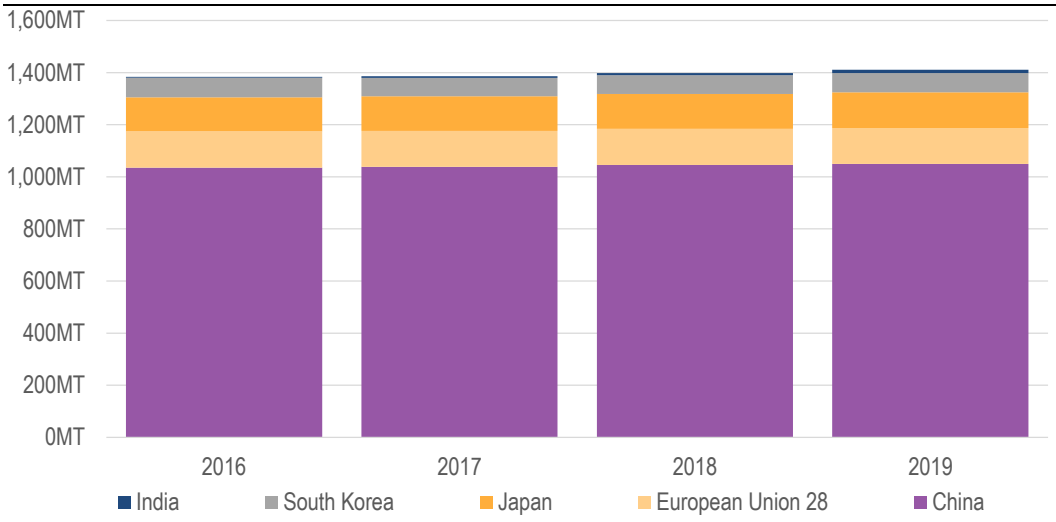
Estimates from the Department of Industry, Innovation and Science (via the World Steel Association and Bloomberg) suggest the demand for seaborn iron ore will remain relatively robust over the next few years (refer to **Figure 4.6**). However, no real growth in demand has been forecast.

The majority of demand will continue to come from China. In the near term, seasonal effects and liquidity constraints[13] are expected to place downside risk on demand from Chinese steel mills.

[13] Tighter regulation being enforced by Chinese Authorities on the banking system is expected to reduce the liquidity of steel mills.

Seaborn demand from India is also beginning to emerge, with India expected to be the largest source of demand for steel outside of China in the coming years.

FIGURE 4.6 VOLUME OF IRON ORE IMPORTS, BY COUNTRY, MILLION TONNES



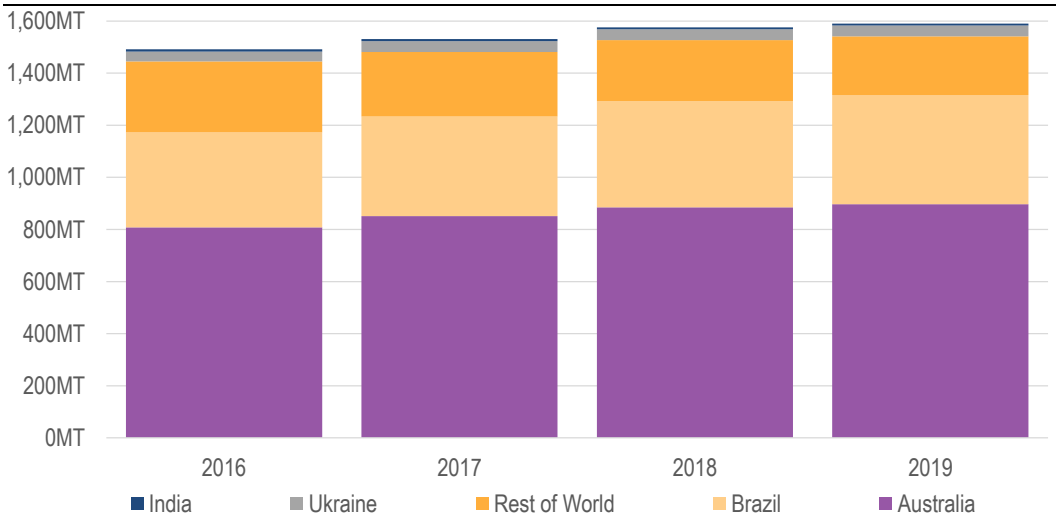
SOURCE: ACIL ALLEN CONSULTING, WORLD STEEL ASSOCIATION, BLOOMBERG

Supply

The Department of Industry, Innovation and Science (via the World Steel Association and Bloomberg) expect the supply of seaborn iron ore to remain robust over the coming years (refer to **Figure 4.7**). The majority of the supply will continue to come from the low cost producing nations of Australia and Brazil, and from the "Big Four" – Vale, Rio Tinto, BHP and FMG.

Higher seaborn iron ore prices have resulted in a number of high cost producers from China, India and other smaller markets restarting operations.[14] However, if the market price forecast in **Figure 4.5** eventuates, a number of these high cost producers will likely exit the market.

FIGURE 4.7 VOLUME OF IRON ORE EXPORTS, BY COUNTRY, MILLION TONNES

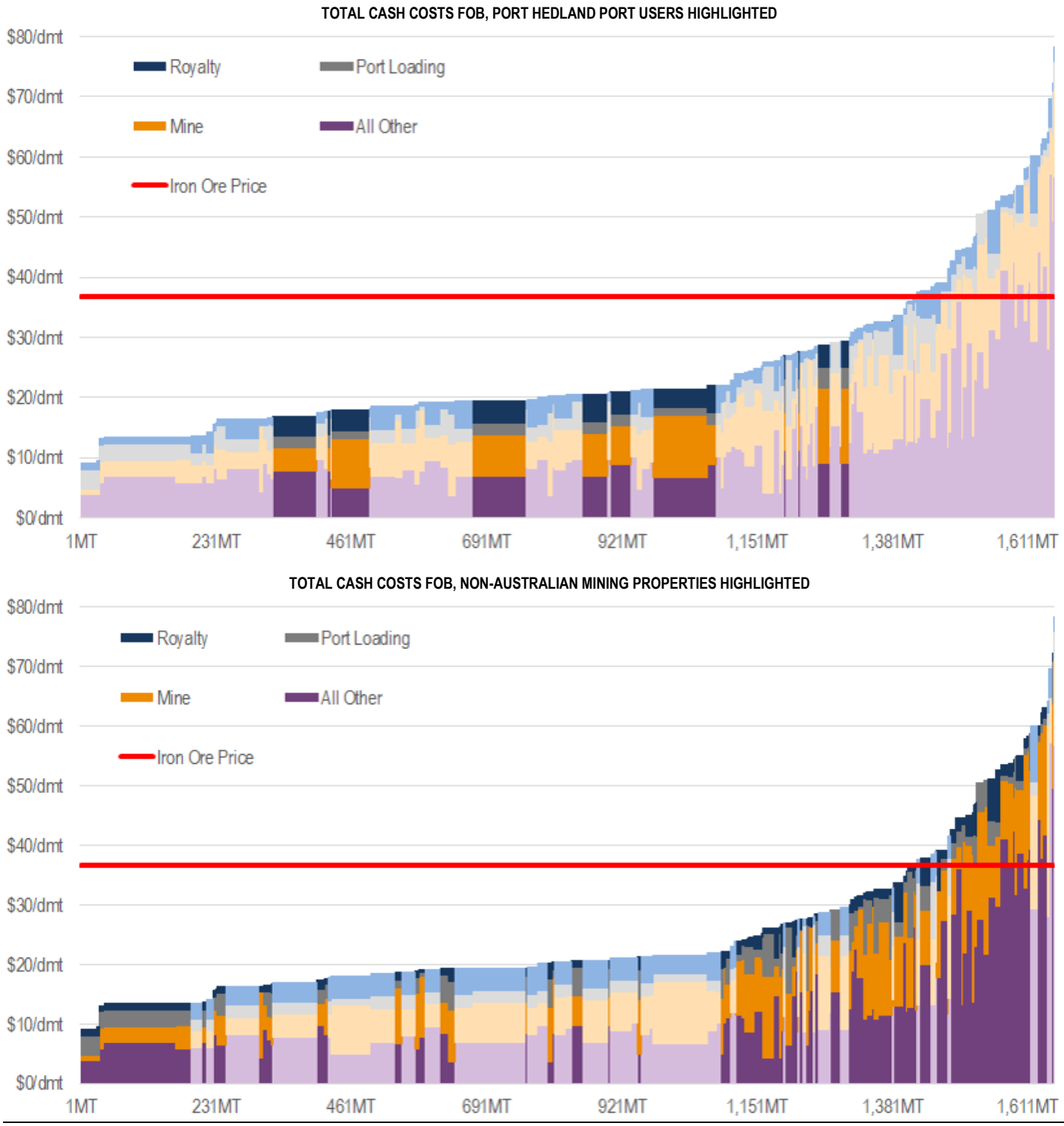


SOURCE: ACIL ALLEN CONSULTING, WORLD STEEL ASSOCIATION, BLOOMBERG

[14] Citi Research, *Commodities 3Q'17 Market Outlook*.

Research conducted by Citi Group suggests the seaborn price may need to fall to as low as US$45 per dtm before a significant supply response it triggered. Cash cost analysis conducted by ACIL Allen (presented in **Figure 4.8**) highlights that even at the lowest price for seaborn iron ore used in this engagement (US$36.7 per dmt from 2022-23 onwards) there is still significant global supply of iron ore (over 1,400 million tonnes).

FIGURE 4.8 2017 TOTAL CASH COST FOB, BY GLOBAL IRON ORE PROPERTY, US$/DMT



Note: dark bars represent size (by million tonnes produced in 2017) of 'highlighted' mining properties. Each bar represents one million tonne of iron ore production.

SOURCE: ACIL ALLEN CONSULTING, SNL METALS AND MINING VIA S&P GLOBAL MARKET INTELLIGENCE

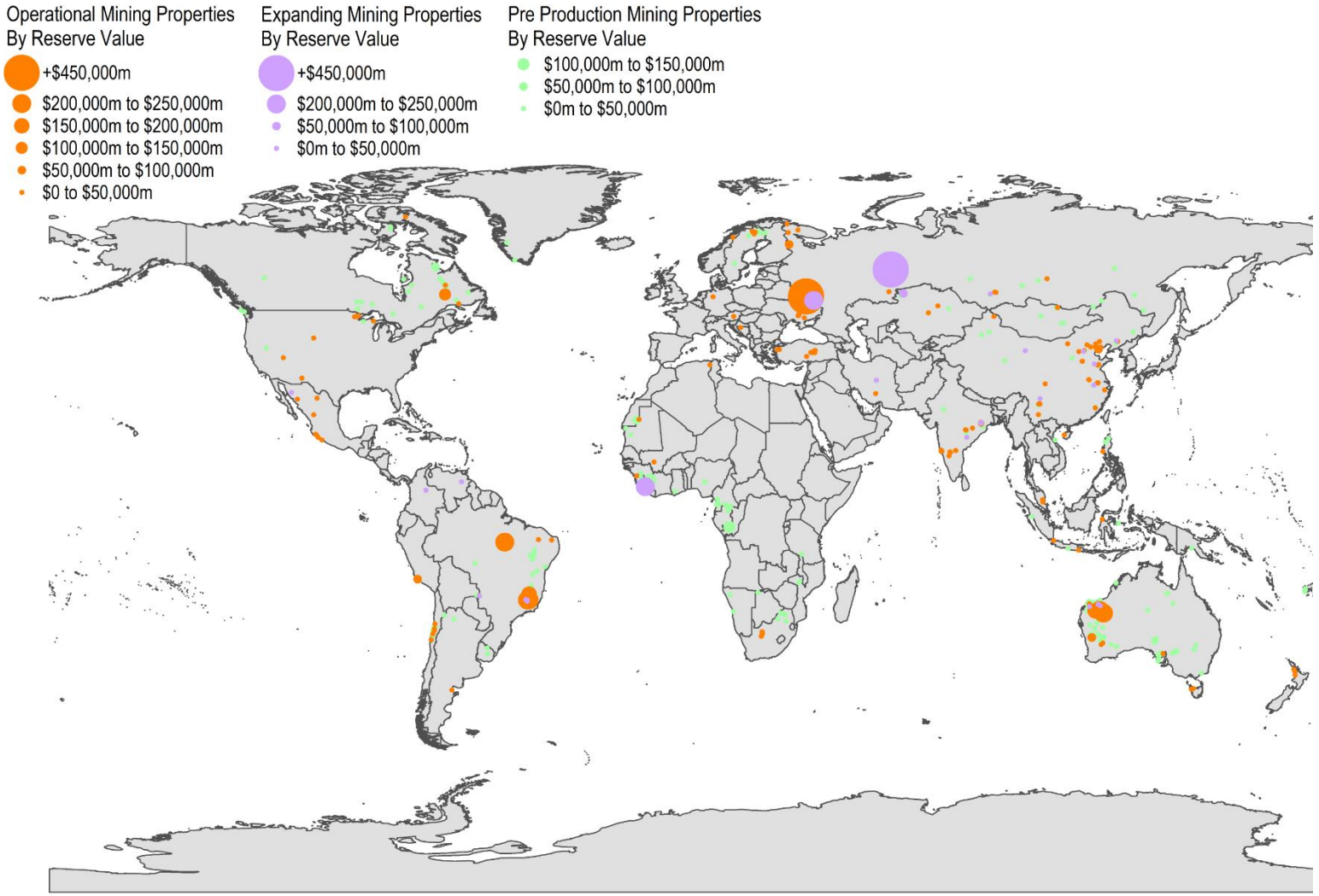
Figure 4.8 also highlights that a significant volume of iron ore is supplied to the seaborne market by cost competitive mining properties that are not users of the Port Hedland Port (represented in the first chart by the lighter shaded columns), and are importantly supplied by international cost competitive mining properties (represented in the second chart by the darker shaded columns).

While there are a significant number of cost competitive mining proprieties around the world, there are also significant reserves remaining around the globe. **Figure 4.9** presents the value of major iron ore mining properties around the world.[15]

Of the operational properties presented in **Figure 4.9**, there is still some US$4 trillion worth of reserves left to be mined. In addition, there is an additional US$1 trillion worth of reserve that are under expansion and a further US$1 trillion worth of reserves that are pre-production.

[15] SNL Metals and Mining.

FIGURE 4.9 GLOBAL MINING PROPERTIES, BY RESERVE VALUE AS AT 2017, US$ MILLION



Definition of development stage:

- Operational: operating and limited production.
- Expanding: expansion.
- Pre-Production: satellite, reserve development, feasibility started, feasibility, prefeasibility/scoping, construction started, preproduction, feasibility compete, construction planned, advanced exploration and commissioning.

SOURCE: ACIL ALLEN CONSULTING, SNL METALS AND MINING VIA S&P GLOBAL MARKET INTELLIGENCE

4.1.3 Port Hedland iron ore

In 2016-17, the total tonnes exported from the Port grew to 495.6 MT, with an estimated value of $49.3 billion (preliminary information based on market data on average spot iron ore price per month), up from 454.1 MT and $29.1 billion in 2015-16. The growth in value was driven by a mid year increase in the spot price of iron ore to a three year high of almost US$90 per tonne, an appreciation of the Australian dollar, and growth in total volumes exported of 9.1 per cent.

The Port services five iron ore producers, with estimates of total tonnes produced and shipped through the Port by operator provided in **Table 4.1** below.

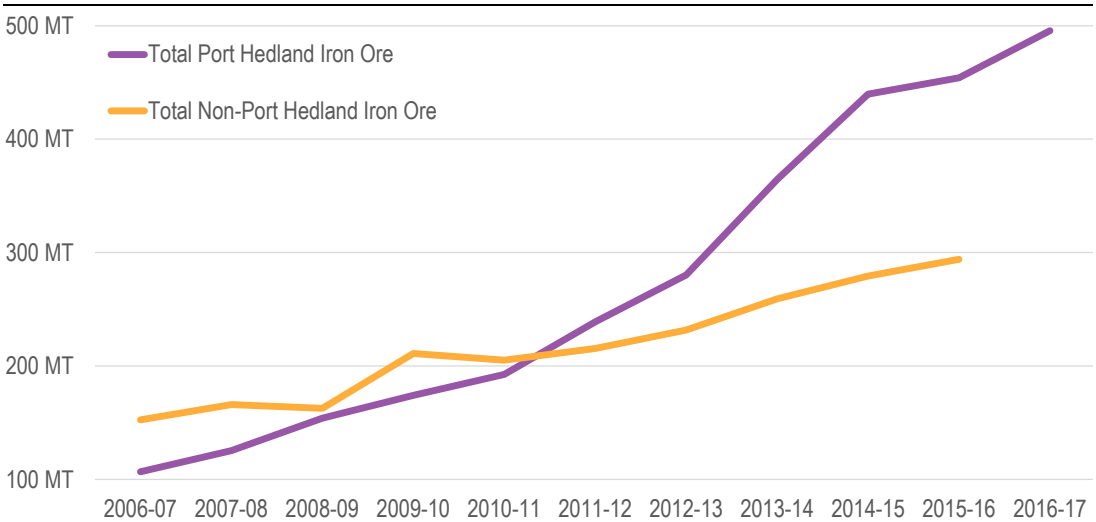
TABLE 4.1 IRON ORE PRODUCERS 2016-17 PRODUCTION

Operator	Ore shipped (MT)	Source
BHP Ltd	268.2 MT	BHP Quarterly Production Reports, adjusted to 100 per cent production to account for share of production accounted for by JV partner (Mitsubishi)
Fortescue Metals Group Ltd	170.0 MT	FMG Quarterly Production Reports
Roy Hill Pty Ltd	34.7 MT	Calculated as a residual of total iron ore exports through Port Hedland port less known shipping data from other iron ore producers.
Atlas Iron Ltd	15.0 MT	Atlas Iron Quarterly Activities Reports (Q1-Q3 FY17) and estimate of Q4 production using FY16 report and forward guidance
Mineral Resources Ltd	7.7 MT	Mineral Resources Quarterly Activities Reports (Q1-Q3 FY17) and estimate of Q4 production using FY16 report and forward guidance

SOURCE: ACIL ALLEN CONSULTING, QUARTERLY PRODUCTION REPORTS, ANNUAL REPORTS, PPA

This marked the continuation of a decade-long trend of significant growth in iron ore exports from the Port, owing to the economic growth and urbanisation of China and its demand for commodities. Port Hedland's iron ore exports have increased almost five-fold from 106.2 MT in 2006-07 to the 495.6 MT last financial year. Total Western Australian iron ore exports grew from 259.0 MT in 2006-07 to 748.1 MT in 2015-16 (data for 2016-17 is unavailable) (**Figure 4.10**).

FIGURE 4.10 IRON ORE EXPORTS, PORT HEDLAND PORT, MILLION OF TONNES, FINANCIAL YEAR



SOURCE: ACIL ALLEN CONSULTING, DEPARTMENT OF MINES, INDUSTRY REGULATION AND SAFETY, PPA (NOTE: 2016-17 DATA FOR WESTERN AUSTRALIA IS NOT AVAILABLE)

4.2 Projected growth of Port Hedland Port iron ore exports

To conduct the economic impact assessment, ACIL Allen has developed a short term forecast and medium term projection for iron ore export income growth facilitated by the Port. Our projection is in two phases:

— short term (2016-17 to 2021-22), which is based on market information; and

— medium term (2022-23 to 2026-27), which is based on information provided by PPA regarding ultimate theoretical capacity of the Port Hedland inner harbour.

ACIL Allen has made additional assumptions regarding the spot price of iron ore, the exchange rate, the location of iron ore production that would substitute the lost output from the Port and its operators, and labour requirements to facilitate the additional tonnage to calculate future iron ore income growth from the Port.

To derive the inputs necessary to undertake the economic modelling, ACIL Allen has assumed that the iron ore exports were effectively "capped" at 2016-17 levels. Capping exports at this level provides an indication of the additional potential economic activity if expansion of export volumes out of the Port is realised.

The difference between the growth projection and the capped amount over the study period is then used to determine how much higher iron ore exports would be in the aggregate.

For the purposes of this study, it is assumed that no new port infrastructure is built at Port Hedland to facilitate exports from producers that currently use Port Hedland, and these producers cannot shift their production to other ports due to prohibitive costs.

These forecasts are outlined below.

4.2.1 Short term volume forecast: FY2022

Over the first five years of the study period, ACIL Allen has used publicly announced plans, forward guidance statements, and information confidentially provided by providers to build a bottom up forecast of iron ore export volumes from the Port. Realising this short term forecast is contingent on companies successfully applying to increase their relevant regulated shipping caps. The forecast by year, including annual growth in millions of tonnes, is outlined below.

TABLE 4.2 PORT HEDLAND IRON ORE EXPORT: SHORT-TERM FORECAST

Year	Total	Annual Change (MT)
2016-17 (actual)	495.6 MT	+41.5 MT
2017-18 (forecast)	528.8 MT	+33.2 MT
2018-19	553.7 MT	+24.9 MT
2019-20	579.6 MT	+25.9 MT
2020-21	602.7 MT	+23.1 MT
2021-22	613.7 MT	+11.0 MT

SOURCE: ACIL ALLEN CONSULTING, BASED ON ANNUAL REPORTS, FORWARD STATEMENTS AND INFORMATION PROVIDED BY PRODUCERS

ACIL Allen forecasts iron ore exports through the Port will increase from 495.6 MT in 2016-17 to 613.7 MT in 2021-22. This equates to annual average growth of 4.4 per cent over the five year period, compared to 16.1 per cent annual average growth in the five years to 2016-17.

4.2.2 Medium term volume projection: FY2027

Following 2021-22, it is assumed iron ore exports from the Port reach the Port's ultimate capacity of 700 MT by 2026-27. This ultimate capacity of 700 MT was provided by PPA during stakeholder consultation for this report. It is assumed iron ore exports increase at a constant rate of 2.7 per cent per annum to reach 700 MT by the end of the period, which is a conservative forecast compared to

the short term forecasts for the preceding five years. The forecast by year, including annual growth in millions of tonnes, is outlined below.

TABLE 4.3 PORT HEDLAND IRON ORE EXPORT: MEDIUM-TERM PROJECTION

Year	Total	Annual Change (MT)
2021-22	613.7 MT	+11.0 MT
2022-23	630.1 MT	+16.4 MT
2023-24	646.9 MT	+16.8 MT
2024-25	664.1 MT	+17.2 MT
2025-26	681.8 MT	+17.7 MT
2026-27	700.0 MT	+18.2 MT

SOURCE: ACIL ALLEN CONSULTING, PILBARA PORTS AUTHORITY

4.2.3 Other considerations

To derive projected iron ore export income, ACIL Allen has adopted the following iron ore price and exchange rate assumptions to translate iron ore volumes to values. ACIL Allen has taken a deliberatively conservative approach regarding iron ore prices for the purposes of this study.

TABLE 4.4 PORT HEDLAND IRON ORE EXPORT: ADDITIONAL ASSUMPTIONS

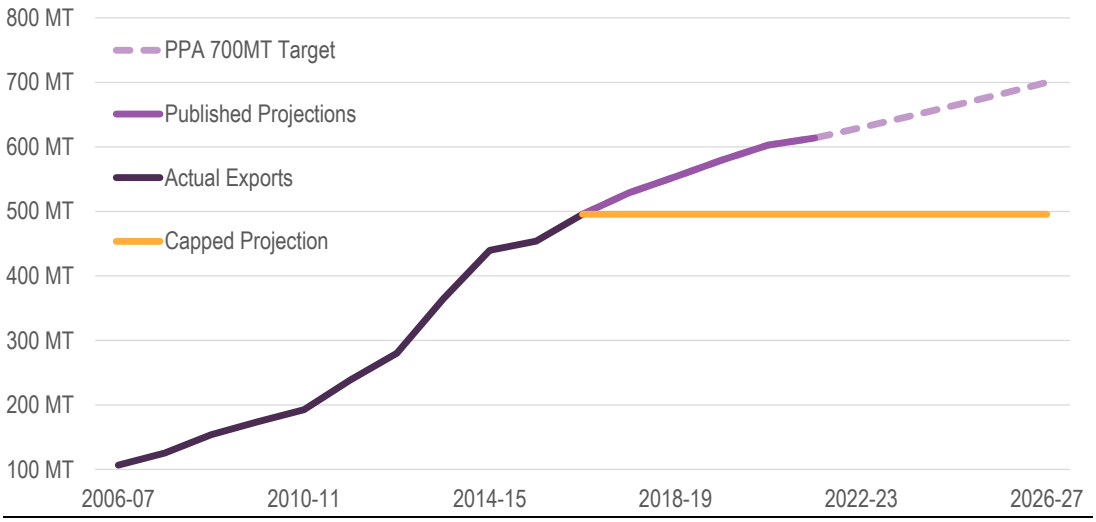
Assumption	Value	Source
2017-18 iron ore price (US$/t, FOB)	US$44.89/t	Consensus forecast developed using input from Macquarie Group, BMI Research, Western Australia Treasury, World Bank and industry operators
2018-19 iron ore price	US$43.33/t	
2019-20 iron ore price	US$41.34/t	
2020-21 iron ore price	US$39.15/t	
2021-22 iron ore price	US$37.63/t	
2022-23 to 2026-27 iron ore price	US$36.70/t	
AUD/USD exchange rate	US$0.76	Reserve Bank of Australia 10 year historical average

SOURCE: ACIL ALLEN CONSULTING, BASED ON ANNUAL REPORTS, FORWARD STATEMENTS AND INFORMATION PROVIDED BY PRODUCERS

4.3 Results

The iron ore export volume scenarios discussed above are presented in **Figure 4.11** below.

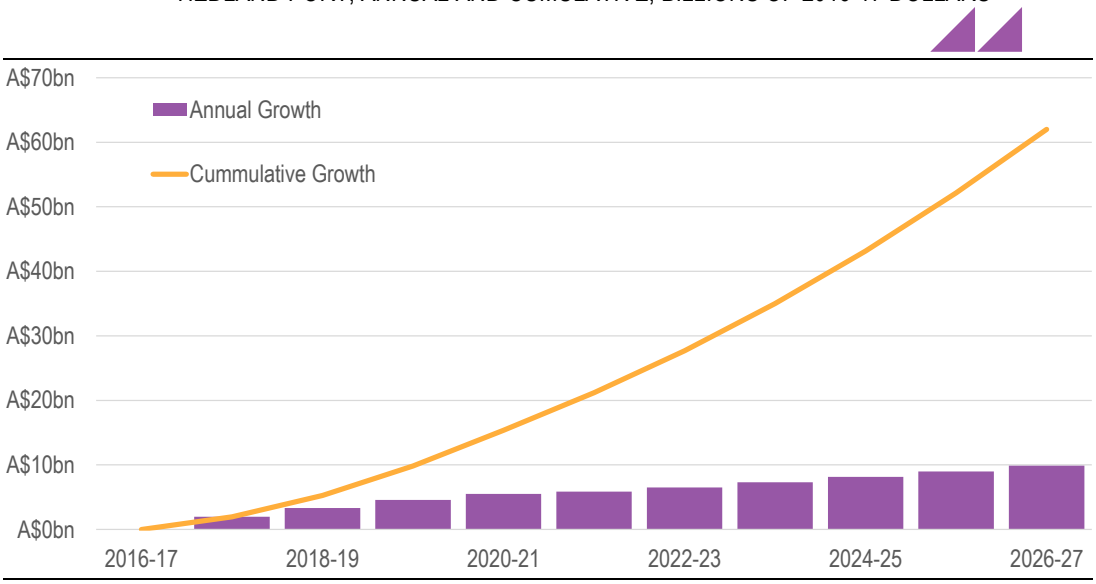
FIGURE 4.11 IRON ORE EXPORT SCENARIOS



SOURCE: ACIL ALLEN CONSULTING

Using the assumptions outlined above, ACIL Allen estimates that should the Port be allowed to grow to its full potential over the coming ten years, the Port will deliver a cumulative $316.2 billion in iron ore export income to the local, State and national economies. For modelling purposes, ACIL Allen estimates there would be a gross gain of iron ore export income of $62.0 billion in the ten years ending 2026-27 (2016-17 dollars) over the hypothetical 2016-17 "capped" volume – if exports were not allowed to grow. This is represented in **Figure 4.12** below.

FIGURE 4.12 INCOME GAINED FROM REALISING IRON ORE EXPORT GROWTH FROM PORT HEDLAND PORT, ANNUAL AND CUMULATIVE, BILLIONS OF 2016-17 DOLLARS



SOURCE: ACIL ALLEN CONSULTING

The next chapter of this report articulates the economic impact associated with this potential gain in income to the local, State and national economies.

5 ECONOMIC IMPACT ASSESSMENT OF REALISING THE FUTURE GROWTH OF THE PORT

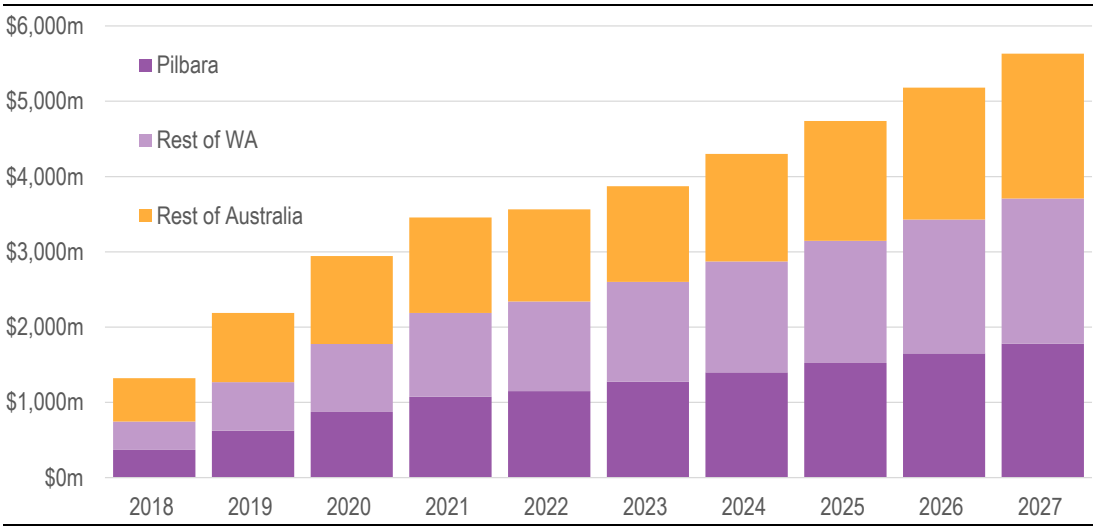
This section explores the broader economic impacts of the expected future growth of the Port Hedland Port as it reaches a theoretical maximum capacity of 700MT per annum by 2026-27 for the Pilbara, Western Australia and Australia economies using ACIL Allen's *Tasman Global* computable general equilibrium model. The economic impact is assessed on an **output** basis (GDP, GSP, GRP), on an **income** basis, and in relation to the impact on **employment** (on a full time equivalent basis). The economic impact is also assessed based on the **total taxation payments** – that is both direct and indirect taxes – that result from Port Hedland Port Supply Chain.

5.1 Real income

ACIL Allen estimates that the potential real income increase associated with the Port Hedland Port reaching its projected export capacity of 700MT is a cumulative $37.2 billion over the ten years ending 2026-27 (2016-17 dollars).

The average potential annual increase in real income increases in line with the growth in iron ore exports – from $1.3 billion in 2017-18 to $5.6 billion in 2026-27. This is highlighted in **Figure 5.1** below.

FIGURE 5.1 REAL INCOME IMPACT, ANNUAL TOTALS, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

The relative impact on the Pilbara region is most significant, given the size of the Pilbara's economy

The potential increase in real income over 10 years is spread evenly across the Pilbara ($11.7 billion), the Rest of Western Australia ($12.4 billion) and the rest of Australia ($13.1 billion). However, the relative impact on the Pilbara region is most significant, given the size of the Pilbara's economy.

The potential real income increase by jurisdiction is outlined in **Table 5.1**.

TABLE 5.1 PROJECTED CUMULATIVE CHANGE IN REAL INCOMES, REAL TERMS, A$ MILLION

	Total	Average	Discounted (7%)
Pilbara	$11,719m	$1,172m	$7,653m
Western Australia	$12,352m	$1,235m	$8,039m
Rest of Australia	$13,126m	$1,313m	$8,731m
Total Australia	**$37,197m**	**$3,720m**	**$24,424m**

Note: totals can be subject to rounding errors

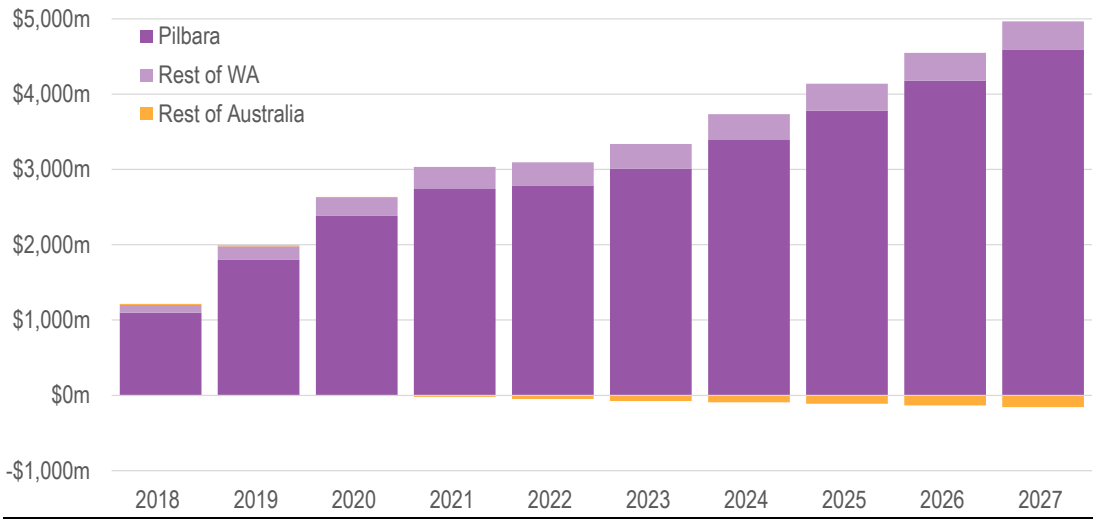
SOURCE: ACIL ALLEN CONSULTING

5.2 Real output

ACIL Allen estimates that the potential real output increase associated with the Port Hedland Port reaching its projected export capacity of 700MT is a cumulative $32 billion over the ten years ending 2026-27 (2016-17 dollars).

The average potential annual increase in real output increases in line with the growth in iron ore exports – from $1.2 billion in 2017-18 to $4.8 billion in 2026-27. This is highlighted in **Figure 5.2** below.

FIGURE 5.2 REAL OUTPUT IMPACT, ANNUAL TOTALS, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

The potential increase in real output is concentrated in the Pilbara region ($29.8 billion), as it is the region in which the value of iron ore exports is realised

The potential increase in real output is concentrated in the Pilbara region ($29.8 billion), as it is the region in which the value of iron ore exports is realised. A further $2.9 billion in output is also realised in the Rest of Western Australia as a result of the purchases of supplies and services required to facilitate the mining and port operations in the Pilbara.

ACIL Allen estimates that output in the Rest of Australia would potentially fall by an average $61 million per annum as the modelled appreciation in the Australian Dollar impacts on the competitiveness of other export industries across the Rest of Australia.

Like the potential income impact, the potential output impact is amplified in the Pilbara region, with the average potential annual increase in the region's output is equivalent to 7.4 per cent of the Pilbara economy's GRP in 2015-16.

The potential real output increase by jurisdiction is outlined in **Table 5.2**.

TABLE 5.2 PROJECTED CUMULATIVE CHANGE IN REAL OUTPUT, REAL TERMS, A$ MILLION

	Total	Average	Discounted (7%)
Pilbara	$29,760m	$2,976m	$21,904m
Western Australia	$2,901m	$290m	$2,152m
Rest of Australia	-$612m	-$61m	-$409m
Total Australia	**$32,049m**	**$3,205m**	**$23,646m**

Note: totals can be subject to rounding errors

SOURCE: ACIL ALLEN CONSULTING

5.3 Real exports

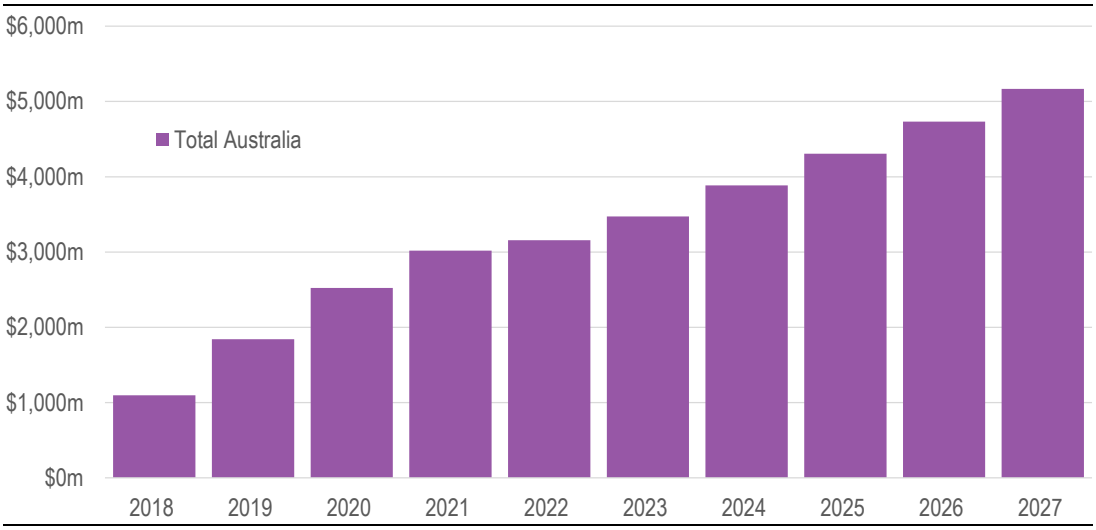
ACIL Allen estimates that the potential increase in real exports associated with the Port Hedland Port reaching its projected export capacity of 700MT is a cumulative $33.2 billion over the ten years ending 2026-27 (2016-17 dollars).

The average potential increase in exports in Western Australia over the study period represents approximately five per cent of Western Australia's total exports in 2015-16

The average potential increase in exports in Western Australia over the study period represents approximately five per cent of Western Australia's total exports in 2015-16.

The average potential annual increase in real exports increases in line with the growth in iron ore exports – from $1.1 billion in 2017-18 to $5.2 billion in 2026-27. This is highlighted in **Figure 5.3** below, while the cumulative changes over the study period are outlined in **Table 5.3**.

FIGURE 5.3 REAL EXPORTS IMPACT, ANNUAL TOTALS, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

TABLE 5.3 PROJECTED CUMULATIVE CHANGE IN REAL EXPORTS, REAL TERMS, A$ MILLION

	Total	Average	Discounted (7%)
Total Australia	**$33,201m**	**$3,320m**	**$24,342m**

Note: totals can be subject to rounding errors

SOURCE: ACIL ALLEN CONSULTING

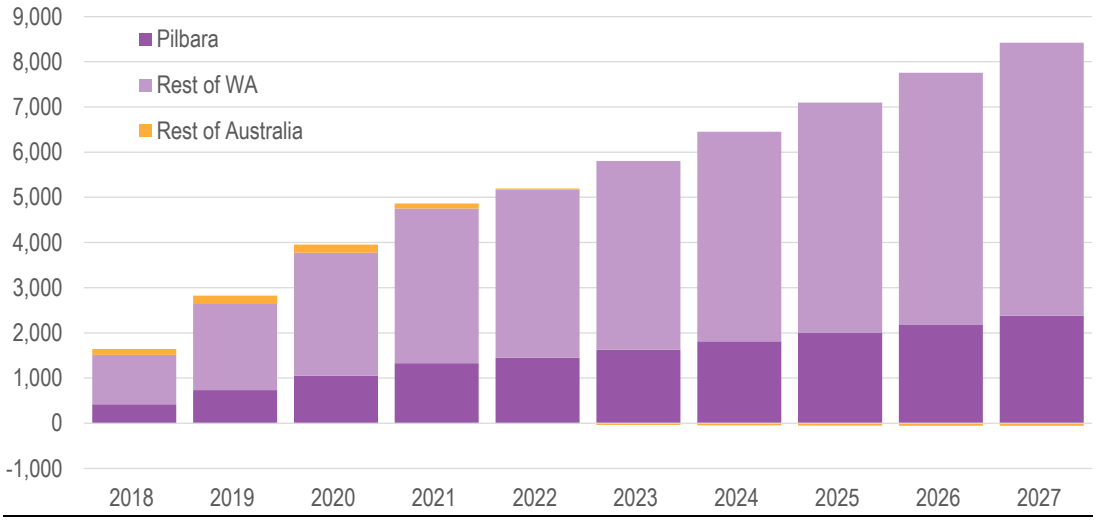
5.4 Employment

The potential increase in employment from growth in the Port's export capacity is an average of 5,377 FTE jobs per annum

ACIL Allen estimates that the potential increase in employment associated with the Port Hedland Port reaching its projected export capacity of 700MT is an average of 5,377 FTE jobs per annum over the ten years ending 2026-27 (2016-17 dollars).

The size of the potential impact progressively increases over time, due to production levels progressively ramping up (see **Figure 5.4** below).

FIGURE 5.4 EMPLOYMENT IMPACT, ANNUAL TOTALS, FTE JOBS



SOURCE: ACIL ALLEN CONSULTING

The potential impact on the Pilbara region is most pronounced, with the number of FTE jobs added per annum equivalent to three per cent of its current workforce

The majority of the potential impact on jobs occurs in the rest of Western Australia (potential increase of 3,838 FTE jobs on average per annum or 71 per cent), with some 28 per cent (potential increase of 1,500 FTE jobs on average per annum) occurring in the Pilbara, and the remaining one per cent (potential increase of 39 FTE jobs on average per annum) occurring in the Rest of Australia. The potential impact on the Pilbara region is most pronounced, with the number of FTE jobs added per annum equivalent to three per cent of its current workforce.

The potential employment increase by jurisdiction is outlined in **Table 5.4**.

TABLE 5.4 PROJECTED CUMULATIVE CHANGE IN EMPLOYMENT, REAL TERMS, FTE JOBS

	Total	Average
Pilbara	14,996	1,500
Rest of WA	38,379	3,838
Rest of Australia	394	39
Total Australia	**53,769**	**5,377**

Note: totals can be subject to rounding errors

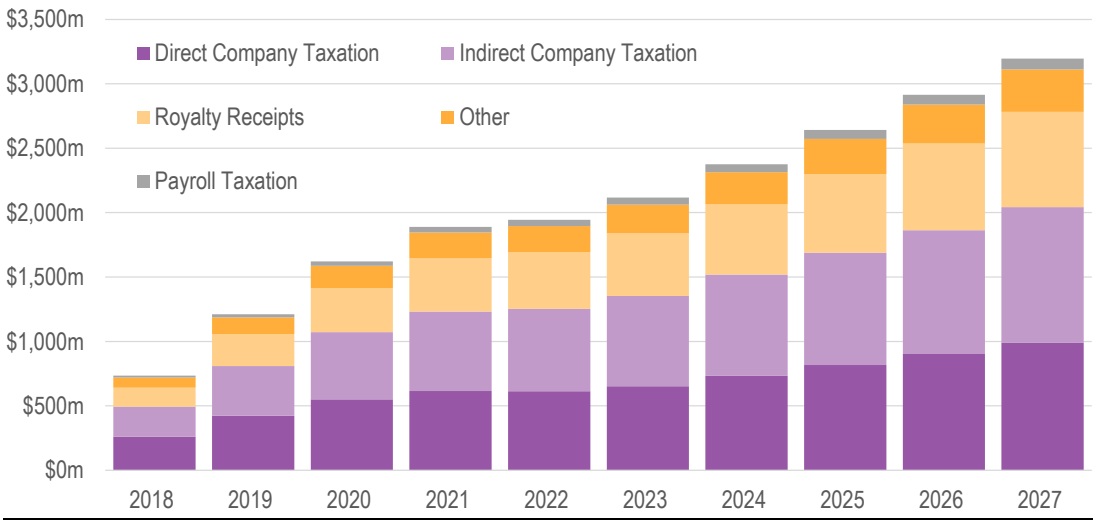
SOURCE: ACIL ALLEN CONSULTING

5.5 Real taxation

ACIL Allen estimates that the potential increase in real taxation and royalty receipts associated with the Port Hedland Port reaching its projected export capacity of 700MT is an a cumulative $20.6 billion over the ten years ending 2026-27 (2016-17 dollars).

The average potential annual increase in real taxation and royalty receipts increases in line with the growth in iron ore exports – from $734 million in 2017-18 to $3.2 billion in 2026-27. This is highlighted in **Figure 5.5** below.

FIGURE 5.5 REAL TAXATION IMPACT, ANNUAL TOTALS, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

The majority of the potential impact on taxation receipts is attributed to Australian company taxation receipts, with direct and indirect company tax receipts potentially $13.3 billion higher over 10 years under the scenario where exports at the Port are not capped. The remaining potential impact on taxation receipts is attributed to:

- Western Australia Royalty receipts, which are potentially $4.6 billion higher over 10 years;
- Australian other tax receipts, which are potentially $2.2 billion higher over 10 years; and
- Western Australia Payroll tax receipts, which are potentially $508 million higher over 10 years.

For the Western Australia Government, the growth in iron ore exports out of the Port will increase its taxation and royalties take on average by $516 million per annum over the study period

The Commonwealth Government will be a significant beneficiary of the growth in iron ore exports out of the Port, with an average annual increase in taxes paid of $2.1 billion per annum over the study period. For the Western Australia Government, the growth in iron ore exports out of the Port will increase its taxation and royalties take on average by $516 million per annum over the study period.

The potential taxation receipts by taxation type and jurisdiction is outlined in **Table 5.5**.

TABLE 5.5 PROJECTED CUMULATIVE CHANGE IN REAL TAXATION, REAL TERMS, A$ MILLION

	Total	Average	Discounted (7%)
Royalty Receipts	$4,651m	$465m	$3,401m
Payroll Taxation	$508m	$51m	$369m
Total WA	**$5,159m**	**$516m**	**$3,770m**
Direct Company Taxation	$6,554m	$655m	$4,842m
Indirect Company Taxation	$6,769m	$677m	$4,969m
Other	$2,161m	$216m	$1,591m
Total Australia	**$20,643m**	**$2,064m**	**$15,172m**

Note: totals can be subject to rounding errors

SOURCE: ACIL ALLEN CONSULTING

5.6 Summary of results

The table below provides a summary of the results of the economic impact assessment of the Port of Port Hedland and its operators on the Pilbara, Western Australian and Australian economies.

TABLE 5.6 SUMMARY OF ECONOMIC IMPACT, REALISING THE POTENTIAL OF PORT HEDLAND PORT, REAL TERMS, A$ MILLION

	Total	Average	Discounted (7%)
	Projected cumulative gain in real economic income		
Pilbara	$29,760m	$2,976m	$19,548m
Rest of Western Australia	$2,901m	$290m	$1,926m
Total Western Australia	**$32,661m**	**$3,266m**	**$21,474m**
Rest of Australia	-$612m	-$61m	-$350m
Total Australia	**$32,049m**	**$3,205m**	**$21,123m**
	Projected cumulative gain in real output		
Pilbara	$11,719m	$1,172m	$7,653m
Rest of Western Australia	$12,352m	$1,235m	$8,039m
Total Western Australia	**$24,071m**	**$2,407m**	**$15,693m**
Rest of Australia	$13,126m	$1,313m	$8,731m
Total Australia	**$37,197m**	**$3,720m**	**$24,424m**
	Projected average gain in employment		
	Total	Average	Peak (Year)
Pilbara	14,996	1,500	2027
Rest of Western Australia	38,379	3,838	2027
Total Western Australia	**53,375**	**5,337**	**2027**
Rest of Australia	394	39	2019
Total Australia	**53,769**	**5,377**	**2027**
	Projected cumulative gain in real taxation		
Royalties (WA)	$4,651m	$465m	$3,027m
Payroll tax (WA)	$468m	$47m	$302m
Total WA	**$5,119m**	**$512m**	**$3,239m**
Company tax (AU)	$6,554m	$655m	$4,327m
Other Company tax (AU)	$6,503m	$650m	$4,250m
Other (AU)	$2,499m	$250m	$1,641m
Total Australia	**$20,676m**	**$2,068m**	**$13,547m**

Note: totals can be subject to rounding errors

SOURCE: ACIL ALLEN CONSULTING

A TASMAN GLOBAL

A.1 Tasman Global

ACIL Allen's computable general equilibrium model *Tasman Global* is a powerful tool for undertaking economic impact analysis at the regional, state, national and global level.

There are various types of economic models and modelling techniques. Many of these are based on partial equilibrium analysis that usually considers a single market. However, in economic analysis, linkages between markets and how these linkages develop and change over time can be critical. *Tasman Global* has been developed to meet this need.

Tasman Global is a large-scale computable general equilibrium model which is designed to account for all sectors within an economy and all economies across the world. ACIL Allen uses this modelling platform to undertake industry, project, scenario and policy analyses. The model is able to analyse issues at the industry, global, national, state and regional levels and to determine the impacts of various economic changes on production, consumption and trade at the macroeconomic and industry levels.

A.1.1 A Dynamic Model

Tasman Global is a model that estimates relationships between variables at different points in time. This is in contrast to comparative static models, which compare two equilibriums (one before a policy change and one following). A dynamic model such as *Tasman Global* is beneficial when analysing issues where both the timing of and the adjustment path that economies follow are relevant in the analysis.

A.1.2 The Database

A key advantage of *Tasman Global* is the level of detail in the database underpinning the model. The database we will use for this project is derived from the Global Trade Analysis Project (GTAP) database (version 8.1). This database is a fully documented, publicly available global data base which contains complete bilateral trade information, transport and protection linkages among regions for all GTAP commodities.

The GTAP model was constructed at the Centre for Global Trade Analysis at Purdue University in the United States. It is the most up-to-date, detailed database of its type in the world.

Tasman Global builds on the GTAP model's equation structure and database by adding the following important features:

- dynamics (including detailed population and labour market dynamics)
- detailed technology representation within key industries (such as electricity generation and iron and steel production)

- disaggregation of a range of major commodities including iron ore, bauxite, alumina, primary aluminium, brown coal, black coal and LNG
- the ability to repatriate labour and capital income
- a detailed emissions accounting abatement framework
- explicit representation of the states and territories of Australia
- the capacity to explicitly represent multiple regions within states and territories of Australia

Nominally the *Tasman Global* database divides the world economy into 141 regions (133 international regions plus the 8 states and territories of Australia) although in reality the regions are frequently disaggregated further. ACIL Allen regularly models Australian projects or policies at the regional level.

The *Tasman Global* database also contains a wealth of sectoral detail currently identifying up to 70 industries (Table 1). The foundation of this information is the input-output tables that underpin the database. The input-output tables account for the distribution of industry production to satisfy industry and final demands. Industry demands, so-called intermediate usage, are the demands from each industry for inputs.

For example, electricity is an input into the production of communications. In other words, the communications industry uses electricity as an intermediate input. Final demands are those made by households, governments, investors and foreigners (export demand). These final demands, as the name suggests, represent the demand for finished goods and services. To continue the example, electricity is used by households – their consumption of electricity is a final demand.

Each sector in the economy is typically assumed to produce one commodity, although in *Tasman Global*, the electricity, transport and iron and steel sectors are modelled using a 'technology bundle' approach. With this approach, different known production methods are used to generate a homogeneous output for the 'technology bundle' industry. For example, electricity can be generated using brown coal, black coal, petroleum, base load gas, peak load gas, nuclear, hydro, geothermal, biomass, wind, solar or other renewable based technologies – each of which have their own cost structure.

The other key feature of the database is that the cost structure of each industry is also represented in detail. Each industry purchases intermediate inputs (from domestic and imported sources) primary factors (labour, capital, land and natural resources) as well as paying taxes or receiving subsidies.

A.1.3 Factors of Production

Capital, land, labour and natural resources are the four primary factors of production. The capital stock in each region (country or group of countries) accumulates through investment (less depreciation) in each period. Land is used only in agriculture industries and is fixed in each region. *Tasman Global* explicitly models natural resource inputs as a sector specific factor of production in resource based sectors (coal mining, oil and gas extraction, other mining, forestry and fishing).

A.1.4 Population Growth and Labour Supply

Population growth is an important determinant of economic growth through the supply of labour and the demand for final goods and services. Population growth for the 112 international regions and for the 8 states and territories of Australia represented in the *Tasman Global* database is projected using ACIL Allen's in-house demographic model. The demographic model projects how the population in each region grows and how age and gender composition changes over time and is an important tool for determining the changes in regional labour supply and total population over the projection period.

For each of the 120 regions in *Tasman Global*, the model projects the changes in age-specific birth, mortality and net migration rates by gender for 101 age cohorts (0-99 and 100+). The demographic model also projects changes in participation rates by gender by age for each region, and, when combined with the age and gender composition of the population, endogenously projects the future supply of labour in each region. Changes in life expectancy are a function of income per person as well as assumed technical progress on lowering mortality rates for a given income (for example, reducing malaria-related mortality through better medicines, education, governance, etc.). Participation rates are a function of life expectancy as well as expected changes in higher education rates, fertility rates and changes in the workforce as a share of the total population.

Labour supply is derived from the combination of the projected regional population by age by gender and the projected regional participation rates by age by gender. Over the projection period labour supply in most developed economies is projected to grow slower than total population as a result of ageing population effects. For the Australian states and territories, the projected aggregate labour supply from ACIL Allen's demographics module is used as the base level potential workforce for the detailed Australian labour market module, which is described in the next section.

SECTORS IN THE *TASMAN GLOBAL* DATABASE

	Sector		Sector
1	Paddy rice	36	Paper products, publishing
2	Wheat	37	Diesel (incl. nonconventional diesel)
3	Cereal grains nec	38	Other petroleum, coal products
4	Vegetables, fruit, nuts	39	Chemical, rubber, plastic products
5	Oil seeds	40	Iron ore
6	Sugar cane, sugar beef	41	Bauxite
7	Plant- based fibres	42	Mineral products nec
8	Crops nec	43	Ferrous metals
9	Bovine cattle, sheep, goats, horses	44	Alumina
10	Animal products nec	45	Primary aluminium
11	Raw milk	46	Metals nec
12	Wool, silk worm cocoons	47	Metal products
13	Forestry	48	Motor vehicle and parts
14	Fishing	49	Transport equipment nec
15	Brown coal	50	Electronic equipment
16	Black coal	51	Machinery and equipment nec
17	Oil	52	Manufactures nec
18	Liquefied natural gas (LNG)	53	Electricity generation
19	Other natural gas	54	Electricity transmission and distribution
20	Minerals nec	55	Gas manufacture, distribution
21	Bovine meat products	56	Water
22	Meat products nec	57	Construction
23	Vegetables oils and fats	58	Trade
24	Dairy products	59	Road transport
25	Processed rice	60	Rail and pipeline transport
26	Sugar	61	Water transport
27	Food products nec	62	Air transport
28	Wine	63	Transport nec
29	Beer	64	Communication
30	Spirits and RTDs	65	Financial services nec
31	Other beverages and tobacco products	66	Insurance
32	Textiles	67	Business services nec
33	Wearing apparel	68	Recreational and other services
34	Leather products	69	Public Administration, Defence, Education, Health
35	Wood products	70	Dwellings

Note: nec = not elsewhere classified.

A.1.5 The Australian Labour Market

Tasman Global has a detailed representation of the Australian labour market which has been designed to capture:

- different occupations
- changes to participation rates (or average hours worked) due to changes in real wages
- changes to unemployment rates due to changes in labour demand
- limited substitution between occupations by the firms demanding labour and by the individuals supplying labour
- limited labour mobility between states and regions within each state.

Tasman Global recognises 97 different occupations within Australia – although the exact number of occupations depends on the aggregation. The firms who hire labour are provided with some limited scope to change between these 97 labour types as the relative real wage between them changes. Similarly, the individuals supplying labour have a limited ability to change occupations in response to the changing relative real wage between occupations. Finally, as the real wage for a given occupation rises in one state relative to other states, workers are given some ability to respond by shifting their location. The model produces results at the 97 3-digit ANZSCO (Australian New Zealand Standard Classification of Occupations) level.

The labour market structure of *Tasman Global* is thus designed to capture the reality of labour markets in Australia, where supply and demand at the occupational level do adjust, but within limits.

Labour supply in *Tasman Global* is presented as a three stage process:

- labour makes itself available to the workforce based on movements in the real wage and the unemployment rate;
- labour chooses between occupations in a state based on relative real wages within the state; and
- labour of a given occupation chooses in which state to locate based on movements in the relative real wage for that occupation between states.

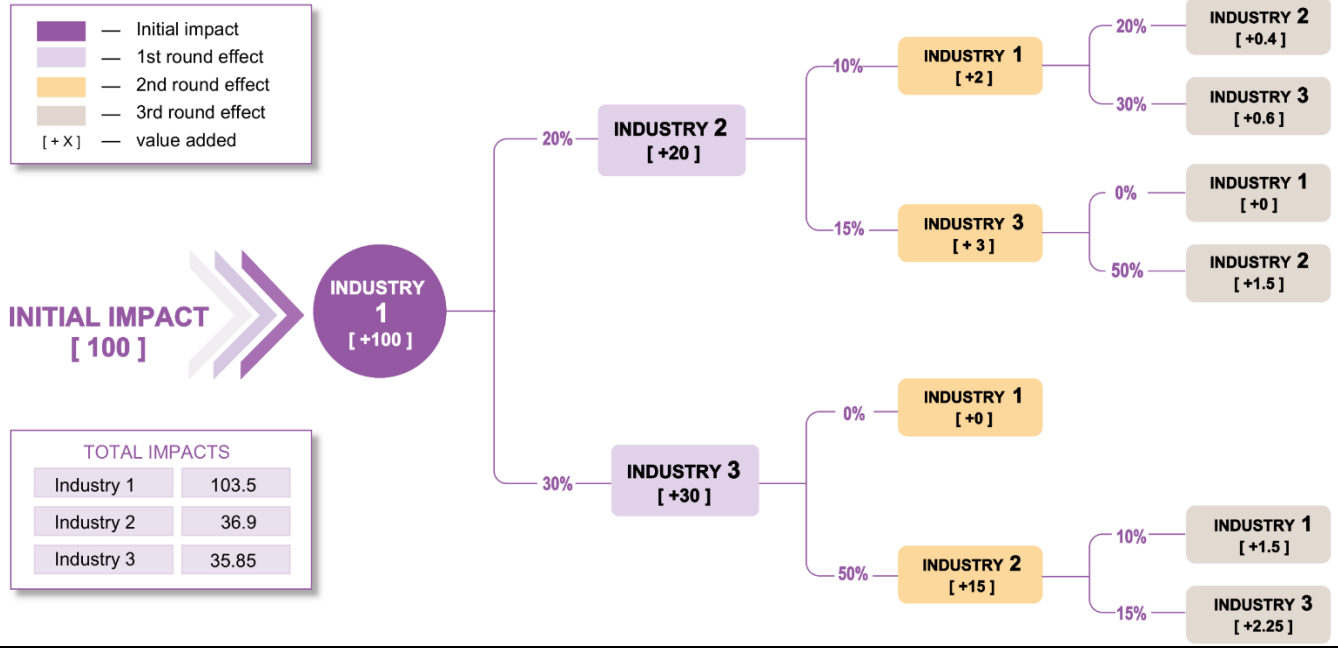
By default, *Tasman Global*, like all CGE models, assumes that markets clear. Therefore, overall, supply and demand for different occupations will equate (as is the case in other markets in the model).

B

INPUT-OUTPUT MODELLING

I-O models capture the direct and indirect effects of expenditure by capturing, for each industry, the industries it purchases inputs from and also the industries it sells its outputs to. For example, the I-O model for Western Australia captures purchases from and sales to industries located in Western Australia, as well as imports from outside of Western Australia. **Figure B.1** depicts how an impact is traced through a (very simple) economy with three industries (1, 2, and 3), and is described below.

FIGURE B.1 "TRACE THROUGH" OF AN INPUT-OUTPUT MODEL



SOURCE ACIL ALLEN CONSULTING:

1. The initial impact occurs in Industry 1 where an additional 100 units of value are added to its output. In order to generate this additional output, Industry 1 requires additional inputs from Industry 2 and Industry 3.
2. Therefore, Industry 2 and 3 increase their output as well. This in turn requires input from Industry 1 and 3 and Industry 1 and 2 respectively which increase their output to satisfy this additional demand, and so on.
3. The impacts grow smaller with each iteration and ultimately converge to zero. This is because they always only share the impact that occurred in the preceding iteration.

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