Australian Government
Department of Industry, Innovation and Science

Office of the Chief Economist

Resources and Energy Quarterly

September 2019

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Resources insights

Foreword

Australian resource exports appear likely to hold up in 2019–20, in the face of volatile commodity markets. Our new projection of $282 billion in exports in 2019–20 has shaved just $3 billion from our June 2019 *Resources and Energy Quarterly* projection. Export earnings in 2020–21 have been revised down by a similar amount, to $258 billion. The decline in earnings in 2020–21 will mainly reflect the impact of the steady return of Brazilian iron ore production to normal, following the fallout from the Brumadinho mine tailings dam collapse.

An increase in gold export earnings and the depreciation of the Australian dollar will help counter the impact of escalating US-China trade tensions. While the trade tensions have led to a weaker outlook for our base metal and energy exports, as the world's 2nd largest gold producer, Australia is benefitting from investors' flight to safety. Our gold earnings are set to surge by one third to $25 billion in 2019–20. More generally, as US-China trade tensions see US dollar commodity prices fall, the Australian dollar has also dropped, holding up Australian resource and energy commodity producers' returns.

While the IMF is forecasting world GDP growth to hold up well over the next year, the outlook for world industrial production has deteriorated, taking with it some of the buoyancy of resource and energy commodities in recent years.

The data in this edition shows that global cutbacks in manufacturing production are already flowing through into commodity markets. The importance of China's burgeoning middle class means that any further decline in Chinese economic growth could have even more significant effects on global supply chains for a range of technology and other products.

Thus far, problems within the global economy remain somewhat quarantined. The usual catalysts for global downturns — miscalculations with interest rates, financial freeze-ups, abrupt collapses in investment — have not yet materialised. But uncertainty is growing. Central banks and governments still have firepower to deploy to prevent a major slowdown, though perhaps less ammunition than was available 10 years ago.

Oil prices have declined in recent months, building on the longer-term price impact of higher US supply. Technological investment in electric vehicles and energy storage is improving the prospects for several emerging commodities, offsetting the impact of trade concerns. Nickel is set to jump in the rankings of significant export earners, as a direct result of this phenomenon. More established commodities, such as steel and aluminium, are set to benefit from some carefully chosen Chinese stimulus measures.

The latest data suggest that mining investment in Australia has turned the corner. For the first time in six years, mining companies are planning to increase their annual spend on building new mines/wells and on expanding and replacing their fleet of plant, machinery and equipment.

This edition includes a special topic on mining productivity. The research suggests that productivity in major parts of the Australian mining sector could be significantly stronger than traditional measures suggest. In globally uncertain times, the factors under our control — such as productivity — become increasingly important.

David Turvey

Head of Analysis and Insights Division and Chief Economist
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About this edition

The *Resources and Energy Quarterly* (REQ) contains the Office of the Chief Economist's forecasts for the value, volume and price of Australia's major resources and energy commodity exports.

A 'medium term' (five year) outlook is published in the March quarter edition of the *Resources and Energy Quarterly*. Each June, September and December edition of the *Resources and Energy Quarterly* features a 'short term' (two year) outlook for Australia's major resource and energy commodity exports. The December *Resources and Energy Quarterly* also includes the annual Major Projects update.

Underpinning the forecasts/projections contained in the *Resources and Energy Quarterly* is the Office of the Chief Economist's outlook for global resource and energy commodity prices, demand and supply. The forecasts/projections for Australia's resource and energy commodity exporters are reconciled with this global context.

The global environment in which Australia's producers compete can change rapidly. Each edition of the *Resources and Energy Quarterly* factors in these changes, and makes appropriate alterations to the forecasts/projections, by estimating the impact on Australian producers and the value of their exports.

In this report, commodities are grouped into two broad categories, referred to as 'resources' and 'energy'. 'Energy' commodities comprise metallurgical and thermal coal, oil, gas and uranium. 'Resource' commodities in this report are all other mineral commodities.

Unless otherwise stated, all Australian and US dollar figures in this report are in nominal terms. Inflation and exchange rate assumptions are provided in the Appendix to the 'Macroeconomics' chapter.

Data in this edition of the *Resources and Energy Quarterly* is current as of 20 September 2019.

Resources and Energy Quarterly publication schedule

Publication	Expected release date	Outlook period
September 2019	30 September 2019	Australian data: 2020–21 World data: 2021
December 2019	19 December 2019	Australian data: 2020–21 World data: 2021
March 2020	30 March 2020	Australian data: 2024–25 World data: 2025
June 2020	29 June 2020	Australian data: 2021–22 World data: 2022

Source: Department of Industry, Innovation and Science (2019)

Overview

Resources and Energy Quarterly September 2019

Australia's mining sector

Accounted for **21%** of Australia's GDP growth in 2018–19

7.9% of GDP in 2018 –19

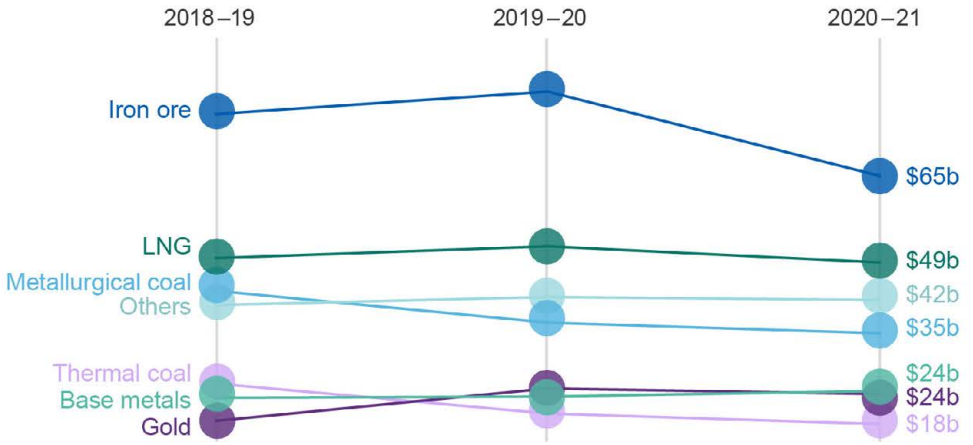
59% of Australia's goods and services exports in 2018–19*

75% of Australia's goods exports in 2018–19*

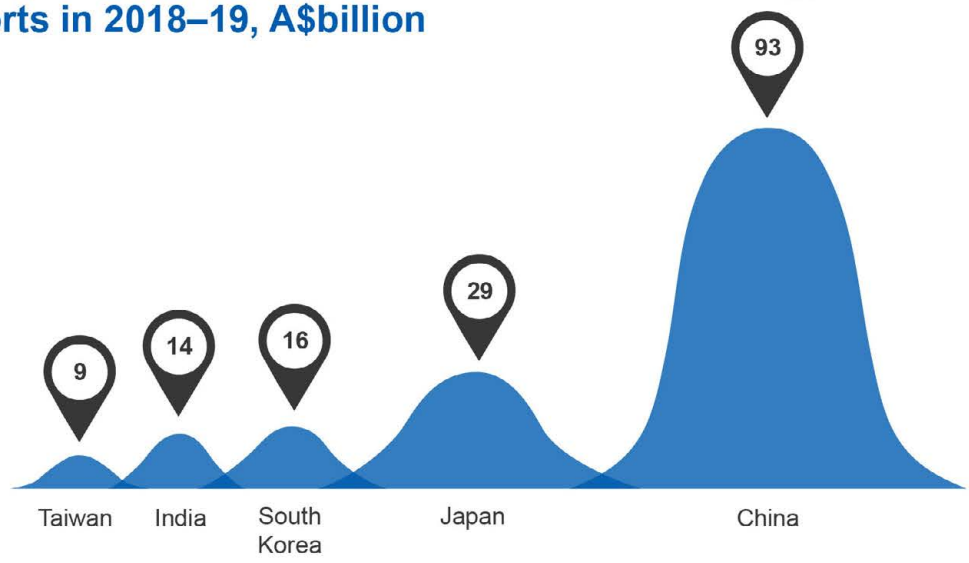
over **247,000** people employed (as at May 2019)

*Export figures are for resources and energy (broader than mining sector)

Australia's resources and energy exports 2018–19, A$billion



Major markets for Australia's resources and energy exports in 2018–19, A$billion



1.1 Summary

- The world industrial production cycle has continued to slow in recent months, and looks set to slow further. The extent of any down-cycle in resource commodities largely depends on whether China can avoid a further slowing in growth, and a resolution of US-China trade tensions.
- The industrial production slowdown has seen the prices of Australia's major resource commodities decline noticeably from the 7-year highs set in the June quarter 2019. Prices are likely to drift down over the outlook period, due to softer demand and rising supply.
- Notwithstanding weaker prices, both higher export volumes and a lower than expected Australian dollar are likely to see Australia's resource and energy export earnings set a new record of $282 billion in 2019–20 (Figure 1.1). Further price falls are likely to drive earnings down to $258 billion in 2020–21.

1.2 Export values

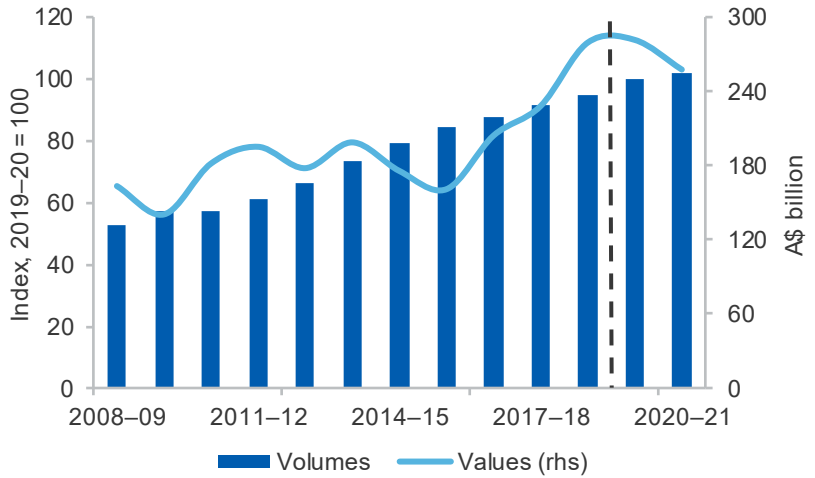
Australia's export values expected to be $282 billion in 2019–20

The Office of the Chief Economist's (OCE) Resources and Energy Export Values Index rose by 12.9 per cent in the year to the September quarter 2019. A 4.8 per cent rise in volumes added to an 8.5 per cent rise in prices. Figure 1.2 shows that in 2019–20, resource export values are forecast to rise by 0.8 per cent to $282 billion, as a 5.5 per cent rise in volumes is largely offset by a 4.6 per cent fall in prices. In 2020–21, while export volumes are expected to rise by a further 1.9 per cent, a forecast rise in the Australian dollar and weaker commodity prices (down 10.8 per cent) will drive an 8.5 percent fall in export earnings to $258 billion.

Ongoing weakness in the Australian dollar is boosting export earnings

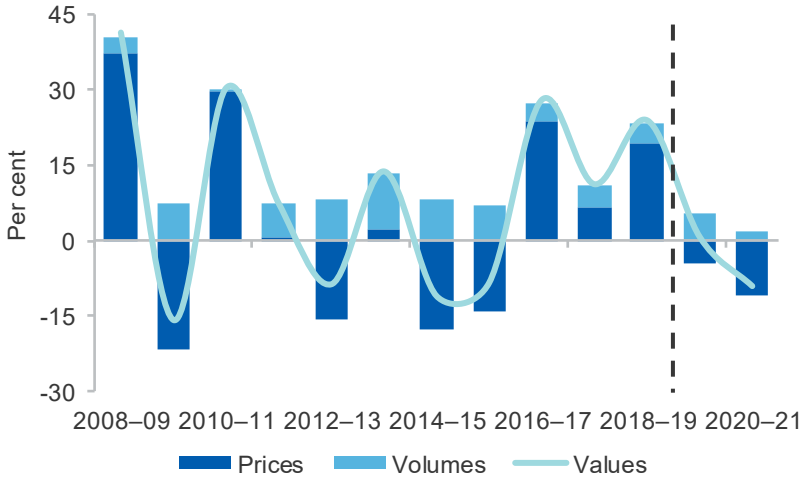
In Australian dollar terms, the OCE's Resources and Energy Commodity Price Index fell by 2.4 per cent (preliminary estimate) in the September quarter, though was still 8.5 per cent higher than a year ago. In US dollar terms, the index fell by 3.8 per cent in the quarter, but was still 2.3 per cent higher than a year before. Figure 1.3 shows that Australian dollar prices for resource commodities fell by 2.5 per cent in the September quarter, while prices of energy commodities fell by 2.0 per cent.

Figure 1.1: Australia's resource and energy export values/volumes



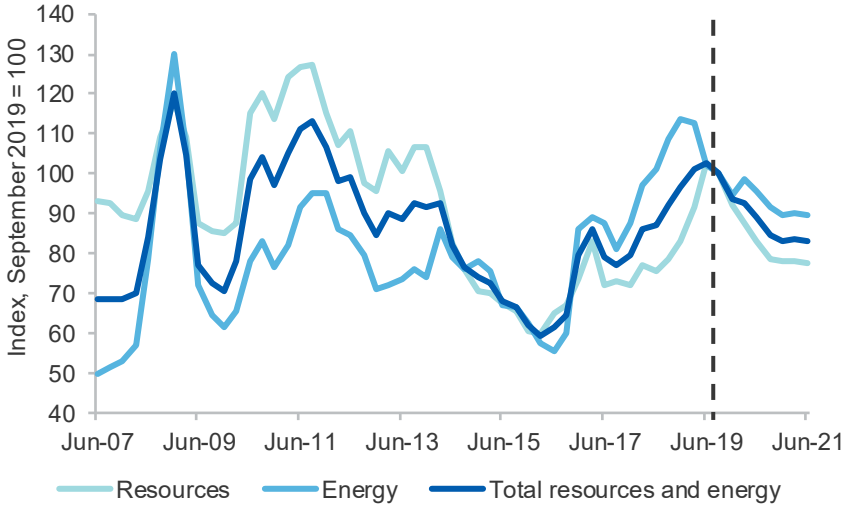
Source: ABS (2019) International Trade in Goods and Services, 5368.0; Department of Industry, Innovation and Science (2019)

Figure 1.2: Annual growth in Australia's resources and energy export values, contributions from prices and volumes



Source: Source: ABS (2019) International Trade in Goods and Services, 5368.0; Department of Industry, Innovation and Science (2019)

Figure 1.3: Resource and energy export prices, AUD terms



Notes: The export price index is based on Australian dollar export unit values (EUVs, export values divided by volumes); the export price index is a Fisher price Index, which weights each commodity's EUV by its share of total export values.

Source: ABS (2019) International Trade in Goods and Services, 5368.0; Department of Industry, Innovation and Science (2019)

1.3 Macroeconomic factors and rising trade tensions

The past quarter has seen growth moderate in the world economy, and the signs are that a further modest slowdown is likely. The US-China trade tensions have played a significant part in this world slowdown, and the escalation of that tension in July-August is set to trigger a further slowdown in the level of world trade and economic activity, as global supply chains adjust to new tariff regimes in the US and China. Anecdotal evidence suggests that many US and Chinese firms had absorbed the impact of the first round of US tariffs (of 10 per cent) — delaying the economic fallout — but with the 1 September US tariff hike to 25 per cent, importers are now moving in earnest to pass them through.

The Chinese economy appears to have steadied at a lower pace of growth in the September quarter, as the impact of stimulatory measures — aimed at offsetting the impact of the institution and escalation of US tariffs on Chinese goods — came through. Market concerns about the impact of the trade tensions has pushed the Chinese exchange rate below the 7 Yuan mark against the US dollar, partly shielding the Chinese trade sector from the US trade measures. Beijing is now rolling out further carefully targeted measures to cushion the impact of the trade tensions.

Growth has slowed in the other major economies, as the fallout from the US-China trade friction spreads. This spread reflects the growing influence of Chinese consumers in world goods and services markets, as China's population becomes wealthier and its middle class one of the world's most influential consumer blocs. Japan has been impacted by slowing exports to China, and trade tensions between South Korea and Japan threaten a further slowdown in North Asia. The Eurozone has slowed noticeably, as the German economy feels the impact of slower Chinese demand, and as 'Brexit' raises concerns in Europe. Central banks may have to ease monetary policy further in order to support economic growth.

The slowdown in world economic growth in the middle of 2019 has led to a sharp drop in global bond yields and the inversion of the US yield curve has sparked concerns of a US recession.

The major risk to world growth is a further escalation of protectionist trade measures between China, Europe, Japan, South Korea and the US. Ongoing uncertainty over the United Kingdom (UK) leaving the European Union customs system is expected to add to business and consumer uncertainty in the UK and the Eurozone, and to add to disruptions in global supply chains. Excess global savings relative to investment — partly caused by ageing populations — threaten to intensify if consumers and businesses adopt a more cautionary stance in reaction to the US-China trade tensions.

Aerial attacks on Saudi Arabian oil facilities have unsettled world oil markets. Tensions in the Middle East could add significantly to the risk premium on the oil price. The looming northern hemisphere winter will impact on energy commodity usage as 2019 ends and 2020 begins.

1.4 Prices

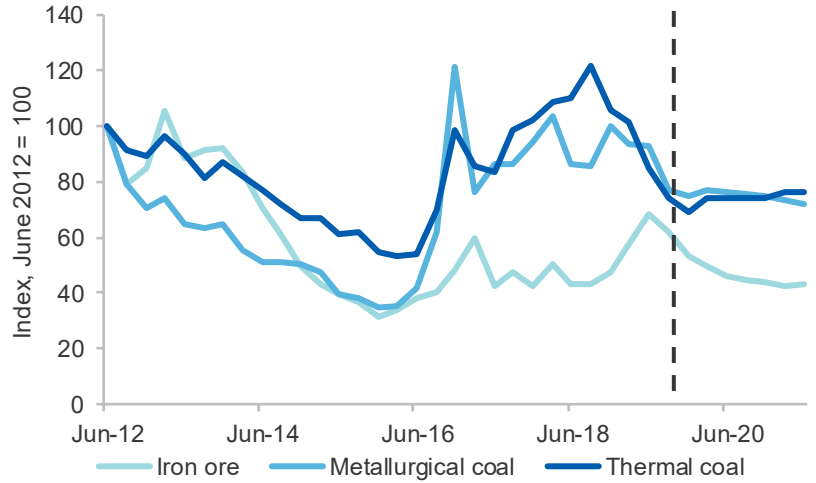
The iron ore price has swung sharply since the June 2019 *Resources and Energy Quarterly;* at one stage, the price exceeded US$120 a tonne, as Chinese steel mills scrambled for supply, before buying fell away and the price fell sharply. The price fell to US$83 a tonne in late August, but then rebounded as Chinese steel mills restocked. The price is forecast to fall over the next two years (Figure 1.4), as growth in Chinese steel output eases and supply recovers.

The prices of metallurgical and thermal coal declined sharply in the September quarter. The metallurgical coal price was impacted by rising supply and concerns of weaker demand. The latter relate to the weaker global economic outlook, seasonally weak Indian demand and Chinese import policies. The metallurgical coal price is likely to ease modestly further over the outlook period. Weaker demand has placed downward pressure on the thermal coal price. Persistently low spot LNG prices have also encouraged coal-to-gas switching — mainly in Europe — adding to weak thermal coal demand. Concurrently, large amounts of thermal coal have entered the seaborne market since 2018. Prices are forecast to be subdued during the outlook period, as oversupply persists (Figure 1.4).

Oil prices have recently declined noticeably, on the back of deteriorating economic conditions. Nevertheless, on the expectation that the benchmark Brent price holds above the US$65 a barrel mark, Australia's growing oil, condensate and LNG exports (of which, the vast majority are linked to oil prices) should result in record petroleum and LNG revenues in 2019–20.

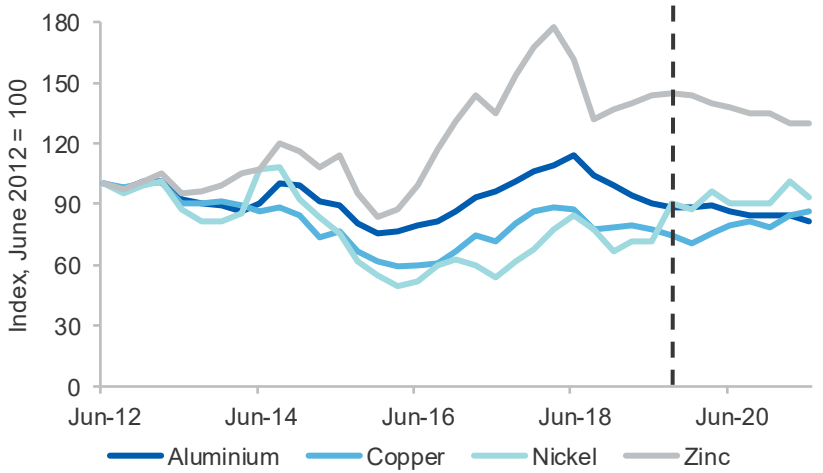
Gold pushed above the US$1,500 an ounce mark in the first half of August, propelled by safe-haven buying. In (currency neutral) IMF Special Drawing Right terms, gold has recently equalled the all-time high set in late 2012. Gold is forecast to benefit from strong central bank, investor and jewellery demand over the coming year or two. Base metal prices have generally weakened over the past quarter, as US-China trade tensions spark worries over base metal demand. With the exception of nickel, base metals are expected to be weak over 2019–20 (Figure 1.5), as the impact of a world economic slowdown outweighs supply concerns.

Figure 1.4: Bulk commodity prices



Notes: Prices are in US dollars, and are the international benchmark prices
Source: Bloomberg (2019)

Figure 1.5: Base metal prices



Notes: Prices are in US dollars, and are the international benchmark prices
Source: Bloomberg (2019)

1.5 Export volumes

Export volumes to grow, driven by growing energy exports

The OCE's Resources and Energy Export Volumes Index (preliminary estimate) rose by 4.5 per cent in the September quarter 2019 year-on-year, but was down slightly from the June quarter record high. Energy commodity volumes rose by 8.4 per cent and resource commodity volumes rose by 1.0 percent. Volumes are expected to show solid growth (largely across-the-board) in 2019–20, but more tepid growth in 2020–21.

1.6 Contribution to growth and investment

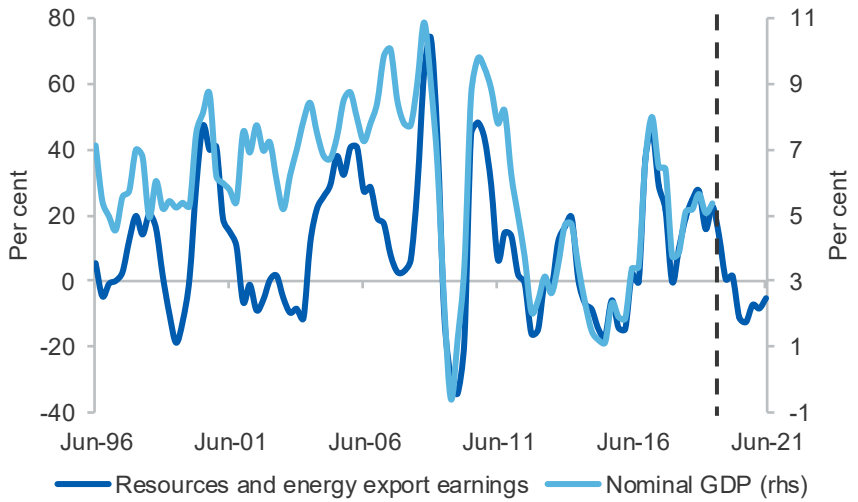
Mining industry continues to support overall economic growth

Australia's real Gross Domestic Product (GDP) grew by 0.5 per cent in the June quarter 2019, and by 1.4 per cent over the year. The mining industry directly accounted for a third of the growth in Australia's GDP in the year to the June quarter 2019. Mining value-added rose by 1.5 per cent in the June quarter to be 3.4 per cent higher over the year, driven by growth in oil and gas extraction and bulk commodity mining.

Oil and gas extraction has been the largest contributor to mining industry value-added growth in the last few years, propelled by growing export volumes associated with the LNG export boom. In the coming few years, with ramp-up in the large LNG projects complete, lower export growth and relatively low investment in the oil and gas production sector are expected to provide a much smaller contribution to Australia's GDP growth.

Since the global financial crisis, swings in Australian resource and energy export earnings have correlated very closely with swings in nominal GDP (Figure 1.6). The rising share of resource and energy commodity export earnings in Australia's nominal GDP — driven by favourable gains in our terms of trade and the fruits of the resource commodity investment boom — appears to have made resource exports a significant swing factor in the economy. With growth in resource export values forecast to have peaked in the first three quarters of 2019, if the correlation persists, a slowing in resource export growth could see nominal GDP growth weaken noticeably over the next year — though from a high base.

Figure 1.6: Australia's nominal GDP vs resource and energy commodity export earnings, annual per cent change



Source: Department of Industry, Innovation and Science (2019), ABS (2019)

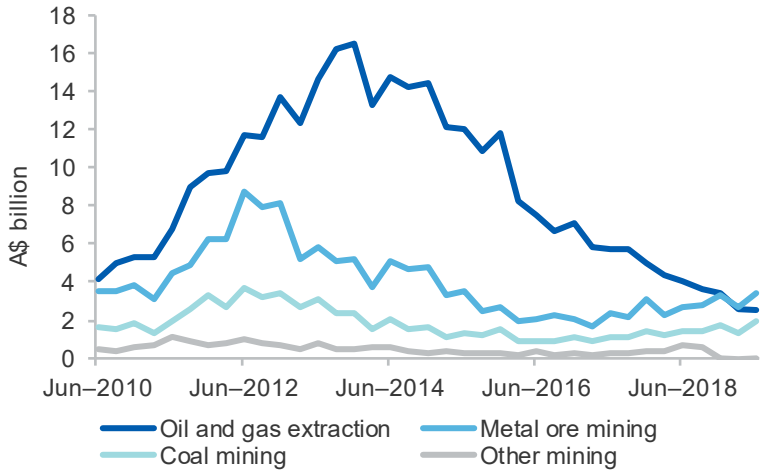
Mining investment is picking up

The ABS Private New Capital Expenditure and Expected Expenditure survey June quarter 2019 shows that investment by the Australia's mining industry was $8.6 billion in the June quarter 2019, down 3.9 percent over the year. Over 2018–19 as a whole, at $33.4 billion, investment fell by 8.3 per cent, the smallest annual decline in over five years. This annual spending compares with almost $95 billion at the height of the LNG boom in 2012–13.

Increased capital expenditure (capex) in the June quarter 2019 was driven by higher investment in metal ores and coal mining (Figure 1.7).

Oil and gas extraction capex appears to be bottoming out, after 6 years of decline. New LNG projects, such as Woodside's Browse and Scarborough developments, are likely to see the level of capex in the oil and gas extraction recover in the 2020s.

Figure 1.7: Mining industry capital expenditure by commodity

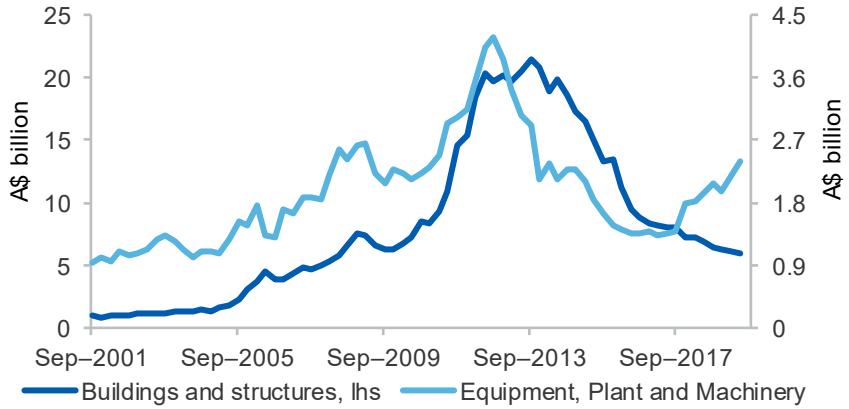


Notes: Other mining includes non-metallic mineral mining and quarrying and exploration and other mining support services; chart data is in nominal terms

Source: ABS (2019) Private New Capital Expenditure and Expected Expenditure, 5625.0

Plant and equipment spending continues to recover strongly, with capex at a 5-year high in the June quarter 2019 (Figure 1.8).

Figure 1.8: Mining industry capital expenditure by type, quarterly



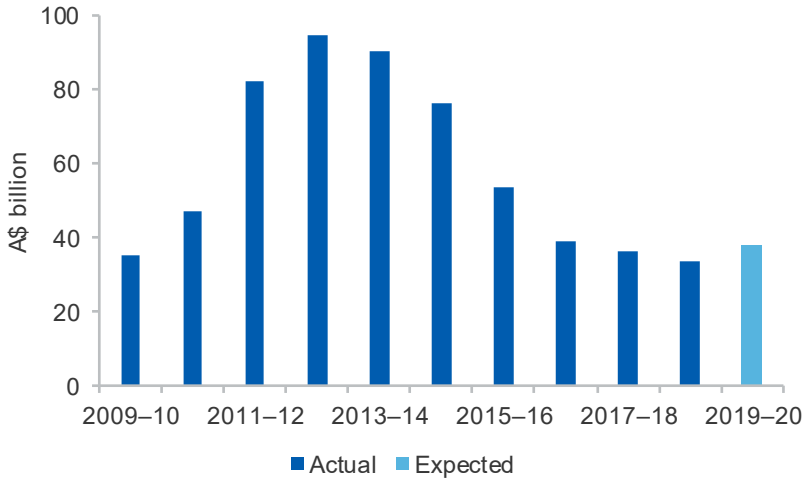
Notes: Chart data is in nominal terms

Source: ABS (2019) Private New Capital Expenditure and Expected Expenditure, 5625.0

Higher commodity prices in the past two years appear to have encouraged miners in Australia to replace ageing plant and equipment and to expand their fleets. Buildings and structures edged further lower in the June quarter, just holding above the $6 billion mark.

Provisional indications (Figure 1.9) support the likelihood that the March quarter 2019 represented the low point of the mining investment cycle. Expectations for capex suggest a rise of around 14 per cent in 2019–20, to just over $38 billion. New investment is likely being drawn by the recent rebound in bulk commodity prices and new prospects for lithium and other critical minerals.

Figure 1.9: Mining industry capital expenditure, fiscal year

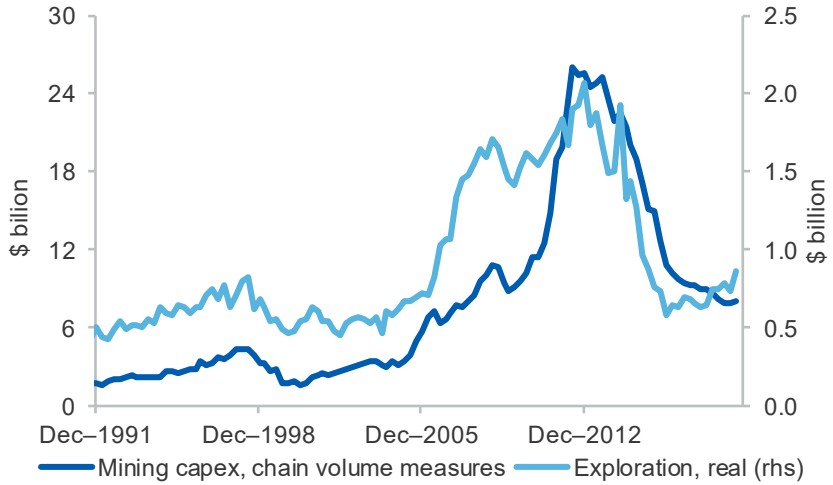


Notes: Chart data is in nominal terms

Source: ABS (2019) Private New Capital Expenditure and Expected Expenditure, 5625.0

Data on exploration spending (adjusted for inflation) supports the survey data that a recovery in mining capital expenditure is under way (Figure 1.10).

Figure 1.10: Mining capital expenditure vs exploration, quarterly



Notes: Chart data is in real terms

Source: ABS (2019) Private Capital Expenditure Survey, Mining, Chain Volume measure, 5625.0

Figure 1.11: Resource and energy exports, by release

Notes: Chart data is in nominal terms

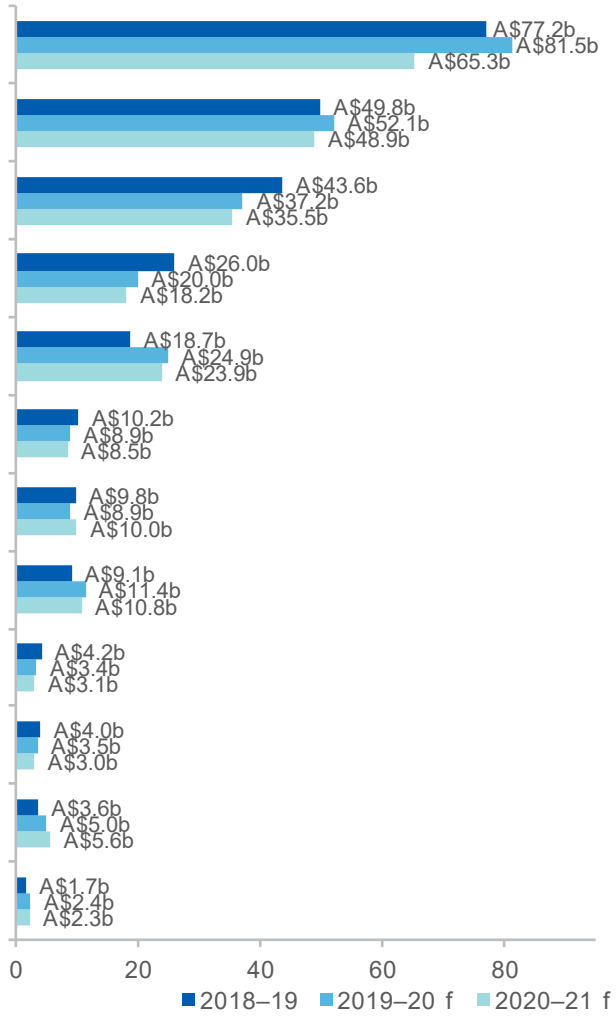
Source: Department of Industry, Innovation and Science (2019)

1.7 Revisions to the outlook

At $282 billion, the new estimate for Australia's resources and energy export earnings in 2019–20 is down slightly from the $285 billion estimate in the June 2019 *Resources and Energy Quarterly* (Figure 1.11). Commodity prices have weakened noticeably, and the impact of that decline has more than outweighed the impact of the adoption of a weaker exchange rate (Australian dollar against the US dollar) profile than in our June forecasts.

In 2020–21, weaker prices — virtually across the board — and a rising exchange rate, will drive a significant fall in export earnings. Export earnings are now forecast to be $258 billion, down from $261 billion forecast in the June 2019 *Resources and Energy Quarterly*.

Figure 1.12: Australia's major resource & energy commodity exports



CAGR per cent change from 2018–19

	2019–20[f]			2020–21[f]		
	volume	EUV	value	volume	EUV	value
Iron ore	▲ 4	▲ 2	▲ 5	▲ 3	▼ -11	▼ -8
LNG	▲ 9	▼ -4	▲ 5	▲ 4	▼ -5	▼ -1
Metallurgical coal	▲ 3	▼ -17	▼ -15	▲ 4	▼ -13	▼ -10
Thermal coal	→ 0	▼ -23	▼ -23	▲ 1	▼ -17	▼ -16
Gold	▲ 13	▲ 18	▲ 33	▲ 7	▲ 5	▲ 13
Alumina	▲ 1	▼ -14	▼ -14	▲ 1	▼ -10	▼ -9
Copper	▼ -2	▼ -7	▼ -9	▲ 3	▼ -1	▲ 1
Crude oil	▲ 23	▲ 2	▲ 25	▲ 11	▼ -2	▲ 9
Aluminium	▼ -6	▼ -13	▼ -18	▼ -3	▼ -12	▼ -14
Zinc	▲ 8	▼ -19	▼ -12	→ 0	▼ -13	▼ -13
Nickel	▲ 9	▲ 28	▲ 40	▲ 12	▲ 12	▲ 25
Lead	▼ -3	▲ 49	▲ 45	▼ -1	▲ 18	▲ 17

Notes: f forecast.

Source: ABS (2019) International Trade in Goods and Services, 5368.0; Department of Industry, Innovation and Science (2019)

Table 1.1: Outlook for Australia's resources and energy exports in nominal and real terms

Exports (A$m)	2017–18	2018–19	2019–20[f]	2020–21[f]	Annual percent change 2018–19	2019–20[f]	2020–21[f]
Resources and energy	228,027	279,327	281,588	257,571	22.5	0.8	–8.5
– real[b]	236,752	285,314	281,588	251,542	20.5	-1.3	–10.7
Energy	101,958	132,610	126,196	115,711	30.1	-4.8	–6.1
– real[b]	106,125	135,793	126,196	115,756	28.0	–6.8	–8.3
Resources	126,068	146,718	155,392	139,040	16.4	5.9	–10.5
– real[b]	131,221	150,239	155,392	135,786	14.5	3.7	–12.6

Notes: **b** In 2019–20 Australian dollars. **f** forecast.
Source: ABS (2019) International Trade in Goods and Services, 5368.0; Department of Industry, Innovation and Science (2019)

Table 1.2: Australia's resource and energy exports, selected commodities

	Prices				Export volumes				Export values, A$b		
	Unit	2018–19	2019–20[f]	2020–21[f]	Unit	2018–19	2019–20[f]	2020–21[f]	2018–19	2019–20[f]	2020–21[f]
Iron ore	US$/t	72	70	58	Mt	820	852	869	77	81	65
Metallurgical coal	US$/t	205	168	163	Mt	183	188	198	44	37	35
LNG	A$/GJ	12.6	12	11	Mt	75	82	81	50	52	49
Thermal coal	US$/t	98	68	71	Mt	210	211	214	26	20	18
Gold	US$/oz	1,264	1,470	1,462	t	326	368	375	19	25	24
Alumina	US$/t	438	347	333	Mt	17,619	17,803	17,839	10	8.9	8.5
Copper	US$/t	6,151	5,905	6,493	Kt	934	919	985	9.8	8.9	10
Oil[a]	US$/bbl	69	68	67	Kb/d	254	312	311	9.1	11	11
Aluminium	US$/t	1,920	1,748	1,657	Kt	1,451	1,362	1,373	4.2	3.4	3.1
Zinc	US$/t	2,658	2,468	2,400	Kt	1,326	1,436	1,319	4.0	3.5	3.0
Nickel	US$/t	12,352	15,675	16,112	Kt	223	243	280	3.6	5.0	5.6
Lithium	US$/t	773	613	594	Kt	1,324	1,504	1,593	1.4	1.3	1.3
Uranium	US$/lb	27	28	35	t	6,773	7,240	6,500	0.6	0.6	0.6

Notes: **a** Export data covers both crude oil and condensate. **f** forecast. **Price information:** Iron ore fob (free-on-board) at 62 per cent iron content estimated netback from Western Australia to Qingdao China; Metallurgical coal premium hard coking coal fob East Coast Australia; Thermal coal fob New castle 6000 kc (calorific content); LNG fob Australia's export unit values; Gold LBMA PM; Alumina fob Australia; Copper LME cash; Crude oil Brent; Aluminum LME cash; Zinc LME cash; Nickel LME cash; Lithium spodumene ore.

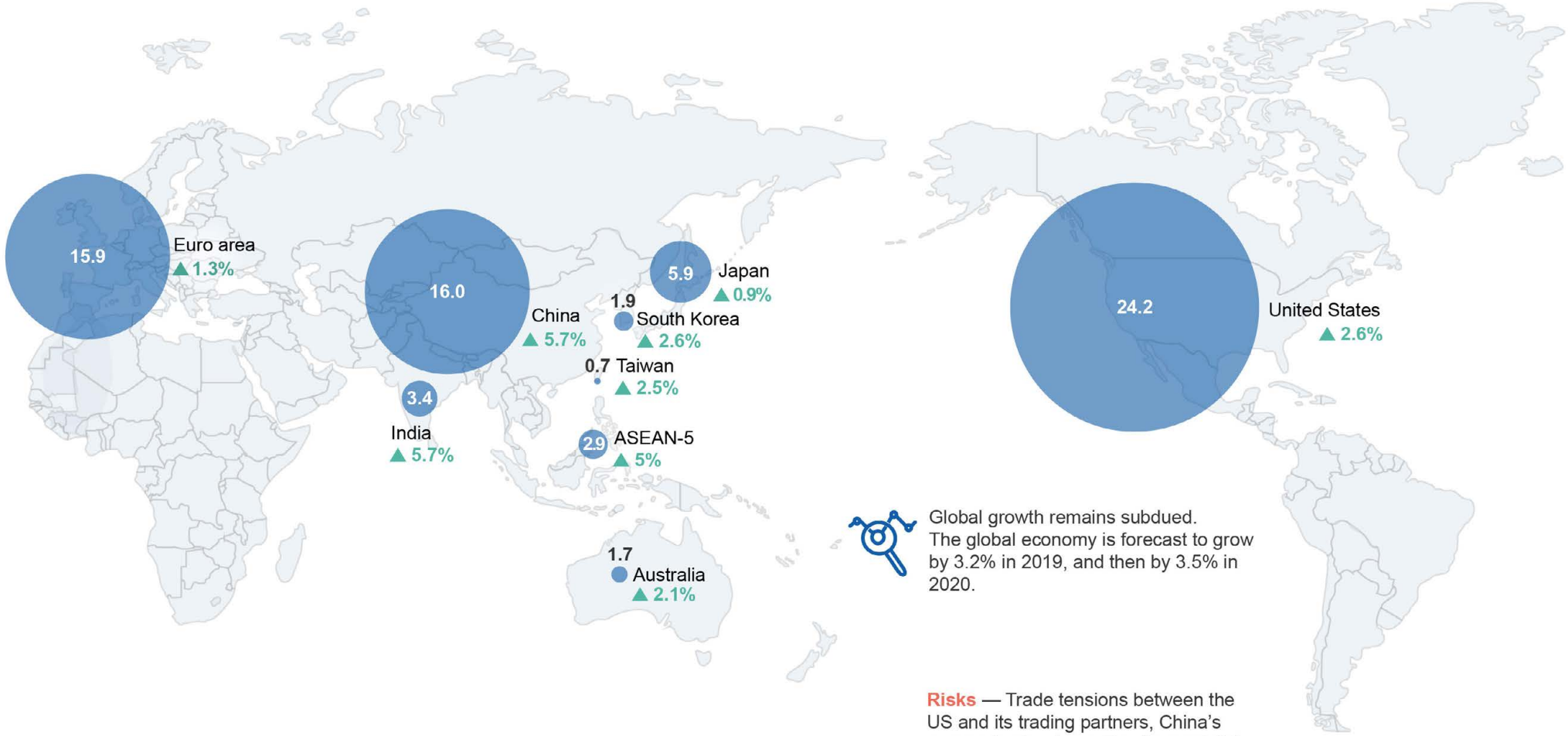
Source: ABS (2019) International Trade in Goods and Services, Australia, Cat. No. 5368.0; LME; London Bullion Market Association; The Ux Consulting Company; US Department of Energy; Metal Bulletin; Japan Ministry of Economy, Trade and Industry; Department of Industry, Innovation and Science (2019)

Macroeconomic Outlook

Resources and Energy Quarterly September 2019

● = Share of global GDP

▲ = Economic growth 2019*



Global growth remains subdued. The global economy is forecast to grow by 3.2% in 2019, and then by 3.5% in 2020.

Risks — Trade tensions between the US and its trading partners, China's economic slowdown, Brexit uncertainty.

*Source: IMF (2019) World Economic Outlook; Department of Industry, Innovation and Science (2019)

2.1 Summary

- The IMF is forecasting world economic growth of 3.2 per cent in 2019, 3.5 per cent in 2020 and 3.6 per cent in 2021.
- World trade and industrial production forecasts have weakened, due to the US-China trade frictions. Targeted stimulus measures are being implemented in China, in an attempt to offset the economic impacts of the US trade measures.

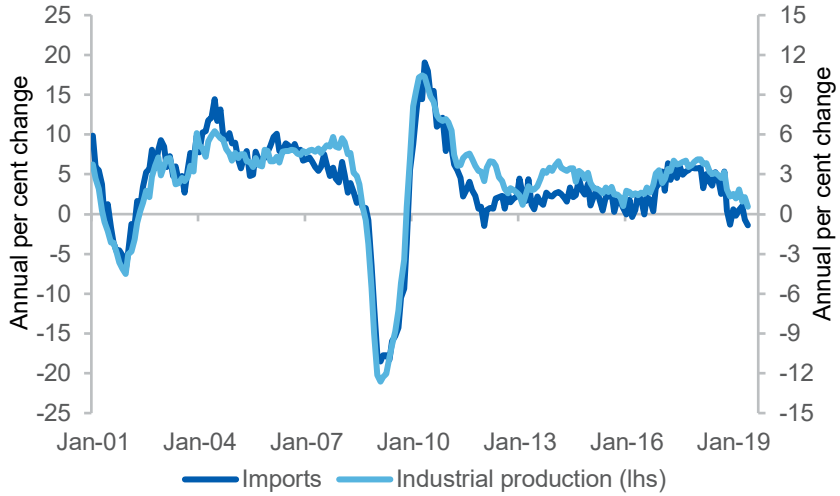
2.2 Global economy

The global economy has slowed again in the past quarter, and forward indicators point to a further slowdown in the December quarter. Some central banks are easing monetary policy, or are delaying a tightening of (already) easy monetary policy, in an attempt to sustain growth at a reasonable pace. The escalation of US-China trade tensions presents the most significant risk to the global outlook, and ongoing uncertainty over Brexit is likely to continue to impact on economic activity in Western Europe.

Global trade has declined noticeably in 2019 (Figure 2.1). The Chinese economy has slowed, and lower Chinese imports have affected export activity in many nations. Global supply chains are being adjusted, as the 10 per cent tariff on US$200 billion of US imports of Chinese goods — first imposed in May — is raised to 25 per cent. (China recently responded with higher tariffs on US$75 billion of imported US goods. An increase in the existing tariff to 30 per cent was then announced by the US Administration. The US also announced, but then partially delayed, a 15 per cent tariff on the final US$300 billion of imports from China that were untaxed.) Businesses are now delaying investment, due to growing uncertainty in trade and foreign investment. There is now a risk that households will start to delay purchases too.

While it is probable that world GDP growth will slow only modestly relative to the expected slowing in industrial production growth (Figure 2.2), the demand for resource and energy commodities is more closely related to world industrial production growth than world GDP growth.

Figure 2.1: World trade vs world industrial production



Source: IMF (2019); Department of Industry, Innovation and Science (2019)

Figure 2.2: Global GDP and industrial production growth

Source: Markit (2019), International Monetary Fund (2019), OCE (2019)

After a particularly buoyant twelve months from mid 2017 to mid 2018, trade tensions and a global slowdown have taken a toll on the global manufacturing Purchasing Managers Index (PMI), which fell to 49.5 in August (Figure 2.3). The index points to a further slowing in industrial production growth — and possibly even a contraction on an annualised basis — in the coming few months.

Figure 2.3: World Manufacturing PMI vs World Industrial Production

Source: CPB (2019), IHS Markit and JP Morgan (2019)

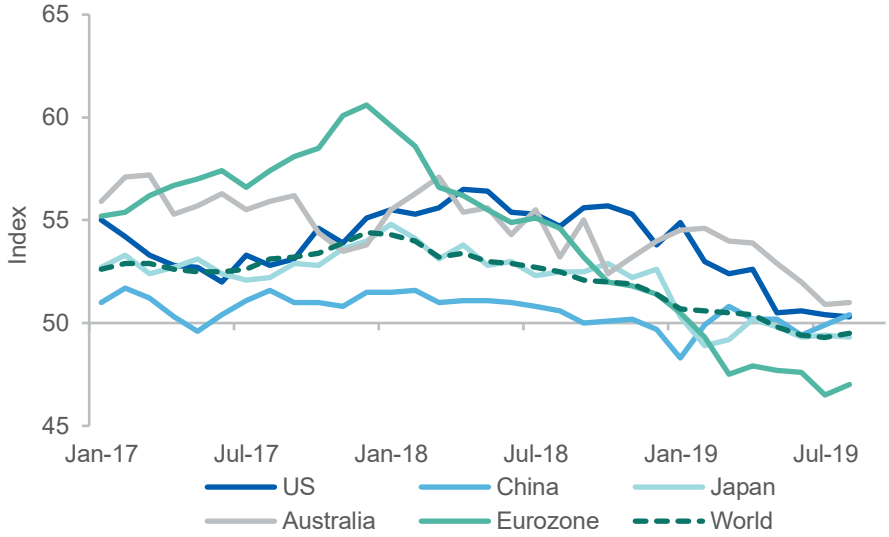
The ongoing US-China trade friction is likely to lead to a limited, highly targeted series of economic stimulus measures in China, as Beijing attempts to achieve its growth target of 6.0-6.5 per cent. Infrastructure projects, increased liquidity in the financial system and measures to increase consumer spending are expected to be the focus of the Chinese government's policy changes.

The government is unlikely to include the property sector among sectors to receive large stimulus: over-building and existing high debt levels could expose banks and local governments disproportionately to any downturn.

With the US-China trade friction drawing out, some manufacturers in China have recently moved production to other countries, including Vietnam and Cambodia, in order to avoid US tariffs.

Of the manufacturing indices, the Eurozone PMI has fallen the most (Figure 2.4). Key economies, such as Germany, have been hit by both Brexit concerns and slowing Chinese demand. Consumer sentiment in middle/high income Chinese households has been impacted by the US-China trade tensions.

Figure 2.4: Manufacturing PMIs



Source: IHS Markit (2019)

Geopolitical problems are also adding to risks to the world economic outlook. Tensions in the Strait of Hormuz, Hong Kong and the ongoing conflict in Syria, are among the more notable of these. But diplomatic tensions between Japan and South Korea, and between India and Pakistan, also have the potential to lower business and consumer confidence over the coming year.

2.3 Country and regional economic conditions

The US economy has slowed modestly so far in 2019

Growth in the US economy has slowed in recent months, as the impact of the 2018 tax cuts largely disappears, and trade tensions impact on business spending. The US Federal Reserve has cut the federal funds rate in response to the slowdown, and in an attempt to head off a further decline in GDP growth. Long term US bond yields have fallen sharply, reducing home loan interest rates and supporting household spending.

The US Institute of Supply Management (Manufacturing) Index hit a 43-month low in August 2019 and moved below the 50 mark (suggesting contractionary conditions). The new and/or increased tariffs announced by the US Administration since the June 2019 *Resources and Energy Quarterly* are likely to see the index fall further. Consumer confidence fell sharply in August and, after a decade of trend decline, initial jobless claims have recently levelled out (Figure 2.5). This, and the heightened trade tensions with China, point to a near term levelling out in the US unemployment rate, with the economy likely at, or close to, full employment anyway.

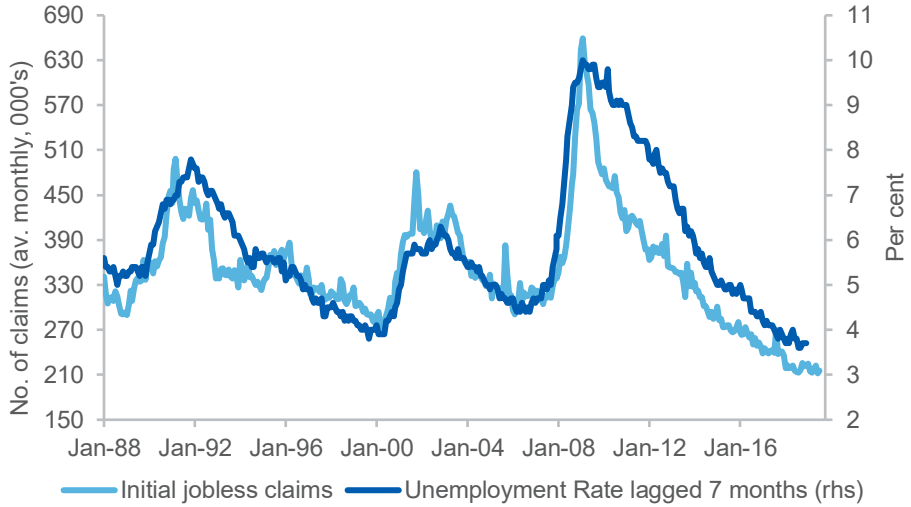
US economic growth is projected to moderate over the outlook period, falling to 2.6 per cent in 2019 and around 1.9 per cent in 2020 and 2021.

US tariffs have had a noticeable adverse impact on the Chinese economy

China's GDP growth slowed to 6.2 per cent in the June quarter, the slowest growth in decades. Chinese industrial production growth has also declined to multi-decade lows, at 4.4 per cent in August. Vehicle sales have fallen noticeably, after years of strong growth (Figure 2.6). Only some of the decline in car sales in China is due to lower government incentives.

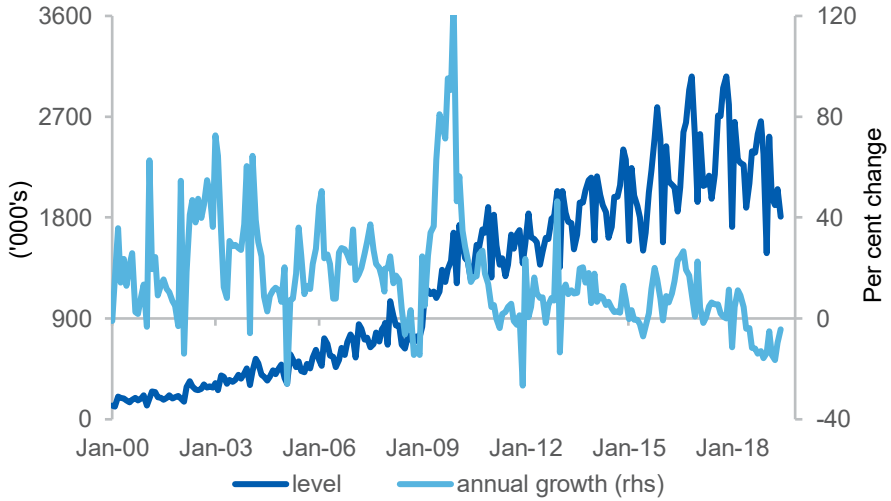
China's Manufacturing PMI, a forward indicator of activity in the manufacturing sector, suggests that activity is set to decline further in the December quarter. Chinese property markets (Figure 2.7) now appear to be cooling, after easing measures in some cities boosted activity in late 2018 and early 2019.

Figure 2.5: US unemployment rate and initial jobless claims, monthly



Source: US Bureau of Labor Statistics (2019)

Figure 2.6: Chinese vehicle sales



Source: Bloomberg (2019)

Any sustained downturn in the Chinese property market would likely have implications for new dwelling construction and motor vehicle purchases, both industries of which use large amounts of steel. Beijing is unlikely to try to maintain economic growth via measures to boost the property sector, seen by some as oversupplied.

Motor car purchases will likely be impacted by the wealth effect: a fall in property values typically discourages consumers from making big ticket purchases.

Figure 2.7: Chinese property indicators

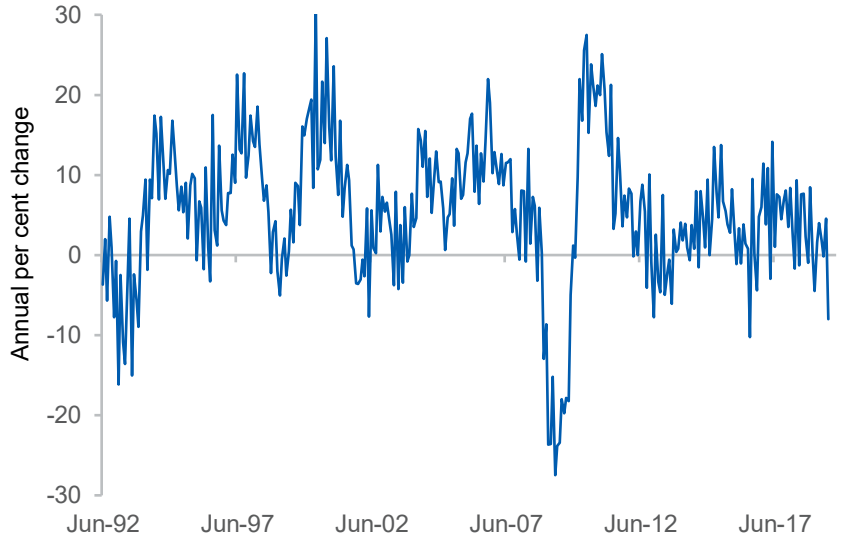
Source: Bloomberg (2019); National Bureau of Statistics of China (2019)

Chinese GDP growth is expected to continue easing slowly over the forecast period, averaging 5.5-6.0 per cent. The Chinese Government may choose to accept slower growth as an unavoidable result of the tariffs imposed on imports of Chinese goods by the US Administration.

Europe faces sluggish growth and rising risks

Eurozone growth has slowed from 2018 levels, led by a noticeable downturn in the German economy. Uncertainty over Brexit and slower exports to China and the US appear to be taking a toll on German exports (Figure 2.8). Leading indicators point to further weakening in the Eurozone, with the Composite PMI pointing to continuing sluggish GDP growth in the September quarter 2019.

Figure 2.8: German exports



Source: Bloomberg (2019)

Following the European Central Bank's (ECB's) policy meeting on 12 September, the bank cut its benchmark deposit rate by 10 basis points to -0.5 per cent, and pledged to reintroduce a quantitative easing program by buying 20 billion euros worth of bonds every month, indefinitely, starting in November. Many Eurozone nations have little/no scope to support growth by easing fiscal policy substantially. IMF forecasts for economic growth in the Eurozone have been revised down, to 1.3 per cent in 2019, and around 1.6 per cent in 2020 and 2021.

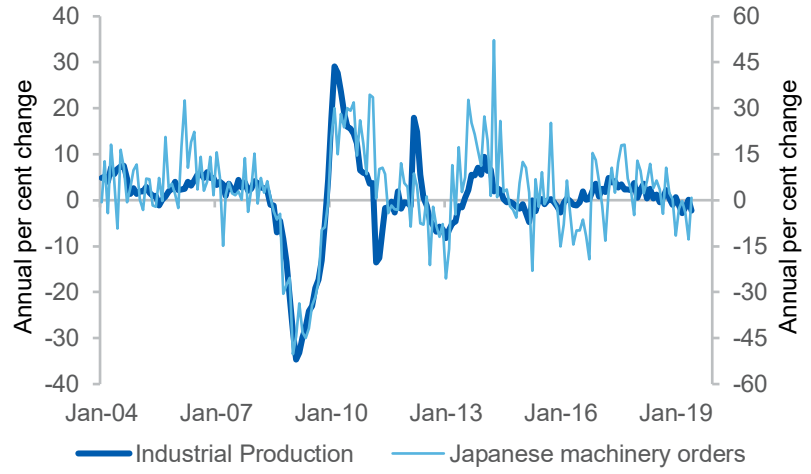
Japan's GDP growth is likely to ease over the outlook period

Japan's Tankan indices for large and small manufacturers have both weakened to their lowest level in almost three years. The declines come as external demand weakens in the face of slowing global growth and increased global trade friction. Japanese vehicle makers are being affected by lower Chinese demand. Machinery orders data point to an ongoing fall in Japanese industrial production in the coming few months (Figure 2.9).

An escalation of trade tensions between Japan and South Korea poses risks to the outlook. This escalation started in July, when Japan placed trade restrictions on three chemical materials widely used by South Korean companies that make semiconductors. Tensions has adversely impacted sectors such as tourism and consumer goods in both nations.

Japanese GDP growth is forecast to be 0.9 per cent in 2019. A US-Japan trade deal — expected at end September — would help to avoid a substantial fall in growth in 2020, which should also be supported by the hosting of the 2020 Olympic games.

Figure 2.9: Japanese industrial production vs machinery orders



Source: Bloomberg (2019)

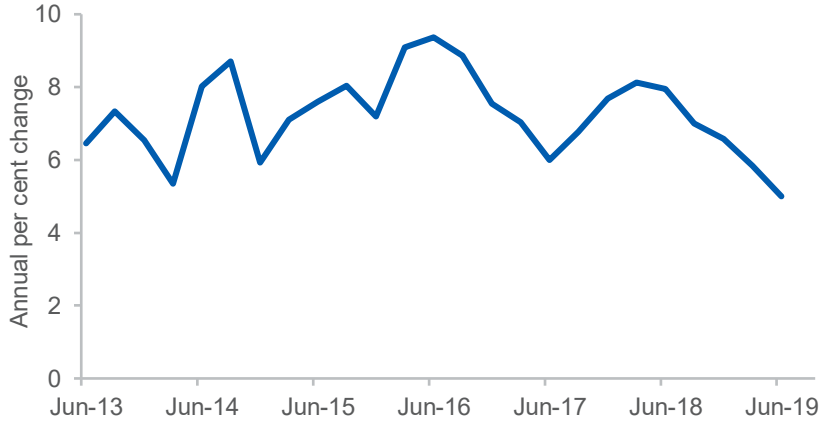
South Korea faces mild constraints as a result of trade tensions

South Korean economic growth has remained relatively weak in recent months, and is expected to be impacted by the tensions with Japan and the anticipated slowdown in China over the next few quarters. Economic growth is projected to be around 2.7 per cent in 2019 and 2020. A modest recovery — to 2.9 per cent — is likely in 2021, as the world is expected to recover from the US-China trade friction-related slowdown.

Indian growth has slowed

Growth in the Indian economy has stepped down a notch in 2019, hurt by weaker consumer confidence. Related to this decline in consumer confidence, motor vehicle sales have weakened noticeably. Indian shadow banks have encountered a liquidity crunch, following the collapse late last year of Infrastructure Leasing & Financial Services, a major nonbank finance company (NBFC) in India. That led to a surge in borrowing costs, forcing NBFCs to freeze, or tighten, lending practices. Indian GDP growth is expected to remain above 5.0 per cent in 2019, and to improve to 6.0 per cent in 2020 and 2021 — as financial conditions ease.

Figure 2.10: Indian GDP growth



Source: Bloomberg (2019)

Table 2.1: Key world macroeconomic assumptions

Per cent	2018	2019[a]	2020[a]	2021[a]
Economic growth[b]				
Advanced economies	2.2	1.9	1.7	1.7
Australia	2.8	2.1	2.8	2.8
Eurozone	1.9	1.3	1.6	1.7
France	1.7	1.3	1.4	1.5
Germany	1.4	0.7	1.7	1.5
Japan	0.8	0.9	0.4	0.5
New Zealand	3.0	2.5	2.9	2.8
South Korea	2.7	2.6	2.8	2.9
United Kingdom	1.4	1.3	1.4	1.5
United States	2.9	2.6	1.9	1.8
Emerging economies	4.5	4.1	4.7	4.9
ASEAN-5[d]	5.2	5.1	5.2	5.2
China[e]	6.6	5.7	5.5	6.0
Chinese Taipei	2.6	2.5	2.5	2.4
Emerging Asia	6.5	6.2	6.2	6.3
India	6.8	5.7	6.0	6.5
Latin America	1.0	0.6	2.3	2.6
Middle East	1.6	1.3	3.3	2.8
World[c]	3.6	3.2	3.5	3.6

Notes: a Assumption; b Year-on-year change; c Weighted using purchasing power parity (PPP) valuation of country gross domestic product by IMF; d Indonesia, Malaysia, the Philippines, Thailand and Vietnam; e Excludes Hong Kong

Source: IMF (2019) World Economic Outlook; Department of Industry, Innovation and Science (2019)

Table 2.2: Exchange rate and inflation assumptions

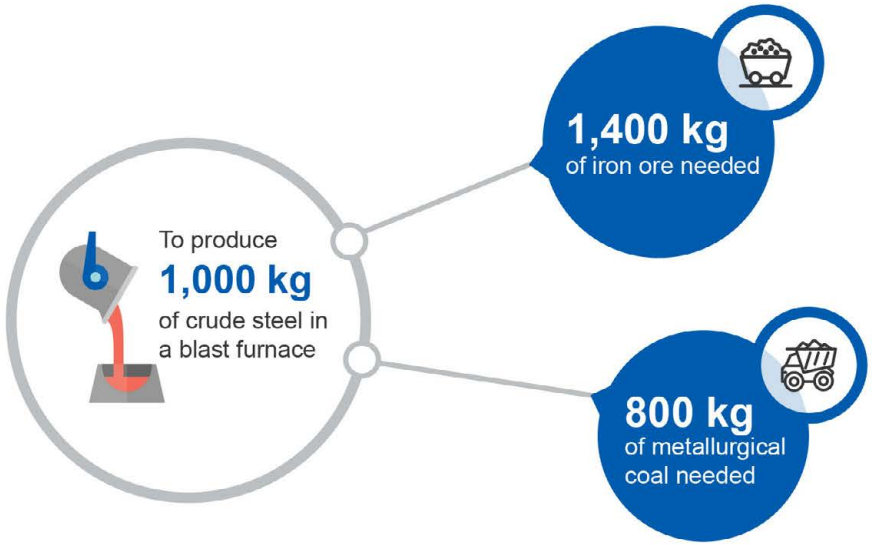
	2018	2019	2020	2021
AUD/USD exchange rate	0.75	0.70	0.72	0.74
Inflation rate				
United States	2.3	2.1	2.3	2.2
	2017–18	**2018–19**	**2019–20**	**2020–21**
Australia	1.9	1.6	2.1	2.4

Notes: The inflation rate for Australia is used to convert Australian export values to real 2019–20 dollars.
The inflation rate for the United States is used to convert commodity prices denominated in USD to real 2019 dollars.

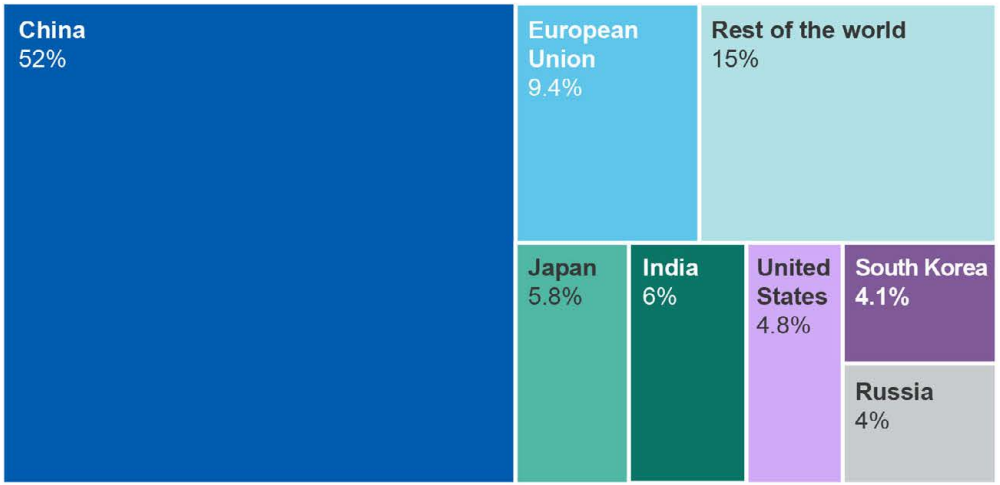
Source: Department of Industry, Innovation and Science (2019); Bloomberg (2019) Survey of economic forecasters

Steel

Resources and Energy Quarterly September 2019

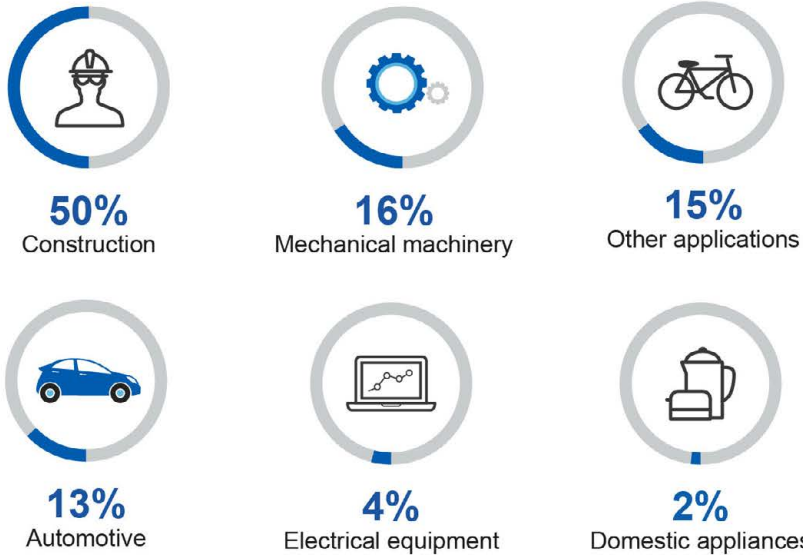


Major steel producers, 2018



Steel consumption per capita (kilograms per person), 2017

Steel use by sector



3.1 Summary

- World steel production appears set to taper off in 2019 as global economic uncertainty affects steel markets.
- World steel production is forecast to start growing again in subsequent years, increasing by around 2.9 per cent between 2019 and 2021.
- The risks to the outlook have risen in recent months, as a range of potential downsides emerge. These include further escalations in trade tensions and the possibility of an earlier than expected global downturn.

3.2 World consumption and production

Steel markets are responding to trade tensions

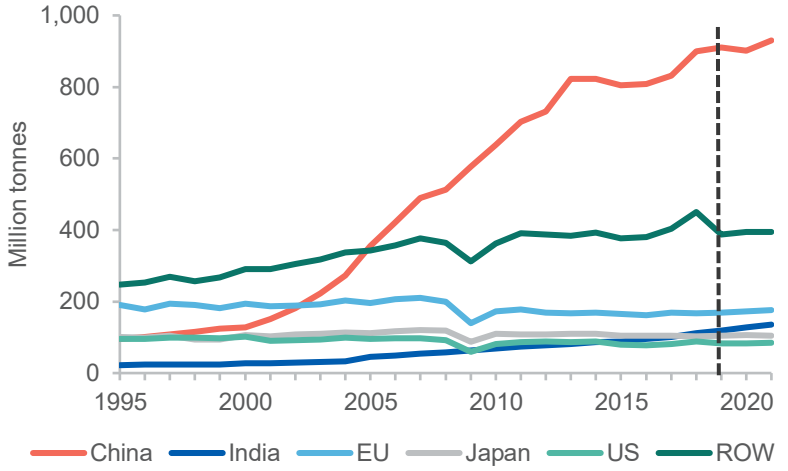
Growth in global steel demand faces headwinds as trade tensions lift and the prospects of recession in the US appear to have edged up. Yield curves for US government bonds have now inverted, with potential impact on confidence and investment.

World steel production is nonetheless estimated to have increased by 5 per cent year-on-year in the eight months to August 2019. The bulk of this growth was driven by China, where output is estimated to have risen by around 10 per cent in the first 8 months of 2019, relative to the same period one year ago (Figure 3.1).

Chinese steel markets have been affected by trade tensions and weather

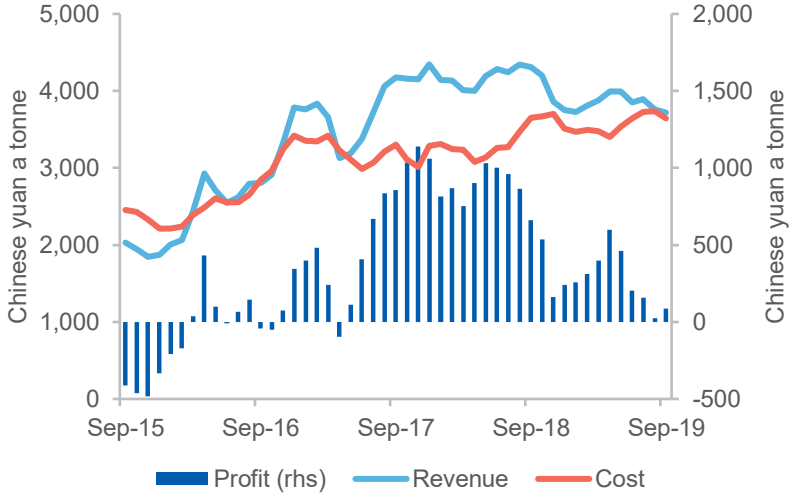
Growth in Chinese steel production weakened mid-year, as heavy rain in some regions and extreme heat across much of the country affected construction starts and reduced demand. Output of crude and finished steel fell in July, amidst falling profit margins (Figure 3.2), and rising costs for raw materials including iron ore. Output is likely to fall further in coming months. The fall partly reflects regular seasonal factors, but has been exacerbated by soft global demand and new environmental restrictions affecting production hubs in northern China. Chinese exports have fallen alongside production, declining by 39.97 million tonnes of finished steel (or around 2.9 per cent) over the year to July, relative to the same period in 2018.

Figure 3.1: Steel production by region



Source: World Steel Association (2019); Bloomberg (2019)

Figure 3.2: Steel industry profits in China



Notes: Monthly average for integrated basic oxygen furnace (BOF) steel mills
Source: Bloomberg (2019) China BOF Steel Profit Index

Strong steel prices have acted as a partial offset, preventing sharper falls in steel production. Chinese steel demand has also been supported by expanded releases of special purpose bonds, which are being used to fund new infrastructure.

Steel production may also be supported by a weaker Chinese currency over the rest of 2019. Trade tensions and resulting falls in the value of the yuan will potentially open new space for Chinese exporters of cold-rolled coil and hot-dipped galvanised coil. Exports may be further boosted should domestic use of steel by private industry in China continue to fall.

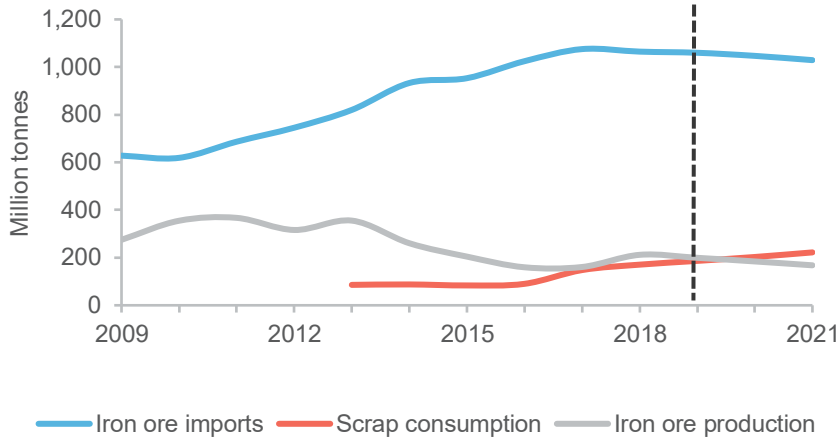
China's steel production is forecast to rise by 1.3 per cent to 937 million tonnes in 2019. Easing domestic use and a depreciating currency will likely push some of this production into export markets.

China's steel production is forecast to stabilise over the outlook period

Steel production is forecast to remain largely steady over the outlook period, reaching around 930 million tonnes in 2021 (Figure 3.4). Steel production in China faces competing pressures, with falling domestic consumption set against rising export prospects (Figure 3.3), and potential new stimulus measures. More stringent environmental regulations, and expected reductions in steel mill capacity — including the closure of Liuzhou Steel and Chanjiang Steel in 2021 — will likely offset growth in other areas. However, there is potential for currently idle steel capacity to return to operation should steel prices improve.

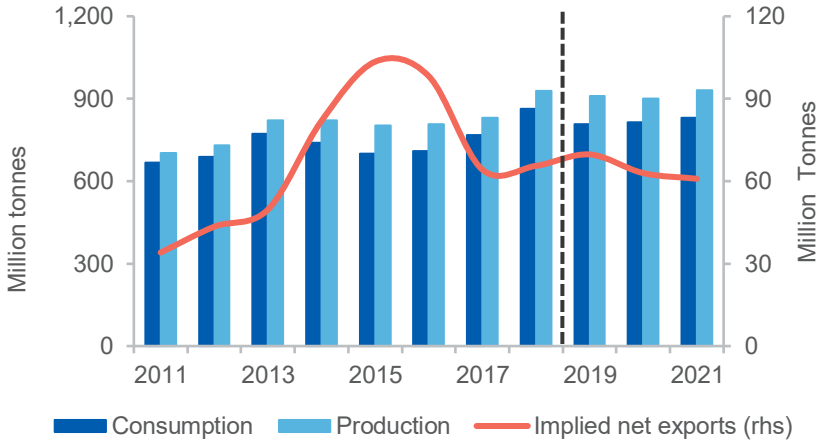
China continues to pivot towards greater use of scrap steel, which has a far lower energy cost than primary production of steel from iron ore. The transition will reduce Chinese dependence on imported iron ore and metallurgical coal (Figure 3.3). Volumes of available scrap are being supported by the rapid pace of demolition and replacement of construction works, alongside a rising proportion of machinery reaching end of life. A partial offset will occur as the Chinese Government continues to curb imports of low-grade and low-quality scrap for environmental reasons,

Figure 3.3: Forecast for Chinese steel inputs



Source: Bureau of International Recycling (2018) World Steel Recycling in Figures 2013–2017; Bloomberg (2019) World Steel Association; Department of Industry, Innovation and Science (2019)

Figure 3.4: China's steel consumption, production and exports



Source: Bloomberg (2019) World Steel Association; Department of Industry, Innovation and Science (2019)

but given China's importance as a market, this policy is likely to drive higher quality in the global scrap market rather than reduced import volumes over the longer term.

Emerging economies in Asia are becoming increasingly important

India and Vietnam are expected to drive growth in production among emerging Asian markets, as they continue to expand their steel industries.

India is an increasingly important source of steel, and passed Japan to become the world's third largest steel producer in 2018 (Figure 3.5). Production continues to rise in 2019, and is expected to be around 5 per cent higher over the first 8 months of 2019 than in the equivalent period for 2018. Usage peaked in March, then edged back as some infrastructure projects were paused during the national election. Subsequently, steel use has risen again, and is expected to increase further over the remainder of 2019, driven by higher spending on infrastructure.

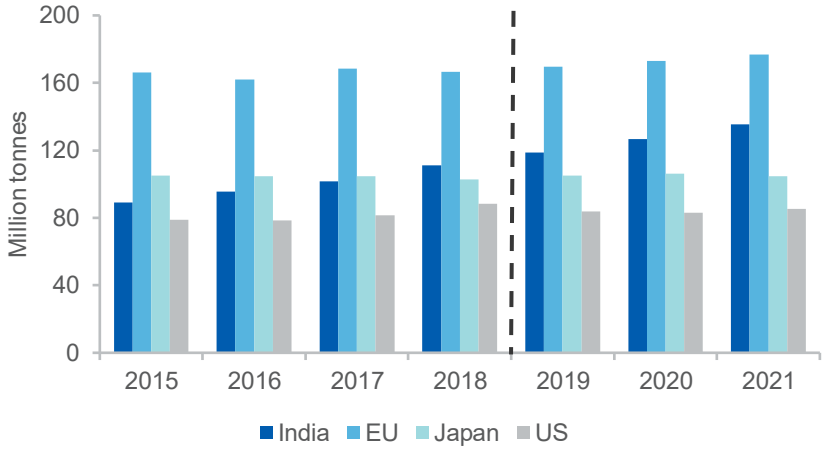
The Indian government has set aside around US$63 billion for infrastructure spending in its 2019–20 budget, and steel production is forecast to increase at an annual average rate of 6.8 per cent to reach 130 million tonnes in 2021. India has raised its projections for the domestic steel industry; its latest National Steel Policy projects steel output capacity of 300 million tonnes and per capita steel consumption of 160 kilograms by 2030, up from 101 million tonnes and 75 kilograms per capita in 2017.

Steel production is easing elsewhere

Steel production in the EU and Japan has shown signs of slowing in recent months. Manufacturing remains weak across most OECD nations, and industrial production is slowing, leading to a slow easing in steel production across most regions (Figure 3.6).

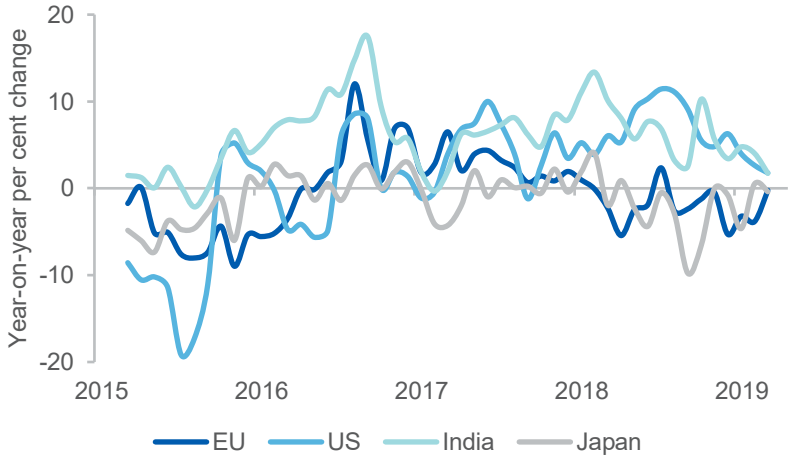
Trade tensions and a shift towards protectionist policies represent the most significant downside risk for steel over the outlook period. Steel remains deeply connected to global economic growth and industrial production and is highly responsive to shifts in these factors.

Figure 3.5: Steel production by region



Source: World Steel Association (2019); Department of Industry, Innovation and Science (2019)

Figure 3.6: Steel production growth by region



Source: Bloomberg (2019) World Steel Association

Table 3.1: World steel consumption and production

	Million tonnes				Annual percentage change		
Crude steel consumption	**2018**	**2019[f]**	**2020[f]**	**2021[f]**	**2019[f]**	**2020[f]**	**2021[f]**
China	798	806	814	831	1.0	1.0	2.0
European Union 28	175	175	175	175	0.0	0.0	0.0
United States	114	114	114	114	0.0	0.0	0.0
India	103	109	114	119	6.0	4.5	4.0
Japan	75	75	75	73	0.2	0.2	-3.0
Russia	59	59	59	59	-0.3	-0.3	-0.3
South Korea	44	43	43	43	-2.0	0.0	0.0
Brazil	22	23	23	24	2.0	2.0	2.0
World steel consumption	1,744	1,763	1,780	1,801	1.1	0.9	1.2
Crude steel production	**2018**	**2019[f]**	**2020[f]**	**2021[f]**	**2019[f]**	**2020[f]**	**2021[f]**
China	900	911	902	930	1.2	-1.0	3.1
European Union 28	166	170	173	177	2.0	2.0	2.0
India	103	105	106	105	2.2	0.9	-1.1
Japan	111	119	127	135	6.8	6.8	6.8
United States	88	84	83	85	-5.3	-0.8	2.6
Brazil	72	72	72	72	0.0	0.0	-0.1
Russia	73	71	70	70	-3.1	-0.4	-0.4
South Korea	30	25	30	35	-16.7	20.0	15.3
World steel production	1,819	1,776	1,785	1,827	-2.4	0.5	2.4

Notes: **f** Forecast.

Source: World Steel Association (2019); Department of Industry, Innovation and Science (2019)

Iron Ore

Resources and Energy Quarterly September 2019

1st

Australia is the largest exporter of iron ore in the world

835 million tonnes exported in 2018

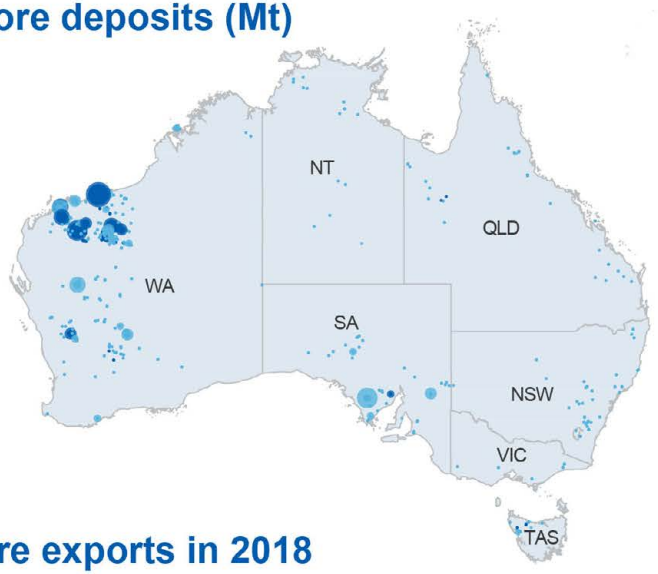
That's enough to build **10,050** Sydney Harbour bridges

$64 billion exported in 2018

29% of the world's iron ore reserves

Major Australian iron ore deposits (Mt)

- <229
- 230–813
- 814–1,777
- 1,778–3,042
- 3,043–5,446
- >5,447
- Deposit
- Operating mine



Global share of iron ore exports in 2018

53%	25%	4%	3%	3%	12%
Australia	Brazil	South Africa	Canada	Ukraine	Rest of the world

Australia's iron ore key export destinations, 2018

81%	8%	6%	2%	3%
China	Japan	South Korea	Taiwan	Rest of the world

Global share of iron ore imports in 2018

68%	9%	8%	5%	10%
China	European Union	Japan	South Korea	Rest of the world

4.1 Summary

- The forecast iron ore price in 2019 has been revised up to average US$80 a tonne Free on board (FOB). This reflects the full effect of supply disruptions — primarily in Brazil — and firm demand from China.
- The iron ore price is forecast to decline to average US$57 a tonne (FOB) by 2021, as the seaborne market gradually returns to balance.
- Australia's iron ore export earnings are set to increase to $77 billion in 2018–19, then to $81 billion in 2019–20. Earnings are then projected to ease to $65 billion in the final year of the outlook period, as seaborne prices gradually decline. Export volumes are expected to remain largely steady at just over 900 Mt over the outlook period.

4.2 Prices

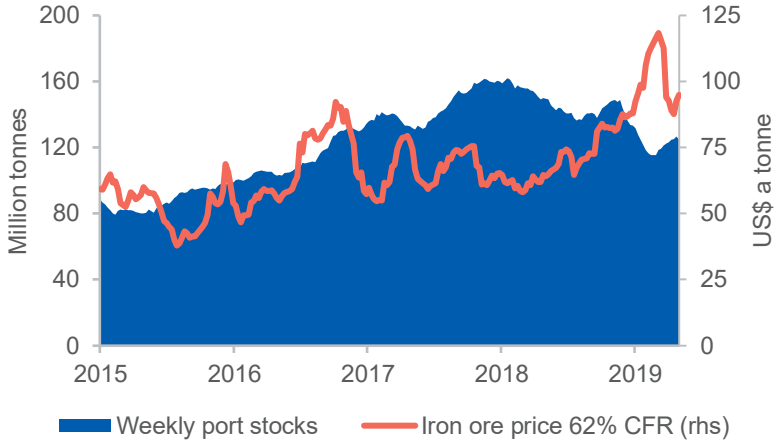
Iron ore prices have lost some of their recent surge

The FOB Australia iron ore price (62% iron content) — at which most Australian iron ore is sold — has declined noticeably in recent months after the first half surge (Figure 4.1).

It is unlikely that prices will drop substantially further in the short-term. Vale has lost 90 million tonnes of output — around one-quarter of its total annual capacity — following the catastrophic collapse of a Brazilian tailings dam in January. In its latest quarterly report, the company has confirmed that production is not expected to return to normal for at least three years. However, the impacts of a second supply disruption — caused by Cyclone Veronica, which affected Australian output early in 2019 — now appear to have passed.

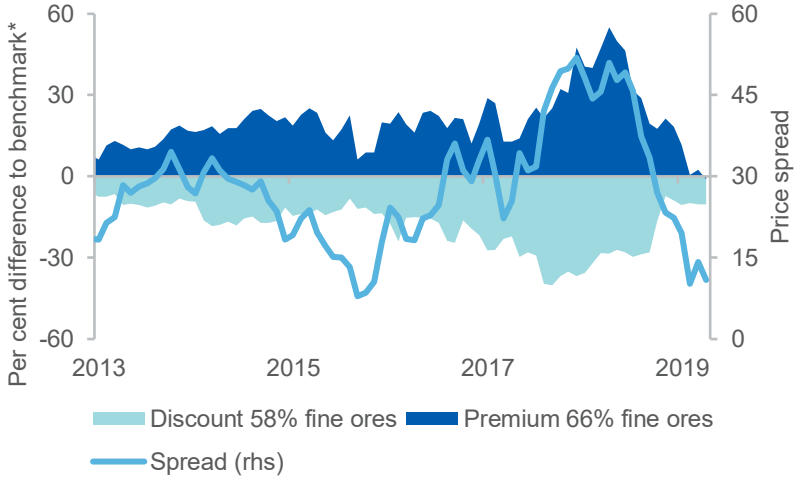
China's port stocks fell continuously over the first eight months of 2019, but have recently shown signs of stabilising. It is not yet clear whether the stabilisation reflects temporary factors — such as the timing of shipments — or whether it is the start of a more sustained recovery in stocks.

Figure 4.1: China's iron ore port stocks and spot price



Notes: China import Iron ore fines 62% Fe spot (CFR Tianjin port)
Source: Bloomberg (2019) Antaike iron ore port stocks and Metal Bulletin

Figure 4.2: Iron ore price spread between grades



Notes: *Benchmark used is 62 per cent iron fines CFR
Source: Bloomberg (2019) China import prices

As outlined in Chapter 3 *Steel*, steel production in China remains high, though the rapid growth in production of early 2019 appears to have paused. With the supply of high grade iron ore (65% Fe content) from Brazil heavily disrupted, Chinese steel makers have pivoted to lower grade ores. This has pushed the price of lower grade ores up in recent months, leading to a reduction in the price premium for higher grades (Figure 4.2).

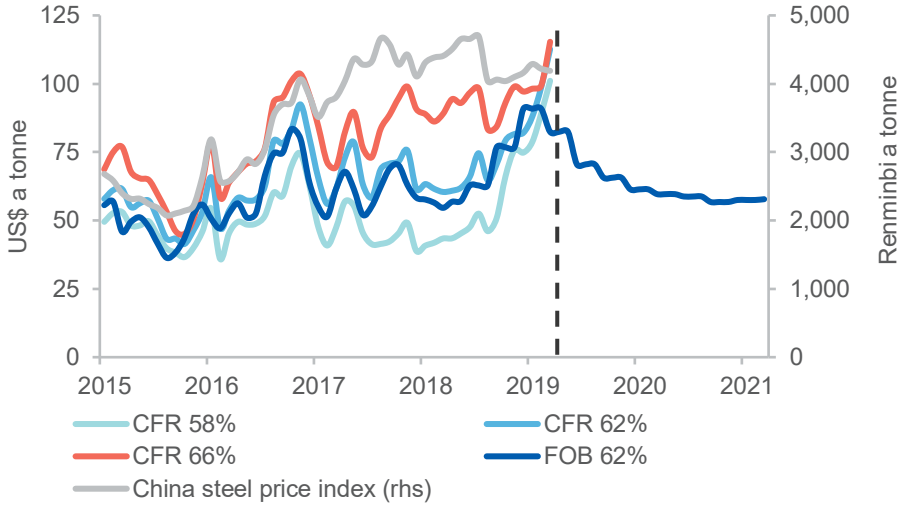
Prices face higher downside risks

Iron ore prices are expected to average around 30 per cent higher in 2019 relative to 2018 (FOB), as supply cuts imposed after the Brazilian tailings dam collapse continue to constrain supply (Figure 4.3). However, Vale's best mining assets — based in northern Brazil — continue to operate without issues. Vale is ramping up its Brazilian output by recommencing production from its large project at Brucutu, and through a greater use of dry tailings stacking. This would allow for some of the lost production to be offset late in 2019, though at least one-third of the supply cut is expected to persist for several more years.

The key influence on future prices is likely to be pace of global economic growth. Recessionary risks appear to be rising at present, with industrial production annual growth close to turning negative (see Chapter 2 *Macro economy*). Among the potential catalysts for a sharper global downturn are rising trade tensions between the US and China, slowing US growth (as corporate tax cuts finish working through the system), high debt in China, and downturns in Germany and other European countries. As steel remains deeply connected to global industrial production, the downside risks to the steel outlook are lifting. However, the overall effect of a downturn on the global economy remains difficult to project, as many countries are likely to respond to a further downturn by enacting new stimulus measures, which typically involve infrastructure development and efforts to stimulate greater production of steel (Figure 4.4).

The iron ore price is forecast to decline to an average US$57 a tonne in 2021, as global production gradually recovers.

Figure 4.3: Iron ore price by grade and China steel price index



Notes: The OCE forecasts the FOB (free on board) Australia iron ore price, not the benchmark CFR (cost and freight) North China iron ore price.

Source: Bloomberg (2019) Metal Bulletin; Department of Industry, Innovation and Science (2019)

Figure 4.4: Iron ore price and China steel production growth

Notes: China import Iron ore fines 62% Fe spot (CFR Tianjin port)

Source: Bloomberg (2019) China import prices; World Steel Association (2019)

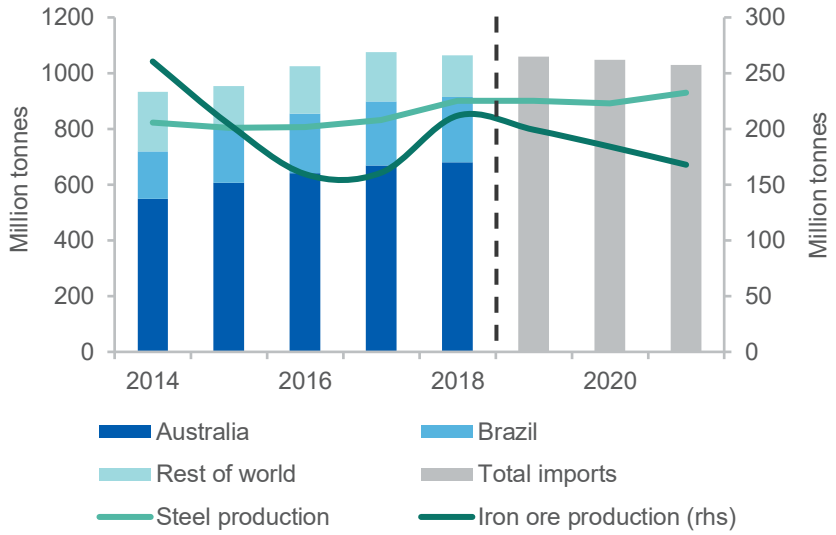
4.3 World trade

China's iron ore imports are forecast to gradually decline

China's iron ore imports have edged back in recent months, falling by around 5 per cent in June (the latest available data) despite high steel production. Supply disruptions have accelerated an existing trend towards greater use of scrap and recycled steel as an alternative to iron ore imports and primary production.

China's iron ore imports peaked at 1,075 million tonnes in 2017, and are forecast to decline over the outlook period — reaching 1,029 million tonnes in 2021 (Figure 4.5) — as rising scrap use substitutes for traditional steel production.

Figure 4.5: China's iron ore imports and production



Notes: China's iron ore production is quality adjusted.

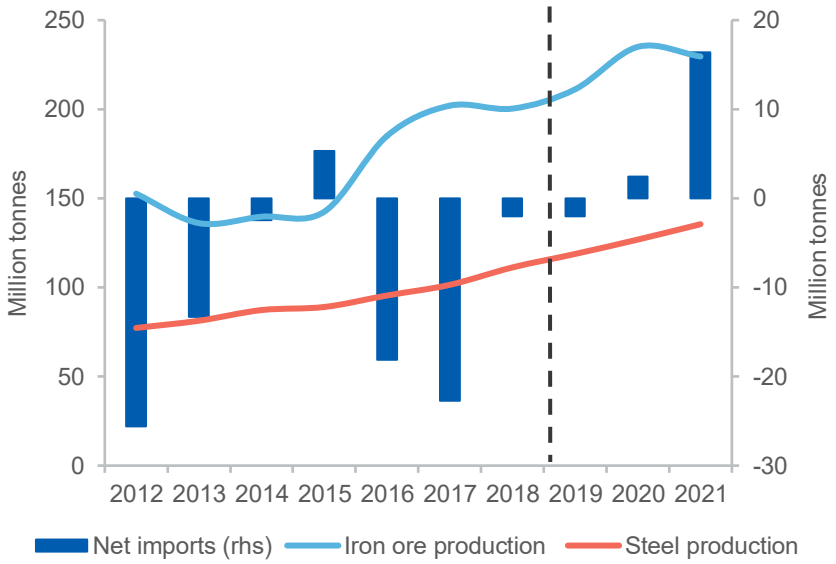
Source: Bloomberg (2019) Antaike Information Development; Bloomberg (2019) China Customs General administration; Department of Industry, Innovation and Science (2019)

India is set to become a net importer of iron ore

India is set to become a highly significant influence on global iron ore markets, as the country continues to industrialise. India currently has low iron ore use per capita, but the government has recently announced that an increase in this measure will be part of its economic plan. India's iron ore production is forecast to increase by 4.6 per cent annually, from an estimated 200 million tonnes in 2018 to 230 million tonnes in 2021. Rising iron ore production will be driven by growing demand from the domestic steel industry.

India is forecast to remain a small net importer of iron ore from 2020 onwards, as the government pursues ambitious steel production targets, but tightly regulates the domestic iron ore industry and continues to clamp down on illegal iron ore mining (Figure 4.6).

Figure 4.6: India's iron ore imports and domestic production



Source: World Steel Association (2019); Department of Industry, Innovation and Science (2019)

Export growth is likely to taper off in the short-term

Global seaborne iron ore supply is forecast to edge down to around 1,550 million tonnes in 2019. This reflects a decline in output from Brazil, offset by rising production elsewhere, including Australia, which is expected to fill much of the gap by 2021 (Figure 4.7).

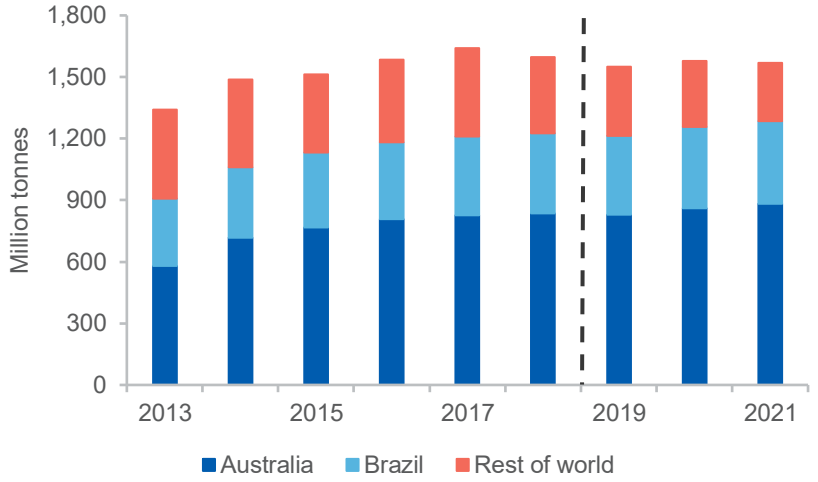
While Vale is seeking to increase production from its other projects in the north of Brazil, overall output is expected to remain below the company's recent average of around 400 million tonnes of output for at least the next three years. High-grade (65% Fe content) iron ore is likely to be particularly affected until Vale's S11D project at the Carajás complex ramps up towards its full capacity. The project is expected to reach its full capacity by 2020.

Also contributing to the output will be the expansion of Anglo American's Minas-Rio mine, which will provide additional high-grade supply. Anglo America has received the preliminary and installation licences for their stage 3 expansion, paving the way for the operation to ramp up towards its nameplate capacity of 26 million tonnes. The mine produced 5.9 million tonnes of high grade iron ore in the June quarter 2019.

Partly offsetting this, it is likely that Vale — and potentially other producers — will focus on shifting from wet to dry processing over the next three years. This will divert resources away from other potential expansions, and may lead to some drag on Brazilian output in the short term. However, in the longer term it will likely improve stability of supply across the global iron ore market.

Vale's high-grade Samarco mine — closed since the tailings dam burst in November 2015 — is expected to return to production by 2020, with output gradually ramping up to nameplate capacity of 32 million tonnes.

Figure 4.7: Outlook for global iron ore exports



Source: World Steel Association (2019); Department of Industry, Innovation and Science (2019)

Increased supply elsewhere to gradually help ease the market deficit

Australian production is likely to ramp up after 2020, but several African projects in the Democratic Republic of Congo are closer to commencement. These include the recently announced Glencore and Zanga joint venture, which is expected to supply 2 million tonnes of high grade iron ore over 2019 and 2020. In mid-2019, the Sapro group delivered its first shipment of high grade (65% Fe) iron ore to China, with the company projecting a ramp-up to 12 million tonnes by 2022.

Tacora's Wabush high grade iron ore mine in Canada is on track to restart in June and gradually ramp up to 6 million tonnes per annum.

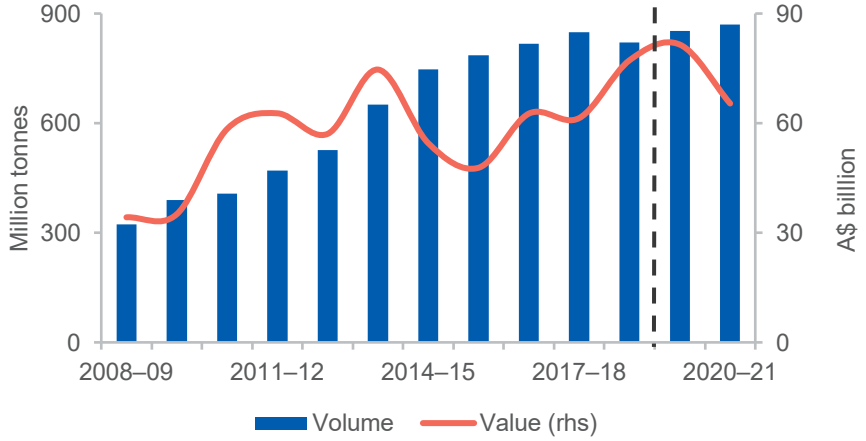
4.4 Australia

Australia's iron ore export earnings have not peaked yet

Australia's iron ore export earnings increased by 25 per cent to $76 billion in 2018–19, the highest level on record (Figure 4.8). The result reflects rapid price growth, which more than offset a small decline in volumes — owing to weather events including Cyclone Veronica. The exchange rate also continues to trend down, adding to global competitiveness and revenue potential for Australian exporters.

Export values are forecast to rise to $81 billion in 2019–20, driven by elevated prices and export volumes, before declining to around $65 billion in 2020–21. Rising production in Australia and elsewhere over this period is expected to pull prices back, while demand is likely to flatten out. Prices (and export revenue) are likely to drop further should a global downturn eventuate. Such a downturn now represents the key risk to Australia's iron ore export outlook.

Figure 4.8: Australia's iron ore export volumes and values



Source: ABS (2019) International Trade, Australia, 5368.0; Department of Industry, Innovation and Science (2019)

Australia's iron ore export volumes are forecast to grow

Australia's iron ore export volumes edged down by 0.2 per cent year-on-year in the June quarter to 219 million tonnes. Export volumes fell sharply in late March following Cyclone Veronica. However, as ports in the Pilbara region returned to regular operation, production recovered again in the June quarter.

Export volumes are forecast to increase by an annual average of 2.9 per cent over the outlook period, from 820 million tonnes in 2018–19 to 869 million tonnes in 2020–21. Higher volumes should be underpinned by Fortescue's Iron Bridge project, and also by development of three large iron ore projects in the Pilbara region. These are Fortescue's Eliwana, which is set to commence in December 2020 and produce 30 million tonnes per year; Rio Tinto's Koodaideri, expected to commence in late 2021 and produce 43 million tonnes per year; and BHP's South Flank, set to produce 80 million tonnes annually and replace existing production from the Yandi operations from 2021.

Revisions to export earnings

Australia's iron ore export earnings for 2018–19 have been revised up from $75.2 billion in the June quarter *Resources and Energy Quarterly*, to $77.2 billion in this release. The change reflects additional information on the likely timing of returns to production from Vale facilities in Brazil, and suggests more of the price gain will be retained in coming years.

Iron ore exploration expenditure expected to rise over the outlook

Australia's iron ore exploration expenditure increased by 4.9 per cent year-on-year to $93.4 million in the June quarter 2019. Iron ore exploration has benefited from the surge in prices early in 2019, and robust demand from key markets including China.

Rising global uncertainty over the last few months may affect exploration over the coming quarters.

Table 4.1: World trade in iron ore

	Million tonnes				Annual percentage change		
	2018	2019[f]	2020[f]	2021 [f]	2019[f]	2020[f]	2021 [f]
Total world trade	1,595	1,550	1,579	1,568	-2.9	1.9	-0.7
Iron ore imports							
China	1,065	1,060	1,047	1,029	-0.4	-1.2	-1.7
European Union 28	148	150	152	153	1.4	1.4	0.2
Japan	129	130	131	129	0.5	0.7	-1.1
South Korea	73	76	75	75	3.0	-0.4	-0.4
India	16	12	15	27	-24.5	20.8	87.2
Iron ore exports							
Australia	835	828	862	881	-0.8	4.1	2.2
Brazil	390	386	396	403	-1.0	2.6	1.8
Ukraine	35	30	29	30	-14.3	-3.3	1.7
India	18	14	12	11	-21.6	-14.1	-11.1

Notes: **f** Forecast.

Source: World Steel Association (2019); International Trade Centre (2019); Department of Industry, Innovation and Science (2019)

Table 4.2: Iron ore outlook

						Annual percentage change		
World	**Unit**	**2018**	**2019[f]**	**2020[f]**	**2021[f]**	**2019[f]**	**2020[f]**	**2021[f]**
Prices [bc]								
– nominal	US$/t	61.2	80.1	61.4	57.5	30.9	-23.4	-6.3
– real [d]	US$/t	62.5	80.1	60.0	55.0	28.1	-25.2	-8.3
Australia	**Unit**	**2017–18**	**2018–19[s]**	**2019–20[f]**	**2020–21[f]**	**2018–19**	**2019–20[f]**	**2020–21[f]**
Production								
– Steel [hs]	Mt	5.71	5.78	5.78	5.79	1.2	0.0	0.2
– Iron ore	Mt	900	913	901	912	1.4	-1.3	1.2
Exports								
Steel	Mt	1.15	1.21	0.99	1.00	5.0	-17.8	0.2
– nominal value	A$m	926	1 261	751	752	36.1	-40.5	0.2
– real value [hi]	A$m	964	1 291	751	734	33.9	-41.9	-2.2
Iron ore	Mt	848	820	852	869	-3.4	3.9	2.0
– nominal value	A$m	61,392	77,211	81,457	65,344	25.8	5.5	-19.8
– real value [i]	A$m	63,901	79,064	81,457	63,774	23.7	3.0	-21.7

Notes: **b** fob Australian basis; **c** Spot price, 62 per cent iron content basis; **d** In 2019 US dollars; **f** Forecast; **h** Crude steel equivalent; Crude steel is defined as the first solid state of production after melting. In ABS Australian Harmonized Export Commodity Classification, crude steel equivalent includes most items from 7206 to 7307, excluding ferrous waste and scrap and ferroalloys; **i** In 2019–20 Australian dollars.

Source: ABS (2019) International Trade in Goods and Services, Australia, 5368.0; Bloomberg (2019) Metal Bulletin; World Steel Association (2019); AME Group (2019); Company Reports; Department of Industry, Innovation and Science (2019)

Metallurgical Coal

Resources and Energy Quarterly September 2019

Australia is the world's **largest exporter** of metallurgical coal

1st

Every tonne of steel produced in a blast furnace needs about **800kg** of metallurgical coal.

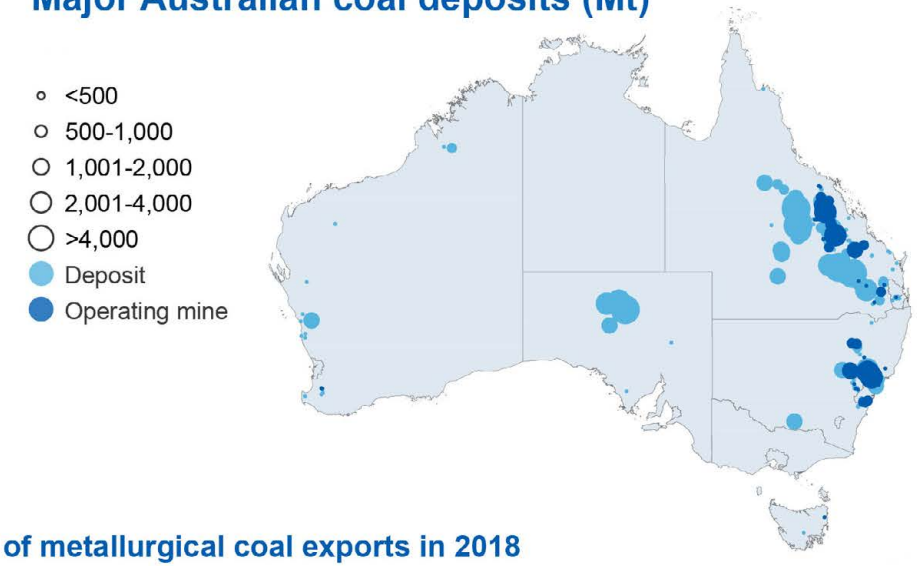
Metallurgical coal is a non-substitutable raw material in the production of steel from iron ore

Australia accounted for around **17%** of world production in 2018

It takes more than 200 tonnes of metallurgical coal to make every wind turbine

Australia exported 183 million tonnes in 2018–19, valued at **$44 billion**

Major Australian coal deposits (Mt)



Australia's metallurgical coal export earnings by destination, 2018–19


26% India


23% China


18% Japan


9% South Korea


6% Taiwan


18% Rest of the world

Global share of metallurgical coal exports in 2018


53% Australia


17% US


9% Canada


8% Russia


8% Mongolia


5% Rest of the world

Global share of metallurgical coal imports in 2018


22% China


20% India


16% Japan


15% EU28


12% South Korea


15% Rest of the world

5.1 Summary

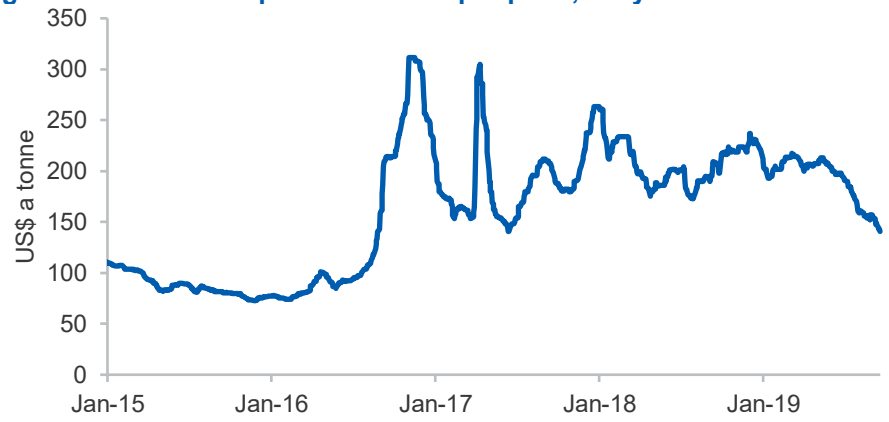
- The premium Australian hard coking coal (HCC) spot price has declined sharply over recent months, and is forecast to remain subdued over the outlook period. Rising supply combined with falling demand is expected to drive an easing of the average price from US$186 a tonne in 2019 to US$158 a tonne in 2021.
- Australia's export volumes are forecast to grow from 183 million tonnes in 2018–19 to 198 million tonnes by 2020–21, reflecting production growth from restarts and new capacity in the Bowen Basin.
- Australia's metallurgical coal export earnings reached a new record of $44 billion in 2018–19. However, a forecast decline in prices is expected to reduce export earnings to $35 billion by 2020–21.

5.2 Prices

The premium Australian HCC spot price has declined sharply

The premium Australian HCC spot price declined sharply over the September quarter, and reached a 27 month low of US$141 a tonne in late September (Figure 5.1). At an estimated average of US$167 a tonne in the September quarter, the price was 18 per cent lower than the June quarter, and 13 per cent lower year-on-year.

Figure 5.1: Australian premium HCC spot price, daily



Source: Platts (2019); Department of Industry, Innovation and Science (2019)

The price has declined more sharply than previously anticipated, driven by a combination of factors. Demand growth has been relatively muted against a background of a deteriorating global economic outlook (see the *macroeconomic outlook* chapter) and weak global steel production outside of China. While Chinese imports of metallurgical coal have been strong, there has been growing negative sentiment impacting on buying from Chinese steel mills, due to multiple drivers. These include slowing demand, declining steel margins and an expected tightening in coal imports. Indian steel demand has been weak given the June to August monsoon season. In the meantime, supply has been growing from Australia, Russia and Mongolia.

The metallurgical coal price is forecast to remain under pressure

The Chinese government is expected to continue implementation of current import policies — with total coal imports expected to be around 280 million tonnes in 2019 — that would lead to a sharp decline in imports towards the end of the year. Prices are therefore forecast to remain weak until the end of 2019, before a mild recovery as quotas are reset for 2020.

Over the outlook period, a well-supplied seaborne market is expected to reduce the average premium HCC spot price from US$186 a tonne in 2019 to US$158 a tonne by 2021. The seaborne market is forecast to be flush with supply as Australia and Russia increase exports. Given Australia's dominance of the seaborne market, weather, logistics and other disruptions in Queensland have the potential to drive intermittent price spikes. India is expected to be the key source of import growth, offsetting a gradual easing in demand from China. Strong demand from India and emerging Asia, in combination with high-cost supply exiting the market, is expected to help put a floor under prices.

Fluctuations in Chinese imports of metallurgical coal are expected to add considerable volatility to the price over the outlook period. The outlook for Chinese imports remains subject to substantial uncertainty, with the extent of an economic slowdown, government stimulatory measures and import policies representing key risks.

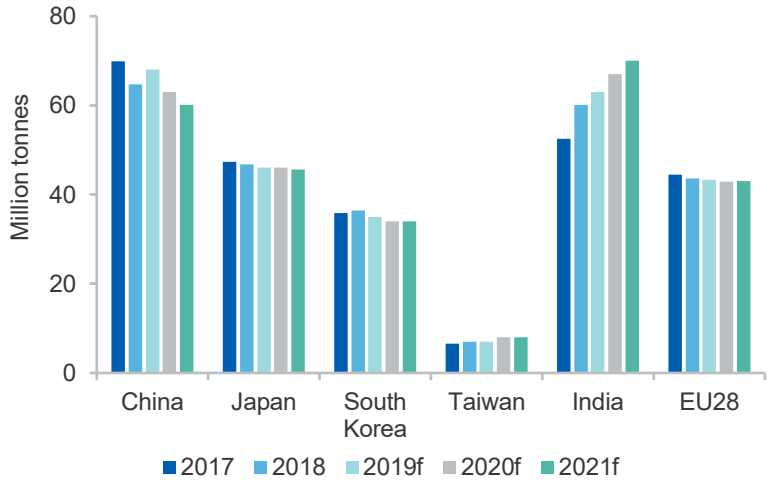
5.3 World trade

After three years of robust growth, growth in world metallurgical coal trade is expected to slow over the outlook period to 2021. A deterioration in the global economic outlook, greater uncertainty over trade relations and softening industrial production are all expected to weigh on steel output, and consequently metallurgical coal demand. World metallurgical coal trade is still forecast to grow over the outlook period, but at a slower rate than previous years.

World imports

Strong steel production in China and India has led most of the gains in seaborne demand for metallurgical coal in 2019 to date, while steel production elsewhere in the world has been weighed down by slowing industrial production. India is expected to emerge as the key source of demand growth over the outlook period. Demand is projected to be subdued or decline marginally among most other major importers, including China, as industrial production growth slows (Figure 5.2).

Figure 5.2: Metallurgical coal imports

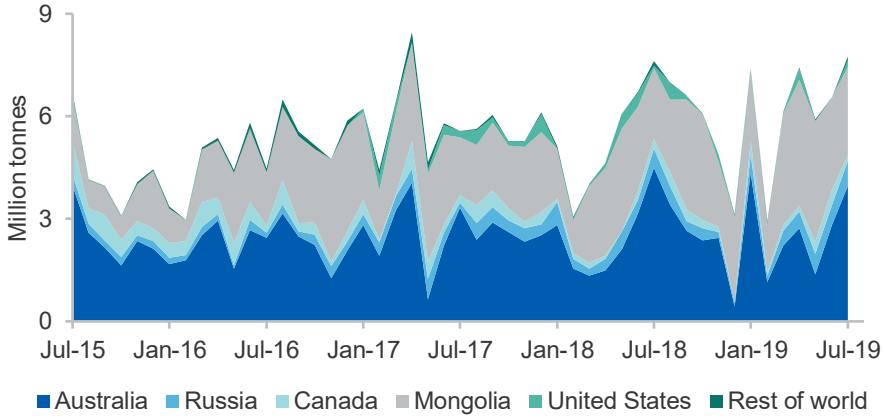


Notes: **f** Forecast
Source: IHS (2019); Department of Industry, Innovation and Science (2019)

China's metallurgical coal imports forecast to ease

China's metallurgical coal imports totaled 44 million tonnes in the first seven months of 2019. Imports have been volatile, but overall, have increased by 18 per cent year-on-year (Figure 5.3). Demand for metallurgical coal has been driven by robust steel production, which grew by 9.4 per cent year-on-year over the same period (see the s*teel* chapter).

Figure 5.3: China's metallurgical coal imports



Source: Bloomberg (2019) National Bureau of Statistics of China

There are a number of conflicting factors influencing China's imports of metallurgical coal, with the risks weighted to the downside. The government is expected to continue implementation of current import policies, with total coal imports anticipated to be around 280 million tonnes in 2019. With coal imports already higher on a year-on-year basis, this would lead to a sharp drop in imports towards the end of 2019 as ports reach their annual quotas.

Most leading indicators (see the *macroeconomic outlook* chapter) are also pointing to a marked slowdown in major steel consuming sectors, including construction and manufacturing (particularly the auto sector). The Chinese government has acknowledged a more challenging external environment and downward economic pressure. An increase in stimulus measures could boost industrial production and infrastructure spending, and provide

further support to steel output and metallurgical demand. However, China's recent policy responses to its economic challenges have been relatively restrained.

China's metallurgical coal imports are forecast to gradually decline as steel production eases in line with economic growth. Nevertheless, China is expected to be more reliant on imports for metallurgical coal compared to thermal coal (for which domestic production is rising), particularly for higher quality grades which are more difficult to source domestically.

Developments in China continue to represent a major risk to the outlook. Changes to China's fiscal, monetary and import policies have the potential to drive significant shifts in the outlook for the country's metallurgical coal imports.

India's metallurgical coal imports have slowed at the start of 2019

India's steel production at the start of the year was impacted by slowing investment and infrastructure projects in the lead up to the general election in May. India's metallurgical coal imports rebounded in the June 2019 quarter, growing by 17 per cent year-on-year compared with a decline of 7.7 per cent in the March quarter. While trade data is not yet available, India's metallurgical coal imports are expected to have weakened in more recent months as monsoon rains dampen steel demand and output.

India's metallurgical coal imports are forecast to grow at an average annual rate of 5.2 per cent over the outlook period, reaching 70 million tonnes. India is expected to overtake China as the world's largest importer of metallurgical coal by 2021.

India has very limited domestic reserves of metallurgical coal, and will need to increase imports to support the rapid growth of its domestic steel sector. Steel production is expected to grow to meet rising domestic consumption. However, the pace at which India's steel sector is able to expand remains uncertain, and presents a risk to the outlook. Slowing economic growth and tighter monetary and fiscal measures implemented by the Indian government are impacting on steel demand — and consequently metallurgical coal — presenting a downside risk.

Japan and South Korea's imports forecast to remain subdued

Metallurgical coal imports into Japan declined by 4.2 per cent year-on-year basis in the first seven months of 2019. Steel demand — which declined by 3.1 per cent over the same period — has weakened, as construction activity for the 2020 Tokyo Olympics comes to an end.

South Korea's imports of metallurgical coal grew by 0.1 per cent year-on-year in the first seven months of 2019, consistent with trends in steel production (which grew by 0.6 per cent over the same period).

Metallurgical coal imports from both Japan and South Korea — the third and fourth largest importers of metallurgical coal, respectively — are forecast to remain subdued over the outlook period. Slowing global and domestic economic growth is expected to weigh on demand for steel products in both countries. Escalating trade tensions between Japan and South Korea could weigh further on economic growth in the two countries.

Metallurgical coal imports forecast to rise in emerging economies

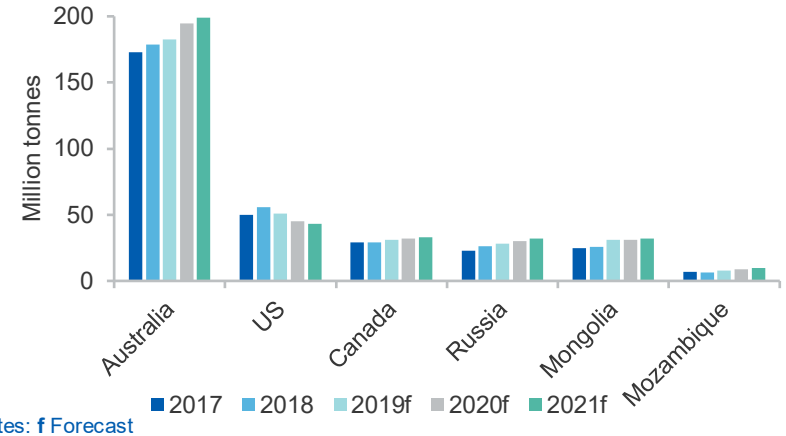
Metallurgical coal imports are forecast to grow in South East Asia, although from a low base. Several blast furnace steel plants are expected to come online over the outlook period — notably in Vietnam — supporting import demand for metallurgical coal.

World exports

Global metallurgical coal exports are forecast to grow over the outlook period, but at a slower pace than previous years as prices moderate.

Australia is expected to lead the bulk of the additions to seaborne supply (see section 5.4) and to comfortably dominate the seaborne metallurgical coal market, accounting for a forecast 56 per cent of world exports in 2021. However, Australia's market share is expected to remain lower than 60 per cent, the market share achieved in the pre-Cyclone Debbie period. Russia, Canada, Mozambique and Mongolia have all increased their exports and their relative share of the internationally traded metallurgical coal market over the last few years (Figure 5.4).

Figure 5.4: Metallurgical coal exports



Notes: **f** Forecast

Source: IHS (2019); Department of Industry, Innovation and Science (2019)

Exports from the United States forecast to ease

The US is the world's second largest exporter of metallurgical coal, with exports growing by 11 per cent to reach 56 million tonnes in 2018. Exports grew substantially between 2016 and 2018, in line with higher prices and to fill the supply gap created by the loss of Australian supply caused by Cyclone Debbie in 2017.

Metallurgical coal exports from the US have since declined — by 11 per cent year-on-year in the first seven months of 2019 — and are forecast to moderate further to 2021. US producers have relatively high production costs and freight rates to Asian markets, and exports are thus forecast to decline as prices ease and exports from other countries increase.

New capacity expected to support Canada's export growth

Canada's metallurgical coal exports grew by 6.5 per cent year-on-year in the first seven months of 2019, driven by an increase in shipments to China and India. However, exports were volatile on a month-to-month basis, due to inclement weather. Canada's metallurgical coal exports are to forecast to grow modestly over the outlook period, driven by new additions to capacity.

Exports forecast to grow from Russia

Russia's exports of metallurgical coal grew by 16 per cent to 26 million tonnes in 2018, making the country the fourth largest exporter of metallurgical coal. Exports have continued to grow in 2019, rising by 14 per cent year-on-year in the first half of the year.

Russia is forecast to add another 4 million tonnes of metallurgical coal to seaborne supply between 2019 and 2021. Growth is expected to be driven by new capacity, rail and port expansions and a weaker Ruble. Beyond the outlook period, the Russian Energy Ministry announced a draft plan that could see total coal (metallurgical and thermal) output rise from 440 million tonnes to between 550 and 670 million tonnes by 2035. The additional volumes are slated for export to Asia by rail.

Mongolia's metallurgical coal exports to China have rebounded

Mongolia — the fifth largest exporter of metallurgical coal in 2018 — primarily exports coal by trucking it to China through the Gants Mod and Ceke border crossings. Mongolia's metallurgical coal exports have surged in 2019 to meet Chinese demand — growing by 30 per cent year-on-year in the first seven months of the year. Mongolia's metallurgical coal export growth is forecast to slow, but continue to tick upwards over the outlook period. With bottlenecks at the Chinese border, substantial investment in infrastructure will be required for any significant growth in export volumes.

Mozambique's exports to grow, but headwinds remain

Mozambique currently has two exporting metallurgical coal mines: Vale's Moatize and Jindal Steel's Songa mines. Mozambique — once touted as the next major supplier of metallurgical coal — has faced a number of headwinds in growing its exports, which were 6 million tonnes in 2018. Vale revised down its 2019 production guidance for the Moatize mine from original guidance of 14 million tonnes to 10 million tonnes, due to processing challenges. Mozambique's metallurgical coal exports are forecast to rise modestly as Moatize ramps up, but the outlook is underpinned by considerable risks, due to a range of transport, quality and community opposition issues.

5.4 Australia

Metallurgical coal export earnings reached a record high

Australia's metallurgical coal export earnings grew by 15 per cent to almost $44 billion in 2018–19, beating the previous record of $38 billion in 2017–18 (Figure 5.5). Growth in export earnings was driven by persistently strong metallurgical coal prices and higher export volumes, which grew by 2.4 per cent to 183 million tonnes.

Metallurgical coal export earnings estimated to have reached a record high

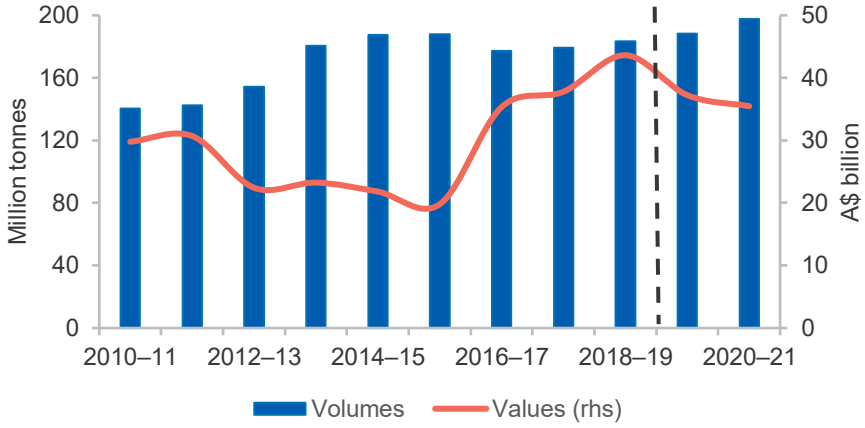
A forecast moderation of prices is expected to drive a decline in metallurgical coal export earnings to $37 billion in 2019–20, and to $35 billion in 2020–21. A forecast rise in export volumes is expected to only partially offset the impact of lower prices (Figure 5.6). Export volumes are forecast to grow to 188 million tonnes in 2019–20, and to 198 million tonnes in 2020–21.

The forecast growth in Australia's metallurgical coal export volumes reflects a raft of restarts and ramp-ups at several mines, including Cook, Baralaba, Byerwen and Gregory Crinum. Supply has also been recovering from disruptions caused by weather, infrastructure, and technical issues. Beyond the outlook period, Anglo American has approved the development of the Aquila project. The Aquila mine was placed on care and maintenance in 2013, due to low prices. Development of the project is set to begin imminently, and first production is scheduled for early 2022.

Revisions to the outlook

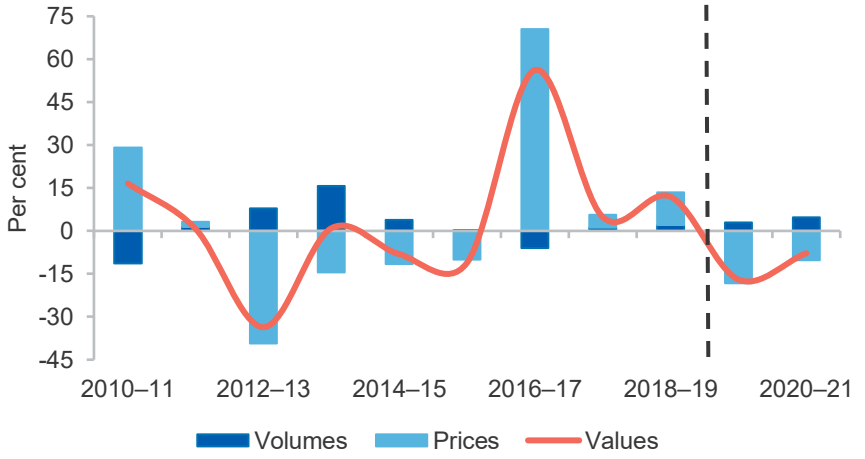
The forecasts for Australia's metallurgical coal export earnings have been revised down by $2.3 billion in 2019–20 compared to the June 2019 *Resources and Energy Quarterly*. This reflects a downwards revision to the price forecast for 2019 — which has declined more rapidly than expected — offsetting the impacts of a downward revision to the exchange rate. Forecast export earnings in 2020–21 are broadly unchanged.

Figure 5.5: Australia's metallurgical coal exports



Source: ABS (2019) International Trade, Australia 5368.0; Department of Industry, Innovation and Science (2019)

Figure 5.6: Annual growth in Australia's metallurgical coal exports values, and contributions from export volumes and prices



Notes: Price changes are based on export unit values.

Source: ABS (2019) International Trade, Australia 5368.0; Department of Industry, Innovation and Science (2019)

Table 5.1: World trade in metallurgical coal

	Unit	2018	2019[f]	2020[f]	2021[f]	Annual percentage change 2019[f]	2020[f]	2021[f]
World trade	Mt	337	344	350	354	2.1	1.7	1.1
Metallurgical coal imports								
China	Mt	65	68	63	60	5.1	-7.3	-4.6
India	Mt	60	63	67	70	4.8	6.3	4.5
Japan	Mt	47	46	46	46	-1.5	0.0	-0.8
European Union 28	Mt	44	43	43	44	-0.9	-0.9	2.5
South Korea	Mt	36	35	34	34	-4.1	-2.9	0.0
Metallurgical coal exports								
Australia	Mt	179	185	195	199	3.4	5.3	2.0
United States	Mt	56	51	45	43	-8.6	-11.8	-4.4
Canada	Mt	29	31	32	33	7.2	3.2	3.1
Russia	Mt	26	28	30	32	6.0	7.1	6.7
Mongolia	Mt	26	31	31	32	20.6	0.0	3.2
Mozambique	Mt	6	8	9	10	28.2	11.1	10.0

Notes: **f** Forecast. Trade data has been revised from the June 2019 *Resources and Energy Quarterly* due to the release of updated IEA *Coal Information* data.
Source: IEA (2019) Coal Information; IHS (2019); Department of Industry, Innovation and Science (2019)

Table 5.2: Metallurgical coal outlook

World	Unit	2018	2019[f]	2020[f]	2021[f]	Annual percentage change 2019[f]	2020[f]	2021[f]
Contract prices[e]								
– nominal	US$/t	208	191	168	159	-8.0	-12.3	-5.0
– real[d]	US$/t	212	191	164	152	-10.0	-14.2	-7.1
Spot prices[g]								
– nominal	US$/t	207	186	168	158	-10.3	-9.8	-5.5
– real[d]	US$/t	212	186	164	151	-12.2	-11.9	-7.5
Australia	**Unit**	**2017–18**	**2018–19**	**2019–20[f]**	**2020–21[f]**	**2019–20[f]**	**2019–20[f]**	**2020–21[f]**
Production	Mt	184	187	193	202	2.1	2.8	4.9
Export volume	Mt	179	183	188	198	2.4	2.7	4.9
– nominal value	A$m	37,793	43,622	37,239	35,466	15.4	-14.6	-4.8
– real value[i]	A$m	39,239	44,557	37,239	34,635	13.6	-16.4	-7.0

Notes: **d** In 2019 US dollars. **e** Contract price assessment for high-quality hard coking coal. **i** In 2019–20 Australian dollars. **f** Forecast. **g** Hard coking coal fob Australia east coast ports.
Source: ABS (2019) International Trade in Goods and Services, Australia, 5368.0; Department of Industry, Innovation and Science (2019); Platts (2019)

Thermal Coal

Resources and Energy Quarterly September 2019

2nd

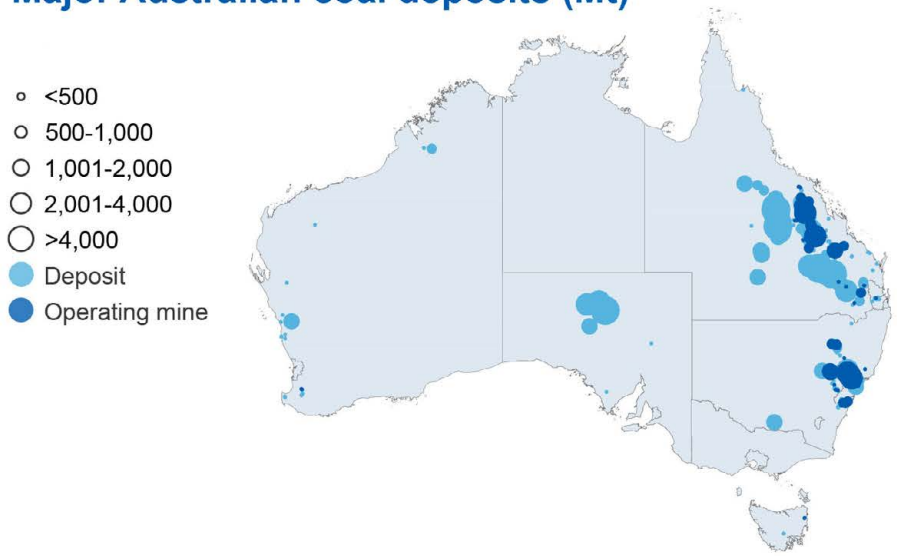
Australia is the **second largest** thermal coal exporter in the world

Australia exported 210 million tonnes thermal coal in 2018–19, valued at **$26 billion**

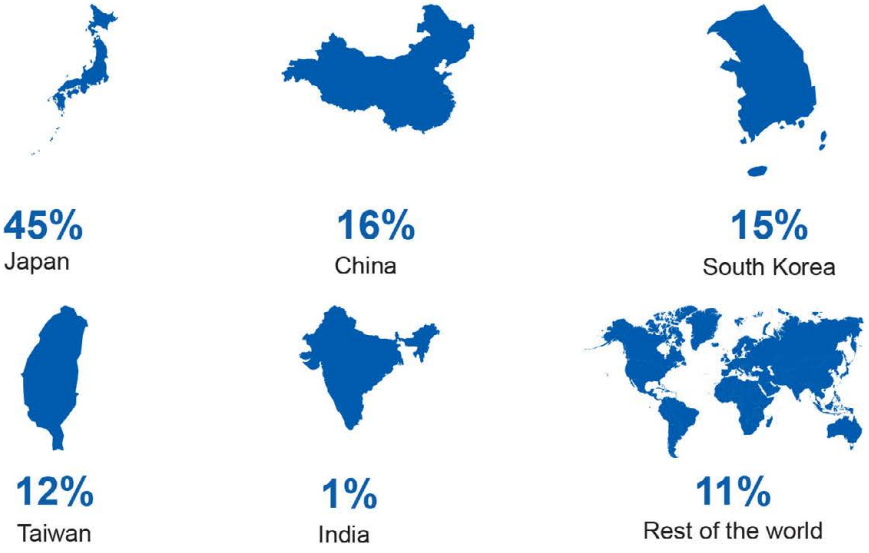
Around **¾** of Australia's thermal coal is exported

Coal generates around **60%** of electricity in Australia

Major Australian coal deposits (Mt)



Australia's thermal coal export earnings by destination, 2018–19



45% Japan

16% China

15% South Korea

12% Taiwan

1% India

11% Rest of the world

Share of global thermal coal exports in 2018

41% Indonesia

19% Australia

16% Russia

7% Columbia

7% South Africa

5% US

5% Rest of the world

Share of global thermal coal imports in 2018

21% China

17% India

12% Japan

11% EU28

10% South East Asia

9% South Korea

20% Rest of the world

6.1 Summary

- The Newcastle benchmark thermal coal spot price is forecast to decline from an average of US$105 a tonne in 2018 to US$72 a tonne in 2021, as demand softens relative to supply.
- Australia's export volumes are forecast to grow from 210 million tonnes in 2018–19 to 214 million tonnes in 2020–21, reflecting modest production growth from new capacity and expansions, a recovery from recent disruptions, and productivity improvements.
- Australia's thermal coal export earnings reached a record $26 billion in 2018–19. Strong growth in export earnings has primarily been driven by high prices in 2018 and a high contract price settled for 2019–20. Export earnings are forecast to decline to $18 billion in 2020–21, as the impact of lower prices offsets higher export volumes.

6.2 Prices

Thermal coal prices have declined on weaker fundamentals

The thermal coal benchmark spot price (Newcastle 6,000 kcal/kg NAR) steadily declined in July and August, hitting a 39 month low of US$61 a tonne in late August. The thermal coal spot price averaged an estimated US$67 a tonne in the September quarter of 2019, 13 per cent lower than the previous quarter and 40 per cent lower year-on-year (Figure 6.1).

Weak demand has placed downward pressure on the thermal coal price. In the first half of 2019, imports from Japan, South Korea and the EU were all lower on a year-on-year basis. While Chinese imports have been resilient, the prospect of tighter import controls have weighed on buying sentiment. Persistently low spot LNG prices have also encouraged some coal-to-gas switching — predominantly in Europe — further dampening import demand for thermal coal. Concurrently, large volumes of thermal coal have entered the seaborne market since 2018, resulting in an oversupplied market.

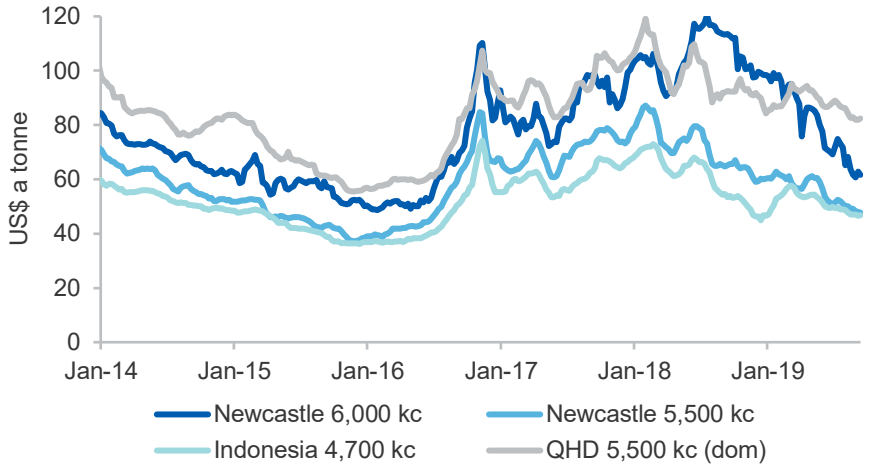
Thermal coal price forecast to remain subdued over the outlook period

The price slide appears to have bottomed, due to the emergence of supply cuts from the US, Colombia and Indonesia. Nevertheless, the benchmark thermal coal spot price is forecast to remain weak over the rest of 2019. With a number of Chinese ports reaching their assigned annual quotas for coal imports, an expected sharp drop in China's thermal coal imports towards the end of 2019 is expected maintain pressure on prices. Strong short-term demand from Japan is expected to provide an offsetting effect, as nuclear reactors are closed for planned maintenance until early 2020.

In the longer term, weak overall demand is expected to keep prices subdued over the outlook period. The price is forecast to average in the low to mid US$70s a tonne range over the outlook period, down from an average of US$105 a tonne in 2018. Towards the end of the outlook period, a gentle recovery in the price is expected, as supply growth slows.

There are several risks to the price outlook for thermal coal. Developments in China's import policies and domestic coal markets are likely to drive ongoing volatility in thermal coal imports and prices. Supply from marginal producers in the US and Indonesia could also take longer than expected to contract, requiring lower prices to bring the market back to balance.

Figure 6.1: Thermal coal prices



Source: IHS (2019)

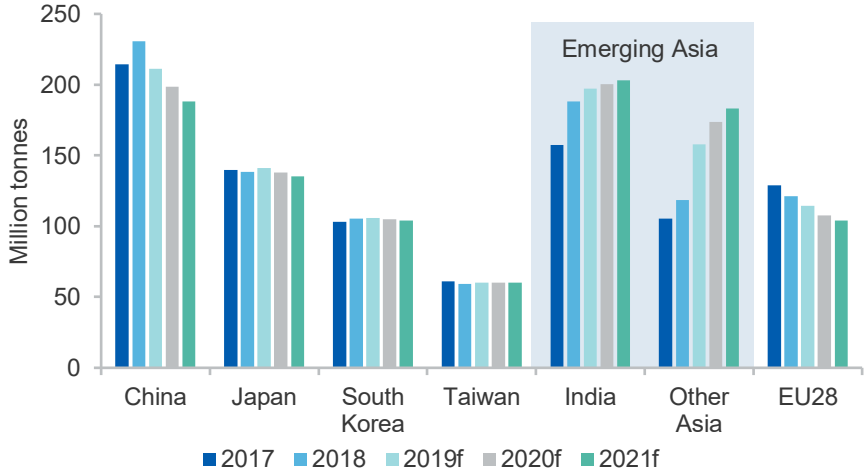
World trade

Strong demand and high prices drove growth in thermal coal trade between 2016 and 2018. This growth is forecast to reverse over the outlook period to 2021, with weaker import demand expected to drive a slight contraction in thermal coal trade.

World imports

In 2018, thermal coal imports grew by 4.6 per cent, to 1.12 billion tonnes. The trend for world imports over the outlook period is expected to be slightly downwards. Imports from most developed countries are in decline, as governments phase out coal-fired power generation. China's thermal coal imports are forecast to moderate, as domestic production continues to grow, and as the impacts of various government policies take effect. Countering these trends, emerging Asian nations are expanding their coal-fired power generation and have seen stronger-than-expected import growth. The overall net result of these divergent trends is a marginal decline in imports out to 2021 (Figure 6.2).

Figure 6.2: Thermal coal imports



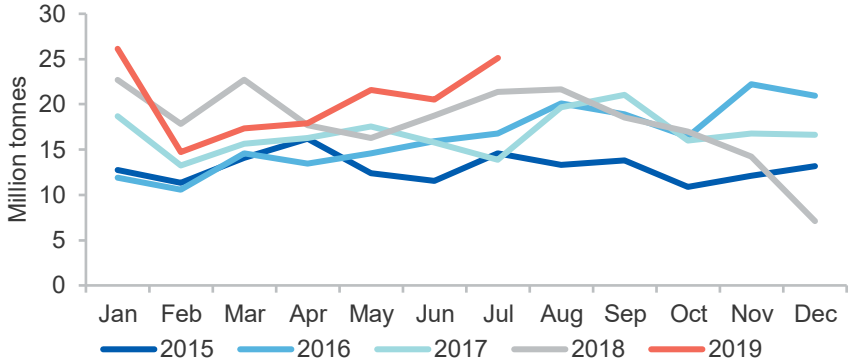
Notes: **f** Forecast

Source: IHS (2019); IEA (2018) Coal Market Report; Department of Industry, Innovation and Science (2019)

China's thermal coal imports forecast to moderate

Thermal coal imports into China — the world's largest importer of thermal coal — have been surprisingly resilient. In the first seven months of 2019, imports stood at an estimated 143 million tonnes, 4.4 per cent higher year-on-year. On a monthly basis, imports have been volatile, reflecting seasonal factors (with lunar new year affecting two months this year instead of the usual one) and the impact of government import policies (Figure 6.3).

Figure 6.3: China's monthly thermal coal imports



Source: Bloomberg (2019) National Bureau of Statistics of China

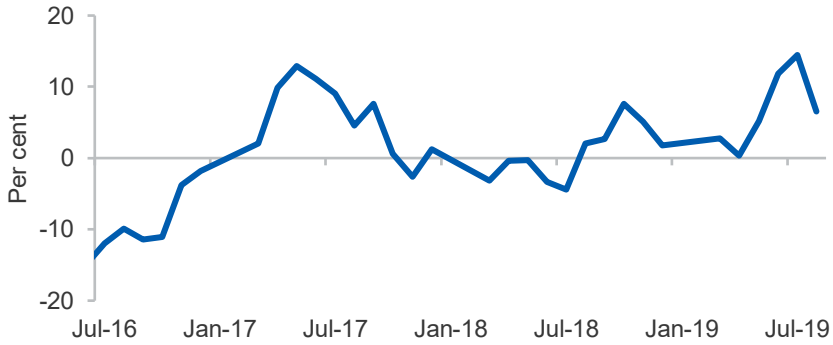
In recent months, imports have been supported by a tighter domestic coal market in China. Domestic production growth has reportedly slowed, after strong growth of 6.9 per cent year-on-year in the first seven months of 2019. Output has been impacted by heavy rainfall, heatwaves and a national safety campaign at mines (which is expected to continue until October in the lead up to the National Day celebrations). Higher domestic prices relative to import prices have supported import demand.

The recent strength in imports has occurred despite several headwinds. Overall thermal coal demand has softened, due to weak industrial power demand and coal-fired power generation. Coal-fired power generation has been displaced by a pick-up in hydro and nuclear power generation, which

rose by 11 and 22 per cent year-on-year, respectively, in the year to July. Imports have also been affected by a range of policy drivers, including enhanced quality testing, which has led to customs clearance delays. The Chinese government is expected to continue implementation of current import policies, with total coal imports expected to be around 280 million tonnes in 2019. With imports already higher on a year-on-year basis, this would result in a sharp drop in thermal coal imports over the remainder of 2019.

In the longer term, Chinese coal production is expected to grow at a faster pace, further reducing imports. After three years of supply-side reforms, the bulk of capacity closures have largely concluded, and new, more efficient, additions to capacity have and will continue to boost production (Figure 6.4). China's railway networks have also been enhanced since 2018, improving the connections between the nation's coal producing regions and its main demand centres.

Figure 6.4: China's raw coal production, year-on-year growth



Source: Bloomberg (2019) National Bureau of Statistics of China

Policy uncertainty has been — and is expected to continue to be — a key risk to the outlook. The government is expected to continue to manage overall import levels to achieve various goals, including balancing domestic consumption and production, stabilising domestic coal prices, and supporting domestic industries.

Japanese thermal coal imports forecast to gradually decline

Japan was the world's third largest importer of thermal coal in 2018, with imports declining by 0.9 per cent to 138 million tonnes over the year. In the first half of 2019, imports declined by a further 2.0 per cent year-on-year, weighed down by a warmer than usual winter at the start of the year.

Japan has continued to diversify its sources of thermal coal imports, with power generators seeking to reduce costs and purchase more cargoes from the spot market after electricity sector reforms. Australia's share of Japan's thermal coal imports has declined from 64 per cent in 2015 to 60 per cent in the first half of 2019. Both Australia and Indonesia — the two largest sources of thermal coal imports to Japan — lost market share to Canada, Russia and the United States in the first half of 2019.

Japan's thermal coal imports are expected to experience a temporary boost through to early 2020. Imports rebounded by 4.2 per cent year-on-year in July, and are likely to remain strong over the northern hemisphere summer with above average temperatures expected to drive up power demand. Coal-fired power generation has also increased, due to a temporary fall in nuclear generation, with two nuclear reactors taken offline for planned maintenance in July. More maintenance is scheduled for the end of 2019.

Despite the short-term gains, the longer-term trend for Japan's thermal coal imports is expected to trend slightly downwards, driven by ongoing nuclear restarts.

At the time of writing, seven of Japan's fleet of 42 reactors are in operation (with another two offline for planned maintenance). Further nuclear restarts appear likely over the next five years. Eighteen reactors have applications to restart with the Nuclear Regulation Authority, and at least three are likely to restart before the end of 2021. However, the outcomes of safety reviews, potential delays in implementing counterterrorism measures, and ongoing community opposition could lead to delays in reactor restarts.

Japan is expected to gradually pivot away from coal. Construction of a 1.3 gigawatt coal-fired power project — originally due to commence in August 2019 — has been delayed, and may not proceed at all. The delay brings the total number of cancelled or delayed coal-fired power projects to three in 2019 alone.

South Korea's coal imports to decline as energy transition accelerates

South Korea was the world's fourth largest importer of thermal coal in 2018. Despite the South Korean government's push to move away from coal, imports grew by 2.4 per cent to a record 106 million tonnes in 2018, due to a fall in nuclear power generation — for scheduled maintenance and unexpected downtime.

In the first seven months of 2019, South Korea's thermal coal imports declined by 10 per cent year-on-year. Imports were weighed down by a range of factors, including the return of nuclear power generation, and the temporary closure of several coal-fired power plants. The temporary closures occurred due to several factors, including planned maintenance, as a means to improve air quality, and in response to a fatal accident at a power plant. South Korea's thermal coal rebounded on a year-on-year basis in July as several coal-fired power plants reopened and the peak summer period commenced.

Overall, South Korea's thermal coal imports are forecast to decline modestly over the outlook period to 2021. Since the change in government in 2017, South Korea has implemented a range of measures and regulations to reduce the country's reliance on coal-fired power generation. These include a change in taxes (from 1 April 2019) to encourage a move away from coal and towards gas, temporarily closing older plants when the air quality is poor, the cancellation of new coal-fired power plant capacity, and plans to close several aging power plants.

Taiwan's coal imports are forecast to remain steady

Taiwan's thermal coal imports have remained broadly steady in the year to date, with this trend forecast to continue. While Taiwan's government is seeking to increase electricity generation from gas and renewables, coal imports are expected to remain resilient in the short-term, hovering at around 60 million tonnes a year over the outlook period.

India's thermal coal consumption is set to outpace production

India — the world's second largest thermal coal importer — imported 188 million tonnes of thermal coal in 2018, an increase of 20 per cent from 2017. Imports accelerated in the first half of 2019, growing by 25 per cent year-on-year.

Domestic production of thermal coal has not kept pace with rapid growth in thermal coal consumption. After strong year-on-year growth of 7.4 per cent in the March quarter, production declined by 1.0 per cent in the subsequent four months to July. Output has been hampered by the monsoon season, which has impacted on production and transport.

At the same time, strong growth in coal-fired power generation has been driven by growth in power demand and government efforts to maintain the reliability of electricity in the lead up to the May general election. Imports of thermal coal have surged to meet demand.

While the government has a long-term goal for self-sufficiency in thermal coal, imports are forecast to remain at high levels in the short-term, reaching 194 million tonnes in 2021. Domestic production is also expected to continue to grow, but at a slower pace than consumption. Coal India Limited — the state-owned coal company, and world's largest coal producer — is targeting production of 1 billion tonnes for 2025–26.

Box 6.1 discusses the key factors that will likely influence the direction and scale of India's future thermal coal imports in the longer term.

Box 6.1: Coal in India

The Office of the Chief Economist recently released the *Coal in India 2019* report. The report updates the latest statistics and developments in India's energy, electricity and mining policies and regulatory settings, and examines how these could impact on the future of thermal coal in India. This box summarises the key findings.

Coal is expected to remain a major part of India's energy mix for decades to come, although its share in the energy mix is expected to decline. In absolute terms, India's thermal coal consumption is likely to grow over the next decade to meet India's growing energy requirements from its rapidly growing population and economy. In the longer term, the outlook for coal in India depends on the prospects for renewable power and storage.

While the Indian government is aiming for self-sufficiency in thermal coal, there are considerable barriers to achieving this goal. The pace of India's domestic output growth will be the key driver of its future import needs. India's coal production — which is dominated by state-owned Coal India — is expected to grow, but at a slower pace than targets set by the Indian government.

India's coal sector continues to face substantial challenges. Long approval and land acquisition processes are the key barriers to growth, with other issues — productivity, competition, investment, transport and domestic pricing — further compounding the challenges. Although reforms have moved in a positive direction, the pace of change has been slow, due to India's complex bureaucracy and financially-strained power sector.

The outlook for India's thermal coal imports is thus finely balanced. With around 80 per cent of India's thermal coal requirements satisfied domestically, the outlook for imports depends on the trajectory and balance of India's future coal consumption and production. While imports are forecast to remain high in the short-term, there are more uncertainties in the longer term.

Source: Department of Industry, Innovation and Science (2019) Coal in India, https://www.industry.gov.au/data-and-publications/coal-in-india-2019-report

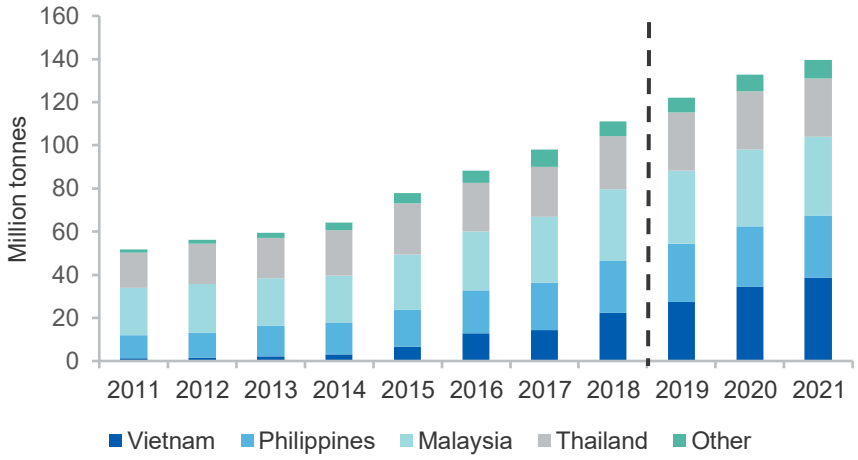
South East Asia to be a key source of import growth

South East Asia was the only region in the world in which coal's share of power generation grew in 2018. While South East Asian countries are relatively small importers individually, collectively, the region is expected to play a substantial role in thermal coal markets.

Thermal coal imports rose by 15 per cent in 2018 to 108 million tonnes, making the region the fourth largest importer in the world. South East Asia is expected to be an ongoing source of import demand growth — and one of the few — for thermal coal markets, driven by new and planned coal-fired power plants (Figure 6.5).

Of particular note, Vietnam has experienced substantial growth in its thermal coal imports, with coal playing a key role in the country's Power Development Plan. Vietnam's imports of thermal coal are set to grow by over 10 million tonnes between 2018 and 2021, as new coal-fired power plants come online.

Figure 6.5: South East Asia thermal coal imports

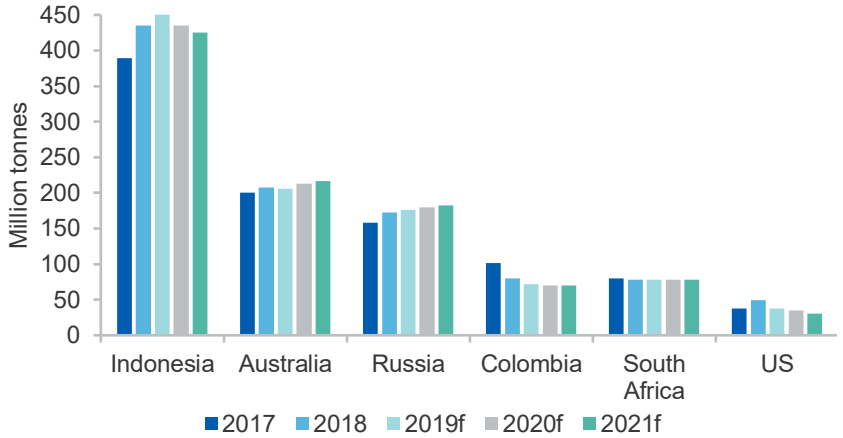


Source: IEA (2019) Coal Information, Department of Industry, Innovation and Science (2019)

World exports

World exports of thermal coal grew by 4.1 per cent to 1.07 billion tonnes in 2018. High prices incentivised export growth, particularly from Indonesia, the US and Russia. Lower prices and demand in 2019 are expected to drive a decline in supply from the more marginal producers. While supply has declined in the first half of 2019, this was more than offset by export growth elsewhere. Australia and Russia are expected to be the key sources of export growth, with growth slowing towards the end of the outlook period (Figure 6.6).

Figure 6.6: Thermal coal exports



Notes: **f** Forecast

Source: IHS (2019); ABS (2019) International Trade, Australia 5454.0; Department of Industry, Innovation and Science (2019)

Indonesia's thermal coal exports to soften, but from a high base

Thermal coal exports from Indonesia — the world's largest thermal coal exporter — grew by 12 per cent year-on-year in 2018, to a record high of 435 million tonnes. The strong pace of growth has continued this year, with exports rising by 9.3 per cent year-on-year in the first half of 2019.

The growth comes despite restrictive government policies, which include annual production quotas to protect Indonesia's depleting coal reserves and a domestic market obligation (DMO). The DMO requires Indonesian producers to sell 25 per cent of output into the domestic market at capped prices.

The Indonesian government has repeatedly strayed from production caps, due to strong market conditions. Thermal coal production in the first half of 2019 totalled 290 million tonnes. Annualised to 580 million tonnes, this substantially exceeds the 2019 production target of 489 million tonnes set earlier this year. The government has also reportedly approved requests from coal producers that could increase production volumes to 600 million tonnes in 2019. With a quarter of output to be set aside for the domestic market, these figures suggest that exports could remain at record levels in 2019.

Beyond 2019, thermal coal exports are forecast to soften from current record levels. Some Indonesian coal producers are relatively high cost, and the decline of prices is expected to drive exports lower. In the longer term, rapidly growing domestic needs are also expected to increasingly weigh on Indonesian exports of thermal coal.

Russia's thermal coal exports forecast to grow

Russia is the world's third largest exporter of thermal coal, and exports grew by 9.1 per cent to 173 million tonnes in 2018. Russia's thermal coal exports have continued to grow in 2019, although at a slower pace — exports were 6.4 per cent higher year-on-year in the first half of the year. Rail and port developments in the east of the country, and the persistently weak ruble are expected to support ongoing growth in Russia's thermal coal exports over the outlook period.

Colombia's thermal coal exports to remain subdued

Colombia's thermal coal exports declined by 21 per cent to 80 million tonnes in 2018. The downwards trend has continued in 2019, with exports falling by 14 per cent year-on-year in the first half of the year. Colombia's traditional export markets — Europe and the Americas — are shrinking, and Colombian exports of thermal coal are not as competitive in Asian markets. As a result, exports are forecast to continue to decline over the outlook period.

South Africa's coal exports forecast to remain subdued

South Africa's thermal coal exports declined by 2.4 per cent to 78 million tonnes in 2018. Thermal coal exports were flat on a year-on-year basis in the first half of 2019, and are expected to trend slightly downwards over the outlook period. South African producers are expected to divert more output to the domestic market, with domestic buyers offering higher prices than those on the seaborne market. Eskom — South Africa's state-owned power utility, which consumes around half of the country's annual output — expects to pay 20 per cent more for coal this year. Tight domestic supply is forcing the utility to enter into short-term, more expensive supply contracts, drawing South African coal away from the seaborne market.

Low prices to drive down exports from the United States

Thermal coal exports from the US grew by 30 per cent to reach 49 million tonnes in 2018, driven by high prices. US producers have high production and freight costs, and are thus swing suppliers to the seaborne market.

Thermal coal exports from the US have subsequently declined in line with lower prices — falling by 11 per cent year-on-year in the first seven months of 2019 — and are set to fall further over the outlook period.

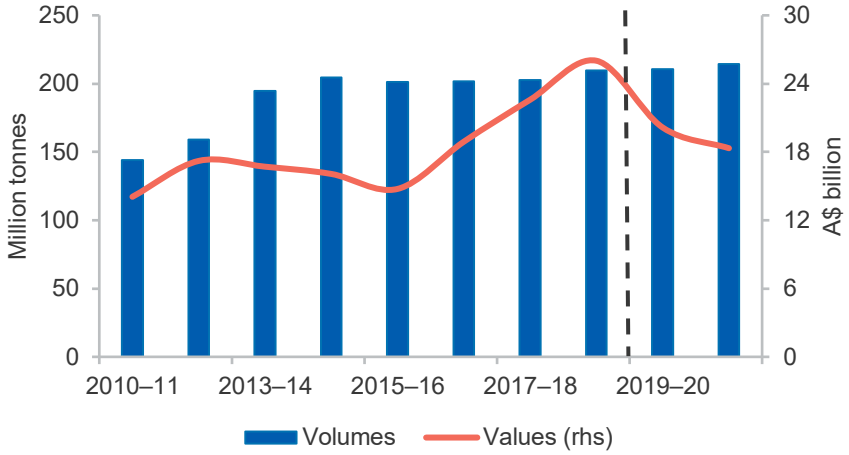
6.3 Australia

Australia's thermal coal exports reached a record high in 2018–19

Australia's thermal coal export earnings reached a record $26 billion in 2018–19, up by 15 per cent from $23 billion in 2017–18 (Figure 6.7). The growth was driven by high prices received by Australian thermal coal exporters, and by higher export volumes — which grew by 3.5 per cent to 210 million tonnes in 2018–19.

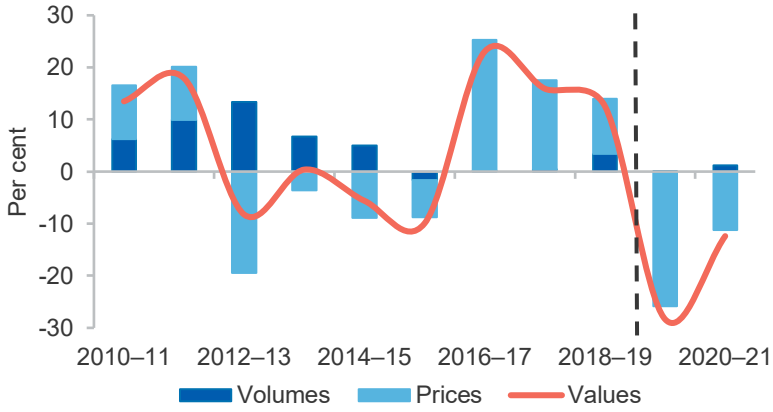
The strong growth in export volumes reflects a recovery from various weather, industrial, technical and infrastructure-related disruptions, that weighed on output in previous years. Ongoing productivity improvements and the ramp up of new capacity — notably at the Mount Pleasant mine in New South Wales —also supported export volumes growth.

Figure 6.7: Australia's thermal coal exports



Source: ABS (2019) International Trade, Australia 5368.0; Department of Industry, Innovation and Science (2019)

Figure 6.8: Annual growth in Australia's thermal coal exports values, and contributions from export volumes and prices



Notes: Price changes are based on export unit values.
Source: ABS (2019) International Trade, Australia 5368.0; Department of Industry, Innovation and Science (2019)

While thermal coal prices have steadily declined in 2019, they were high in the second half of 2018, supporting the strong results for 2018–19. Australian thermal coal export unit values (EUV, the average price received per tonne of coal) have also been strong, due to the high contract price of US$95 a tonne settled for the 2019–20 Japanese financial year.

Although it is difficult to assess the precise volumes of Australian thermal coal sold under contracts, it is estimated that around a third of Australia's thermal coal exports were sold on contracts in 2018–19, a decline from an estimated 40 to 50 per cent five years ago. Buyers tend to prefer purchasing on the spot market when prices are in decline. The falling share also represents a shift in the buying preferences of Japanese utilities towards purchasing more coal on shorter term contracts — or at spot — to lower costs following electricity sector reforms.

Australia's thermal coal export earnings are forecast to decline

Export earnings are projected to decline over the outlook period — in line with weaker prices — to $18 billion in 2020–21. The impact of lower prices is expected to be partially offset by modest growth in export volumes (Figures 6.8).

Export volumes are forecast to grow by 4 million tonnes over the next two years, reaching 214 million tonnes in 2020–21. This growth reflects a mix of productivity improvements, expansions, and the ongoing ramp up of the Mount Pleasant mine and other smaller operations. Although there is a large pipeline of potential projects in Australia, declining prices and growing challenges in developing greenfield projects could weigh on final investment decisions and export growth beyond the outlook period.

Revisions to the outlook

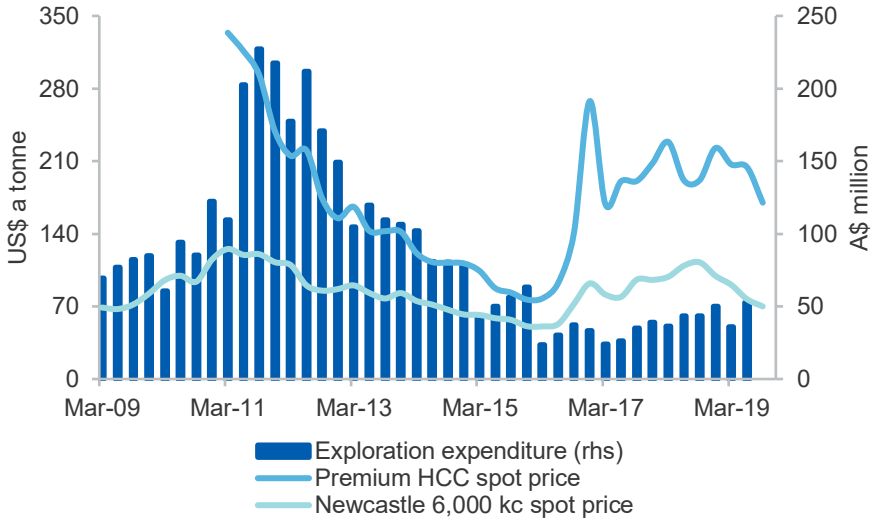
Australia's forecast thermal coal export earnings have been revised down by $1.2 billion in 2019–20 and by $1.0 billion in 2020–21 compared to the June 2019 *Resources and Energy Quarterly*. The revision reflects a lower forecast benchmark thermal coal price, which declined at a faster-than-expected pace in the September quarter of 2019, and a slight downward revision to export volumes. BHP has indicated that production at the Mount Arthur mine in New South Wales could fall by up to a fifth in 2019–20, partly due to the company shifting its focus to producing higher quality products.

Coal exploration expenditure shows positive signs, but headwinds remain

Australia's coal exploration expenditure (including both metallurgical and thermal coal) totaled $182 million in 2018–19. This represents an increase of 18 per cent from 2017–18. However, Australian coal exploration expenditure remains substantially lower than its peak in 2011 (Figure 6.9).

There are growing challenges for coal projects in Australia and around the world, particularly for thermal coal. There is a growing reluctance to commit to greenfield projects, and an expanding list of lenders have announced they will no longer finance thermal coal projects. Pension and equity funds are also divesting from coal, community opposition is growing, and challenging regulatory conditions are also impacting on investment decisions.

Figure 6.9: Australian coal exploration expenditure and prices



Source: ABS (2019) Mineral and Petroleum Exploration, cat. no. 8412.0; IHS Markit (2019), Platts (2019)

Table 6.1: World trade in thermal coal

	Unit	2018	2019[f]	2020[f]	2021[f]	Annual percentage change 2019[f]	2020[f]	2021[f]
World trade	Mt	1,119	1,131	1,130	1,125	1.1	-0.1	-0.4
Thermal coal imports								
Asia	Mt	841	869	868	868	3.1	0.1	0.0
China	Mt	231	213	199	185	-8.4	-6.0	-6.8
India	Mt	188	197	200	203	4.7	1.6	1.5
Japan	Mt	138	141	140	138	1.9	-0.7	-1.4
South Korea	Mt	106	106	105	104	0.5	-0.9	-1.0
Taiwan	Mt	59	60	60	60	0.9	0.0	0.0
Thermal coal exports								
Indonesia	Mt	435	455	440	425	4.5	-3.3	-3.4
Australia	Mt	208	206	213	216	-0.8	3.3	1.7
Russia	Mt	173	179	181	183	3.7	1.1	1.1
Colombia	Mt	80	73	71	70	-8.2	-2.7	-1.4
South Africa	Mt	78	78	78	78	-0.2	0.0	0.0
United States	Mt	49	38	35	30	-22.6	-7.9	-14.3

Notes: **f** forecast. Trade data has been revised from the June 2019 *Resources and Energy Quarterly* due to the release of updated IEA *Coal Information* data.

Source: IEA (2018) Coal Information 2018, accessed through the IEA 20/20 Professional Browser; IEA (2018) Coal Market Report 2018; IHS (2019); Department of Industry, Innovation and Science (2019)

Table 6.2: Thermal coal outlook

World	Unit	2018	2019[f]	2020[f]	2021[f]	Annual percentage change 2019[f]	2020[f]	2021[f]
Contract prices[b]								
– nominal	US$/t	110	95	72	74	-13.9	-23.7	2.9
– real[c]	US$/t	113	95	71	71	-15.8	-25.4	0.7
Spot prices[d]								
– nominal	US$/t	105	77	70	72	-27.0	-9.1	2.9
– real[e]	US$/t	108	77	68	69	-28.6	-11.1	0.7
Australia	**Unit**	**2017–18**	**2018–19**	**2019–20[f]**	**2020–21[f]**	**2019–20[f]**	**2019–20[f]**	**2020–21[f]**
Production	Mt	267	270	273	276	1.2	1.1	1.3
Export volume	Mt	203	210	211	214	3.5	0.4	1.7
– nominal value	A$m	22,586	25,968	19,981	18,199	15.0	-23.1	-8.9
– real value[h]	A$m	23,450	26,524	19,981	17,773	13.1	-24.7	-11.0

Notes: **b** Japanese Fiscal Year (JFY), starting April 1, fob Australia basis. Australia–Japan average contract price assessment for steaming coal with a calorific value of 6700 kcal/kg gross air dried; **c** In current JFY US dollars; **d** fob Newcastle 6000Kcal net as received; **e** In 2019 US dollars; **f** Forecast; **h** In 2019–20 Australian dollars.

Source: ABS (2019) International Trade in Goods and Services, Australia, Cat. No. 5368.0; IHS (2019); NSW Coal Services (2019); Queensland Department of Natural Resources and Mines (2019); Company Reports; Department of Industry, Innovation and Science (2019)

Gas

Resources and Energy Quarterly September 2019

LNG is natural gas cooled to

–162°C

Australia exported

75 million tonnes

of LNG in 2018–19

21%

rise from 2017–18 export volumes

2nd

largest LNG exporter in the world in 2018

Combined nameplate capacity of Australia's 10 LNG projects is

88 million tonnes per annum

Most Australian LNG is sold at oil-linked contract prices

Australia's LNG export earnings by destination, 2018–19

47%	31%	12%	4%	3%	4%
Japan	China	South Korea	Singapore	India	Rest of the world

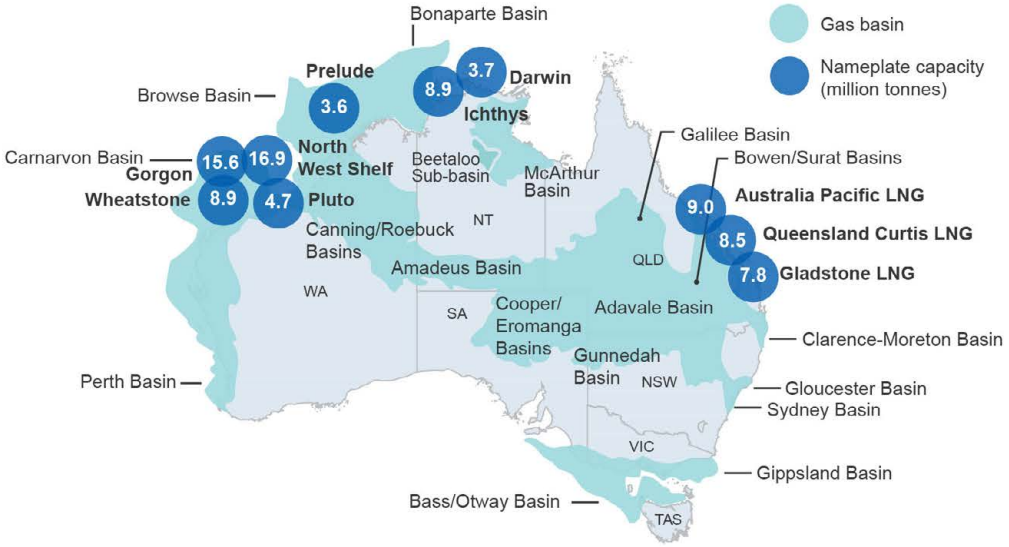
Share of world LNG exports in 2018

25%	21%	7%	7%	6%	34%
Qatar	Australia	Malaysia	United States	Nigeria	Rest of the world

Share of world LNG imports in 2018

26%	16%	13%	7%	5%	32%
Japan	China	South Korea	India	Taiwan	Rest of the world

Australia's LNG projects and gas basins



7.1 Summary

- Australia exported $50 billion of LNG in 2018–19. Export earnings are forecast to lift to $52 billion in 2019–20, driven by growing export volumes, before falling back to $49 billion, as prices ease.
- Australia's LNG export volumes are forecast to increase from 75 million tonnes in 2018–19 to 81 million tonnes in 2020–21, as the last two projects in Australia's recent wave of LNG investment ramp up output.
- Australian LNG export prices are forecast to decline slightly in 2019–20 and 2020–21, due to an appreciating exchange rate and easing oil-linked contract prices (at which most Australian LNG is sold).

LNG prices in Asia continue to diverge

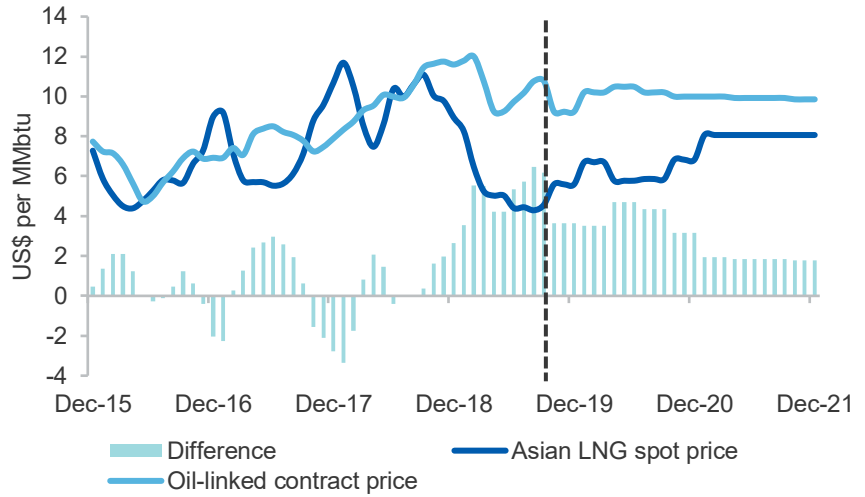
Gas pricing arrangements vary from region to region. In Asia, 70 per cent of LNG traded in 2018 was sold on long-term contracts, where the price of LNG is linked to the price of oil by a time lag of several months. The majority of the remaining 30 per cent was sold on the spot market (at least 70 per cent and probably far more) or by short-term contract.

LNG spot prices in Asia have continued to diverge from long-term oil-linked contract prices over the past few months, as shown in Figure 7.1. In August, LNG spot prices were at their lowest level on record, averaging US$4.30 per million British thermal units (MMbtu), or A$6.00 a gigajoule, while an indicative oil-linked contract price was around US$10.80/MMbtu (A$15.10/GJ).

The fall in spot prices has been driven by a combination of growing supply capacity and weak demand from major consumers in Asia. On the supply side, the ramp up of new capacity in the US, Australia and Russia has added to downward pressure on prices. Meanwhile, growth in China's LNG purchases has slowed, and the imports of Japan and South Korea — the world's largest and third largest LNG buyers respectively — have declined. The weak demand response to low LNG spot prices is partly because large North East Asian customers purchase the bulk of their LNG on long-term contracts, where prices are set by oil prices (commonly the Japan Customs-cleared crude price, also known as the JCC).

In contrast to LNG spot prices, long-term oil-linked contract prices have increased in recent months. While there is no single oil-linked contract price in Asia — but rather a patchwork of different contractual pricing arrangements agreed at different points in time — indicative figures suggest that the differential between spot and long-term contract prices is at its widest level on record (Figure 7.1).

Figure 7.1: LNG prices, monthly



Notes: The Argus Northeast Asian spot price is shown. LNG prices are DES (Delivered Ex Ship). DES prices include shipping and insurance. The long-term oil-linked contract price is indicative only, and is estimated at 14 per cent of the 3-month lagged Japan Customs-cleared crude oil price plus shipping.

Source: Argus (2019); Bloomberg (2019)

A key question is what the implications of this decoupling between long-term contract and spot prices might be, especially if decoupling endures for a sustained period. Buyers are reportedly reducing purchases on long-term contracts as their contractual flexibility permits (exercising so-called 'downward tolerance'), and increasing purchases of spot cargoes.

Buyers are also pushing to have contract prices lowered during the price reviews that are built into long-term supply agreements. Japanese utility Osaka Gas is in arbitration with Exxon Mobil's PNG LNG project after the

parties failed to settle on a price during price review negotiations. In the longer term, low spot prices relative to oil-linked prices may encourage buyers to push for shorter, more flexible contracts and gas-based pricing (as opposed to oil-linked pricing). Figure 7.2 shows how spot and short-term LNG trade has grown since the early 2000s.

Figure 7.2: Global LNG trade

Source: GIIGNL (2019)

The differential between LNG spot and long-term prices to narrow

LNG spot prices, which are driven by supply-demand fundamentals (as opposed to oil-linked contract prices), are expected to recover from their current record low levels over the period to 2021. In 2019 and 2020, the recovery is expected to be modest, as additions to world supply capacity either outpace or keep pace with demand growth (Figure 7.3). LNG spot prices are forecast to average US$5.40/MMbtu (A$7.30/GJ) in 2019 and US$6.30/MMbtu (A$8.30/GJ) in 2020.

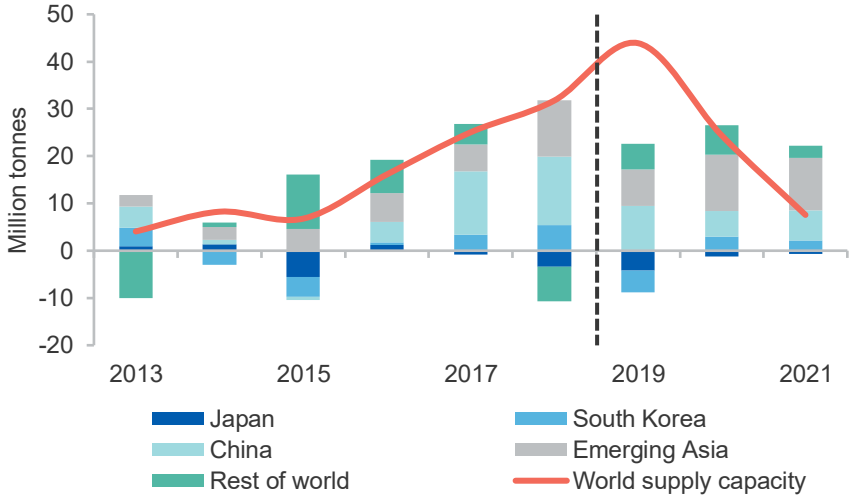
In 2021, the pace of the recovery is expected to accelerate. LNG spot prices are forecast to recover to US$8.10/MMbtu (A$10.30/GJ). Supply growth looks likely to slow dramatically in the early 2020s, as the ramp up of new capacity in the US, Australia and Russia draws to a close. Demand is consequently expected to begin closing the gap on global production capacity in 2021.

Meanwhile, LNG contract prices in Asia are forecast to gradually decline over the outlook period to 2021, tracking the fall in oil prices (see chapter 8 *Oil*) with a lag. In short, the differential between oil-linked contract prices and LNG spot prices is expected to narrow over the outlook period.

7.2 World trade

LNG trade has grown rapidly over the past few years, driven by surging demand in Asia and the ramp up of new projects commissioned between 2009 and 2015. In 2018, LNG trade totalled 309 million tonnes, up 7 per cent from 288 million tonnes in 2017. In 2019 and 2020, the continued expansion in global LNG supply capacity is expected to either outpace or keep pace with growth in LNG demand, before capacity growth slows dramatically in 2021. From 2021, the LNG market is expected to begin rebalancing, as demand growth absorbs the available capacity (Figure 7.3).

Figure 7.3: Annual change in LNG demand and world supply capacity



Source: Department of Industry, Innovation and Science (2019); Nexant (2019)

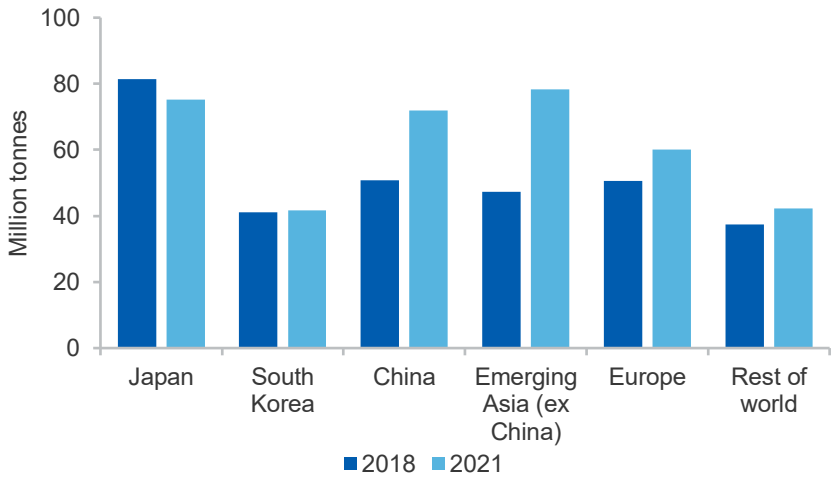
7.3 World imports

Nuclear restarts to reduce Japan's LNG imports

Japan is the world's leading LNG buyer, importing 81 million tonnes of LNG in 2018. However, Japan's LNG imports fell by 9 per cent year-on-year in the first eight months of 2019, due to a relatively mild winter at the start of the year and increased nuclear power generation.

Japan's LNG imports are forecast to fall by 6 million tonnes over the outlook period to 75 million tonnes in 2021 (Figure 7.4). Overall energy demand in Japan is expected to decline slightly. At the same time, LNG is expected to face increasing competition in the electricity generation sector from both nuclear and renewable power generation. At the time of writing, nine of Japan's 42 nuclear reactors had gained approval to restart and seven were in operation. Further nuclear restarts appear likely over the next five years. Eighteen reactors have applications to restart with the Nuclear Regulation Authority, and at least three reactors are likely to restart before the end 2021.

Figure 7.4: LNG import forecasts



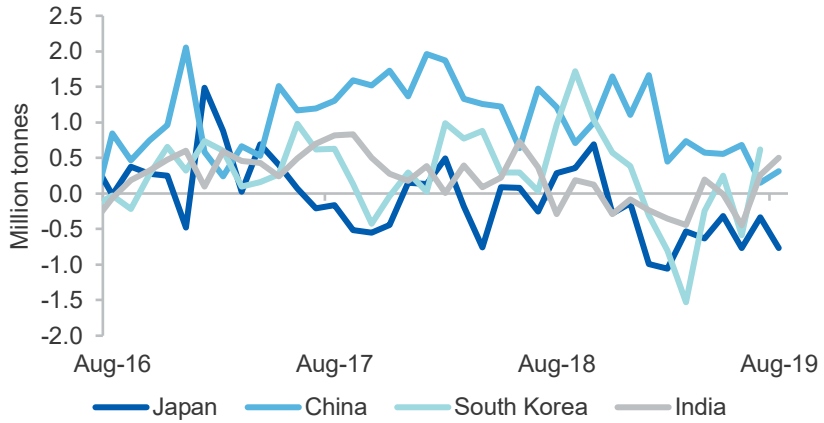
Source: Department of Industry, Innovation and Science (2019); Nexant (2019)

However, several possible eventualities are complicating the outlook for nuclear energy in Japan, and could see Japan import more LNG than what is forecast. In April, Japan's Nuclear Regulation Authority stated that it would order the shutdown of any nuclear reactors that have not met deadlines to implement counterterrorism measures. A number of reactors are at risk of missing these deadlines over the outlook period (to 2021). In addition, ongoing public opposition to nuclear energy in Japan could delay the restart of more nuclear power reactors.

China to shape future developments in global LNG markets

China was the second largest LNG buyer in the world in 2018, importing 51 million tonnes of LNG (69 billion cubic metres). China's LNG imports continued to increase rapidly in the first eight months of 2019, up 15 per cent on the same period a year earlier. However, import growth has slowed considerably in recent months, as shown in Figure 7.5.

Figure 7.5: Year-on-year change in LNG imports



Source: Bloomberg (2019); Argus (2019)

Strong growth in China's gas consumption is expected to continue over the outlook period, driven by China's efforts to reduce air pollution and 'turn China's skies blue again'. China is aiming to raise the share of gas in the overall energy mix from 7.0 percent in 2017 to a target range of 8.3–10

per cent in 2020, and to 15 per cent in 2030. In 2021, China's gas consumption is forecast to reach 364 billion cubic metres, up from around 280 billion cubic metres in 2018.

LNG is expected to play a major role in servicing rising Chinese gas demand: China's LNG imports are forecast to reach 72 million tonnes (98 billion cubic metres) in 2021. While both domestic production and pipeline imports are forecast to grow, they are not expected to keep pace with rising domestic demand.

China is targeting domestic gas production of 207 billion cubic metres in 2020, up 30 per cent from around 160 billion cubic metres in 2018. However, China faces difficulties in lifting domestic output, including challenging geology, and could fall short of its 2020 production target.

China's pipeline gas imports are also expected to increase over the next few years. Both the Central Asia–China Gas Pipeline expansion and the Power of Siberia pipeline from Russia to northern-eastern China are scheduled for completion in late 2019. The impact of China's decision to increase tariffs on US LNG from 10 per cent to 25 per cent from 1 June 2019 is discussed in Section 7.5.

South Korea's imports increased rapidly last year

South Korea was the world's third largest buyer of LNG in 2018, with LNG imports reaching an all-time high of 41 million tonnes. The rise was due to a sharp fall in nuclear power generation, with reactors offline for both regular maintenance and unexpected downtime. South Korea's LNG imports fell by 10 per cent in the first seven months of 2019, with demand constrained by a mild winter earlier in the year and the return of nuclear generation capacity to operation. The return of nuclear generation capacity is expected to drive a short-term fall in South Korea's imports to 37 million tonnes in 2019.

After 2019, LNG imports are expected to increase again, reaching 42 million tonnes in 2021. South Korea's long-term plan is to shift its energy mix towards renewables and gas, and away from nuclear and coal. Against this backdrop, South Korea lowered taxes on LNG imports and raised taxes on thermal coal imports on 1 April 2019, and plans to close several more aging coal-fired power stations before 2022.

LNG demand to increase amongst other emerging Asian economies

Several other emerging Asian economies are expected to contribute to rising LNG demand over the outlook period. India's LNG imports are forecast to increase from 21 million tonnes in 2018 to 28 million tonnes in 2021. India is aiming to lift gas' share of the energy mix from the current 5 per cent to 15 per cent by 2030. While India's domestic gas production is forecast to grow, it is not expected to keep pace with demand. India has considerable gas resources, but the commercial potential of these resources is uncertain.

There is also significant scope for increased LNG demand in other emerging Asian economies, such as Pakistan, Bangladesh, Indonesia, Malaysia and Thailand. Pakistan is already a significant LNG buyer, with imports reaching 10 million tonnes in 2018, after the country experienced a domestic gas shortage. While individually these countries are relatively small importers of LNG, collectively they are expected make a substantial contribution to rising global LNG demand.

Europe expected to increase LNG imports

Europe has absorbed much of the increase in LNG production over 2019. For producers, Europe acts as the 'destination of last resort' in LNG markets, given it has plentiful gas storage capacity. Europe's LNG imports are forecast to climb from 51 million tonnes in 2018 to 60 million tonnes in 2021. While European gas consumption is expected to remain relatively flat, rising LNG imports are expected to be driven by declining gas production. Gas production in Europe has been declining since 2000, mainly due to resource depletion in the North Sea and efforts to reduce seismic activity at the Groningen gas field in the Netherlands.

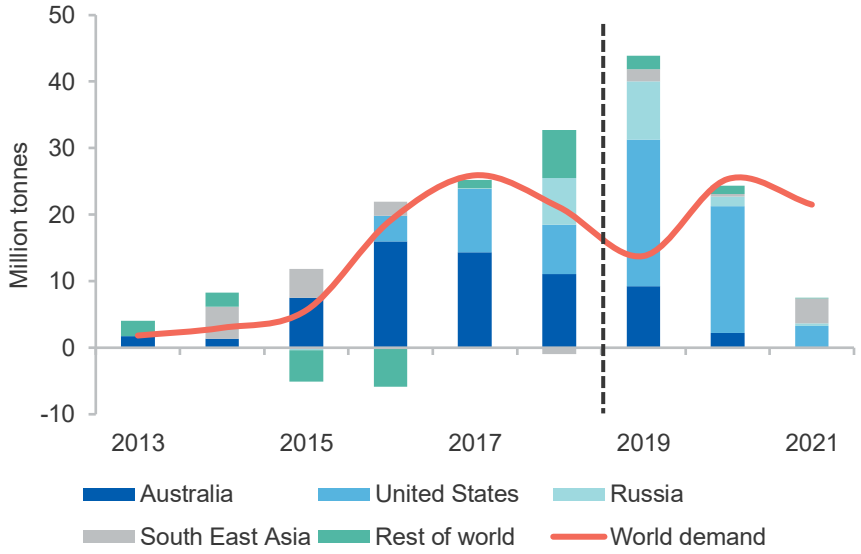
LNG is expected to face increasing competition from pipeline gas, with the controversial Nord Stream II gas pipeline scheduled for completion in 2019. With a capacity of 55 billion cubic metres per annum (equivalent to around 40 million tonnes of LNG), Nord Stream II connects Russian gas fields to the EU pipeline network at Germany's Baltic coast.

7.4 World exports

A major expansion in global LNG production capacity is underway

The expansion in global LNG supply capacity seen over the past few years still has some way to run. World supply capacity is expected to increase rapidly in 2019 and 2020 (Figure 7.6), driven primarily by the US, and supported by the continued ramp-up in Australia (see the next section). This growing supply capacity is expected to temper increases in LNG spot prices in Asia over this period.

Figure 7.6: Change in global nameplate capacity and LNG demand



Notes: Nameplate capacity is the maximum annual production capacity of an LNG plant.
Source: Department of Industry, Innovation and Science (2019); Nexant (2019)

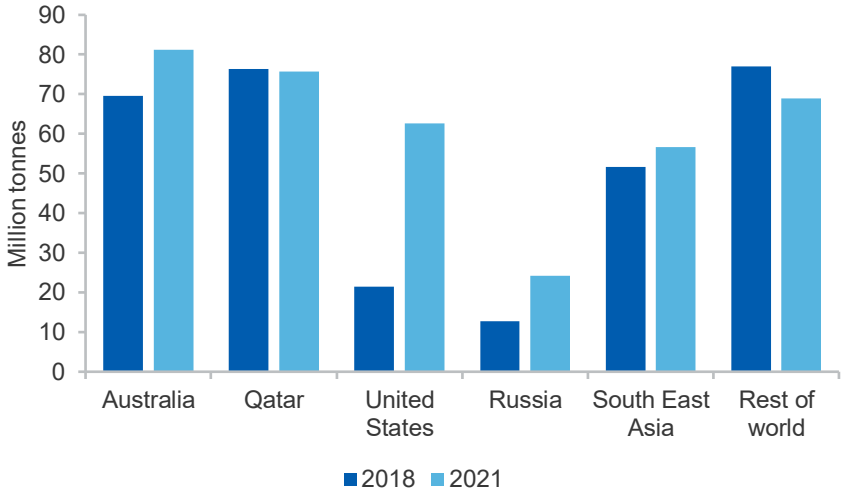
The combined nameplate capacity of US LNG projects is on track to reach around 70 million tonnes per annum (mtpa) in 2020. All six US plants are expected to be operational by the end of 2019, and production will continue to ramp up in 2020. This expansion in LNG infrastructure is expected to make the US the world's third largest LNG exporter, behind Australia (where nameplate capacity will soon reach 88 mtpa) and Qatar (where nameplate capacity is expected to remain at 77 mtpa for the next few years). Russia's LNG export capacity stands at 27 mtpa, following the completion of Yamal LNG — the country's second LNG project after Sakhalin.

In 2021, growth in global supply capacity is expected to drop to its lowest level since 2013, with the only additions to capacity likely to be from new trains at existing projects in the US and Indonesia (Figure 7.6).

Qatar's LNG exports are projected to remain largely unchanged

Qatar was the world's largest LNG exporter in 2018, exporting 76 million tonnes of the liquefied fuel. According to International Energy Agency (IEA) data, Qatar's exports have ranged from 72–77 million tonnes a year since 2011, although other sources put the peak of Qatar's LNG exports at around 80 million tonnes.

Figure 7.7: LNG export forecasts



Source: Department of Industry, Innovation and Science (2019); Nexant (2019)

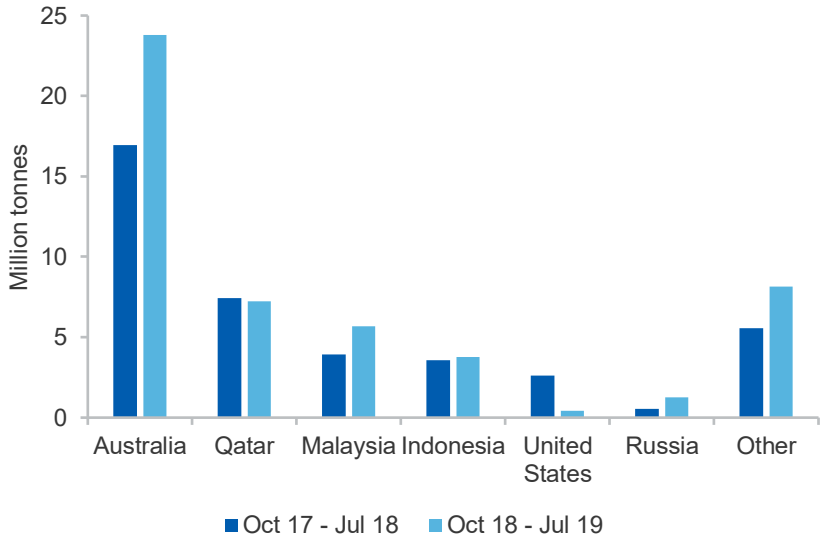
Qatar's LNG exports were unchanged year-on-year over the first eight months of 2019. Qatar's LNG exports are forecast to remain at around 76 million tonnes through to 2021 (Figure 7.7). Beyond the outlook period of this report, Qatar has plans to increase LNG production capacity by 43 per cent to 110 million tonnes in 2024.

Box 7.1 discusses Qatar's LNG exports in more detail, and whether the country will be surpassed as the world's largest LNG exporter by Australia.

LNG has been caught up in US-China trade tensions

LNG trade has recently been caught up in trade tensions between China and the US. On 13 May, China announced that it would increase tariffs on LNG imports from the US from 10 per cent to 25 per cent, effective from 1 June 2019, as part of its response to the US raising tariffs on US$200 billion of Chinese goods.

Figure 7.8: China's LNG imports by source before and after the imposition of tariffs on US LNG in September 2018



Source: Bloomberg

To date, the 10 per cent tariff — which commenced on 24 September 2018 — has encouraged a reorganisation of trade flows; China has purchased more LNG from other sources, while US LNG exports have been directed to other markets. The effect of tariffs on short-term LNG prices appears to have been minimal, or has been swamped by other factors, such as rapidly increasing supply capacity in LNG markets.

Australia has accounted for the majority of the increase in China's imports since China imposed tariffs on US LNG in September 2018 (Figure 7.8). However, it is difficult to attribute this increase directly to the effect of tariffs, given China's rapidly growing LNG demand and the ramp up of new Australian projects (such as Wheatstone and Ichthys) over the same period.

The impact of China lifting tariffs on imports of US LNG to 25 per cent from June 2019 will become clearer in coming months, as data for the second half of 2019 becomes available. It is possible that trade flows will continue to reorganise around increased tariffs, with few apparent effects on the total market. However, tariffs may also mean that China has to bring in more LNG from higher cost, non-US sources. If non US-origin LNG is more costly for China to import, then tariffs could potentially have the effect of reducing China's LNG purchases.

A longer-term risk is that escalating trade tensions discourage or delay final investment decisions (FIDs) for a second wave of US LNG projects. Some US LNG developers are reportedly holding off on FIDs, with US-China trade tensions one consideration. Trade tensions may also deter China — which is expected to become the world's largest LNG buyer in the early 2020s — from investing in new US LNG projects. However, China could take more US LNG in the event that trade tensions are resolved.

7.5 Australia

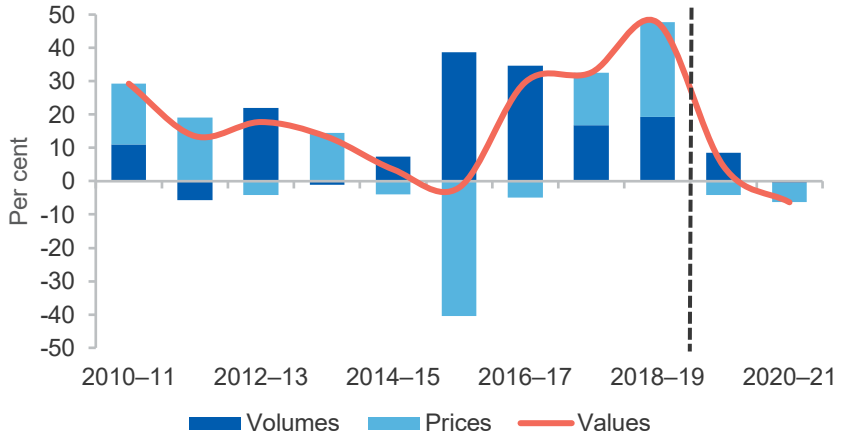
Australia's LNG exports are surging

Australia exported $50 billion of LNG in 2018–19, up from $31 billion in 2017–18. Higher export earnings have been driven by the recovery in oil prices (relative to 2017–18), and the ramp up of LNG exports, particularly from the Wheatstone and Ichthys LNG projects. Australia and Qatar have continued to jostle for the title of the world's largest LNG exporter over the course of 2019 (see Box 7.1).

Australia's LNG export earnings to remain broadly stable

The value of Australia's LNG exports is forecast to increase to $52 billion in 2019–20, driven by the ramp up in export volumes from Prelude and Ichthys (Figure 7.9 and 7.10). Shell shipped the first LNG cargo from its Prelude project on 11 June, and production is expected to ramp up during 2019–20. Production at the Ichthys project was around 80 per cent of nameplate capacity during the June quarter.

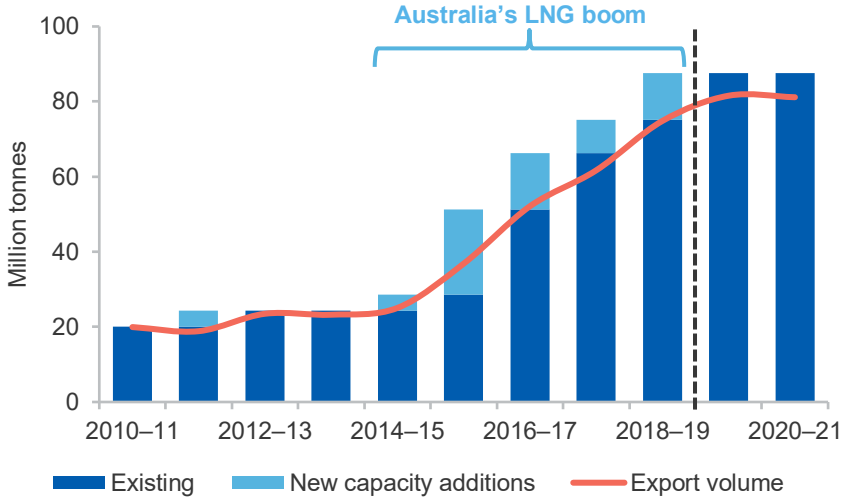
Figure 7.9: Growth in Australia's LNG export earnings, contributions from volumes and prices



Source: ABS (2019); Department of Industry, Innovation and Science (2019)

In 2020–21, the value of Australia's LNG exports is expected to fall back to $49 billion, as oil-linked contract prices (at which most Australian LNG is sold) edge down and the exchange rate appreciates. LNG export volumes are expected to remain broadly stable in 2020–21 (Figure 7.10). Tapering production at Darwin LNG is expected to weigh on export volumes towards the end of the outlook period. ConocoPhillips confirmed in June that it expected the Darwin LNG plant to shut down for 1-2 years, starting between 2021 and 2023, when gas from the Bayu-Undan field is exhausted.

Figure 7.10: Australia's LNG exports and export capacity



Source: ABS (2019); Department of Industry, Innovation and Science (2019)

Export earnings have been revised down

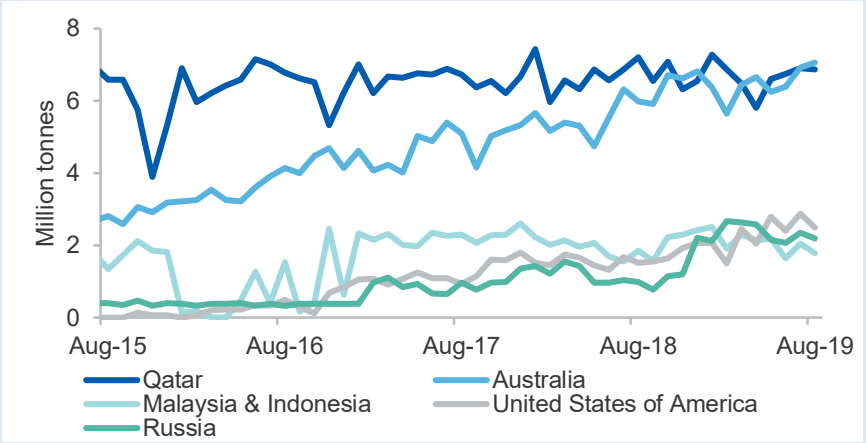
The forecast for Australian LNG export earnings has been revised down from the June 2019 *Resources and Energy Quarterly*, by $1.5 billion in 2019–20 and $1.6 billion in 2020–21. Lower forecast export earnings reflect a lower oil price forecast (see chapter 8 *Oil*), partly offset by a weaker exchange rate outlook.

Box 7.1: The title of the world's largest LNG exporter

Australia and Qatar continue to jostle for the title of the world's largest LNG exporter. In 2018, Qatar's exports of 76 million tonnes comfortably outstripped Australia's 70 million tonnes, although Australia did export more LNG at the end of 2018 before Qatar subsequently regained the lead (Figure 7.11). In the first eight months of 2019, Australia had exported 52 million tonnes of LNG, compared to Qatar's 54 million tonnes.

Australia is forecast to edge past Qatar as the world's largest LNG exporter (on an annual basis) in 2019, shipping 78 million tonnes of LNG (compared to an anticipated 76 million tonnes in Qatar). Australia is then forecast to extend its lead further in 2020, as exports climb to 81 million tonnes and Qatar's output remains steady (Figure 7.13). However, the narrow difference between the projected exports of the two nations means that Australia overtaking Qatar is far from certain, especially in 2019.

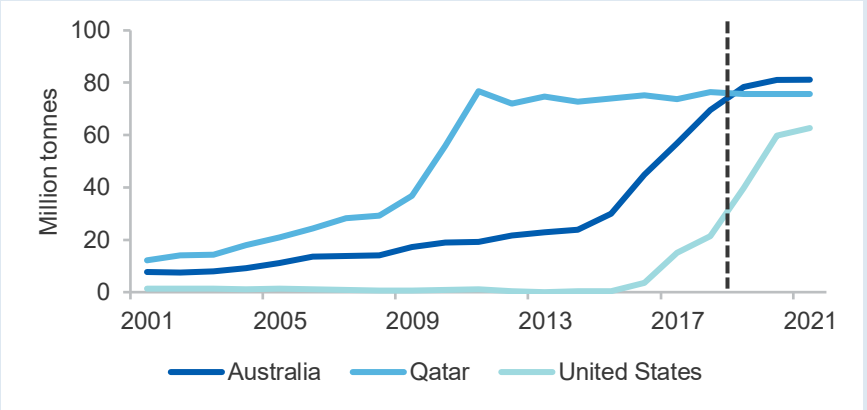
Figure 7.11: Monthly LNG exports of key producers



Source: Bloomberg (2019)

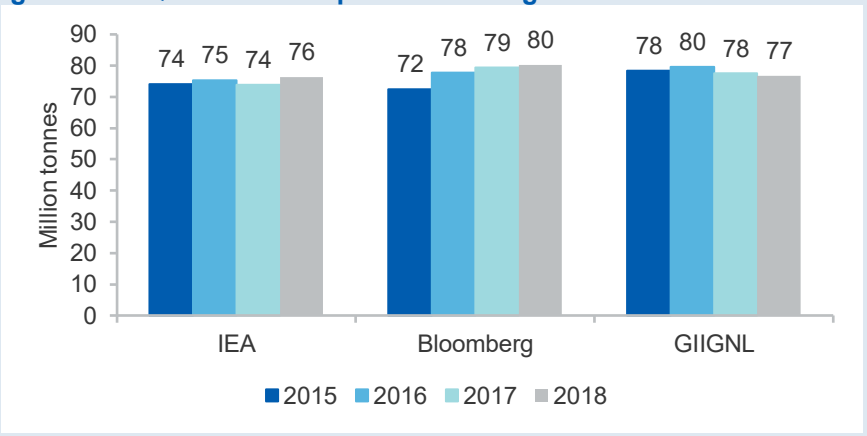
The tussle for the title of the world's largest LNG exporter is further complicated by a lack of clarity around the precise level of Qatar's LNG exports. IEA data (used in this report) puts Qatar's exports at 76 million tonnes in 2018, while data from the International Group of Liquefied Natural Gas Importers (GIIGNL) has exports at 77 million tonnes, and shipping data suggests Qatar exported 80 million tonnes. It is possible that Australia may overtake Qatar in 2019 according to IEA or GIIGNL data, but not according to another data source. Whatever the case, during the mid-2020s, Australia is expected to be surpassed as the world's largest LNG exporter by both Qatar and the US.

Figure 7.12: LNG export projections for Australia, Qatar and the US



Source: Nexant (2019); IEA (2019); Department of Industry, Innovation and Science (2019)

Figure 7.13: Qatar's LNG exports according to different data sources



Source: IEA (2019); Bloomberg (2019); GIIGNL (2019)

Table 7.1: World gas outlook

	Unit	2018	2019[f]	2020[f]	2021[f]	Annual percentage change 2019[f]	2020[f]	2021[f]
JCC oil price[a]								
– nominal	US$/bbl	72.9	66.6	68.8	66.8	-8.7	3.3	-2.9
– real[h]	US$/bbl	74.5	66.6	67.2	63.9	-10.7	0.9	-5.0
Asian LNG spot price[bg]								
– nominal	US$/MMbtu	9.8	5.4	6.3	8.1	-45.1	17.0	28.2
– real[h]	US$/MMbtu	10.0	5.4	6.1	7.7	-46.3	14.4	25.5
LNG trade	Mt[c]	308.7	322.5	347.8	369.3	4.5	7.9	6.2
Gas production	Bcm	3,800.8	3,884.3	3,955.5	4,016.3	2.2	1.8	1.5
Gas consumption	Bcm	3,814.9	3,894.0	3,966.1	4,045.9	2.1	1.9	2.0

Notes: **a** JCC stands for Japan Customs-cleared Crude; **b** Historical data is the North Asia SLInG weekly spot price; **c** 1 million tonnes of LNG is equivalent to approximately 1.36 billion cubic metres (bcm) of gas; **f** Forecast; **g** 1 MMBtu is equivalent to 1.055 GJ; **h** In 2019 US dollars; **s** estimate.

Source: ABS (2019) International Trade in Goods and Services, Australia, 5368.0; Department of Industry, Innovation and Science (2019); Company reports; Nexant World Gas Model (2019)

Table 7.2: Australian gas outlook

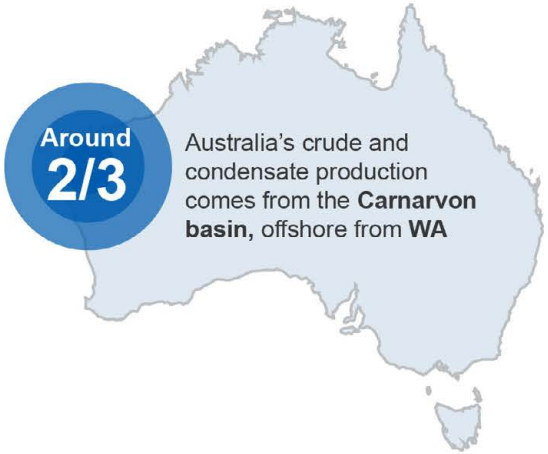
	Unit	2017–18	2018–19	2019–20[f]	2020–21[f]	Annual percentage change 2018–19	2019–20[f]	2020–21[f]
Production[d]	Bcm	120.3	145.2	151.7	154.6	20.7	4.5	1.9
– Eastern market	Bcm	55.0	55.3	54.9	54.6	0.5	-0.8	-0.5
– Western market	Bcm	63.8	82.3	82.8	85.9	28.9	0.7	3.7
– Northern market[k]	Bcm	1.4	7.6	14.0	14.2	439.3	84.4	1.2
LNG export volume	Mt[c]	61.7	74.9	81.6	81.2	21.3	9.0	-0.5
– nominal value	A$m	30,907	49,768	52,076	48,881	61.0	4.6	-6.1
– real value[e]	A$m	32,170	50,963	52,076	47,707	58.4	2.2	-8.4
LNG export unit value[g]								
– nominal value	A$/GJ	9.5	12.6	12.1	11.4	32.7	-4.0	-5.7
– real value[e]	A$/GJ	9.9	12.9	12.1	11.1	30.6	-6.2	-7.9
– nominal value	US$/MMBtu	7.8	9.5	8.9	8.9	22.4	-6.4	-0.2
– real value[e]	US$/MMBtu	8.1	9.7	8.9	8.7	20.5	-8.6	-2.6

Notes: **c** 1 million tonnes of LNG is equivalent to approximately 1.36 billion cubic metres (bcm) of gas; **d** Production includes both sales gas and gas used in the production process (i.e. plant use) and ethane. Historical gas production data was revised in the June quarter 2017 to align with Australian Petroleum Statistics published by the Department of Environment and Energy; **e** In 2019–20 Australian dollars; **f** Forecast; **g** 1 MMBtu is equivalent to 1.055 GJ; **h** In 2019 US dollars; **k** Gas production from Bayu-Undan Joint Production Development Area is not included in Australian production. Browse basin production associated with the Ichthys project is classified as Northern market; **s** estimate.

Source: ABS (2019) International Trade in Goods and Services, Australia, 5368.0; Department of Industry, Innovation and Science (2019); Company reports; Nexant World Gas Model (2019)

Oil

Resources and Energy Quarterly September 2019

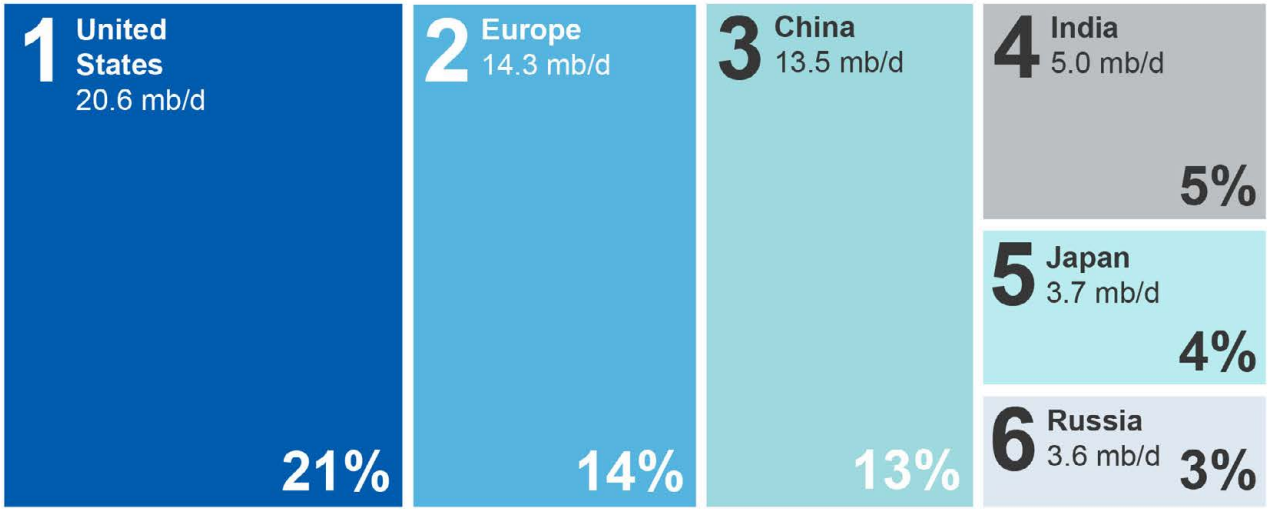


Around 18%
of refinery feedstock is domestically produced, the remainder is imported

In the last 5 years the Brent spot price ranged from
US$26 – US$94
a barrel, and averaged
US$58 a barrel

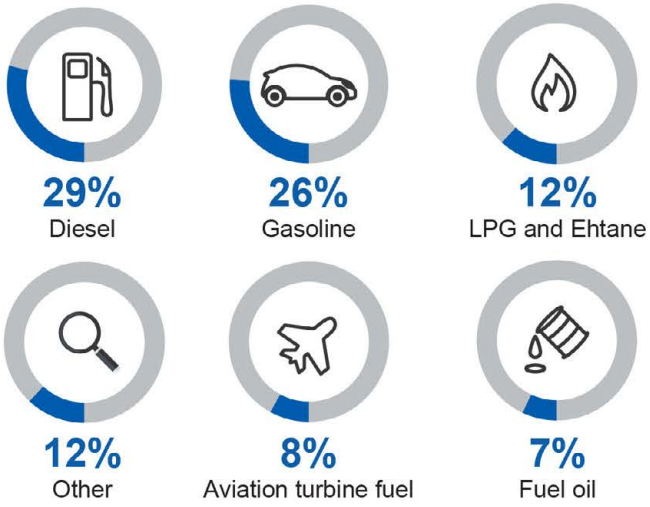
Australia's crude oil, condensate and LPG resources (PJ)

Key consumer markets of oil products (2019 forecast)



Note: Measured in million barrels per day.

World consumption of oil products



8.1 Summary

- Deteriorating world economic conditions have dominated oil markets since May 2019, driving prices to their lowest levels since early January. An attack on Saudi Arabia's oil production facilities on 14 September 2019 shocked markets, adding a risk premium to prices on fears that Saudi oil infrastructure is vulnerable to major disruption.
- Australia's condensate and LPG export volumes are rising and forecast to peak during the outlook period, while crude oil production in 2018–19 reached its lowest level in generations.
- Earnings from crude, condensate and LPG exports are forecast to continue their upward trend, rising from $10.1 billion in 2018–19 to $13.7 billion in 2019–20, before falling slightly to $12.9 billion in 2020–21. The 2019–20 peak reflects expected export volume growth and the impact of a weaker Australian dollar.

8.2 Prices

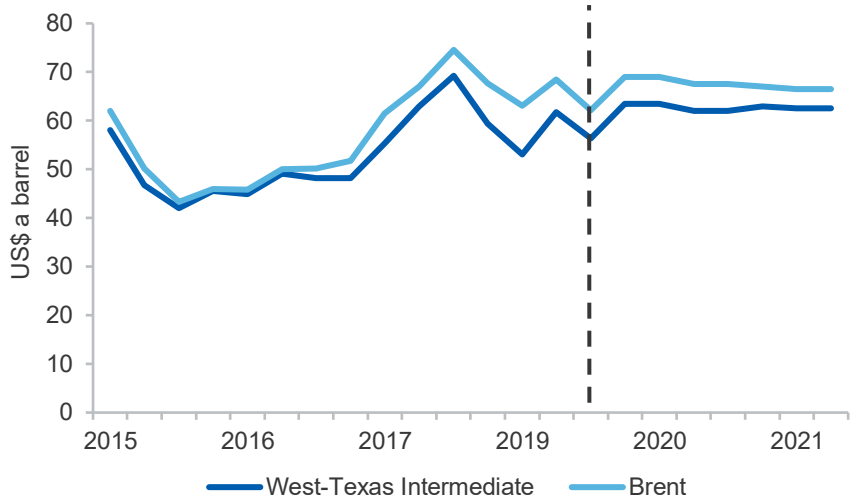
Demand and supply uncertainty in short term

The Brent crude oil benchmark price has moved noticeably lower since its 2019 peak of US$74 a barrel on 16 May 2019. It averaged US$62 a barrel over the September quarter, 10 per cent lower than the June quarter. By contrast, the West Texas Intermediate (WTI) benchmark fell by only 6 per cent, to $56 a barrel, as the gap between Brent and WTI narrowed. Taking a longer term perspective, the average Brent spot price for the September 2019 quarter remains close its average price of US$63 (real 2019 dollars) over the last 5 years. WTI is below its average price of US$59 (real 2019 dollars) over the same period (Figure 8.1).

Price increases in the first half of the year were supported by the curtailment of supply under the 'Vienna Agreement', under which OPEC, Russia, Kazakhstan, Mexico and seven other countries (collectively referred to as 'OPEC+') agreed to reduce crude oil production by 1.2 million barrels a day. Over-compliance with that agreement, as well as unplanned outages in Venezuela and Iran, have offset increased US output. As a result, total world oil production in 2019 is expected to be no higher than 2018. This year will be the first time annual production growth has been at or below zero since 2009. Despite OPEC+ members holding down output, daily spot Brent oil prices plunged by 30 per cent from late May to early August. The plunge reflected signs of weakening oil consumption growth, due to a softening in the US, European and Asian economies, as trade tension impacts were felt in the real economy. The negative mood dominated the behaviour of oil markets, despite estimates indicating that consumption volumes could modestly exceed production this year and next — due to the OPEC+ restrictions and other unplanned outages.

Sentiment turned firmly towards supply risk on 14 September with an attack on two key parts of the oil production infrastructure in Saudi Arabia. News of the attack caused Brent oil futures contracts to rise by $12 a barrel when Asian markets next opened. This was the largest intraday move since the futures contract started trading in 1988. At time of writing, spot prices for both Brent and WTI benchmarks remained elevated at least 5 per cent above their pre-attack levels.

Figure 8.1 Historical and forecast oil prices



Source: Bloomberg (2019); Department of Industry, Innovation and Science (2019)

The 2020 mandate for international shipping to switch to low-sulphur bunker fuel is starting to be felt. Since early August, markets have seen a sharp drop in the price of high sulphur fuel oil relative to low sulphur gasoil, providing an early indication of declining demand for the high sulphur products. As 2020 nears, this demand shift could put upward pressure on the prices of light sweet crude oils — such as the Brent and WTI benchmarks — which suit refining into low sulphur fuels (see June 2019 *Resources and Energy Quarterly*, Box 8.1).

Even with improving world economic growth expected in 2021, elevated production relative to consumption is expected to lead to prices easing over the outlook period. The Brent crude benchmark price is forecast to average US$67 a barrel over the outlook period, down from its 2018 level of $71 a barrel (Figure 8.1).

8.3 World oil consumption

World oil consumption growth is expected to increase at an average annual rate of 1.2 million barrels a day over the outlook period, from 99 million barrels a day in 2018 to 103 million barrels a day in 2021.

This is slower than the average growth of the last three years, and reflects the slowing pace of growth in the world economy, with 2019 growth expected to be particularly slow at 1.1 million barrels a day. This is the second consecutive edition of *Resources and Energy Quarterly* in which consumption growth expectations for 2019 are being revised down, in light of trade tensions and a weakening global economy.

Non-OECD countries are expected to account for all of the growth in world oil consumption over the outlook period, led by China and India. Non-OECD consumption is forecast to reach 55 million barrels a day in 2021, up from a revised figure of 52 million barrels a day in 2018.

By contrast, consumption by the OECD nations is expected to remain steady at 48 million barrels a day over the outlook period. While transport needs continue to expand in these markets, efficiency improvements are offsetting the growth in transportation. Fuel switching will become more relevant to this equation over time as electric vehicles (EV) take a growing share of the new light vehicle market — but the most dramatic growth in EV sales is expected to occur beyond the outlook period (see section 15.2 in *Lithium* chapter).

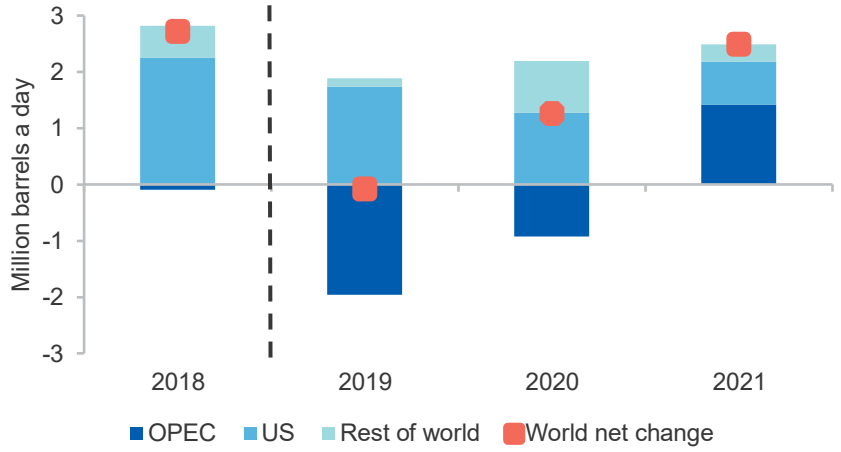
8.4 World oil production

World production growth in 2019 remains on track to be no higher than 2018 levels, due to the success of OPEC+ in limiting output, and the impact of US sanctions on Venezuela and Iran (Figure 8.2).

OPEC+ cuts, unplanned outages and heightened geopolitical risk

OPEC+ total oil (crude and natural gas liquids) production has continued to decline in recent months, reaching 53.7 million barrels a day in August — around its lowest level in over four years. This amounted to a 2.8 million barrel a day reduction on the October 2018 level (the level used as benchmark in the ongoing Vienna Agreement). This large reduction in output was the combination of bigger voluntary cuts than required under

Figure 8.2: Annual change in forecast world oil production by region



Source: IEA (2019); Department of Industry, Innovation and Science (2019)

the Vienna Agreement — and involuntary outages (particularly affecting Iran).

Saudi Arabia's voluntary cuts reduced output by 0.9 million barrels a day, while key partner Russia reduced output by 0.1 million barrels a day, relative to the October 2018 benchmark. Russia's production through August jumped to its highest level in 5 months.

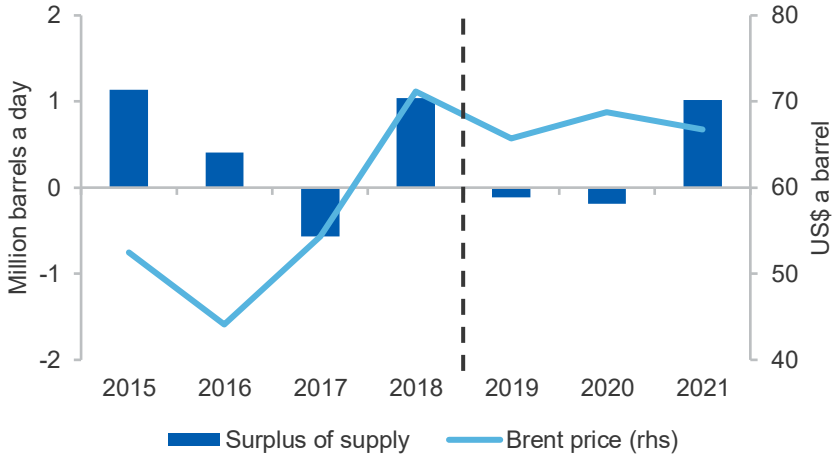
Involuntary cuts have affected the OPEC members exempt from the Vienna Agreement: Iran (output down 1.2 million barrels a day, a 27 per cent decline) and Venezuela (output down 0.5 million barrels a day, a 36 per cent decline). The outlook for these producers, isolated by US sanctions, is for output to fall further. OPEC output is forecast to remain below 2018 levels throughout the outlook period, even assuming an eventual peaceful resolution of tensions between the US and Iran during the outlook period.

Should US sanctions on Iran oil sales be completely lifted in late 2019, Iranian production would be expected to recover quickly through 2020, adding up to an additional two million barrels a day onto a market already expected to be adequately supplied (see Figure 8.3). Venezuela's production is not expected to rebound during the outlook period, even if US sanctions are lifted.

On 14 September 2019 there was an attack on the world's largest crude oil processing facility in Abqaiq, Saudi Arabia, causing fires and extensive damage. The aerial attack simultaneously struck equipment at the Khurais oil field, Saudi Arabia's second largest. These attacks had the potential to disrupt up to 5.7 per cent of the world's oil supply.

In the aftermath of the attacks, the US immediately made its strategic oil reserves available to steady the market. Saudi Arabia also has ample strategic reserves to draw on to supply customers while the damage is repaired. Notwithstanding the availability of reserves to plug temporary shortfalls, the concern of market participants is that the attack revealed Saudi oil production infrastructure to be vulnerable.

Figure 8.3: World oil production, consumption and price forecasts



Notes: Surplus of supply equals annual production volume minus consumption volume.

Source: Bloomberg (2019); Department of Industry, Innovation and Science (2019); International Energy Agency (2019).

If the scale of impact of the attack emboldens further violence, or if the security situation in the region spirals towards armed conflict, then Saudi Arabia could face major involuntary outages over the outlook period. As the world's second largest oil producer — supplying one-eighth of total world production — a major Saudi outage would have large and unpredictable impacts on production and price.

Rapid US growth continues

US oil output is expected to increase by 1.7 million barrels a day in 2019 alone, an 11 per cent rise (Figure 8.2). Although slowing over the outlook period, the US will dominate supply growth on the back of a long period of investment in exploration, rigs and infrastructure. Even with the industry consolidating as a result of increased bankruptcies of smaller companies, and a falling number of active rigs, US production is forecast to increase strongly. Cumulative growth of 25 per cent over the three year outlook period is forecast, reaching 19.3 million barrels a day in 2021, up from 15.5 million barrels a day in 2018.

8.5 Australia's production and trade

Oil export earnings surged 29 per cent in 2018–19

Higher crude and condensate export volumes, higher prices and a weaker Australian dollar combined to drive export earnings up to $9.0 billion in 2018–19, a 31 per cent increase on the previous financial year.

The outlook for crude and condensate remains strong, with production forecast to increase at an average annual rate of 11 per cent, up from 340,000 barrels a day in 2018–19 to 417,000 barrels a day in 2020–21.

Annual earnings from crude and condensate exports are forecast to peak at $11.4 billion in 2019–20, due to rising export volumes and a weaker Australian dollar. Exports are then expected to fall to $10.8 billion in 2020–21 as the Australian dollar recovers from current lows, and as oil prices decline (Figure 8.4).

2018–19 was a bumper year for condensate production, associated with output from new offshore LNG projects. Condensate increased by 52 per cent during the year, more than offsetting the ongoing decline in crude production (Figure 8.5).

Australia's crude oil production at its lowest level in 49 years

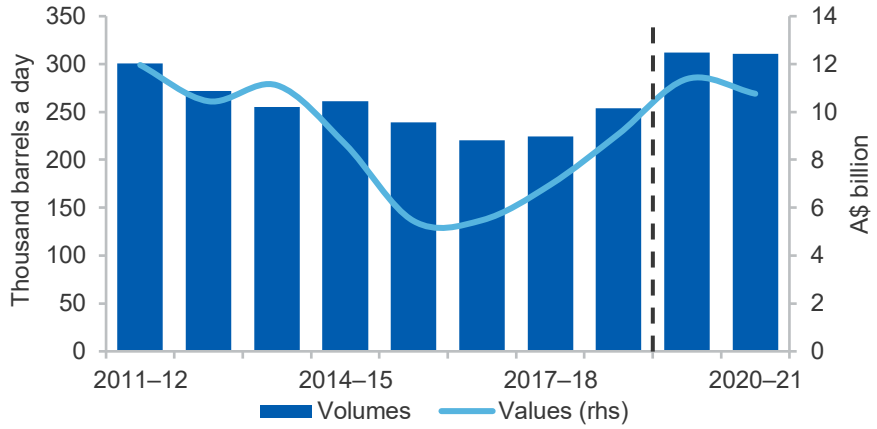
Australian crude oil production averaged 108,000 barrels a day in 2018–19 — this was the lowest annual level since 1969–70. With Woodside's Greater Enfield expansion coming online in Carnarvon in 2019–20, crude production is expected to rise strongly from the current low. Total Australian crude oil production in 2020–21 is forecast to be 21 per cent higher than the 2018–19 level.

Condensate and LPG production up strongly

Condensate output is forecast to grow 10 per cent a year, from 232,000 barrels a day in 2018–19 to 287,000 barrels a day in 2020–21.

In the Browse Basin off the Western Australian coast the recent start-up of Train 1 at INPEX's Ichthys facility has quickly reached full capacity, producing around 70,000 barrels a day during the first two quarters of 2019. Shell's Prelude facility has also commenced some operations and is

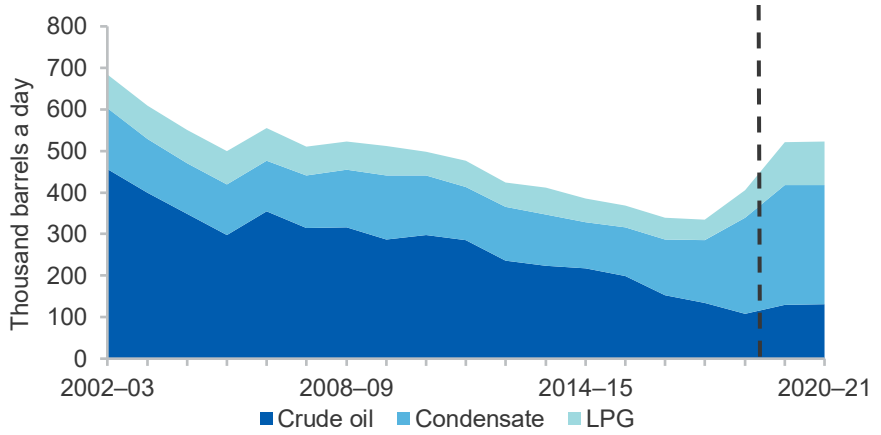
Figure 8.4: Australia's annual oil exports



Notes: Includes crude oil and condensate, but excludes LPG.

Source: ABS (2018); Department of Industry, Innovation and Science (2019).

Figure 8.5: Quarterly composition of Australia's oil production



Source: EnergyQuest (2019); Australian Petroleum Statistics (2019); Department of Industry, Innovation and Science (2019).

expected to ramp up strongly in the second half of 2019, producing nearly 30,000 barrels a day once it reaches full capacity.

As a result of Ichthys coming online, and of Esso's Gippsland Basin joint venture in the Bass Strait returning from maintenance to normal output, LPG production in the June quarter 2019 was 60 per cent higher year-on-year at 80,000 barrels a day. With Prelude also likely to start producing LPG later in 2019, Australian LPG output is expected to reach 105,000 barrels a day in 2020–21 — an annual average growth rate of 26 per cent from 2018–19.

Exploration expenditure low, but trend could be turning

Exploration expenditure was $378 million in the June quarter 2019, up 20 per cent year-on-year (Figure 8.6). After a decade of decline to reach a low of $1.0 billion in fiscal year 2017-18, exploration expenditure for 2018-19 was higher at $1.3 billion.

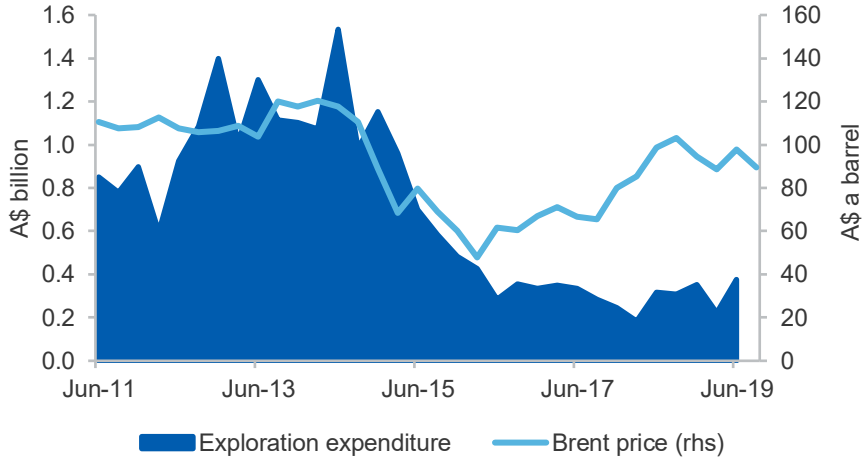
Australia's fuel consumption growth stalls, refinery production steady

Australia's refinery production was 502,000 barrels a day in 2018-19. To meet growing Australian demand, an estimated 61 per cent of refined product consumed in Australia was imported in 2018–19, including 70 per cent of diesel and 36 per cent of automotive gasoline.

The growth in Australia's domestic consumption of oil products fell in the first two quarters of 2019, following the slowing economy. After above-average growth of 3.5 per cent in 2017–18, growth fell to 0.5 per cent in 2018–19, well below the average of the past decade. During the same period, Australian GDP grew by 1.4 per cent — the lowest growth in a decade — and per capita GDP growth was negative. Consumption growth is expected to remain anaemic through 2019, and start to recover with stronger GDP growth from early 2020 (Figure 8.7).

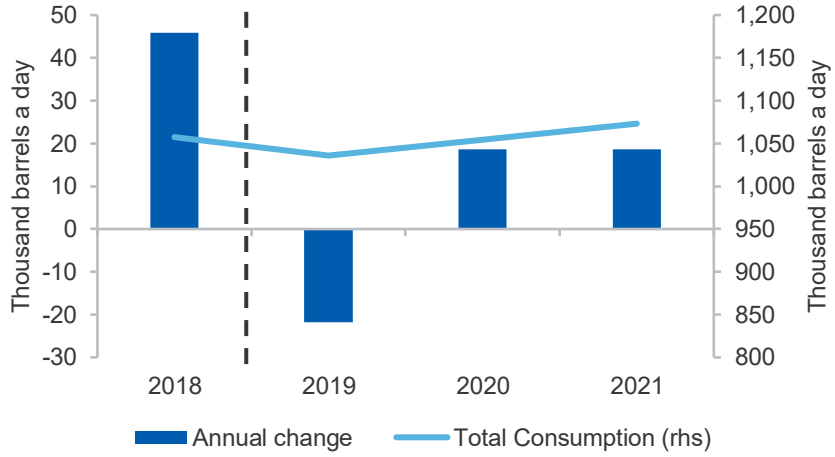
The slowdown is not expected to impact Australia's refineries. Rather, growth in the import of refined oil products is expected to slow in line with slower consumption growth.

Figure 8.6: Quarterly petroleum exploration and A$ oil price



Source: ABS (2019) Mineral and Petroleum Exploration Expenditure, cat. 8412.0, Bloomberg (2019).

Figure 8.7: Annual Australian oil consumption forecasts



Notes: All petroleum products, including gasoline, diesel, aviation fuels, LPG, lubricants.

Source: Australian Petroleum Statistics (2019), Department of Industry, Innovation and Science (2019)

Revisions to the outlook

Since the June 2019 Resources and Energy Quarterly, the world oil consumption outlook has been revised down through the outlook period, including a reduction in the 2019 growth forecast from 1.3 to 1.1 million barrels a day. Historical consumption for 2018 has been revised up from 99.1 to 99.3 million barrels a day on the basis of more accurate sales data.

Revisions have been made to the world production outlook, increasing actual and forecast world production throughout the outlook period. This is driven by higher OECD production (especially for the US and Canada) increasing actual and expected growth rates in 2018 and 2020. In 2021, production is forecast to be 104.0 million barrels a day, higher than forecast in the June 2019 Resources and Energy Quarterly by 0.5 million barrels a day.

Australia's forecast oil export earnings have been revised down by $200 million in 2018–19 and by $600 million in 2019–20, compared to the forecast in the June 2019 Resources and Energy Quarterly. Both revisions are a result of lower realised and forecast oil prices. Export volumes are unchanged.

Table 8.1: Oil outlook

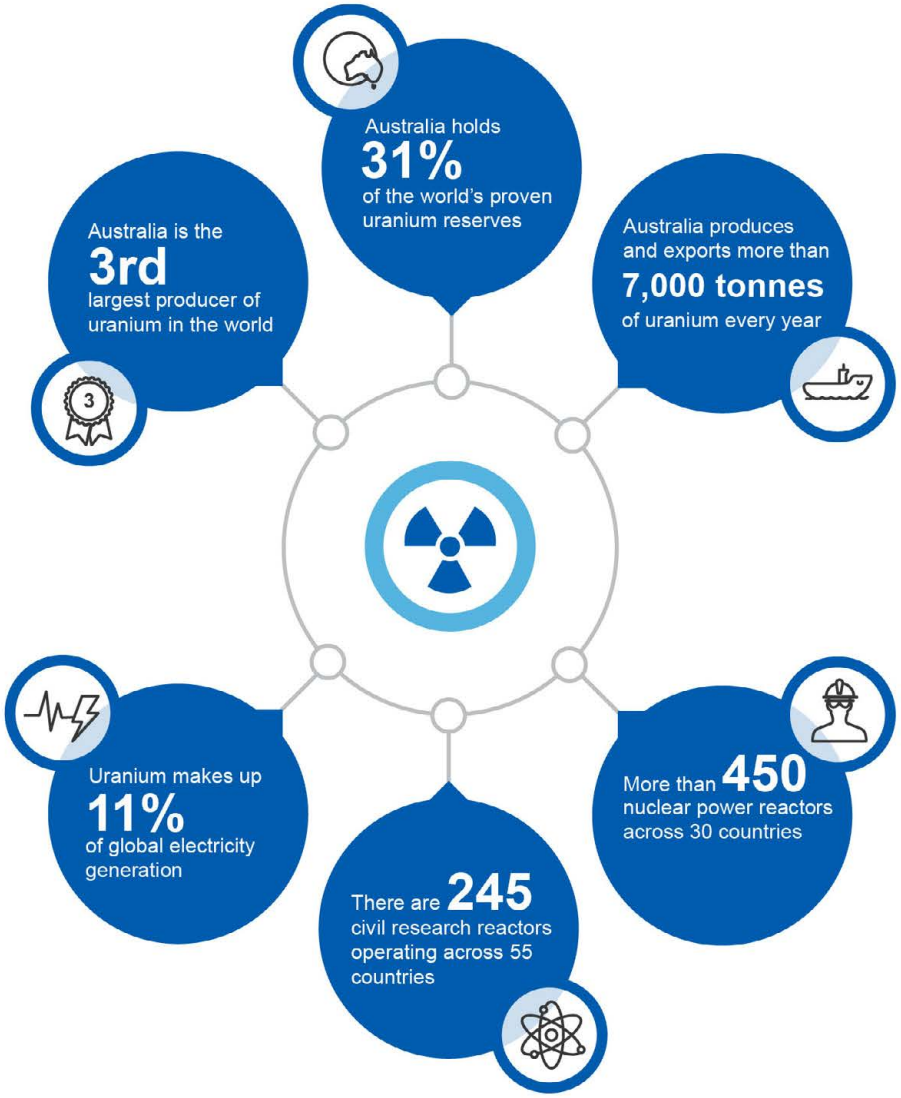
						Annual percentage change		
World	**Unit**	**2018**	**2019[f]**	**2020[f]**	**2021[f]**	**2019[f]**	**2020[f]**	**2021[f]**
Production[a]	mb/d	100.3	100.2	101.6	104.0	-0.1	1.3	2.5
Consumption[a]	mb/d	99.3	100.3	101.6	102.9	1.1	1.3	1.3
WTI crude oil price								
– Nominal	US$/bbl	65.1	58.7	63.3	62.8	-9.9	7.8	-0.8
– Real[b]	US$/bbl	66.5	58.8	61.8	60.0	-11.6	5.1	-2.9
Brent crude oil price								
– Nominal	US$/bbl	71.2	65.7	68.8	66.8	-7.7	4.7	-2.9
– Real[b]	US$/bbl	72.7	65.9	67.2	63.9	-9.4	2.1	-5.0
Australia	**Unit**	**2017–18**	**2018–19**	**2019–20[f]**	**2020–21[f]**	**2018–19[f]**	**2019–20[f]**	**2020–21[f]**
Crude and condensate								
Production[a]	kb/d	286	340	418	417	19.0	22.9	-0.1
Export volume[a]	kb/d	225	254	312	311	13.1	22.8	-0.4
– Nominal value	A$m	6,958	9,079	11,377	10,761	30.5	25.3	-5.4
– Real value[g]	A$m	7,242	9,297	11,377	10,502	28.4	22.4	-7.7
Imports[a]	kb/d	386	375	346	342	-2.9	-7.8	-1.0
LPG production[ac]	kb/d	50	66	103	105	32.9	55.4	2.5
Refined products								
– Refinery production[a]	kb/d	494	502	489	488	1.6	-2.6	-0.2
– Export volume[ad]	kb/d	18	16	17	13	-8.0	5.0	-25.0
– Import volume[a]	kb/d	645	645	661	673	0.0	2.6	1.8
– Consumption[ae]	kb/d	1,040	1,046	1,047	1,061	0.5	0.1	1.4

Notes: **a** The number of days in a year is assumed to be 365, and a barrel of oil equals 158.987 litres; **b** In 2019 calendar year US dollars; **c** Primary products sold as LPG; **d** Excludes LPG; **e** Domestic sales of marketable products, including imports; **f** Forecast; **g** In 2019–20 financial year Australian dollars.

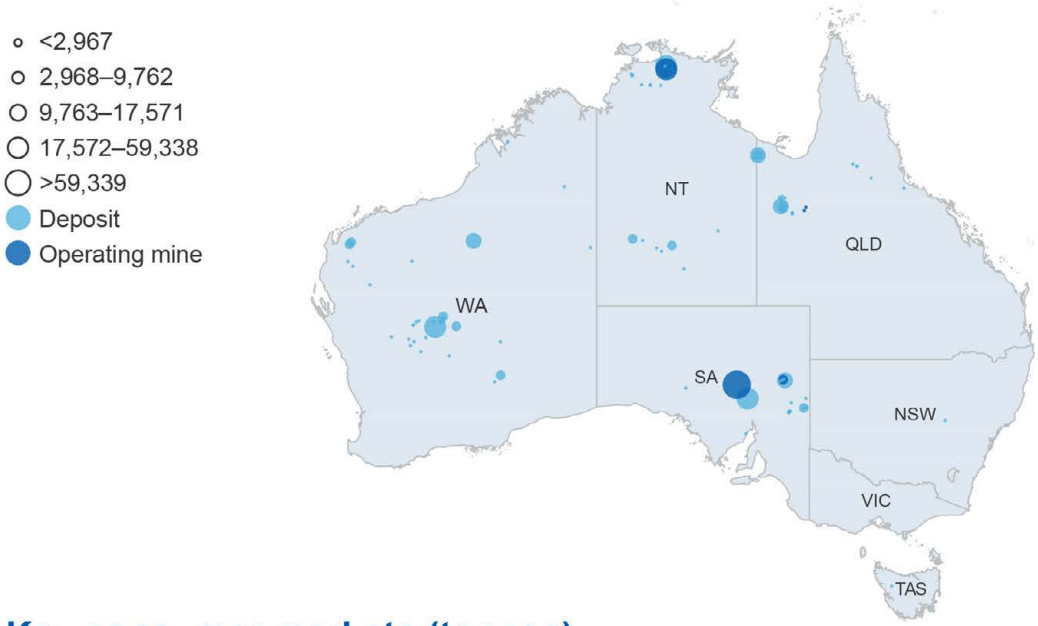
Sources: ABS (2019) cat. 5368.0, International Energy Agency (2019), EnergyQuest (2019), US Energy Information Administration (2019), Department of Environment and Energy (2019), Department of Industry, Innovation and Science (2019).

Uranium

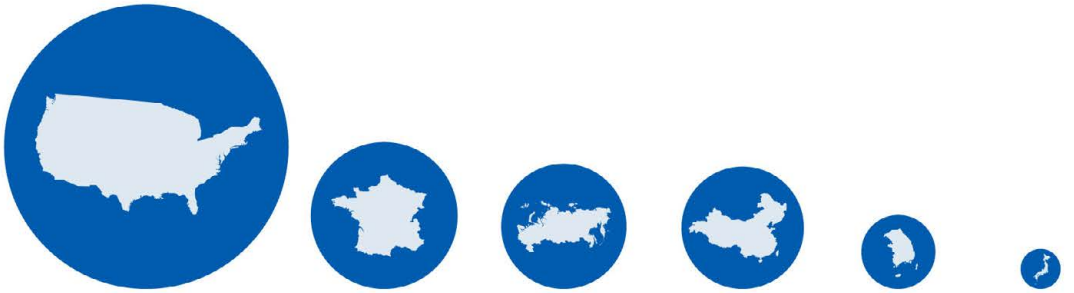
Resources and Energy Quarterly September 2019



Major Australian uranium deposits (tonnes)



Key consumer markets (tonnes)



USA	France	Russia	China	South Korea	Japan
17,847	**9,216**	**7,767**	**7,757**	**4,816**	**2,517**

9.1 Summary

- Gradually rising uranium demand, and production cuts imposed by large suppliers, are expected to push prices up from around US$25 a pound towards US$40 a pound over the next two years.
- Uranium production in Australia is expected to decline over the outlook period, as output winds down at the Ranger mine ahead of its scheduled closure at the start of 2021.
- Australia's uranium export earnings will likely be affected by falling production, with lower volumes offsetting the impact of higher prices, leading to a small decline in export values (to $614 million) by 2021.

9.2 Prices

Uranium prices are largely stable, but change is in prospect

Uranium prices have been stable at relatively low levels for around a year. Prices hit a historical low point in 2017, and lifted only when large producers in Kazakhstan and Canada cut their output, reducing global supply by almost one-fifth. Prices have remained between US$25 and US$28 a pound since this time, with many mines producing at a net loss.

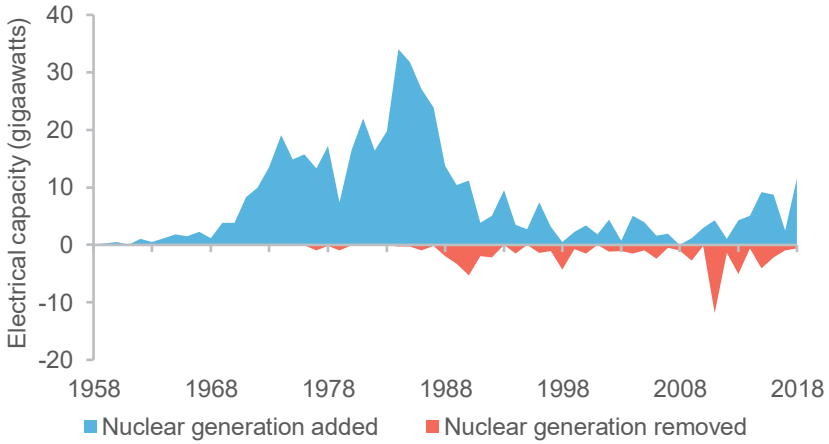
Prices eased back in June and July following a petition filing by US uranium miners. The miners sought an investigation into whether the US should seek to curb uranium imports under section 232 of the US 1962 Trade Expansion Act. The July announcement that uranium imports would not be subject to new tariffs or quotas has been welcomed by most global producers, and may be expected to restore confidence and raise prices slightly in coming months.

Over the longer term, new reactor constructions in China, South Asia, and Eastern Europe, should continue to drive gradual price growth in an environment of tight supply (Figure 9.1). Further out, prices may grow more strongly as deployment continues to rise (Figure 9.2) and the full effect of mine and project postponements over the period of relatively depressed prices plays out.

Figure 9.1: Uranium price outlook

Source: Cameco Corporation (2019) Uranium Spot Price; Ux Consulting (2019) Uranium Market Outlook

Figure 9.2: World nuclear power generation



Source: International Energy Agency (2019); World Nuclear Association (2019); Department of Industry, Innovation and Science (2019)

9.3 World consumption

Nuclear power growth faces a significant potential upside

Uranium demand is expected to grow moderately, from 85,300 tonnes in 2018 to 90,400 tonnes by 2021 (Figure 9.3).

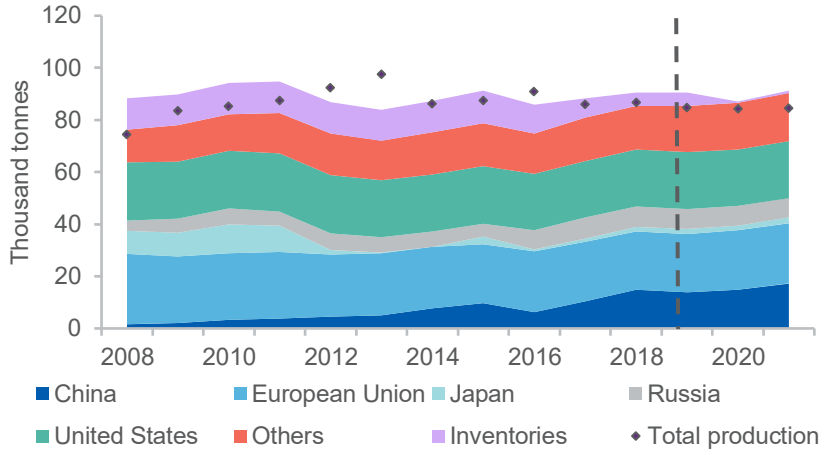
Recent indicators suggest a more positive outlook for nuclear power in the US, which remains the largest global user. In June, utility company Xcel Energy announced that the operation of its Monticello nuclear plant would be extended by at least 10 years, while its two coal plants would close 10 years ahead of schedule. Georgia Power also announced in August that fuel loading would begin for the Vogtle plant's newly constructed unit 3.

The US Department of Energy launched a new National Reactor Innovation Centre in August, with an intention of accelerating licencing and commercialisation, and to provide more opportunities for research and testing of fuels and materials. This is a notable change in direction, following a 15 year period in which no significant initiatives were announced, and several programs were cancelled. It follows announcements that nuclear power would now count as a renewable energy source under the California's Renewables Portfolio Standard, effectively qualifying nuclear power for large carbon-free energy incentives. The Ohio Clean Air program, which passed the state's lower house in August, also provides new incentives for nuclear plants.

Two new reactors in Western Europe have begun fuel loading in preparation for grid connection. The world's first European Pressurised Reactor (EPR) — sited at Olkiluoto in Finland — is expected to be grid-connected in October. A second EPR — located at Flamanville in France — is expected to be connected later in 2019.

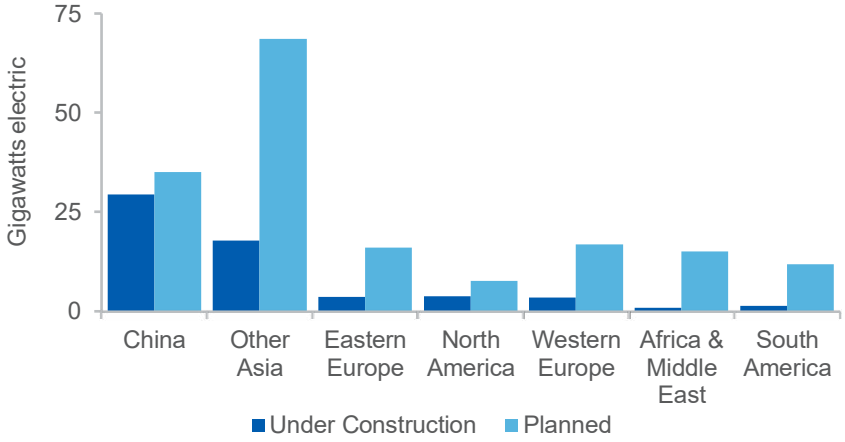
In China, the Taishan nuclear plant's second reactor achieved full generating capacity for the first time in August, following its grid connection in June. In August, the Yangjiang nuclear power plant announced that its recently completed unit 6 had met commercial operation conditions, and was starting to generate grid power.

Figure 9.3: World uranium consumption and inventory build (U3O8)



Source: International Energy Agency (2019); World Nuclear Association (2019); Ux Consulting (2019)

Figure 9.4: New nuclear capacity



Source: International Energy Agency (2019); World Nuclear Association (2019); Department of Industry, Innovation and Science (2019)

Also in August, Ghana's government announced the establishment of a new organisation to oversee construction and operation of the country's first nuclear plant. Site selection is now set to begin, with the government prioritising nuclear generation as a sustainable development goal.

Concrete pouring for unit 2 of the Rooppur power plant in Bangladesh concluded in August, with foundations for unit 1 having been completed earlier in 2019. The Russian state nuclear corporation has been contracted to build two large 1200 MWe reactors on the site.

The Russian and Indian governments have also recently signed agreements to construct 20 new reactors in India over the next 20 years.

Technological progress is picking up pace, with development of small modular reactors (SMRs) accelerating in recent months. In South Korea, a collaboration agreement has been announced between Doosan Heavy Industries and NuScale, a US-based small modular developer. The agreement includes a review process for NuScale's proposed reactor design, with development and deployment to be managed by Doosan. Utah Municipal Power Systems has already announced plans to commence construction of the first NuScale reactor in 2023.

In the UK, the Government has allocated resources from its Industrial Strategy Challenge Fund to support development of an SMR by a consortium of companies that includes Rolls-Royce, Siemens, BAM Nuttall, SNC Lavalin/Atkins, Assystem, Wood, Arup, Laing O'Rourke, National Nuclear Laboratory and Nuclear AMRC.

China's National Nuclear Corporate has launched a project to construct an SMR in July, with construction of a demonstration ACP100 model set to start in late 2019. The development of SMRs is recorded as a 'key project' in China's latest five year plan.

In July, Canadian Nuclear Laboratories launched a new R&D program to accelerate the development and construction of SMRs in Canada. Under the program, vendors will be able to access public research facilities, and incentives will be provided for collaboration and work to progress fuel development, reactor physics, and transportation. The Canadian government has also commenced environmental assessments for an SMR project proposed by the Ultra Safe Nuclear Corporation and Global First Power. The project would develop a micro modular reactor, intended as 'a model for future SMR deployments that could support remote industrial applications and provide a viable option to displace fossil fuel use'.

SMRs have significant potential to change the way uranium markets work. Some will offer pathways for thorium-based power generation as a substitute for uranium fuel. Some will have capability to act as 'breeder' reactors — burning used reactor fuel from other reactors as a power source, creating closed-loop production and removing nuclear waste. Some SMR models will have the capability to combine liquid fuel with fluoride or salt, creating a mixture which acts as both fuel and coolant. SMRs constructed in this way will be incapable of melting down, and small enough to transport on trucks. The long deployment window of traditional reactors may become avoidable with SMRs, which will be capable of assembly line production and rapid shipment and connection in markets around the world. This could create a uranium market with the potential for more rapid growth than the uranium market of today.

9.4 World production

Conditions for uranium producers are belatedly improving

In aggregate, global mine production is expected to edge up from 59,700 tonnes of U3O8 in 2018, to 62,700 tonnes by 2021. In August, Kazatomprom — Kazakhstan's National Atomic Company, and the largest uranium supplier in the world — announced that current production cuts will be maintained for a further year, taking them to the end of 2021. Supply cuts by the company will remove almost 6,000 tonnes of uranium supply over the outlook period, and will likely lead to a gradual ramp-up of supply pressures. Rising secondary supply and high inventories will likely absorb some of the resulting price pressure, at least in the short-term.

While many uranium projects have been postponed or placed in hiatus in recent years, some have continued to progress, in anticipation of a price recovery. A feasibility study released in July confirms that the Tiris project

in Mauritania is ‘one of the most compelling uranium development projects in the world’, according to Aura Energy — an Australian company. The study found the project has very low operational and capital costs, with Aura Energy estimating a total capital cost of around US$60 million to realise the project.

9.5 Australia

Low prices have sharply reduced uranium exploration

Only $3 million was invested in uranium exploration in Australia in the March quarter. This is higher through the year, but well below the peak in 2010, when quarterly exploration was above $40 million.

The closure of Ranger will drive a decline in production by 2021

Australian uranium output and production are set to decline from 2020, as the Ranger uranium mine remains on schedule to close in January 2021.

In August, the Government asked the House Standing Committee on the Environment and Energy to undertake an investigation of the nuclear fuel cycle, with a report to be provided by the end of 2019. The inquiry will report on the potential for nuclear deployment in Australia, and to study ‘the circumstances and prerequisites necessary for any future government's consideration of nuclear energy generation including small modular reactor technologies in Australia’. The inquiry will consider issues such as environmental implications, energy affordability, social licence, transport, waste management, and workforce capacity.

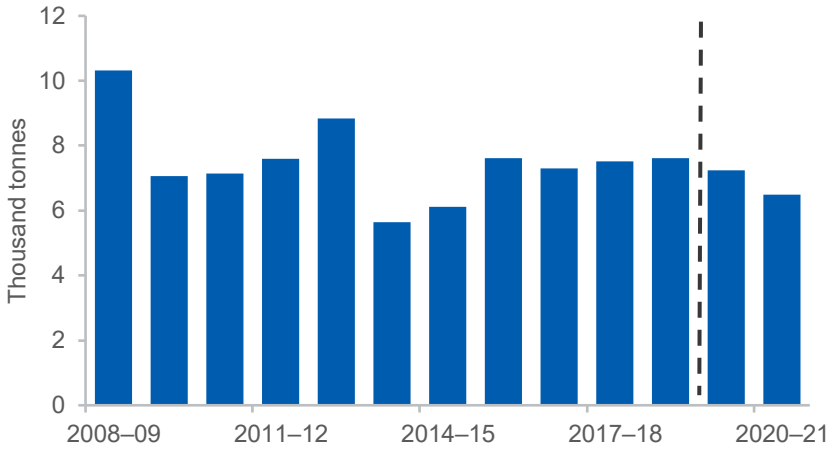
Conditions for exporters remain difficult, but price growth should help

Following the trajectory of production, export volumes are expected to decline from 2019–20, though price growth may provide some offset (Figures 9.6 and 9.7).

Revisions to the outlook

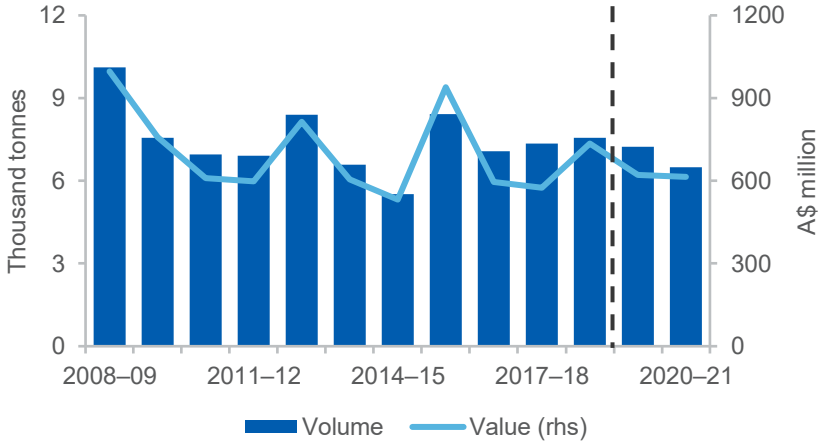
Australia’s forecast uranium export earnings for 2019–20 is largely unchanged from the previous release.

Figure 9.5: Australia’s uranium production



Source: BHP (2018); Operational Review, Department of Industry, Innovation and Science (2019); Energy Resources of Australia (2018); ASX Announcements — Operations Review; company media announcements (2019)

Figure 9.6: Australia's uranium exports



Source: Department of Industry, Innovation and Science (2019)

Table 9.1 Uranium outlook

						Annual percentage change		
World	**Unit**	**2018**	**2019[f]**	**2020[f]**	**2021[f]**	**2019[f]**	**2020[f]**	**2021[f]**
Production	kt	61.0	62.4	63.1	64.8	2.3	1.1	2.7
Africa[b]	kt	10.0	10.1	10.4	10.4	0.9	3.4	0.0
Canada	kt	8.3	8.2	8.2	8.2	-1.0	0.0	0.0
Kazakhstan	kt	25.5	26.7	26.8	29.5	4.5	0.3	10.1
Russia	kt	3.4	3.7	3.7	3.8	6.7	0.0	3.1
Consumption	kt	85.3	85.3	86.5	90.4	0.0	1.4	4.4
China	kt	14.8	13.9	15.0	17.2	-6.6	8.0	14.9
European Union 28	kt	22.5	22.5	22.6	23.1	0.0	0.8	2.2
Japan	kt	1.6	1.9	1.9	2.4	18.8	0.0	26.0
Russia	kt	8.0	7.7	7.4	7.4	-3.9	-3.2	-0.4
United States	kt	21.8	21.8	21.7	21.8	0.0	-0.7	0.6
Spot price	US$/lb	24.1	26.4	31.7	37.5	9.3	20.1	18.3
real[c]	US$/lb	24.7	26.4	31.0	35.8	7.0	17.4	15.8
Australia	**Unit**	**2017–18**	**2018–19[s]**	**2019–20[f]**	**2020–21f[f]**	**2018–19[s]**	**2019–20[f]**	**2020–21f[f]**
Mine production	t	7,521	7,618	7,240	6,500	1.3	-5.0	-10.2
Export volume	t	7,343	7,571	7,240	6,500	3.1	-4.4	-10.2
– nominal value	A$m	575	734	621	614	27.7	-15.4	-1.2
– real value[d]	A$m	604	739	621	599	22.4	-16.0	-3.5
Average price	A$/kg	80.0	86.3	85.7	94.4	7.9	-0.7	10.1
– real[d]	A$/kg	83.1	88.2	85.7	92.2	6.1	-2.8	7.5

Notes: **b** Includes Niger, Namibia, South Africa, Malawi and Zambia; **c** In 2019 US dollars; **d** in 2019–20 Australian dollars; **f** forecast.
Source: Australian Department of Industry, Innovation and Science (2019); Cameco Corporation (2019); Ux Consulting (2019) Uranium Market Outlook

Gold

Resources and Energy Quarterly September 2019

Australia is the **2nd largest** producer of gold in the world

321 tonnes

of gold produced by Australia in 2018-19

9%

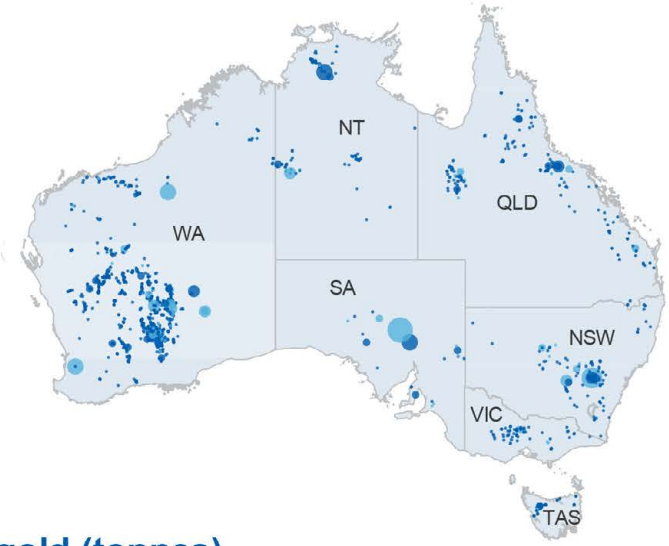
of world mine gold supplied by Australia in 2018

world record find

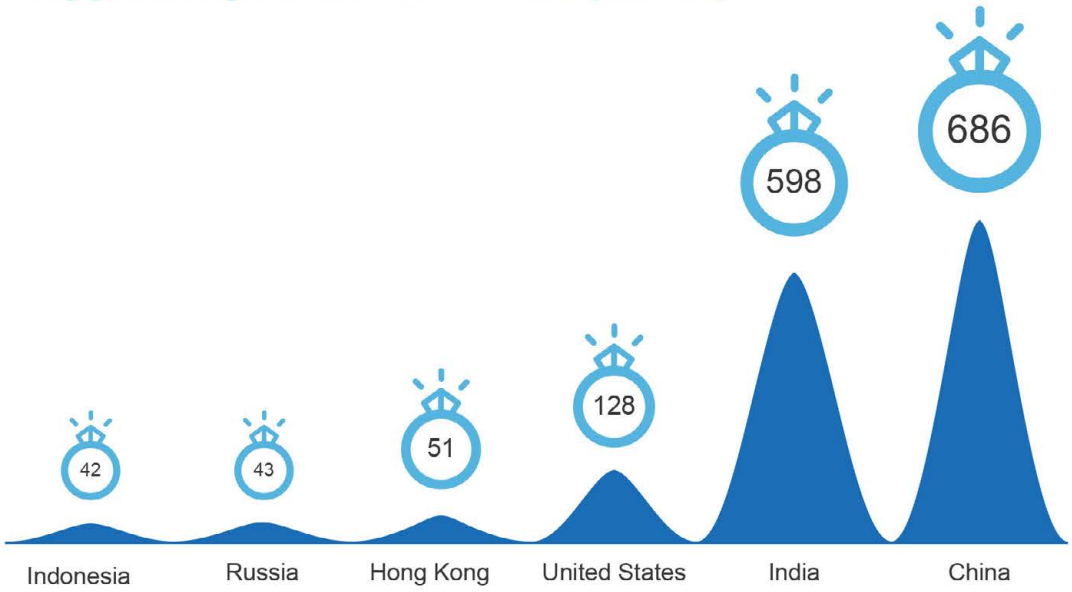
Australia holds the record for the world's largest gold nugget weighing 72 kg, found in Victoria in 1869

Major Australian gold deposits (tonnes)

- <20
- 21–70
- 71–185
- 186–473
- 474–1,027
- >1,028
- Deposit
- Operating mine



Key jewellery consumer markets (tonnes)



Global uses of gold (tonnes)

51% Jewellery

25% Gold coins and bars

15% Central Bank Reserves

7% Electronics and Industrial

1% Global Backed Exchange Traded Funds

1% Dental and medical

10.1 Market summary

- Australian gold prices are forecast to rise to a record annual average high of A$2,042 an ounce in 2020, due to trade tensions and geopolitical risks and a low Australian dollar.
- Australia's gold exports are forecast to hit a record high of $25 billion in 2019–20, reflecting expected rises in gold prices and a rise in export volumes to 368 tonnes.
- China's restrictive gold import licence policy represents a notable risk to gold exporters such as Australia.

10.2 Prices

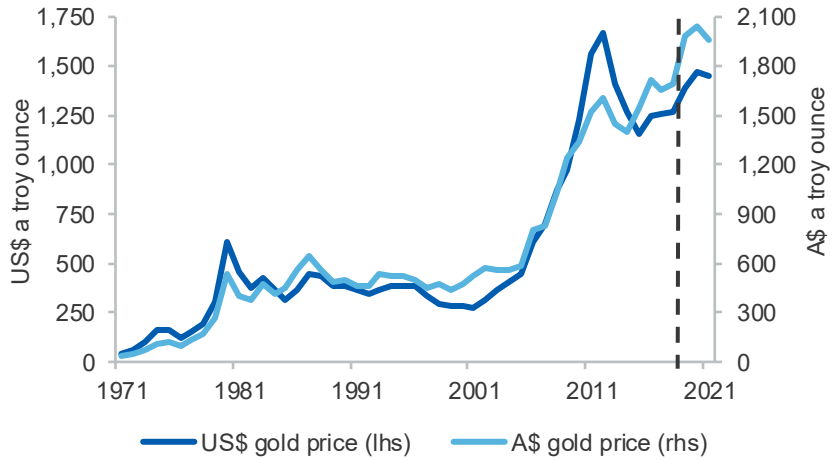
Australian gold prices hit a record high in August 2019

The London Bullion Market Association (LBMA) gold price reached a six year high of US$1,547 an ounce on 3 September 2019, propelled by an escalation of trade tensions between the US and China (see the *Macroeconomic chapter*). The trade tensions pushed the Australian dollar to an 11-year low of US$0.67 on 2 September. The lower Australian dollar, in combination with higher US dollar gold price, has pushed the Australian dollar gold price to a new record level of A$2,289 an ounce on 3 September 2019 (Figure 10.1).

Gold is expected to perform well over the remainder of 2019, as markets respond to ongoing trade tensions and geopolitical problems. The Brexit uncertainty has risen following the United Kingdom Parliament's vote to block a 'no deal' Brexit on 4 September 2019. Civil unrest in Hong Kong shows no signs of ending. The stalled US and North Korea nuclear talks pose a risk to regional (east Asia) and global security, while the confrontation between the US and Iran has the potential to escalate. Other uncertainties include a change of government in Italy and the rapid plunge of the Argentine Peso after the country's presidential election in August 2019.

Reflecting these issues, the US gold price is forecast average US$1,390 an ounce in 2019, with the Australian gold price forecast to be A$1,980 an ounce.

Figure 10.1: US dollar and Australian dollar gold prices, Yearly average



Source: LBMA (2019) Gold price PM and Australian gold price AM; Department of Industry, Innovation and Science (2019)

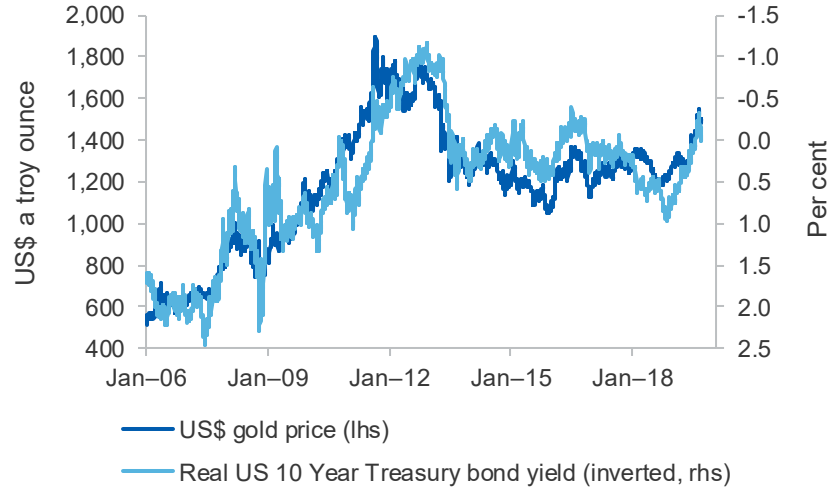
Gold is forecast to perform well in 2020 and 2021

Trade tensions are expected to continue having flow-on impacts to consumer and business confidence over the outlook period. The global economy faces a higher recessionary risk as signalled by the inverted yield curve (Figure 10.2). A correction in global equity markets could potentially result in a flow of funds into gold.

Central banks' gold purchases are likely to support gold prices over the next few years, with a forecast increase of 11 per cent in 2019, to 732 tonnes. Purchases are expected to stay above 700 tonnes in 2020.

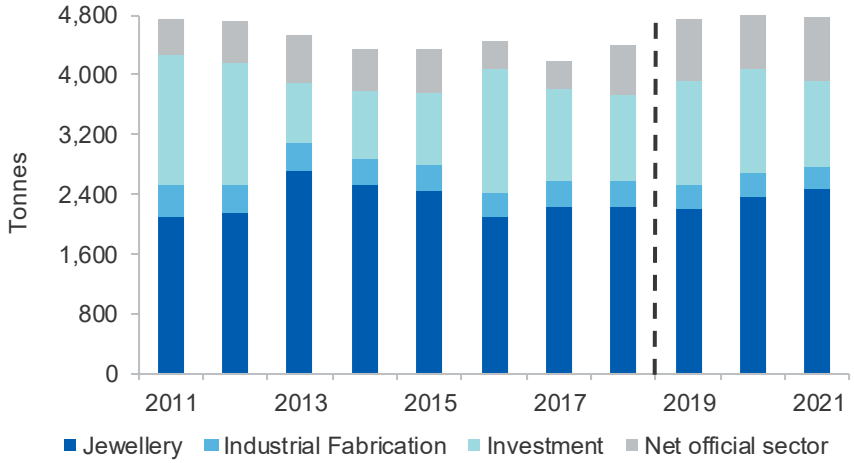
As gold faces higher demand as a safe haven asset, gold prices are expected to lift to an average US$1,470 an ounce in 2020, before falling to an average US$1,450 an ounce in 2021. The Australian gold price is forecast to average A$2,040 an ounce in 2020, before falling to an average of A$1,960 an ounce in 2021.

Figure 10.2: US dollar gold prices and Real 10-Year bond yield



Source: Bloomberg (2019)

Figure 10.3: World gold consumption



Source: World Gold Council (2019); Department of Industry, Innovation and Science (2019)

10.3 Consumption

World gold consumption increased strongly in the first half of 2019

World gold consumption increased by 7.9 per cent in the first half of 2019 to 2,182 tonnes, propelled by central bank buying and inflows into gold backed exchange traded funds (ETFs).

Demand from the official sector — central banks and other institutions — rose by 57 per cent year-on-year to 374 tonnes. Economic uncertainty, due to trade tensions and a desire to diversify out of the US dollar, appears to have been the catalyst for central banks' growing appetite towards gold. According to the World Gold Council, nine central banks — Poland, Russia, China, Kazakhstan, India, Ecuador, Colombia, Turkey and the Kyrgyz Republic — all increased their gold reserves by at least a tonne in the first half of 2019.

Gold-backed ETF holdings increased by 77 per cent year-on-year in the first half of 2019, with over 108 tonnes (or US$1.9 billion) of global inflows. Volatile equity markets and the shifting stance of the US Federal Reserve — which has now begun to cut interest rates — supported demand for gold backed ETFs.

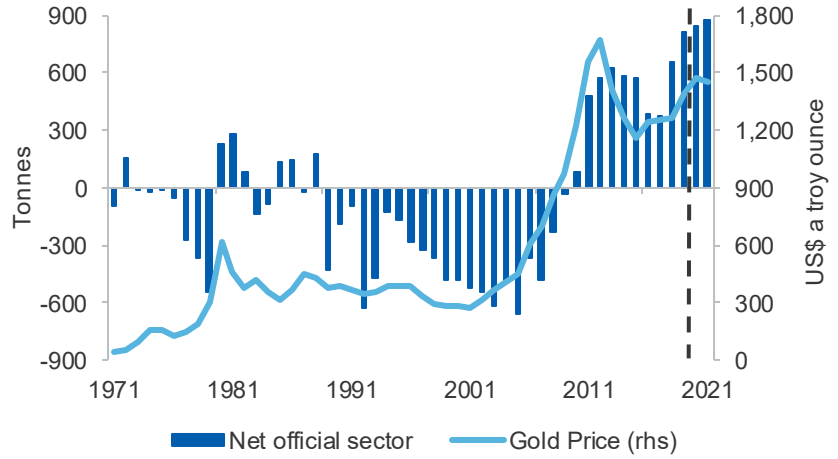
Gold jewellery consumption increased by 1.3 per cent year-on-year in the first half of 2019, to 1,062 tonnes, mainly driven by increased demand from India — the world's second largest jewellery consuming nation. The growth in Indian demand was due to lower prices during the wedding season, and more auspicious (lucky) wedding days in 2019 compared to 2018. Jewellery consumption in the United States — the world's third largest jewellery market — was at a ten-year high of 53 tonnes in the first half of 2019.

The outlook for global gold consumption for the remainder of 2019 remains positive, driven by central bank buying. After 20 years and three renewals, the Central Bank Gold Agreement (CBGA) — the European Central Bank (ECB) and 21 central banks in Europe — is expected to end in September 2019. The CBGA restricted the tonnage of gold sold in any year for member central banks. As a result, world gold consumption is forecast to grow by 7.9 per cent in 2019, to 4,745 tonnes.

World consumption to rise in 2020 and 2021

World gold consumption is forecast to grow by 3.7 per cent in 2020 and 1.2 per cent in 2021 (Figure 10.3). The growth is expected to be largely driven by central banks' gold buying, which is forecast to increase by 3.5 per cent a year over the next two years, reaching over 872 tonnes by 2021 (Figure 10.4). The official sector purchases will reflect a desire to diversify central bank reserves.

Figure 10.4: Net official sector consumption and Gold prices



Source: World Gold Council (2019); Department of Industry, Innovation and Science (2019)

Outside of Europe, the People's Bank of China (PBoC) — China's central bank — has been a regular buyer of gold, and is expected to continue buying gold over the outlook period. As at June 2019, the PBoC had added to its gold reserves in seven consecutive months, bringing its gold inflow to over 84 tonnes since December 2018.

Retail investment is expected to drive up global gold demand. Retail investment is forecast to rise by 7.3 per cent in 2020, and by a further 3.0 per cent (to 1,297 tonnes) in 2021. This reflects the impact of trade tensions, the global economic slowdown, and political uncertainty in Europe, Venezuela and the Middle East. In China, escalating trade tensions with the US are likely to boost gold demand, as retail investors seek to buy gold as a hedge against the depreciation of the Renminbi.

Jewellery demand is forecast to rise by 7.5 per cent (to 2,364 tonnes) in 2020, and by a further 4.6 per cent (to 2,473 tonnes) in 2021. Demand from China — the world's largest jewellery consumer — is expected to remain strong, supported by safe haven demand and the Chinese government's monetary and fiscal stimulus. In addition, jewellery production innovation — which has resulted in a widening product offering — will provide consumers with greater choices and potentially support higher demand for gold. In India — the world's second largest gold jewellery consumer — strong demand growth is expected, driven by economic growth, ongoing urbanisation, rising incomes, and improved consumer sentiment.

10.4 Production

World gold supply increased in the first-half of 2019

World gold supply rose by 2.1 per cent year-on-year in the first-half of 2019 to 2,324 tonnes, driven by rising mine production and increased recycling. Gold mine production grew by 0.3 per cent year-on-year to 1,720 tonnes, as several projects in major gold producing countries ramped up production. Output increased from the Cadia gold mine in Australia, the Natalka mine in Russia, and the Brucejack, Rainy River and Moose River mines in Canada. However, production in China — the world's largest gold producer — continued to decline, falling by 4.0 per cent year-on-year in the second quarter of 2019. Environmental reforms introduced in 2017 have continued to impact the country's gold production. The shift of Indonesia's Grasberg gold mine's operations from open mine to underground has also reduced production volumes.

Gold recycling grew by 6.5 per cent year-on-year in the first half of 2019, reaching 602 tonnes. This was driven by a surge in gold prices, with China being the main driver of the growth, as low cost and convenient online gold recycling platforms boosted gold buy-back activities. Outside of China, recycled gold supply rose modestly in the Middle East, India and ASEAN

countries, as gold consumers adopted a wait-and-see approach in anticipating further gold price increases in the short term.

World gold supply is forecast to grow by 2.5 per cent in 2019 to 4,769 tonnes, as gold producers ramp-up production to maximise the benefits of high gold prices.

World gold production expected to rise over the outlook period

World gold supply is forecast to increase at an average annual growth rate of 1.8 per cent in 2020 and 2021, reaching 4,939 tonnes in 2021 (Figure 10.5). Supply growth is expected to be driven by stronger mine and scrap

Figure 10.5: World gold production

Source: World Gold Council (2019) Supply Trends; Department of Industry, Innovation and Science (2019)

output. Global mine production is forecast to increase by 2.0 per cent (to 3,608 tonnes) in 2020 and by 1.6 per cent (to 3,665 tonnes) in 2021. An expected short term upward movement in gold prices — in both US dollar and other major currencies — and solid project pipelines in Australia, Russia and Canada — are all likely to drive higher global gold mine output, with miners focusing on expansion, and extending mine life.

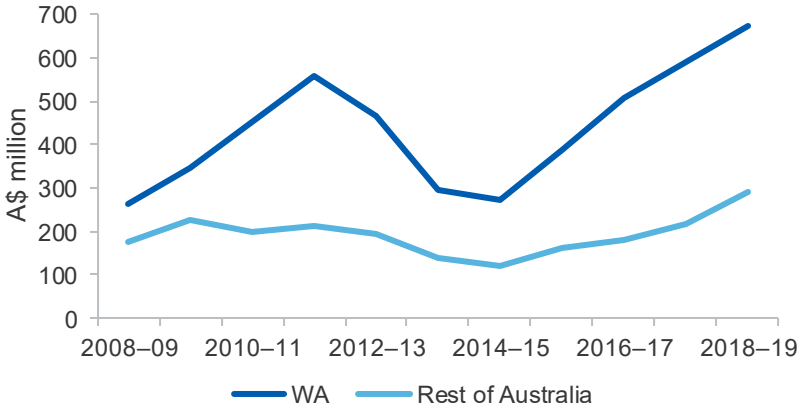
In the latter part of the outlook period, Grasberg — the world's largest gold mine, located in Indonesia — is expected to ramp-up its underground production. China's gold output is expected to be more stable, as Chinese gold producers adapt to stricter environmental regulations. In Australia, encouraged by all-time high Australian dollar gold prices, Gruyere joint-venture partners Gold Fields and Gold Road Resources have begun ramping up development at the Gruyere gold mine in Western Australia.

10.5 Australia

Gold exploration expenditure rose strongly in 2018–19

Australia's gold exploration expenditure rose by 19 per cent in 2018–19, to $964 million, driven by higher Australian gold prices. Western Australia remained the centre of gold exploration activity in Australia, accounting for 70 per cent (or $673 million) of total gold exploration expenditure (Figure 10.6).

Figure 10.6: Australia's gold exploration

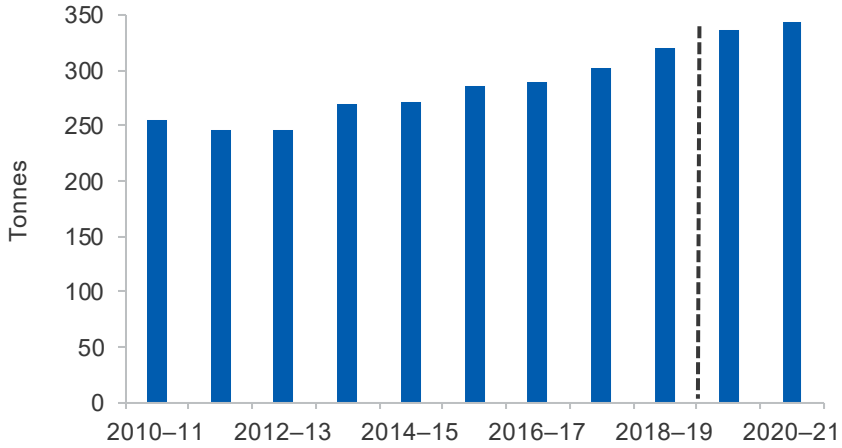


Source: ABS (2018) Mineral and Petroleum Exploration (cat. no. 8412.0)

Australian gold mine production increased in 2018–19

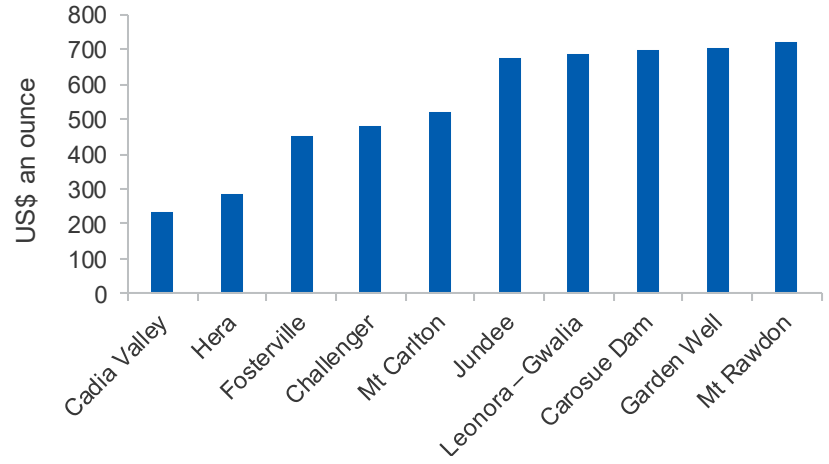
Australia's gold mine production increased by 6.3 per cent in 2018–19, to 321 tonnes (Figure 10.7), propelled by increased production in several large gold mines in New South Wales and the Northern Territory.

Figure 10.7: Australia's gold production



Source: Deparment of Industry, Innovation and Science (2019)

Figure 10.8: Australia's top ten lowest all-in sustaining costs gold mines in 2018



Source: AME (2019)

Newcrest's NSW Cadia Valley production rose by 52 per cent, to over 28 tonnes (the mine's largest ever annual gold production), driven by improved mill production time and throughput. The strong growth in output entrenched Cadia as Australia's largest gold producing mine in 2018–19. Newmont's Tanami production increased by 13 per cent, to over 16 tonnes, driven by an improvement in ore grades. However, production at Newmont's Boddington gold mine in Western Australia fell by 6.0 per cent, to 21 tonnes, due to lower ore grades. Newmont and Barrick's joint-venture Superpit gold mine in Western Australia saw its production decrease by 36 per cent, to 15 tonnes, with a rock fall incident in mid-May 2018 leading to increased processing of lower grade stockpiles — due to limited access to mining areas.

Figure 10.8 shows the top ten lowest all-in sustaining cost (AISC) gold mines in Australia in 2018. Newcrest's Cadia Valley was the lowest cost mine, with an average AISC of US$236 an ounce of gold, followed by Aurelia's Hera mine in NSW (AISC of US$286 an ounce) and Kirland Gold's Fosterville mine in Victoria (AISC of US$453 an ounce).

Australian gold mine output forecast to grow in the short term

Australia's gold mine production is forecast to grow by 4.8 per cent in 2019–20, to 337 tonnes, and then by a further 2.2 per cent to 344 tonnes in 2020–21. The growth is expected to be driven by a number of new mines. Gold Roads' Gruyere gold mine in Western Australia (with an annual production of 8.4 tonnes) poured its first gold in July 2019. Regis Resources' McPhillamys mine in NSW (annual production of 6.2 tonnes) is expected to commence production in early 2021. Capricorn Metals' Karlawinda gold mine project in Western Australia (annual production of 4.0 tonnes) is expected to be commissioned in March 2021.

The Australian gold industry is experiencing a production revival, fuelled by repetitive record Australian gold prices. Some Australian gold producers have decided to reopen gold mines previously on care and maintainance, or which were on suspended production at lower prices.

In Victoria, the Stawell mine operated for 35 years until it closed in 2016. However, with record high gold prices, Arete Capital Partners (the mine's

new owner) decided to restart the mine in January 2019. Production at the Victorian Morning Star gold mine also restarted in April 2019.

Australian gold exports fell slightly in 2018–19

Australia's gold exports decreased by 0.9 per cent in 2018–19, to under $19 billion (Figure 10.9), due to a 6.5 per cent fall in export volumes. Exports to Hong Kong — Australia's largest gold export market — fell by 48 per cent, as the Chinese government's decision to curb gold imports reduced gold imports from Hong Kong, and subsequently, demand for Australian gold.

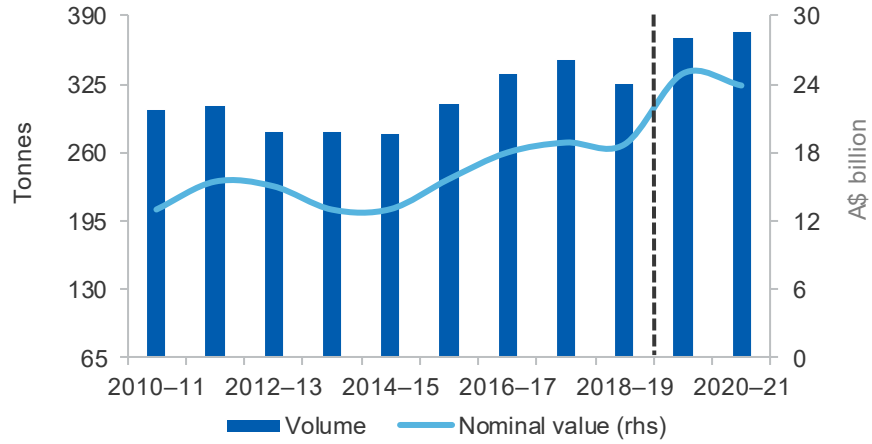
In the period between 2008–09 and 2018–19, demand for Australian gold was largely dominated by China, Hong Kong, the United Kingdom and India. China started to import Australian gold in 2010–11, and it reached a record high of $8.1 billion in 2013–14. The need to diversify central bank reserves was the key driver of the People's Bank of China's growing appetite towards gold. Australian gold exports to Hong Kong accelerated from 2015–16, as the Special Administrative Region's close links to China and the collaboration between the Shanghai Gold Exchange and the Chinese Gold and Silver Exchange increased physical gold trading activities. India was Australia's largest gold export market in 2009–10, at $7.1 billion. However, exports have fallen since 2009–10, due to increased imported duties and increased gold refining capacity in India (Figure 10.10).

Gold exports to hit record in 2019–20

Australia's gold export earnings are forecast to increase by 33 per cent in 2019–20 to $25 billion (Figure 10.9) — a record gold export value — driven by higher gold prices and export volumes. After a large jump in 2019–20, Australia's gold export values are forecast to fall by 4.2 per cent in 2020–21 to $24 billion, as the AUD/USD recovers.

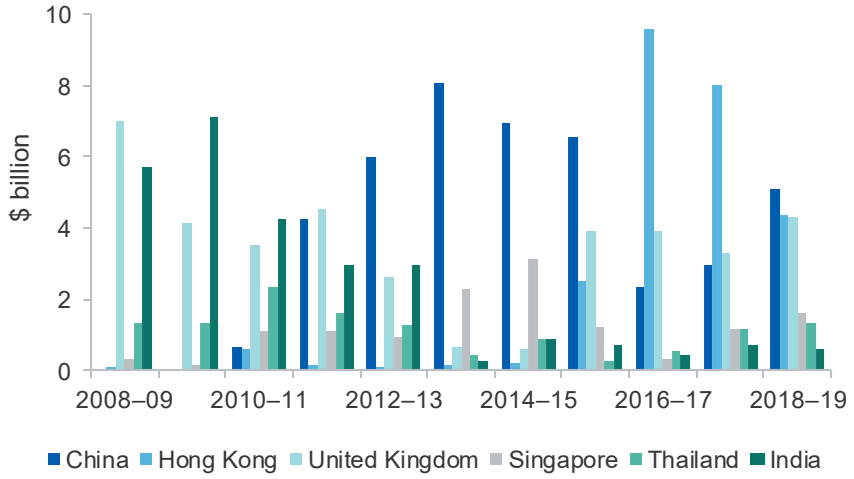
One key risk to this assessment is the decision to restrict gold imports into the country by the Chinese government, which is seeking to prevent

Figure 10.9: Australia's gold exports



Source: ABS (2019) International Trade, 5464; Department of Industry, Innovation and Science (2019)

Figure 10.10: Australia's major gold export markets



Source: ABS (2019) International Trade, 5464.0

capital outflows and support the Chinese currency. Since June 2019, the Chinese State Administration of Foreign Exchange has restricted licences to pay for gold imports by not issuing licences to sell the Renminbi for US dollars. As a result, gold has become backlogged in secure warehouses, reducing gold imports into China. It is unclear when this restriction will be lifted, but the potential impact is significant given China's large appetite for gold in recent years.

Revision to the outlook

The outlook for global gold prices has been revised up by 4.9 per cent (to US$1,391 an ounce) in 2019 and by 4.5 per cent (to US$1,470 an ounce) in 2020, from estimates in the June 2019 *Resources and Energy Quarterly*. The revision reflects a larger than expected increase in trade tensions — and an associated deterioration in global economic — and rising geopolitical tensions.

Global gold production forecasts have been revised up by 6.1 per cent in 2020 and 13 per cent in 2021 to reflect the impact of upward price movements on mine production.

The outlook for Australia's gold mine production in 2020–21 has been revised up by 3.6 per cent (or 12 tonnes), to reflect the production updates from mining companies.

The outlook for Australia's gold export earnings in 2019–20 and 2020–21 has been revised up by 13 per cent (or $2.8 billion) and 7.9 per cent (or $1.7 billion), respectively, from the June 2019 *Resources and Energy Quarterly*. The weaker Australian dollar and a faster than expected increase in gold prices account for the forecast gain.

Table 10.1: Gold outlook

						Annual percentage change		
World	**Unit**	**2018**	**2019[f]**	**2020[f]**	**2021[f]**	**2019**	**2020[f]**	**2021[f]**
Total demand	t	4,397	4,745	4,922	4,982	7.9	3.7	1.2
Fabrication consumption[b]	t	2,576	2,521	2,677	2,780	-2.1	6.2	3.9
Mine production	t	3,501	3,537	3,608	3,665	1.0	2.0	1.6
Price[c]								
Nominal	US$/oz	1,269	1,391	1,470	1,450	9.6	5.7	-1.4
Real[d]	US$/oz	1,297	1,391	1,437	1,387	7.3	3.3	-3.5
Australia	**Unit**	**2017–18**	**2018–19**	**2019–20[f]**	**2020–21[f]**	**2018–19**	**2019–20[f]**	**2020–21[f]**
Mine production	T	302	321	337	344	6.3	4.8	2.2
Export volume	T	348	326	368	375	-6.5	13.1	1.8
Nominal value	A$m	18,888	18,721	24,941	23,892	-0.9	33.2	-4.2
Real value[e]	A$m	19,611	19,122	24,941	23,332	-2.5	30.4	-6.5
Price								
Nominal	A$/oz	1,674	1,754	2,108	1,982	4.7	20.2	-6.0
Real[e]	A$/oz	1,738	1,791	2,108	1,936	3.0	17.7	-8.2

Notes: **b** includes jewellery consumption and industrial applications; **c** London Bullion Market Association PM price; **d** In 2019 calendar year US dollars; **e** In 2019–20 financial year Australian dollars; **f** Forecast.

Source: ABS (2019) International Trade, 5465.0; London Bullion Market Association (2019) gold price PM; World Gold Council (2019); Department of Industry, Innovation and Science (2019)

Aluminium

Resources and Energy Quarterly September 2019

Australia's global ranking

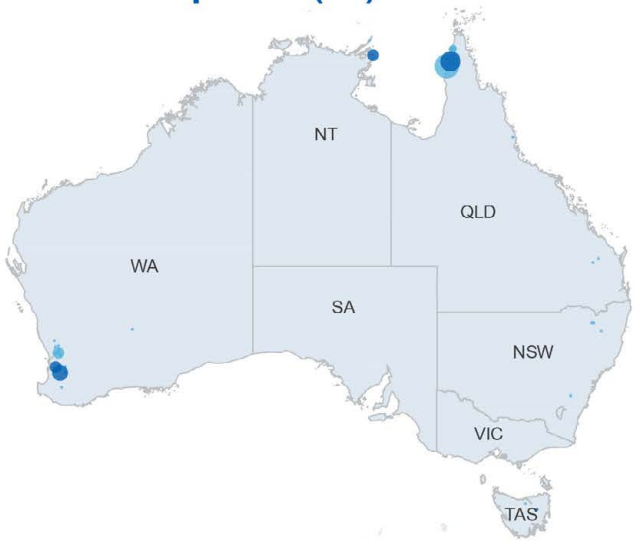
- 1st — Alumina exporter
- 1st — Bauxite producer
- 2nd — Alumina producer

3 stages of producing aluminium

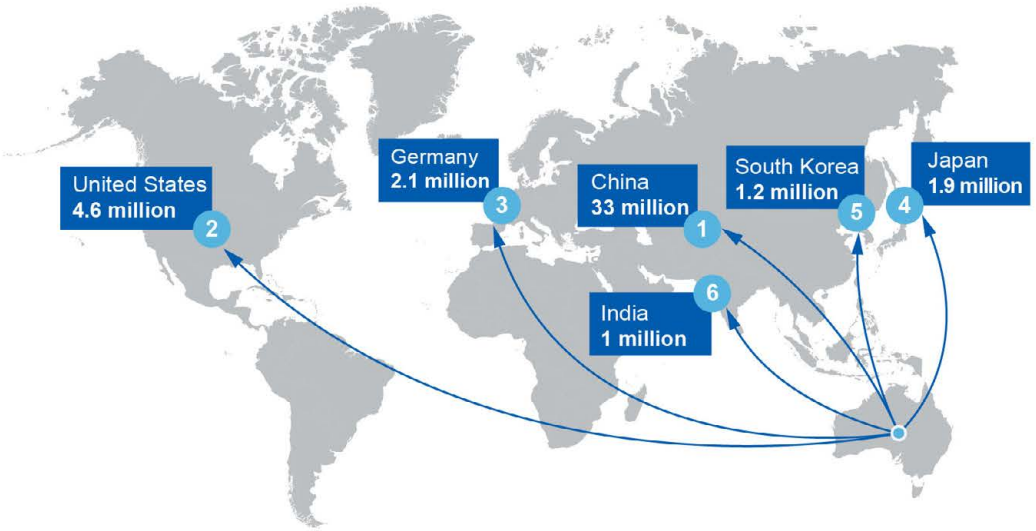
1. **Mining** bauxite ore
2. **Refining** to recover alumina
3. **Smelting** to make aluminium

Major Australian alumina deposits (Gt)

- <0.01
- 0.02–0.03
- 0.04–0.09
- 0.10–0.20
- 0.21–0.44
- >0.45
- Deposit
- Operating mine



Key consumer markets for aluminium (tonnes)



Global uses of aluminium

- **28%** Transport
- **23%** Construction
- **13%** Electrical
- **12%** Packaging
- **10%** Machinery
- **7%** Consumer durables
- **7%** Other

11.1 Summary

- Trade tensions between the US and China, and growing aluminium supply are expected to drive aluminium prices lower in 2020 and 2021, to average US$1,700 and US$1,615 a tonne, respectively. Alumina prices are also forecast to fall over the outlook period, to average US$330 a tonne in 2021.
- With no planned expansions to smelter or refinery capacity in Australia until after 2020–21, annual output is forecast to remain steady at 1.6 million tonnes for aluminium and 20 million tonnes for alumina over the outlook period.
- Due to lower forecast prices, the total value of Australian exports of aluminium, alumina and bauxite is expected to fall to $13 billion in 2020–21, after reaching a peak of $16 billion in 2018–19.

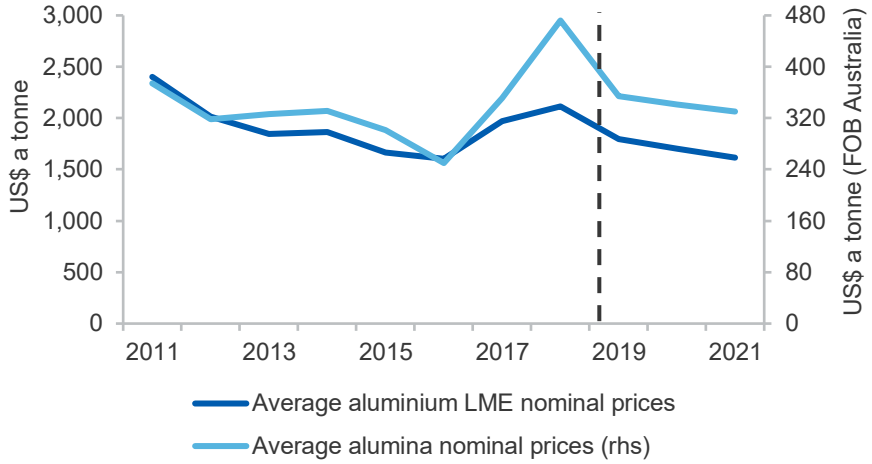
11.2 Prices

Aluminium and alumina prices fell sharply in the September quarter 2019

The London Metal Exchange (LME) spot price for aluminium fell by 15 per cent year-on-year in the September quarter 2019, averaging US$1,766 a tonne. Escalating trade tensions between the US and China continued to dampen aluminium demand from China — the world's largest aluminium consumer. The fiscal stimulus measures the Chinese government has implemented since October 2018 to offset the impacts of trade tensions with the US have not provided a boost to aluminium demand and global aluminium prices. The price fall was largely contained by the continued inventory drawdown (Figure 11.2) and decreased aluminium production. The LME spot price is expected to remain under pressure for the rest of 2019, and is forecast to fall by 15 per cent in 2019, from an average US$2,111 a tonne in 2018 to an average US$1,793 a tonne in 2019.

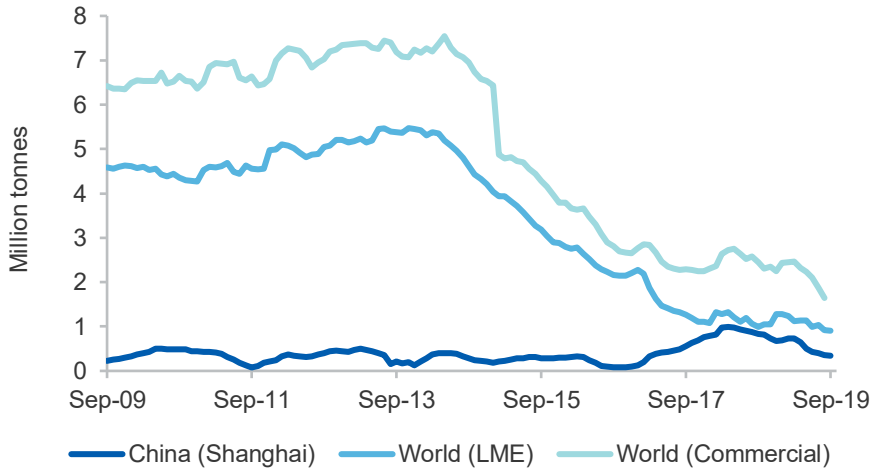
The free on board (FOB) Australian alumina price was also lower in the September quarter 2019, dropping by 44 per cent year-on-year to average US$302 a tonne. The price fall was attributed to the US-China trade tensions and higher supply, helped by the start of production at the 2 million tonnes per year Al Taweelah refinery in the United Arab Emirates

Figure 11.1: World aluminium and alumina prices



Source: LME (2019) spot prices; Metals Bulletin (2019) Alumina monthly price; Department of Industry, Innovation and Science (2019).

Figure 11.2: Aluminium stocks



Source: Bloomberg (2019); World Bureau of Metal Statistics (2019)

(UAE) in April 2019. The FOB Australian alumina price is forecast to decrease by 25 per cent in 2019 to average US$355 a tonne. Supply is expected to outpace demand, and the trade tensions between the US and China are expected to continue for the remainder of 2019, placing downward pressure on the alumina price.

Aluminium and alumina prices to fall in 2020 and 2021

The LME aluminium spot price is forecast to decrease by 5.2 per cent to average US$1,700 a tonne in 2020, and by a further 5.0 per cent in 2021 to average US$1,615 a tonne (Figure 11.1). Prices are expected to decline on the back of growing aluminium production — forecast to increase at an annual average rate of over 3.0 per cent over the outlook period — and weaker aluminium consumption — forecast to decrease at an annual average rate of 1.6 per cent a year between 2020 and 2021.

China's winter production curtailment policy — implemented over the last two winters to improve air quality — is expected to cease in December 2019. Production curtailments have slowed down local industrial production and economic growth. This removal is likely to add more aluminium output and create some headwinds to aluminium prices. Adding further pressure is the impact of US-China trade.

The FOB Australian alumina price is forecast to fall by 3.7 per cent to average US$342 a tonne in 2020, and then average US$330 a tonne in 2021 (Figure 11.1), driven by growing global supply. Norsk Hydro's 6.2 million tonnes per year Alunorte alumina refinery in Brazil — the world's largest — resumed full production in July 2019, following the Brazilian regulators and courts' decision to lift output restriction in May 2019.

11.3 Consumption

Falls in global aluminium and alumina consumption in the first half 2019

Global aluminium consumption fell by 4.6 per cent year-on-year over the first half of 2019, to nearly 31 million tonnes. Both escalating trade tensions between the US and China, and slowing global economic growth, softened the demand for aluminium. China — the world's largest aluminium consumer — consumed 17 million tonnes of aluminium in the first half of 2019, a fall of 5.3 per cent year-on-year. Over this period, sales in the Chinese automotive sector (one of the country's largest aluminium consumers) fell by 12 per cent year-on-year, to 12 million units.

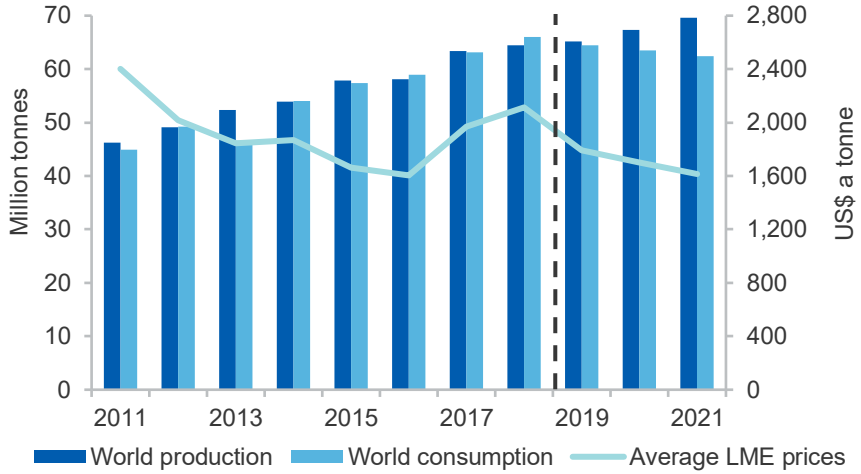
Trade tensions between the US and China seem unlikely to be resolved this year, and are expected to flow on to lower business and investment confidence and to a slowdown in global economic growth. Global industrial production — a leading indicator for aluminium demand — is forecast to increase at a slower pace, averaging annual growth of 1.1 per cent in 2019. As a result, global aluminium consumption is forecast to fall by 2.0 per cent in 2019, to 64 million tonnes (Figure 11.3).

World alumina usage declined by 1.8 per cent year-on-year in the first half of 2019 to 58 million tonnes, driven by lower global aluminium production (down by 0.7 per cent year-on-year). Aluminium output in China — the world's largest aluminium producer — fell by 0.4 per cent year-on-year in the first half of 2019, as concerns about the trade tensions with the US discouraged Chinese aluminium smelters from raising output. Operational issues in the Albras Aluminium smelter in Brazil and the Becancour Aluminium smelter in Canada also drove weaker demand for alumina.

The return to full production of the Albras and Becancour aluminium smelters, and new aluminium capacity additions from China, are expected to lift the demand for alumina in the second half of 2019. However, this expected growth in alumina consumption is likely to be constrained by the escalating trade tensions between the US and China. As a result, world alumina consumption is forecast to grow modestly in 2019, by just 0.3 per cent, to 120 million tonnes.

World bauxite usage rose by 4.1 per cent year-on-year in the first half of 2019 to 176 million tonnes, propelled by increased alumina production in Australia — the world's second largest alumina producer — and the UAE. World consumption of bauxite is forecast to rise by 0.3 per cent in 2019 to 120 million tonnes. The expected growth is supported by the return to full production of the 6.5 million tonnes per year Alunorte alumina refinery in Brazil in the second half of 2019, and the production ramp-up at the 4 million tonnes per year Al Taweelah alumina refinery in the UAE.

Figure 11.3: World aluminium production, consumption and prices



Source: International Aluminium Institute (2019); AME (2019); World Bureau of Metal Statistics (2019); Department of Industry, Innovation and Science (2019)

New aluminium capacity fuels increased demand for alumina and bauxite

World primary aluminium demand is forecast to fall at an average annual rate of 1.6 per cent in 2020 and 2021, to 62 million tonnes by 2021 (Figure 11.3). The decline is expected to be driven by slowing demand from the global automotive industry. Despite the Chinese government's infrastructure projects designed to offset the impacts of trade tensions with the US, and ambitious initiatives for promoting electric vehicle production to improve air quality, economic uncertainties are expected to discourage consumers from purchasing vehicles in China. In the US, higher vehicle prices (driven by higher import tariffs) and weaker consumer confidence are expected to negatively impact consumer demand for vehicles.

World alumina consumption is forecast to increase at an average annual rate of 0.8 per cent in 2020 and 2021, to reach 122 million tonnes by 2021 (Figure 11.4). Alumina demand is driven by primary aluminium production, which is forecast to increase at an average annual rate of 3.4 per cent between 2020 and 2021. Despite slowing economic growth, China is expected to remain the world's largest (and growing) source of alumina demand, accounting for 57 per cent (or 70 million tonnes) of world alumina consumption in 2021. The US is expected to see a gradual increase in demand over the outlook period. Russia, India and the UAE are also expected to remain large sources of demand for alumina.

World bauxite consumption is forecast to rise at an average annual rate of 0.8 per cent in 2020 and 2021, to over 120 million tonnes by 2021, driven by new alumina capacity from China and Indonesia (see section 11.4).

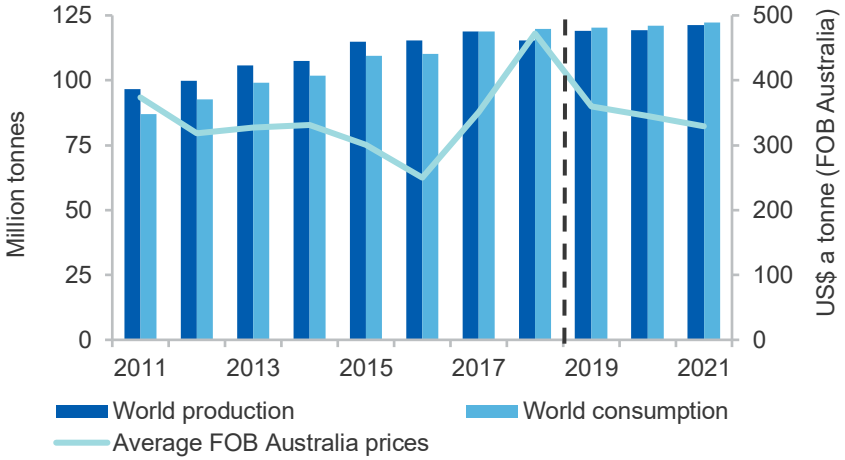
11.4 Production

World production of aluminium, alumina and bauxite to rise in 2019

World aluminium production decreased by 0.7 per cent year-on-year in the first half of 2019 to nearly 32 million tonnes, due to lower output in China, Brazil and Canada. Production in China — the world's largest aluminium producer — decreased by 0.4 per cent year-on-year in the first half of 2019, to nearly 18 million tonnes. Trade tensions with the US and the Chinese government's stricter environmental regulations have put a brake on production growth in China. In Brazil, Albras Aluminium has curtailed 50 per cent of its annual capacity of 460,000 tonnes since mid-April 2018. Its raw material supplier, Alunorte, has been operating at half-capacity since March 2018, due to restrictions imposed by Brazilian environmental authorities amid concerns of water contamination. In Canada, Alcoa's 438,000 tonnes a year Becancour aluminium smelter operated at only 15 per cent of its capacity, due to an 18-month lock-out of unionised workers.

Global aluminium supply is forecast to increase by 1.2 per cent in 2019, to reach 65 million tonnes (Figure 11.3). The rise will be driven by increases in Chinese aluminium capacity, originating from the ramp-up of new aluminium smelters. These include the 500,000 tonnes per year East Hope Guyang aluminium smelter, and the 300,000 tonnes per year Guangxi Baikuang Bose-Wenshan aluminium smelter. Outside of China, Alcoa's Becancour aluminium smelter in Canada restarted smelting capacity on 26 July 2019, following a successful negotiation between the company and the unions on a pay dispute.

Figure 11.4: World alumina production, consumption and prices



Source: International Aluminium Institute (2019); AME (2019); World Bureau of Metal Statistics (2019); Department of Industry, Innovation and Science (2019)

However, the 130,000 tonnes per year Mostar aluminium smelter in Bosnia closed operations in August 2019, after failing to secure a bail-out deal from the government and potential investors. The Bosnian government is hoping to reopen the smelter, but is facing substantial challenges with long-running power supply issues.

World alumina supply rose by 8.0 per cent year-on-year in the first half of 2019, to 60 million tonnes (Figure 11.4), driven by the addition of new refineries and output expansions at existing alumina refineries. In Australia, Alcoa's Western Australia alumina refining operations (Kwinana, Pinjarra and Wagerup) recorded a production increase of 3.3 per year-on-year in the first half of 2019, to 4.6 million tonnes. The 2 million tonnes per year Al Taweelah alumina refinery in the UAE started production in April 2019.

World alumina supply is forecast to rise by 3.2 per cent in 2019 to 119 million tonnes, driven by the ramp-up of new and existing alumina refineries. The Alunorte alumina refinery in Brazil resumed full production in July 2019, bringing 3 million tonnes per year of alumina production capacity back online. The Al Taweelah alumina refinery in the UAE is expected to reach at least 70 per cent of its capacity by the end of 2019, as the bauxite supply from Guinea is due to commence in the December quarter.

World bauxite production increased by 4.2 per cent year-on-year in the first half of 2019 to 176 million tonnes, propelled by a 7.3 per cent rise in bauxite production in Australia — the world's largest bauxite producer. The addition of new capacity at Rio Tinto's Amrun bauxite project and Metro Mining's Bauxite Hills project in Queensland, and higher output at Worsley's Boddington mine in Western Australia contributed to higher output in Australia.

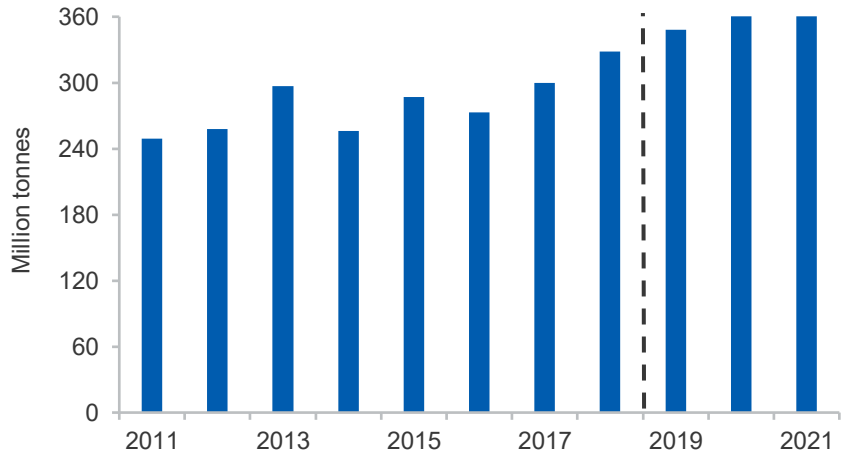
World bauxite production is forecast to increase by 5.9 per cent in 2019 to nearly 348 million tonnes, driven by the production ramp-up at the Amrun bauxite project in Western Australia. Emirates Global Aluminium's 12 million tonnes a year Guinea Alumina Corporation bauxite project commenced production in the early first half of 2019, and is expected to ramp up production in the December quarter of 2019.

World production of aluminium, alumina and bauxite to continue to rise

World aluminium production is forecast to rise by 3.3 per cent in 2020 and by a further 3.5 per cent in 2021, to reach 70 million tonnes in 2021 (Figure 11.3). The gains will be driven by new additional capacity from China, Iran and Indonesia. In China, Baoshan Iron and Steel is expected to test production at its 300,000 tonnes per year aluminium project by mid-2020. Inner Mongolia Mengtai Group commenced construction of its 200,000 tonnes a year aluminium alloy project in June 2019. Phase one capacity of 100,000 tonnes is expected to come online in 2020. Iran is implementing its plan to increase its annual aluminium production to 1.5 million tonnes by 2025, with the 300,000 tonnes per year SALCO aluminium smelter due to commence production in 2020. In July 2019, PT Indonesia Asahan Aluminium (Inalum) announced plans to increase production at the Asahan aluminium smelter in Indonesia from 250,000 to 2.0 million tonnes per year by 2035.

World alumina production is forecast to increase by 0.2 per cent in 2020 to above 119 million tonnes, and by a further 1.6 per cent in 2021, to reach 121 million tonnes (Figure 11.4). The growth is expected to be driven by China, India and Indonesia. In India, with improved bauxite sourcing, Vedanta is planning to increase production capacity at its Lanjigarh refinery to 2.7 million tonnes in the short term, and to 6.0 million tonnes in the medium term. In China, the Qiya Aluminium Group's 2.4 million tonnes per year Qiya Linfen alumina refinery is expected to commence production in 2020. In Indonesia, the 1.2 million tonnes per year joint-venture Mempawah alumina refinery project (Chalco from China and two local Indonesian companies) is expected to come online in 2020.

Figure 11.5: World bauxite production



Source: Department of Industry, Innovation and Science (2019)

World bauxite production is forecast to increase by 7.7 and 1.8 per cent in 2020 and 2021, to 375 and 381 million tonnes, respectively (Figure 11.5).

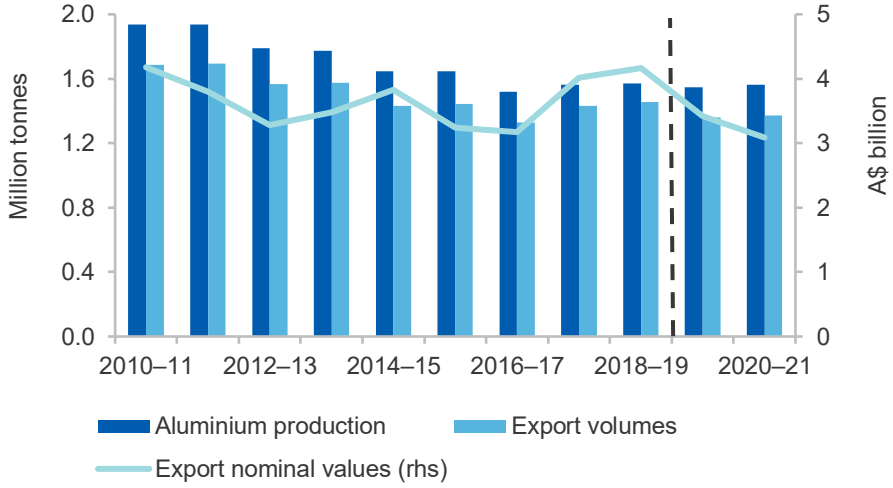
The gains are expected to be driven by newly added capacity in Australia — the world's largest bauxite producer — and Guinea. With a growing investment pipeline, Guinea is likely to overtake China as the world's second largest bauxite producer by the end of the outlook period.

11.5 Australia's exports and production

Strong aluminium, alumina and bauxite exports earnings in 2018–19

Australia's aluminium, alumina and bauxite exports rose by 15 per cent in 2018–19, to a record high of almost $16 billion. The increase was driven by higher volumes of aluminium and bauxite exports and a twelve-year high in alumina prices, which averaged US$540 a tonne in the September quarter of 2018. The spike in the alumina prices was due to supply concerns, primarily in China, the curtailment of production at the Alunorte refinery in Brazil and workers striking at Alcoa's Australian operations. Higher aluminium export volumes (up 1.7 per cent) were mainly driven by increased exports to the US (up 326 per cent to 281,000 tonnes), due to the tariff-exempt status that the US Administration granted to Australia. Environmental priorities in China had flow-on effects to Australian bauxite exports to China. In 2018–19, Australia's bauxite export volumes to China increased by 12 per cent, to nearly 33 million tonnes.

Figure 11.6: Australia's aluminium exports and production



Source: ABS (2019) International Trade in Goods and Services, 5368.0; Department of Industry, Innovation and Science (2019)

Lower alumina prices lead to weaker export outlook to 2020–21

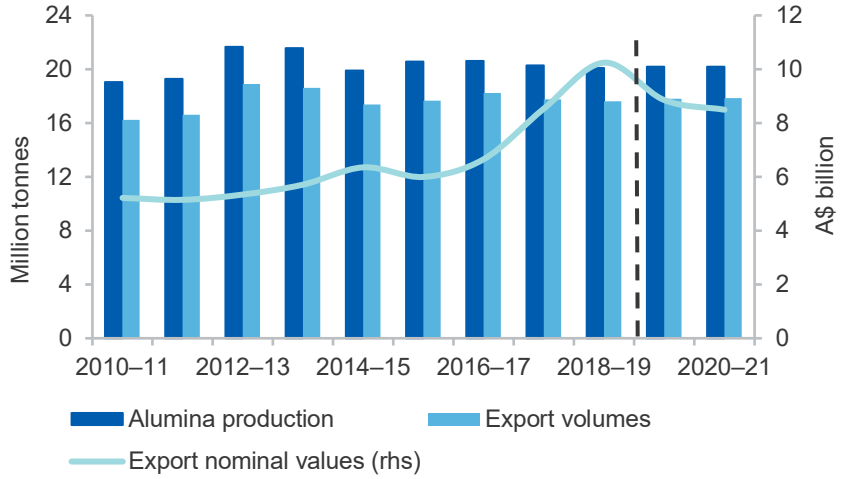
After reaching a record high of $16 billion in 2018–19, Australia's aluminium, alumina and bauxite export earnings are forecast to fall by 13 per cent in 2019–20, and by a further 4.8 per cent in 2020–21 to $13 billion in 2020–21. The decline is due to the impact of an expected softening of prices for aluminium and alumina over the outlook period, which will only be partially offset by the impact of increased export volumes of bauxite.

Growing global supply is expected to soften alumina prices over the outlook period. Alunorte alumina refinery in Brazil — the world's largest — has returned to full production capacity in the second half of 2019, and is expected to add over 3 million tonnes per year to the global alumina output.

Bauxite export volumes are forecast to rise at an annual average rate of 4.1 per cent a year, reaching 36 million tonnes by 2020–21. The majority (over 97 per cent) is expected to be shipped to China, where alumina refiners continue to rely on imported materials from Australia and Guinea to replace their depleted and poor quality bauxite. Despite an expected rise in export volumes, Australia's bauxite exports are expected to contribute around 10 per cent (or $1.4 billion) to Australia's total aluminium, alumina and bauxite exports.

The risk to Australian bauxite exports is the influx of bauxite exports to China from Guinea. In June 2019, Guinea accounted for 52 per cent of China's total bauxite imports whereas Australia only accounted for 32 per cent of China's total bauxite imports. It is likely that the Malaysian Government will relax its ban on bauxite mining in Pahang — an area that accounts for 70 per cent of Malaysia's bauxite production — in 2020. The decision is expected to add pressure to Australian bauxite exporters, as another major bauxite supplier enters the Chinese bauxite market.

Figure 11.7: Australia's alumina exports and production



Source: ABS (2019) International Trade in Goods and Services, 5368.0; Department of Industry, Innovation and Science (2019)

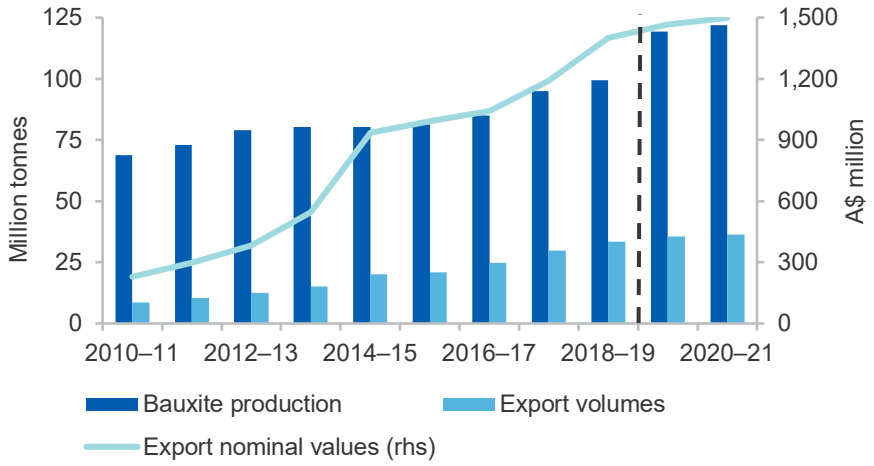
Australia's aluminium exports are not expected to return to the strength of 2017–18 and 2018–19, where export earnings reached over $4.0 billion a year. Exports to Japan are expected to fall as the construction for the 2020 Tokyo Olympics comes to an end. Aluminium exports to South Korea are also expected to drop as slowing economic growth dampens the production and sale of vehicles. Similarly, aluminium shipments to the US are expected to fall over the outlook period. In June 2019, the US Administration agreed to Tesla's request to waive 10 per cent tariffs for one year on imported aluminium from Japan, used in the manufacture of battery cells at Tesla's Nevada Gigafactory.

Steady aluminium production, slight fall in alumina production, but moderate growth in bauxite production in 2018–19

Australia's aluminium production grew by 0.5 per cent in 2018–19 to around 1.6 million tonnes, driven by a 1.7 per cent rise in Portland Aluminium's production, with production from other aluminium smelters remaining broadly unchanged. Over this period, Australia's bauxite production increased by 4.7 per cent to over 99 million tonnes, propelled by the addition of new capacity at Rio Tinto's Amrun bauxite project and

Metro Mining's Bauxite Hills project in Queensland, and higher output (up 5.7 per cent, to 18 million tonnes) at Worsley's Boddington mine in Western Australia. However, Australia's alumina production fell by 0.9 per cent in 2018–19, to around 20 million tonnes, impacted by several cyclones in Queensland.

Figure 11.8: Australia's bauxite exports and production



Source: ABS (2019) International Trade in Goods and Services, 5368.0; Department of Industry, Innovation and Science (2019)

Amrun's return to full capacity to drive strong growth in bauxite output

With no planned expansions to smelter or refinery capacity in the short-term, annual output is forecast to remain at 1.6 million tonnes of aluminium and 20 million tonnes of alumina through to 2020–21.

Australia's bauxite production is forecast to grow by 18 and 2.1 per cent in 2019–20 and 2020–21, to 119 and 121 million tonnes, respectively. The Amrun bauxite project is expected to reach full production capacity of 23 million tonnes per year in late 2019.

Revision to the outlook

The outlook for aluminium prices in 2020 and 2021 has been revised down by 8.8 and 20 per cent, respectively, from the June 2019 *Resources and Energy Quarterly*. An unexpected escalation of trade tensions between the US and China is the main driver of this revision.

The outlook for global aluminium consumption in 2020 and 2021 has been revised down by 8.2 and 13 per cent, to 64 and 62 million tonnes, respectively, from the June 2019 *Resources and Energy Quarterly*. A faster than expected deterioration in trade relations and industrial production has contributed to this revision.

Table 11.1: Aluminium, alumina and bauxite outlook

						Annual percentage change		
World	**Unit**	**2018**	**2019[f]**	**2020[f]**	**2021[f]**	2019[f]	**2020[f]**	**2021[f]**
Primary aluminium								
Production	kt	64,408	65,173	67,327	69,653	1.2	3.3	3.5
Consumption	kt	66,028	64,475	63,533	62,417	-2.4	-1.5	-1.8
Prices aluminium[c]								
- nominal	US$/t	2,111	1,793	1,700	1,615	-15.1	-5.2	-5.0
- real[d]	US$/t	2,158	1,793	1,662	1,545	-16.9	-7.3	-7.0
Prices alumina spot								
- nominal	US$/t	472	356	342	330	-24.5	-4.0	-3.5
- real[d]	US$/t	482	356	334	316	-26.1	-6.2	-5.5
Australia	**Unit**	**2017–18**	**2018–19**	**2019–20[f]**	**2020–21[f]**	**2018–19[f]**	**2019–20[f]**	**2020–21[f]**
Production								
Primary aluminium	kt	1,564	1,573	1,548	1,561	0.5	-1.6	0.9
Alumina	kt	20,280	20,103	20,198	20,193	-0.9	0.5	0.0
Bauxite	Mt	95.0	99.4	119.3	121.7	4.7	20.0	2.0
Consumption								
Primary aluminium	kt	172	156	185	234	-9.6	18.6	26.7
Exports								
Primary aluminium	kt	1,431	1,451	1,362	1,373	1.5	-6.2	0.9
- nominal value	A$m	4,013	4,171	3,416	3,087	3.9	-18.1	-9.6
- real value[e]	A$m	4,167	4,260	3,416	3,015	2.2	-19.8	-11.7
Alumina	kt	17,746	17,619	17,803	17,839	-0.7	1.0	0.2
- nominal value	A$m	8,537	10,245	8,852	8,494	20.0	-13.6	-4.0
- real value[e]	A$m	8,864	10,464	8,852	8,295	18.1	-15.4	-6.3
Bauxite	kt	29,880	33,546	35,533	36,307	12.3	5.9	2.2
- nominal value	A$m	1,190	1,401	1,467	1,498	17.7	4.7	2.1
- real value[e]	A$m	1,236	1,431	1,467	1,463	15.8	2.5	-0.3
Total value								
- nominal value	A$m	13,740	15,816	13,735	13,080	15.1	-13.2	-4.8
- real value[e]	A$m	14,266	16,155	13,735	12,774	13.2	-15.0	-7.0

Notes: **c** LME cash prices for primary aluminium; **d** In 2019 calendar year US dollars; **e** In 2019–20 financial year Australian dollars; **f** Forecast.

Source: ABS (2019) International Trade in Goods and Services, 5368.0; AME Group (2018); LME (2019); Department of Industry, Innovation and Science (2019); International Aluminium Institute (2019); World Bureau of Metal Statistics (2019)

Copper

Resources and Energy Quarterly September 2019

Australia is the world's **2nd largest exporter** of copper ores and concentrates

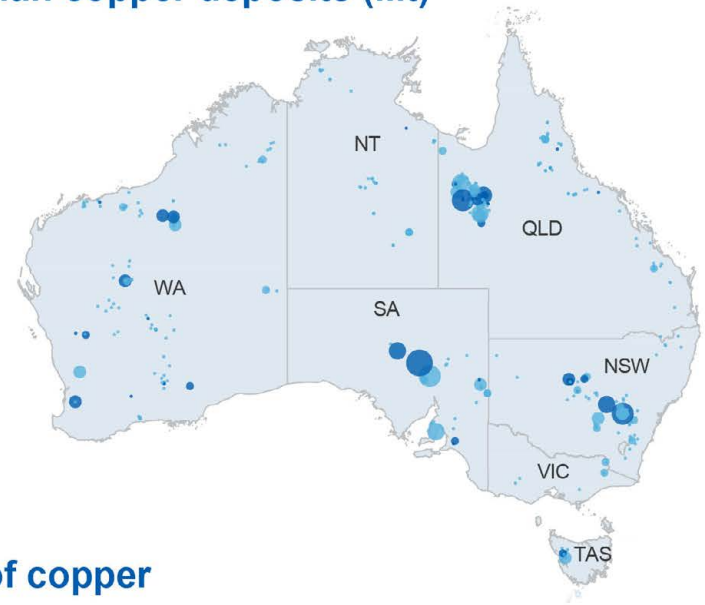
Australia is the **7th largest** producer of copper in the world

Copper is **100% recyclable** and nearly **80%** of the copper that has ever been produced is still in use today

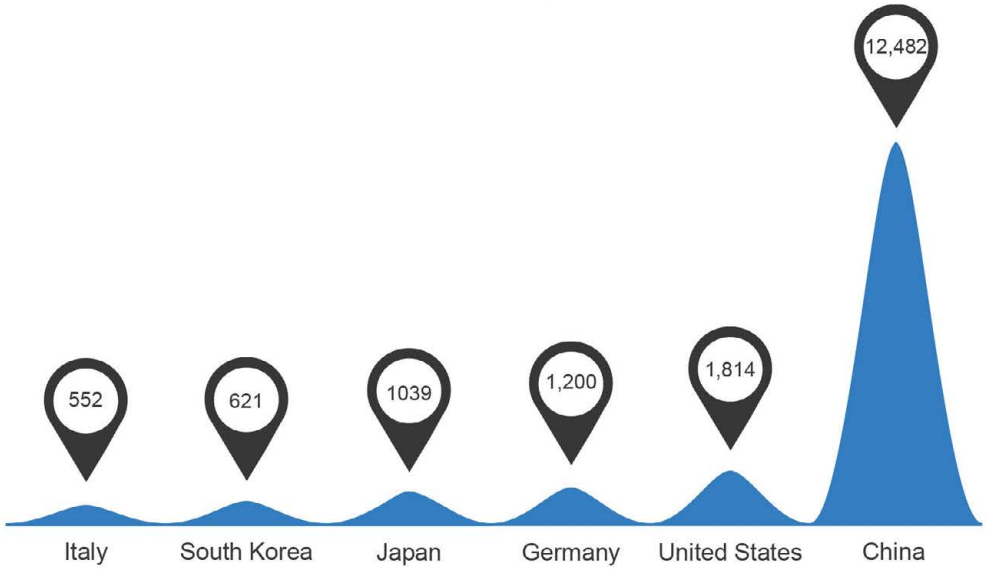
The average home contains **180 kg** of copper

Major Australian copper deposits (Mt)

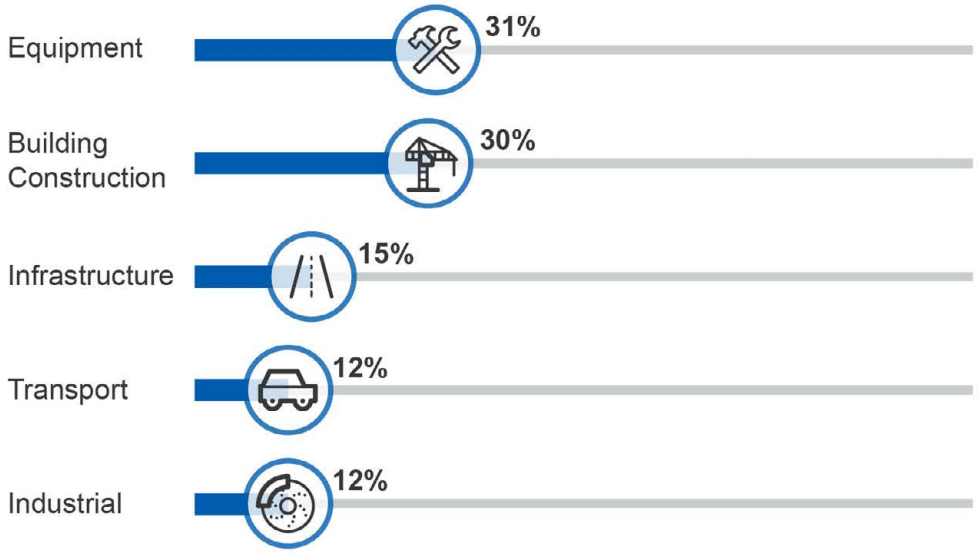
- <0.01
- 0.02
- 0.03–0.8
- 0.9–2.1
- 2.2–6.8
- >6.9
- Deposit
- Operating mine



Key copper consumer markets (thousand tonnes)



Global uses of copper



12.1 Summary

- Trade tensions and reduced economic activity have led to recent volatility in copper prices. Looking forward, growing consumption is expected to support prices reaching a forecast US$6,620 a tonne in 2021, up from US$6,525 a tonne in 2018.
- Australia's copper exports are expected to grow, due to higher production from Australia's existing mines and new projects. Export volumes are forecast to increase from 934,000 tonnes in 2018–19 to 985,000 tonnes in 2020–21 (metal content terms).
- Australia's copper export earnings are forecast to reach just over $10 billion in 2020–21, up from $9.8 billion in 2018–19, supported by growing production and higher prices.

12.2 Prices

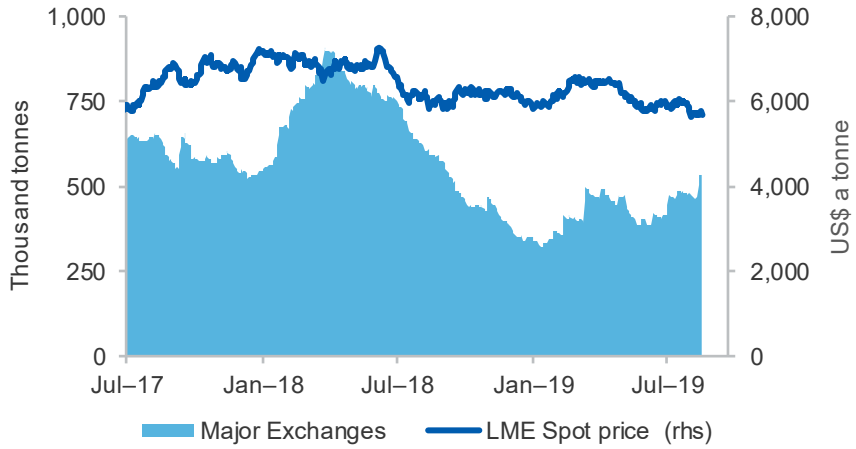
Lower industrial activity weights on copper prices

After falling in the first half of the year, copper prices continued to show weakness in the September quarter. Reduced industrial activity in China and concerns around world economic growth weighed on prices, which reached a low of US$5,585 a tonne at the start of September. Concerns about expanding US tariffs put further pressure on prices. The copper price averaged US$5,858 a tonne in the September quarter, 4.0 per cent lower year on year (Figure 12.1).

Resilient consumption growth expected to support price increases

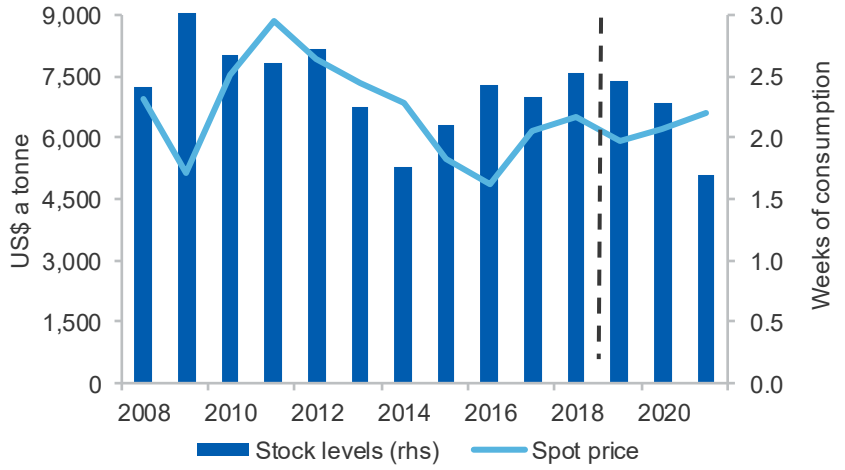
Prices are expected to stabilise and turn around over the outlook period, as production constraints contribute to an ongoing deficit in world copper markets. Higher consumption, supported by stimulus spending, is expected to promote modest price growth over the outlook period, although at a slower pace than previously expected. Prices are forecast to grow at an average annual rate of 5.6 per cent over the outlook period, to average US$6,620 a tonne in 2021 (Figure 12.2). The market outlook faces competing risks; strong consumption growth could support price increases, but the expectations and economic impacts of trade tensions pose a negative risk to copper prices.

Figure 12.1: Recent copper spot price and stock movements



Source: LME (2019) official cash price; Bloomberg (2019) stock inventory at LME, COMEX and SHFE.

Figure 12.2: Outlook for copper prices and stocks



Source: LME (2019) official cash price; Department of Industry, Innovation and Science (2019)

12.3 World consumption

Consumption expected to grow despite economic constraints

Reduced industrial activity in China and the negative impact of US-China trade tensions has weighed on world copper consumption in recent quarters. Consumption in the first half of 2019 was 11 million tonnes, 1.5 per cent lower than the same period in 2018 (Figure 12.3).

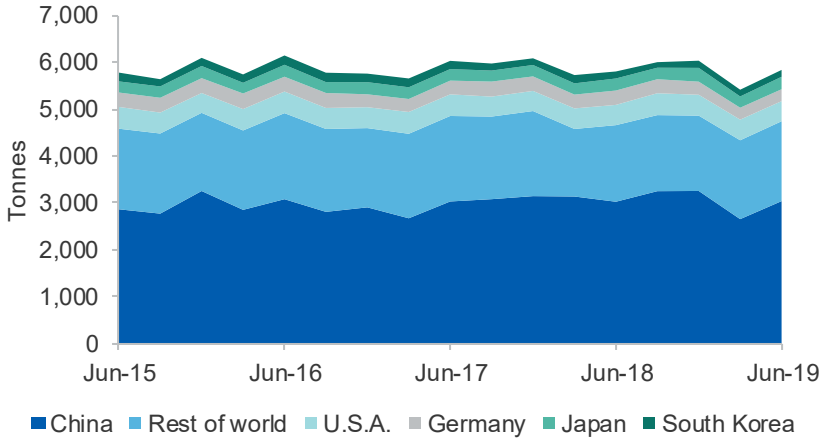
Copper consumption is expected to rebound and see relatively strong growth over the outlook period, although at a slower pace than previously forecast. World copper consumption is forecast to increase at an average annual rate of 2.3 per cent over the outlook period, to reach 25 million tonnes in 2021.

This forecast is heavily dependent on the level of industrial activity in China, which accounts for around half of world refined copper consumption. Although China's imports of refined copper have stagnated in the first half of 2019, healthy growth in domestic consumption has remained. Government spending is expected to help maintain consumption growth, through infrastructure spending and investment in electricity generation. Expanding electric vehicle manufacturing and surging growth in renewable energy production is also expected to support further growth. Over the outlook period, China's copper consumption is forecast to grow an average 1.6 per cent a year, to reach 13 million tonnes in 2021.

Consumption growth will also be supported by expanding markets outside of China. Countries such as India and Vietnam, which currently account for just 2.0 and 1.3 per cent of world consumption respectively, are expected to see annual consumption growth of 5 to 7 per cent over the outlook period.

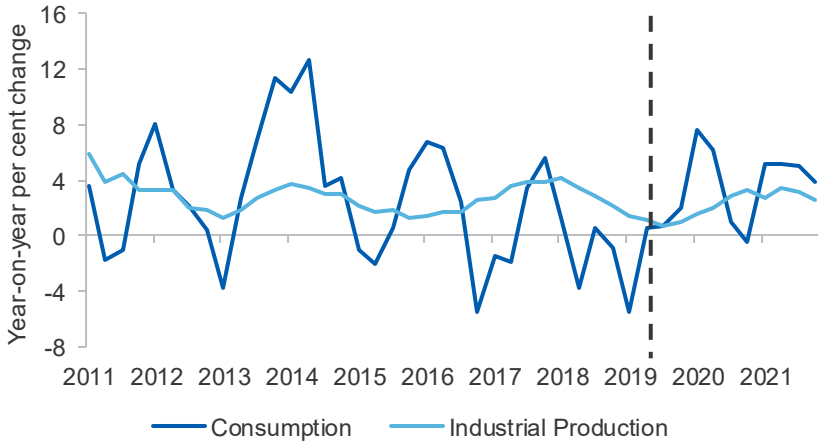
Copper is fundamentally tied to industrial production and economic growth, so poor growth in world trade and industrial production over the coming year is likely to impact on copper usage (Figure 12.4).

Figure 12.3: World copper consumption by major market



Source: World Bureau of Metal Statistics (2019); Department of Industry, Innovation and Science (2019)

Figure 12.4: World copper consumption and industrial production



Source: World Bureau of Metal Statistics (2019); Bloomberg (2019) Netherland CPB; Department of Industry, Innovation and Science (2019)

12.4 World production

Copper production stagnant in first half of 2019

Multiple shutdowns and changes in ore grades have constrained recent copper mine production. In the first half of 2019, mine production just exceeded 10 million tonnes, slightly lower than the same period in 2018.

Lower production — a result of lower ore grades at BHP's Escondida operations in Chile and mine transitioning in Indonesia — outweighed production increases elsewhere. More recently, protests against government granting of a new production licence in Peru have blocked exports since mid-July.

New capacity and higher prices to support production growth

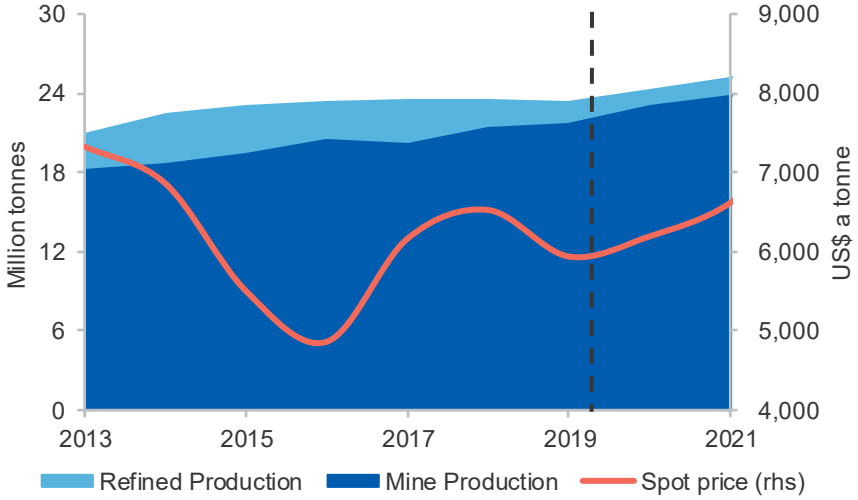
Despite these constraints, copper production is expected to grow by 3.7 per cent over the outlook period, to reach just under 24 million tonnes in 2021, up from 21 million tonnes in 2018 (Figure 12.5). Around 1 million tonnes of new production capacity is expected to come online by the end of 2021. The largest of these is the Cobre Panama mine in Peru, which has an annual capacity of 340,000 tonnes. The mine started operations in February, and is expected to reach full capacity by the end of the year, with a potential expansion beyond the outlook period.

Changes in national taxation regimes in Zambia and the Democratic Republic of the Congo may impact on future mine production, as higher tax rates and reduced regulatory certainty may reduce the viability of future production.

Capacity expansions in China boost refined production

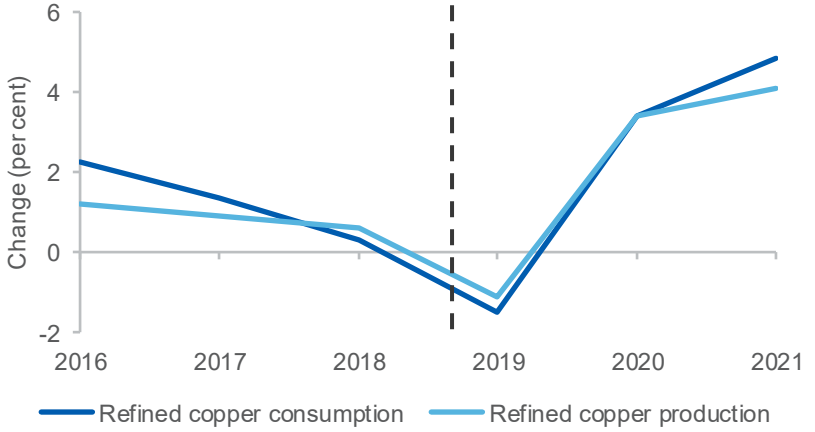
Refined copper production is expected to increase in 2019, as output returns to normal after the numerous outages and shutdowns of 2018 (Figure 12.6). Output of refined copper is forecast to increase by an average rate of 2.3 per cent a year to reach 25 million tonnes in 2021, primarily supported by new refinery capacity in China. However, shortages in concentrate supply and tightening environmental restrictions may limit future production growth in refined production.

Figure 12.5: World copper production and prices



Source: World Bureau of Metal Statistics (2019); Department of Industry, Innovation and Science (2019)

Figure 12.6: World balance of refined copper



Source: World Bureau of Metal Statistics (2019); Department of Industry, Innovation and Science (2019)

Australia

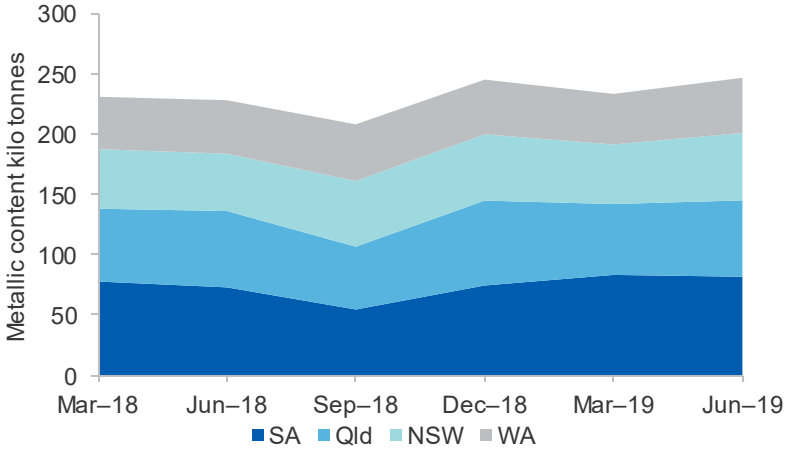
Mine production expected to increase steadily over outlook period

Australia's copper production is forecast to rise from 934,000 tonnes in 2018–19 to just over 100 000 tonnes in 2020–21, growing at an average annual rate of 5.6 per cent. Production at BHP's Olympic Dam operations in South Australia continues to recover following the 2018 outages, with June quarter production 17 per cent higher than the June quarter 2018 (Figure 12.7). Australia's output will also be boosted by the start-up of OzMineral's Carrapateena mine in South Australia. Carrapateena has an annual copper production capacity of 65,000 tonnes, and is expected to begin operations in the December quarter of 2019.

Higher production supports growing copper exports

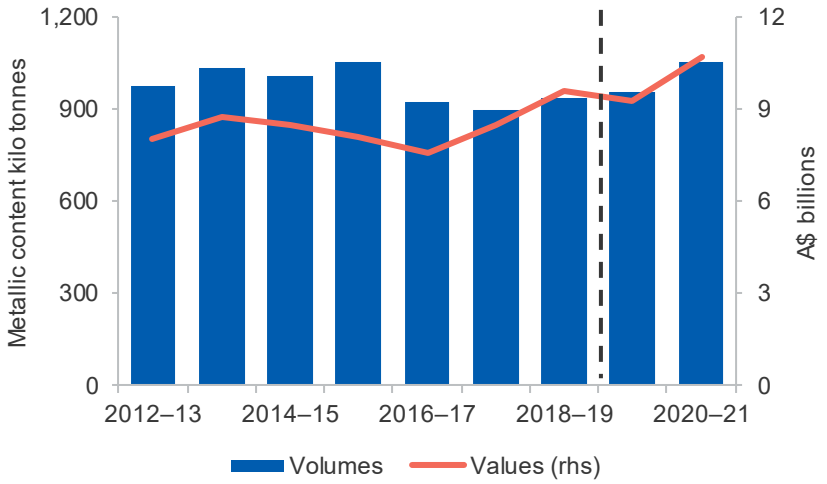
In line with higher output volumes, Australia's copper export earnings are forecast to rise from $9.8 billion in 2018–19 to over $10 billion by 2020–21, growing at an average rate of 6.4 per cent a year (Figure 12.8). Modest prices increases are expected to also support this earnings growth.

Figure 12.7: Australia's copper production by selected state



Source: Department of Industry, Innovation and Science (2019)

Figure 12.8: Australia's copper export volumes and values



Source: ABS (2019) International Trade in Goods and Services, 5368.0; Department of Industry, Innovation and Science (2019)

WA activity drives boom in exploration activity

Copper exploration rose to $329 million in 2018–19, a 71 per cent increase on the previous year. Expenditure has trended higher over the last four quarters, however there was a considerable increase in the June quarter, with expenditure reaching $109 million. These increases have been driven by activity in Western Australia, which accounts for around a third of Australia's total exploration expenditure. In the first half of 2019 expenditure undertaken in Western Australia was $96 million, more than three times the same period in 2018.

Revisions to the outlook

Australia's forecast copper export earnings for 2020–21 have been revised down by $2.2 billion since the June 2019 *Resources and Energy Quarterly,* due to lower forecast prices.

Table 12.1: Copper outlook

						Annual percentage change		
World	**Unit**	**2018**	**2019[f]**	**2020[f]**	**2021[f]**	2019[f]	**2020[f]**	**2021[f]**
Production								
– mine	kt	21,365	21,712	22,985	23,818	1.6	5.9	3.6
– refined	kt	23,540	23,400	24,193	25,183	-0.6	3.4	4.1
Consumption	kt	23,645	23,446	24,560	25,425	-0.8	4.7	3.5
Closing stocks	kt	1 158	1 394	954	923	20.3	-31.6	-3.2
– weeks of consumption		2.5	3.1	2.0	1.9	21.3	-34.7	-6.5
Prices LME								
– nominal	US$/t	6,525	5,938	6,193	6,615	-9.0	4.3	6.8
	USc/lb	296	269	281	300	-9.0	4.3	6.8
– rea[b]	US$/t	6,668	5,938	6,053	6,328	-10.9	1.9	4.5
	USc/lb	302	269	275	287	-10.9	1.9	4.5
Australia	**Unit**	**2017–18**	**2018–19**	**2019–20[f]**	**2020–21[f]**	**2018–19**	**2019–20[f]**	**2020–21[f]**
Mine output	kt	867	934	946	1,019	7.7	1.3	7.7
Refined output	kt	369	435	391	391	17.7	-10.1	0.0
Exports								
– ores and cons[c]	kt	1,987	1,916	1,992	2,246	-3.6	4.0	12.7
– refined	kt	317	396	344	343	24.9	-13.2	-0.3
– total metallic content	kt	894	934	919	985	4.4	-1.6	7.2
Export value								
– nominal	A$m	8,451	9,766	8,891	10,020	15.6	-9.0	12.7
– real[d]	A$m	8,774	9,975	8,891	9,779	13.7	-11.1	10.0

Notes: b In 2019 calendar year US dollars; c Quantities refer to gross w eight of all ores and concentrates; d In 2019–20 financial year Australian dollars; f Forecast

Source: ABS (2019) International Trade, 5465.0; LME (2019) spot price; World Bureau of Metal Statistics (2019) World Metal Statistics; Department of Industry, Innovation and Science (2019)

Nickel

Resources and Energy Quarterly September 2019

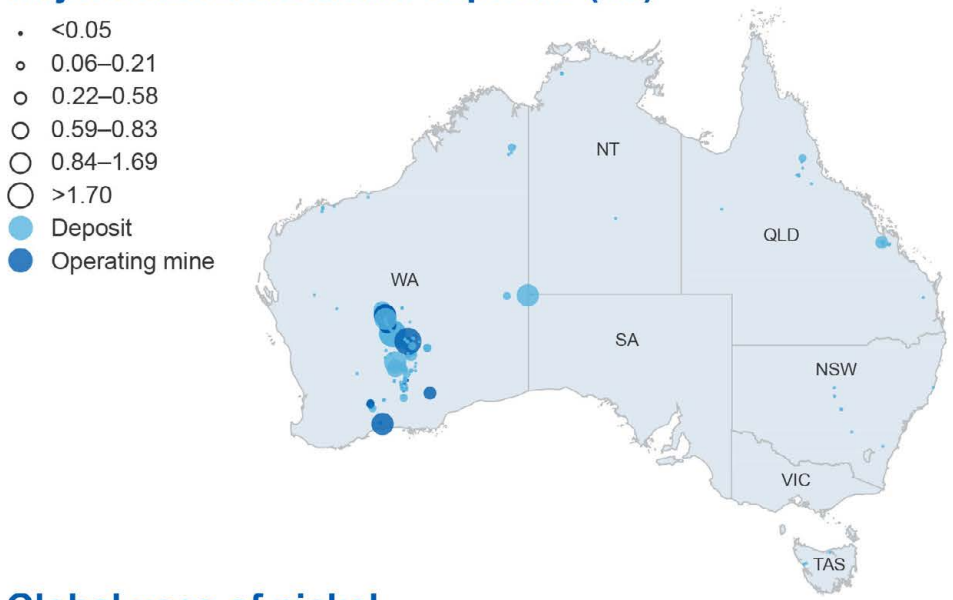
6th largest miner in the world

Australia produces **>200** thousand tonnes of nickel each year

Nickel exports contribute more than **$3b** to Australia's economy

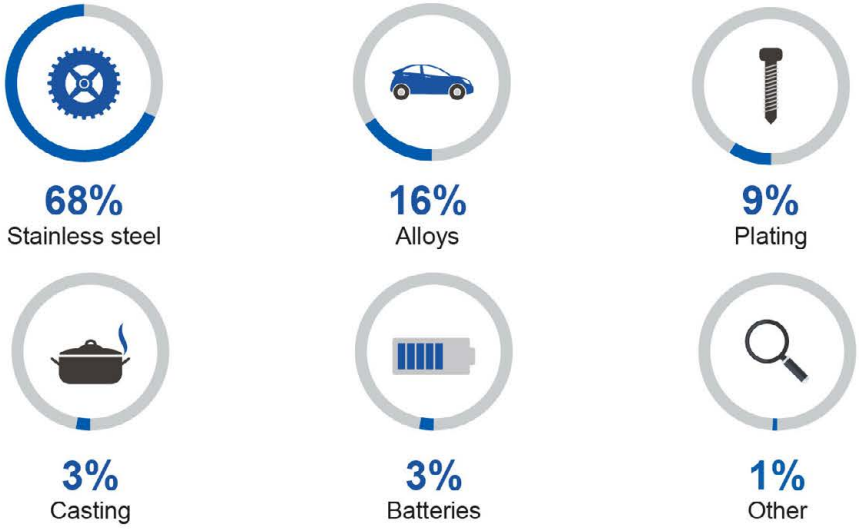
10% of world nickel mined is in Australia

Major Australian nickel deposits (Mt)



Key nickel consumer markets (tonnes)

Global uses of nickel



13.1 Summary

- Nickel prices have shown recent resilience, rising in the September quarter with healthy consumption growth and concerns around world production. In 2019, nickel prices are forecast to average US$13,800 a tonne, increasing to US$16,500 a tonne in 2021.
- There are a number of development projects underway that are expected to support Australia's mine production reaching 207,000 tonnes in 2020–21. Refined production is expected to increase to 141,000 tonnes in 2020–21, as BHP's Kwinana refinery expansion comes online.
- Australia's total nickel export earnings are forecast to increase from $3.6 billion in 2018–19 to $5.6 billion in 2020–21. Expanding production and, to a lesser extent, higher prices are expected to facilitate this growth.

13.2 Prices

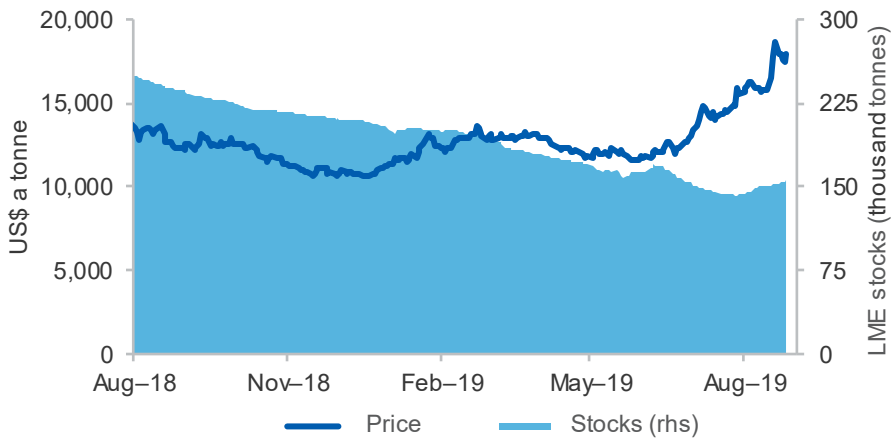
Nickel prices show strength, diverging from other base metals

Nickel prices have strengthened considerably in the September quarter, supported by healthy consumption, unexpected production outages and Indonesia's announcement of an export ban to be introduced in 2022. The nickel price averaged US$14,927 a tonne in the September quarter, 11 per cent higher than the same period in 2018 (Figure 13.1). London Metal Exchange (LME) stock levels have continued to draw down, reaching the lowest level in six years. The nickel market is expected to be under-supplied in 2019, which will be the fifth year of market deficit.

Strong consumption growth expected to support prices

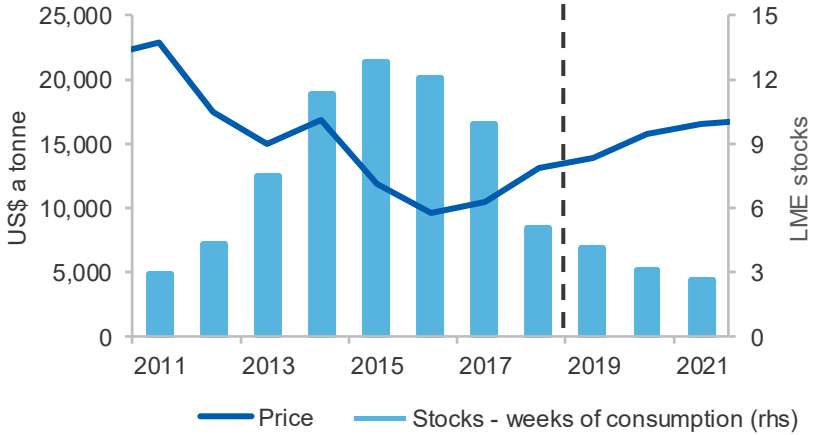
Over the outlook period, nickel prices are forecast to grow as world consumption growth outpaces production growth. Prices are forecast to average just over US$13,800 a tonne in 2019, before rising to reach US$16,500 a tonne in 2021 (Figure 13.2). This price outlook is largely dependent on China's stainless steel consumption growth and the ongoing influence of the US-China trade tensions. The impact that Indonesia's export ban will have on market dynamics, and therefore prices, is also a risk to the outlook.

Figure 13.1: Recent nickel price and stocks



Source: Bloomberg (2019) London Metal Exchange

Figure 13.2: Nickel LME spot price and inventories



Source: Bloomberg (2019) London Metal Exchange; International Nickel Study Group (2019); Department of Industry, Innovation and Science (2019)

13.2 World consumption

Strong outlook for nickel consumption in existing and emerging markets

Nickel consumption has remained steady despite some deterioration in world economic conditions. In the first half of the year world refined nickel consumption grew by 4.6 per cent year-on-year (Figure 13.3). China accounts for just over half of world consumption, and boosted world consumption further with a 9.4 per cent year-on-year increase in the first half of the year. Consistent growth in stainless steel demand has supported this growth.

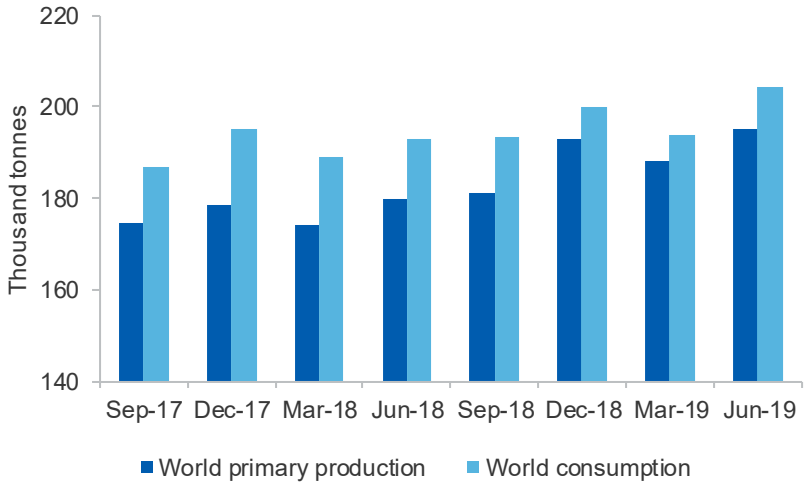
Consumption is forecast to grow at an average 3.3 per cent a year over the outlook period, from 2.3 million tonnes in 2018 to 2.6 million tonnes in 2021. This is expected to be driven primarily by strong usage in China, where consumption is forecast to grow around 2 per cent a year. Engineering and manufacturing activity in other markets, including Japan, Indonesia and the US are also expected to support consumption growth.

Nickel used in batteries is a small but growing market, currently accounting for about 3 per cent of nickel consumption. As the nickel intensity of battery manufacturing increases to improve battery storage capacity, demand for nickel sulphate is expected to grow. However, electric vehicle manufacturing is influenced by purchasing incentives, climate policy and world economic conditions, thus making it difficult for the market to anticipate how quickly consumption markets will grow.

13.3 World production

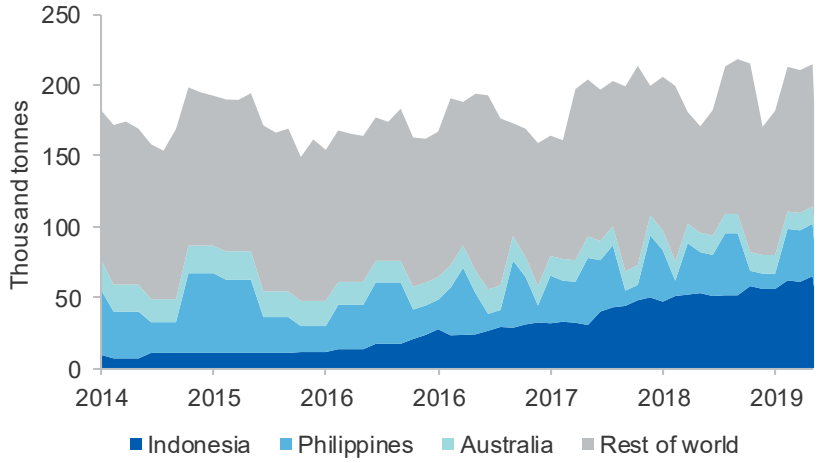
In the first half of the year mined nickel production grew by 9.1 per cent year-on-year, supported by higher production in the Philippines (Figure 13.4). Over the outlook period, world mine production is forecast to grow from 2.4 million tonnes in 2018 to 2.8 million tonnes in 2021, increasing at an average rate of 5.5 per cent a year. World refined production is forecast to grow from 2.2 million tonnes in 2018 to 2.6 million tonnes in 2021, rising at an average rate of 6.1 per cent a year. Three new mine projects in China are expected to bring 130,000 tonnes of capacity online by 2021 and 93,000 tonnes of new capacity is expected in Indonesia.

Figure 13.3: World balance of refined nickel



Source: International Nickel Study Group (2019)

Figure 13.4: World mined nickel production, monthly



Source: International Nickel Study Group (2019), Department of Industry, Innovation and Science (2019)

Indonesia's export ban to reduce world production

In late August, the Indonesian Government announced that nickel ore exports will be banned from January 2020. This announcement had an immediate impact on nickel prices and is expected to change market fundamentals over the outlook period. The ban is intended to promote development in Indonesia's domestic refining capacity and was previously expected to be introduced in 2022. In the past, bans of this nature have been introduced for bauxite and forestry exports, and previously in nickel in 2014, which was later relaxed in 2017 (Figure 13.5).

Indonesia is the largest nickel producer in the world, accounting for 26 per cent of world production in 2018. Indonesia exported around 120,000 tonnes of nickel in the first half of 2019; a complete stop to exports could remove around 10 per cent of nickel ore from the world market. Lower production volumes are likely to increase the world market deficit, supporting stronger nickel prices. It is expected exports will lift in the second half of 2019 in anticipation of the ban, however prices are expected to remain at elevated levels in 2019.

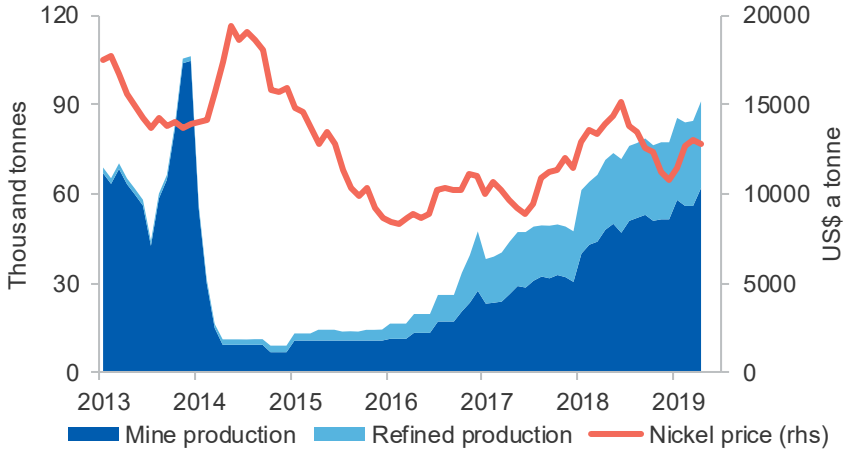
There are a number of uncertainties around how the ban will be implemented and what the impact will be on world markets. In the past, export bans have subsequently had concessional arrangements made or been delayed, even at the eleventh hour. This ban is due to be enacted very soon – giving industry little time to adjust. Current world market conditions are different compared to 2014, during Indonesia's previous nickel export ban, when destocking and new production from the Philippines addressed some of the supply gap. World stocks are currently at significantly low levels and alternative production sources are limited.

13.4 Australia

Australia's production grows with new capacity

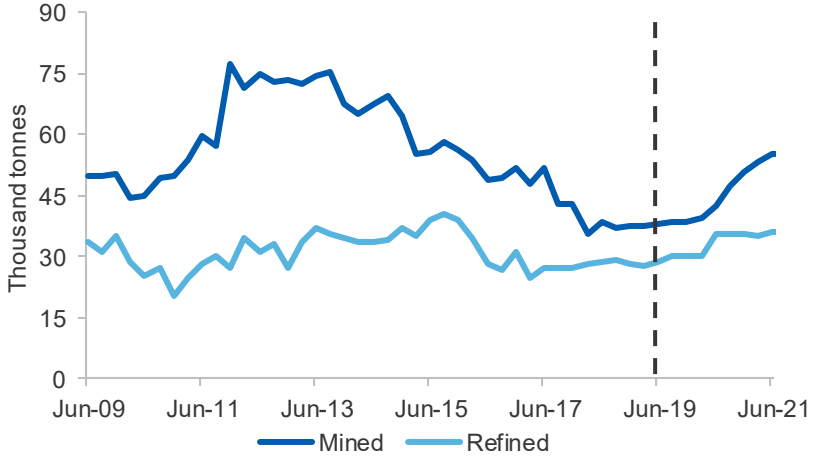
In the September quarter, Australia's mined nickel production grew by 14 per cent year-on-year, supported by the ramp-up in production at Panoramic Resources' Savanah mine in Western Australia.

Figure 13.5: Indonesia's nickel production and world prices



Source: International Nickel Study Group (2019), Bloomberg (2019) London Metal Exchange (2019)

Figure 13.6: Australia's quarterly nickel production



Source: Department of Industry, Innovation and Science (2019)

Australia's mine production is forecast to reach 207,000 tonnes in 2020–21, up from 150,000 tonnes in 2018–19 (Figure 13.6). Higher nickel prices and potential growth in consumption markets is supporting investment activity in Australian projects. New mine projects include BHP's Yakabindie operation (expected online in late 2020), as well as the potential restart of Posidon Nickel's Black Swan mine, both in Western Australia.

Australia's refinery production is forecast to grow at 9.1 per cent a year to reach 141,000 tonnes in 2020–21, up from 114,000 tonnes in 2018–19. De-bottlenecking projects, as well as capacity expansions are expected to support this growth. BHP plans to add nickel sulphate capacity to the Kwinana refinery in Western Australia, with the first stage of 100,000 tonnes annual capacity potentially coming online in 2020.

Higher export earnings to be supported by growing production

Growing production volumes and increasing prices are expected to support higher export earnings over the outlook period. Australia's nickel exports are forecast to grow at an average annual rate of 8.7 per cent a year, from $3.6 billion in 2018–19 to $5.6 billion in 2020–21 (Figure 13.7).

This growth is primarily supported by higher expected prices, however export volumes are also expected to increase steadily over the outlook. Export volumes are forecast to increase from 223,000 tonnes in 2018–19 to 280,000 tonnes in 2020–21.

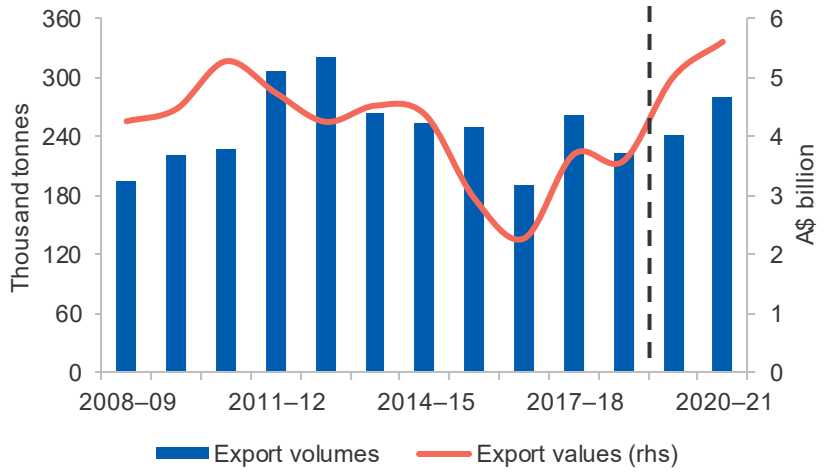
Exploration activity continues on motivation of battery manufacturing

Australia's nickel and cobalt exploration was $203 million in 2018–19, broadly consistent with 2017–18 (Figure 13.8). Exploration activity has remained at recent elevated levels after picking up in late 2017, supported by expectations of market growth in battery manufacturing.

Revisions to the outlook

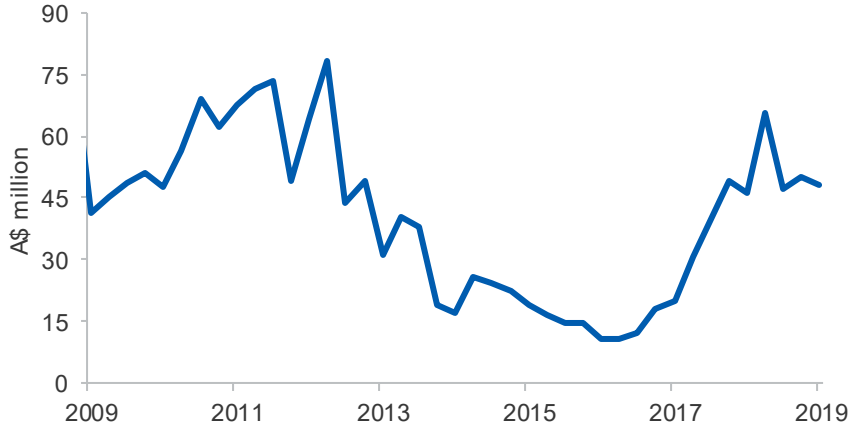
Forecasts for Australia's nickel export earnings have been revised up since the June 2019 *Resources and Energy Quarterly* due to the higher price forecast. Australia's export earnings have been revised up by $385 million and $657 million for 2019–20 and 2020–21, respectively.

Figure 13.7: Australia's nickel export volumes and values



Source: ABS (2019) International Trade in Goods and Services, 5368.0; Department of Industry, Innovation and Science (2019)

Figure 13.8: Quarterly nickel and cobalt exploration expenditure



Source: ABS (2019) Mineral and Petroleum Exploration 8412.0

Table 13.1: Nickel outlook

						Annual percentage change		
World	**Unit**	**2018**	**2019[f]**	**2020[f]**	**2021[f]**	**2019[f]**	**2020[f]**	**2021[f]**
Production								
– mine	kt	2,350	2,574	2,702	2,755	9.5	5.0	2.0
– refined	kt	2,182	2,357	2,555	2,605	8.0	8.4	2.0
Consumption	kt	2,327	2,420	2,493	2,568	4.0	3.0	3.0
Stocks	kt	225	161	199	186	-28.2	23.4	-6.6
– weeks of consumption		5.0	3.5	4.2	3.8	-31.0	19.8	-9.3
Price LME								
– nominal	US$/t	13,133	13,816	15,795	16,501	5.2	14.3	4.5
	Usc/lb	596	627	716	748	5.2	14.3	4.5
– real [b]	US$/t	13,420	13,816	15,440	15,784	3.0	11.8	2.2
	Usc/lb	609	627	700	716	3.0	11.8	2.2
Australia	**Unit**	**2017–18**	**2018–19**	**2019–20[f]**	**2020–21[f]**	**2018–19**	**2019–20[f]**	**2020–21[f]**
Production								
– mine[c]	kt	160	150	159	207	-6.3	5.9	30.4
– refined	kt	111	114	126	141	2.1	10.8	12.3
– intermediate		27	13	16	16	-53.2	28.0	0.0
Export volume[d]	kt	262	223	243	280	-15.0	8.9	15.4
– nominal value	A$m	3,701	3,588	5,006	5,607	-3.1	39.5	12.0
– real value[e]	A$m	3,853	3,674	5,006	5,472	-4.6	36.3	9.3

Notes: **b** In 2019 calendar year US dollars; **c** Nickel content of domestic mine production; **d** Includes metal content of ores and concentrates, intermediate products and nickel metal; **e** In 2019–20 financial year Australian dollars; **f** Forecast

Source: ABS (2019) International Trade in Goods and Services, Australia, Cat. No. 5368.0; Company reports; Department of Industry, Innovation and Science; International Nickel Study Group (2019); LME (2019); World Bureau of Metal Statistics (2019)

Zinc

Resources and Energy Quarterly September 2019

Australian zinc exports are tipped to **grow by 14%** to 1.4 million tonnes in 2019

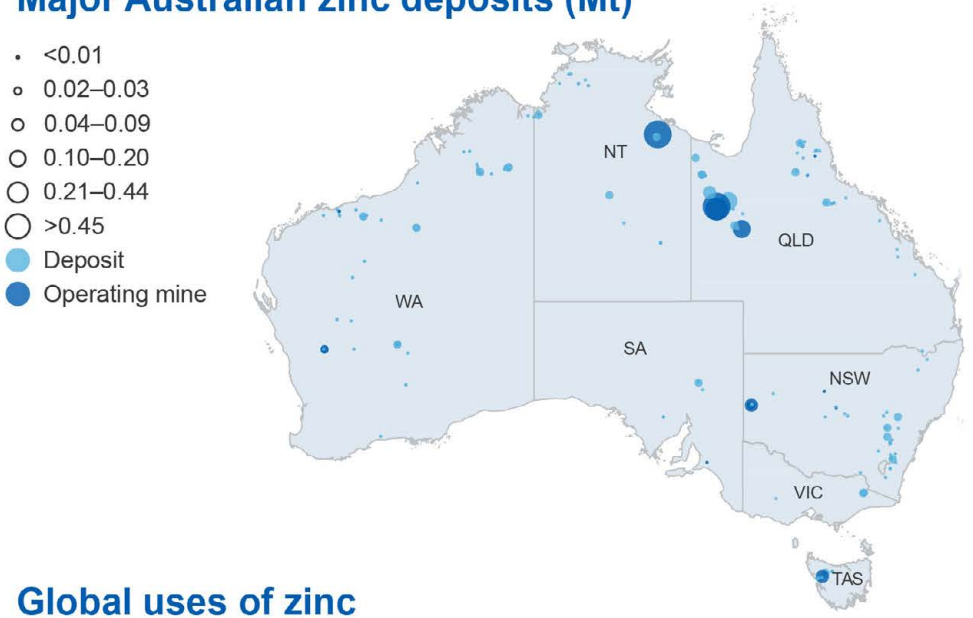
Australia produced over **2 million tonnes** of zinc ores and concentrates in 2018

Zinc exports contributed **$4 billion** to the Australian economy in 2018

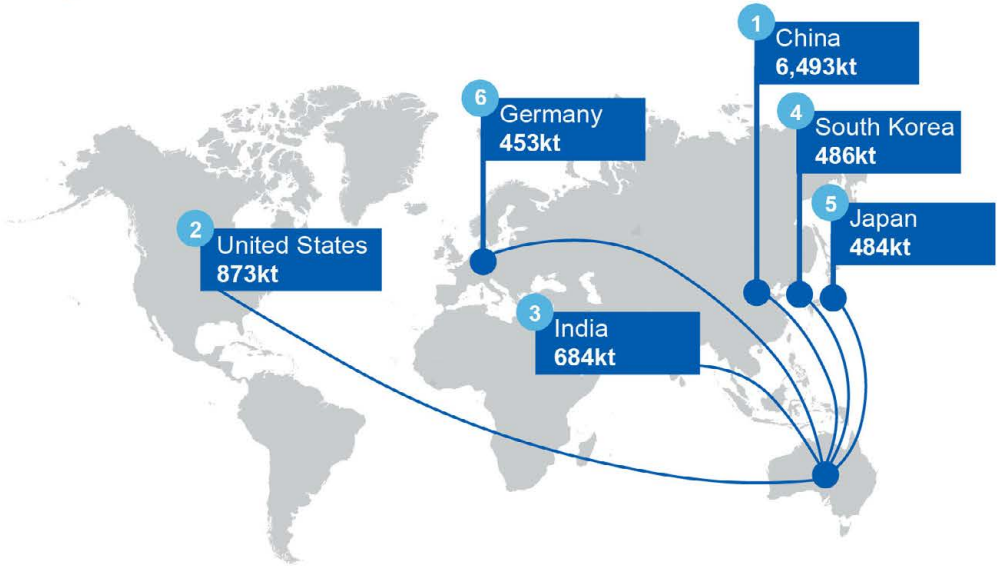
Australia is the **3rd highest** producer of zinc in the world

Australia holds **28%** of the worlds known zinc resources

Major Australian zinc deposits (Mt)

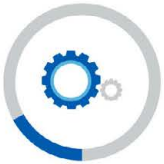


Key zinc consumer markets



Global uses of zinc

50% galvanise steel



17% diecasting

17% make brass and bronze alloys

6% rolled zinc

6% chemicals

4% other

14.1 Summary

- Zinc prices have been volatile in 2019. In April, prices eclipsed US$3,000 per tonne, owing to an acute stock shortage, but have since dropped to three-year lows, reflecting trade tensions and supply growth. Prices are expected to decrease over the forecast period, as robust production growth boosts inventories and China's slowing economy shrinks demand for the metal.
- The rich lodes and tailings of the Mt Isa region are forecast to propel Australia's mined zinc production to 1.5 million tonnes in 2019—20, before production tapers off as a mix of smaller mines hit lower grades and some reach end of life.
- The value of Australia's zinc exports is forecast to decline from $4.0 billion in 2018-19 to $3.0 billion in 2021—21, due mainly to softer prices.

14.2 Prices

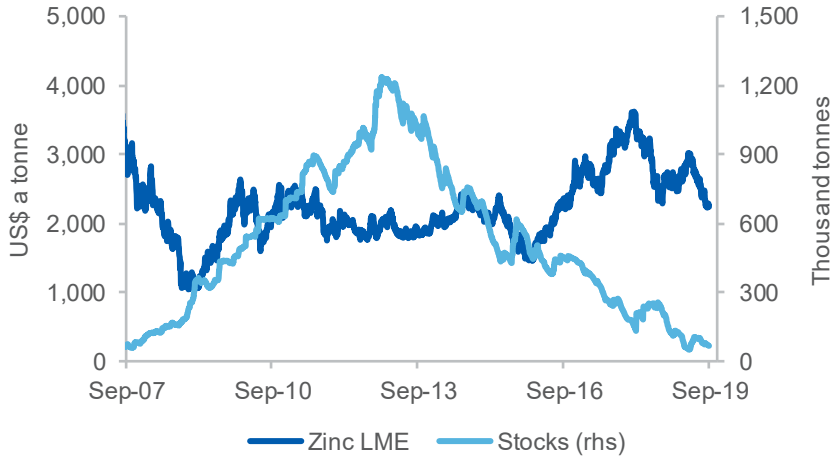
Prices to decline over the outlook period

Zinc prices have fluctuated in 2019. The London Metal Exchange (LME) zinc spot price breached US$3,000 per tonne in April, as LME inventories reached an 11-year low of 50,000 tonnes. It then started to decline, falling to US$2,190 per tonne in early September — the lowest it has been for three years (See Figure 14.1).

A number of tensions are at play. Zinc inventories are at record lows, owing to bottlenecks at Chinese smelters and the flow-on effects of a series of mine closures between 2013 and 2016. This helped boost prices in April 2019. However, it has not been enough to keep the price of zinc high in the face of deteriorating sentiment, an uncertain economic outlook and weak industrial output.

China's manufacturing purchasing managers index (PMI) and industrial products outputs have trended lower this year, and trade policy uncertainty has weighed on economic activity in advanced economies. All this suppresses demand for a metal closely tied to the manufacturing and automotive industries.

Figure 14.1: Historical zinc prices and stocks



Source: London Metal Exchange (2019) and Department of Industry, Innovation and Science

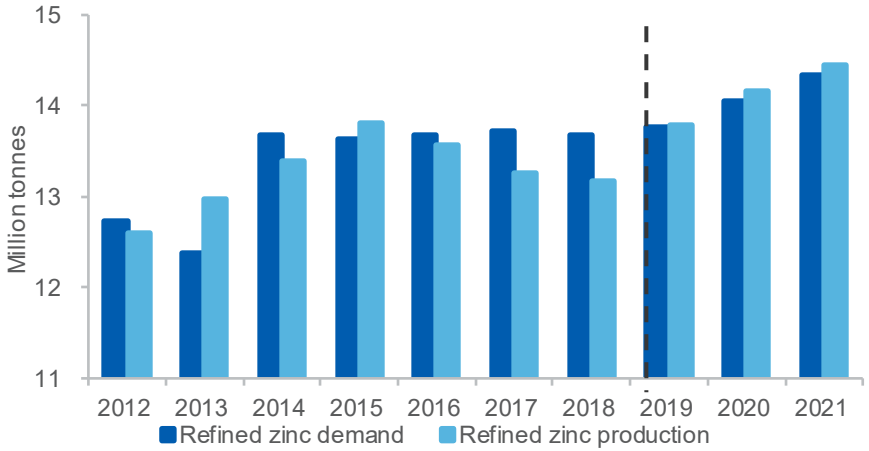
Anticipation of a zinc oversupply is also crimping prices. While there was a slight decrease in Chinese refined zinc production in July, production has still increased 11 per cent quarter-on-quarter, and shows signs it will continue to pick up speed. There are also a wave of new or expanded zinc mines ramping up production (see Section 14.3), such that world mined production is expected to grow by 4.4 per cent this year, after three years of decline.

The zinc market is set to return to surplus in 2019

With plenty of concentrate available, subdued demand, and Chinese smelters operating at greater capacity, the market for refined zinc is likely to return to a very small supply surplus this year, after three years of deficit (see Figure 14.2).

Over the longer term, rising zinc production and softer demand should see the price of zinc decrease by an average of 6.0 per cent per year over the forecast period — from an average of US$2,594 per tonne during 2019 to US$2,425 per tonne in 2021.

Figure 14.2: Refined zinc production versus refined zinc demand



Notes: The zinc market looks likely to return to a small surplus by the end of the year.
Source: International Lead and Zinc study Group (2019) and Department of Industry, Innovation and Science

World consumption

Emerging market economies to play key role in rising zinc consumption

Known as the 'Great Protector' for its anti-rust qualities, zinc's fortunes are closely tied to steel production. Steel use is expected to rise over the outlook period, albeit at a slower pace than in previous years (see the *steel* chapter). Refined zinc consumption should follow suit; it is anticipated to increase by 568,000 tonnes from 2019 to 2021, or an average of 1.4 per cent each year (see Figure 14.3)

Emerging Asian economies are expected to continue playing an important role in fuelling zinc consumption. India, with its ambitious steel-making targets, will experience the highest demand growth from 2019 to 2021 — an average of 6.2 per cent per year. This is higher than China, which will average 3.2 per cent growth over the forecast period, due to its slowing economy. Outside of Asia there will likely be a general decline in refined zinc consumption, as weakening industrial production dampens demand for the metal.

China expected to continue to consume large quantities of zinc, but downside risks to future demand have risen

China accounts for around half of global zinc and steel consumption, and its appetite for zinc remains large, though stunted in the short term. From January to June this year, refined zinc usage has been only three tonnes higher than last year (going from 3,074,000 to 3,077,000 tonnes) which means it is unlikely that zinc demand will grow much this year. Trade tensions, subdued industrial production, and a devaluation of the yuan — which curtails China's purchasing power — appear to be the main causes.

There is a degree of uncertainty surrounding the pace of China's future economic activity and industrial production growth. While the government is implementing economic stimulus measures in an attempt to offset the impacts of trade frictions, these are more restrained than in previous downturns. China also contends with economic challenges of a deeper, structural nature, such as mounting consumer debt, an ageing population, and low productivity, which complicate future growth prospects. Notwithstanding this, China's rate of GDP growth remains robust and will continue to be one of the highest in the world, averaging between 5.5 and 6.0 per cent over the forecast period. This growth should sustain zinc demand, though perhaps not at previous rates.

14.3 World production

Mined output to rise over the outlook period

The forecast mined zinc production increase from 2018 to 2019 has been revised down from 6.2 percent to 4.4 per cent compared to the June 2019 *Resources and Energy Quarterly*, because of weaker than expected production results between January and June this year. China and Peru — the world's two biggest zinc producers — experienced slightly negative growth in the first half of the year. Indian production growth has also been weaker, as the country navigates the transition from open pit to underground mining.

Mined output is expected to pick up pace in the second half of the year, as Vedanta Zinc International's 250,000 tonne per year Gamsberg mine and New Century's tailing project ramp up production. It should continue to rise over the outlook period, as a number of projects come online in response to the zinc supply deficit that emerged in 2016 (Figure 14.2).

Australia — the world's third biggest mined zinc producer — will make a hefty contribution to the anticipated increase in global mined output. From mid-2017 to December 2018, zinc exploration spending totalled $151 million — almost equal to the total amount of expenditure for the three years prior to that. The results of this investment flurry have started coming to fruition, and mine production increased by 39.7 per cent from 2017—18 to 2018—19.

Refined production to lift with mine output after slow start in 2019

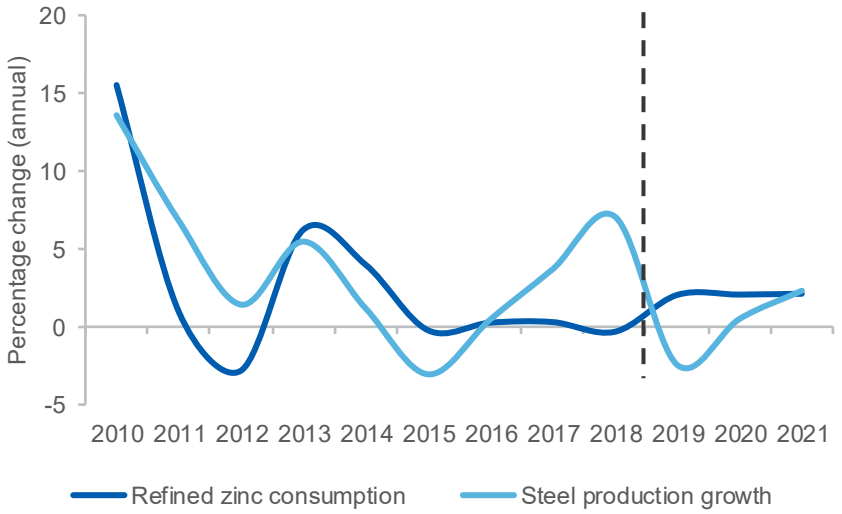
Refined zinc metal supply has suffered a number of short-term set-backs in 2019, which is reflected in weaker than forecast figures for the first half of 2019. Rising Chinese production and an increase in mine output are expected to compensate for this, and global refined production is expected to grow in 2019, after four years of decline. This trend should continue over the forecast period — total refined production is predicted to top 14 million tonnes in 2020 and grow to 14.4 million tonnes in 2021.

Refined production has faced complications in 2019. Smelters in China faced environmental restrictions, leading to bottlenecks. In addition, Africa's largest zinc refinery was shut-up for five weeks because of a strike. This has meant that refined output actually decreased from January to June in comparison with the same period last year.

However, Chinese production has since picked up pace, increasing steadily since February. Increased concentrate output and high treatment charges — prices charged by smelters for the cost of refining concentrates into pure zinc — are expected to incentivise production over the coming months, helping push the global market into a small surplus by 2019.

India is expected to see the largest growth in refined production output — a forecast 26.2 per cent increase from 2018 to 2021 to 942 thousand tonnes, or an average of 8.1 per cent each year.

Figure 14.3: Annual change in global steelmaking and zinc use



Source: International Monetary Fund (2018), Department of Innovation, Industry and Science (2019) estimates

14.4 Australia

Zinc exports are expected to grow in line with rising production

Australian mined zinc production surged to 1.3 million tonnes from 2018—19, a 39.7 per cent increase on 2017—18. By 2019—20, production will have almost recovered to the amounts achieved before the 2015 phase-out of the New Century mine, which roughly halved output. After hitting a five-year peak of 1.48 million tonnes in 2020, zinc production is forecast to taper off slowly.

Exports are tipped to grow in line with rising production, but lower prices will soften the revenue impact. Volumes (in metallic content terms) are forecast to peak at 1.43 million tonnes in 2019—20 and moderate in 2020–

21, returning to 2018—19 levels. Earnings are forecast to decrease from an estimated $4.0 billion in 2018—19 to $3.0 billion in 2020—21 (see Figure 14.4).

Australian mined production is surging

Australia's zinc production increased by almost 40 per cent year-on-year for January to July — to 1.3 million tonnes (in metal content terms). This increase was driven by production in the Mt Isa Region, where a number of producers have revitalised operations that were shuttered in 2015.

Queensland leads the way in terms of production and production growth (see Figure 15.5). New Century's ambitions to become one of the world's top ten zinc producers were bolstered by a 12 per cent production quarter-on-quarter increase in June and a landmark royalty agreement with the Queensland Government. Meanwhile, MMG's recently commissioned high-grade Dugald River mine had strong results, despite a planned maintenance shutdown, and Glencore's Mt Isa operations produced 59 per cent more zinc concentrate from January to June 2019 than the same period last year, owing largely to the resurgence of the Lady Loretta mine.

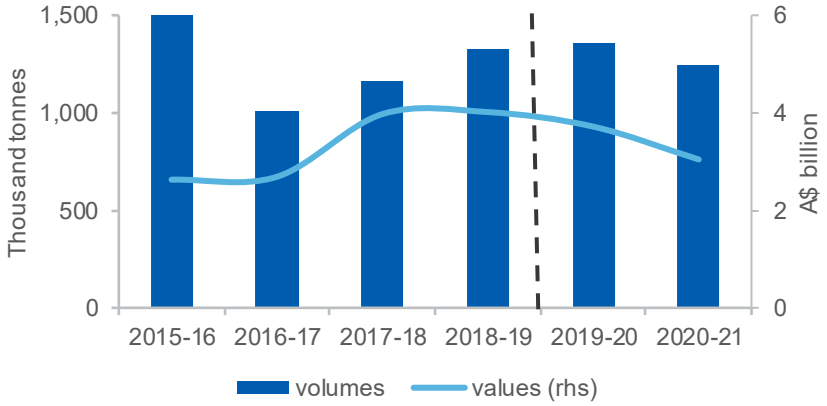
Production in other states has also been high. From January to June, Glencore's Northern Territory open-pit zinc mine, MacArthur River, produced 24 per cent more zinc than the same period year, and MMG's Rosebery's production increased by 4 per cent.

Exploration expenditure picks up pace after slow start to 2019

Exploration spending for silver, lead and zinc jumped to $23 million in the June quarter of 2019. While this is not as high as the June quarter of 2018 — which hit $28 million — it is 44 per cent higher than last quarter, and suggests that producers see room in the market for zinc concentrate. New Century and Heron Resources, in particular, continued their investment in exploration activities, as they seek to expand beyond recovering tailings to traditional mining.

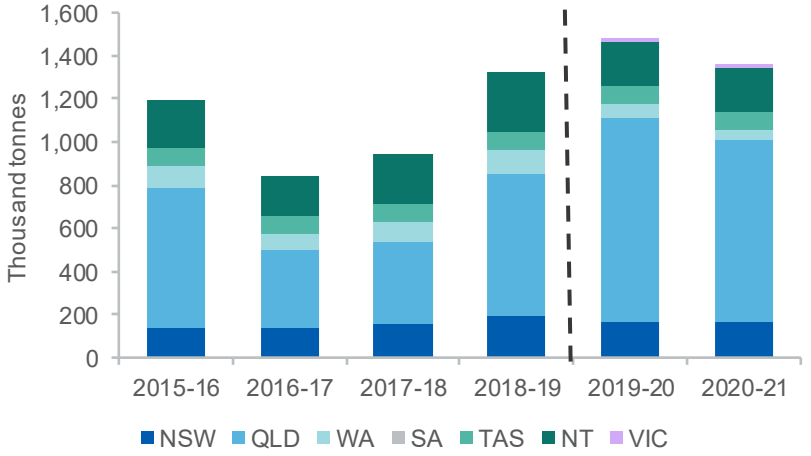
With zinc prices expected to decline over the forecast period and a number of zinc mines ramping up production, it is expected that exploration spending will become more subdued over the next two years.

Figure 14.4: Australian zinc exports, metallic content



Source: ABS (2019) International Trade in Goods and Services, 5368.0, Department of Innovation, Industry and Science (2019)

Figure 14.5: Australian zinc production by state



Notes: Company reports; Department of Innovation, Industry and Science (2019)

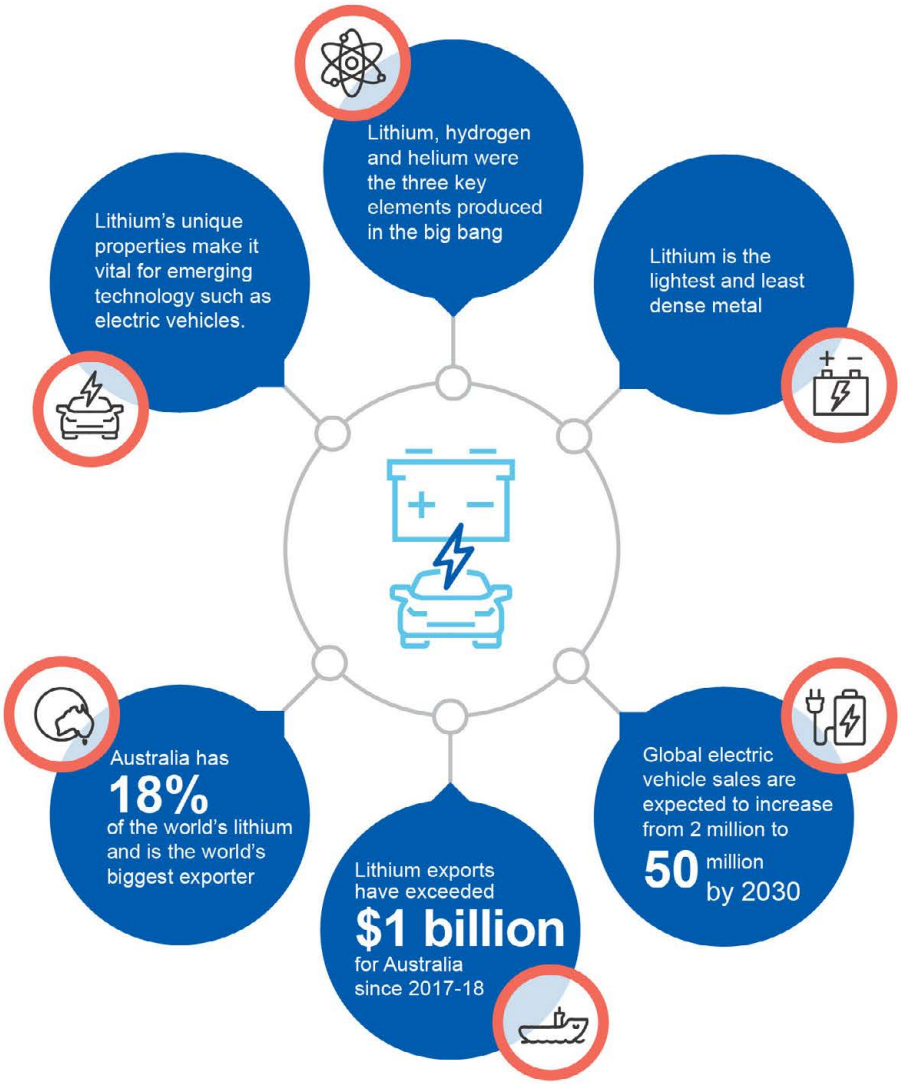
Table 14.1: Zinc outlook

						Annual percentage change		
World	**Unit**	**2018**	**2019[f]**	**2020[f]**	**2021[f]**	**2019[f]**	**2020[f]**	**2021[f]**
Production								
– mine	kt	12,698	13,254	13,910	13,928	4.4	4.9	0.1
– refined	kt	13,177	13,789	14,066	14,356	4.6	2.0	2.1
Consumption	kt	13,677	13,689	13,966	14,256	0.1	2.0	2.1
Closing stocks	kt	894	994	1,094	1,194	11.2	10.1	9.1
– weeks of consumption		3	4	4	4	11.1	7.9	6.9
Price								
– nominal	US$/t	2,925	2,594	2,440	2,425	-11.3	-6.0	-0.6
	USc/lb	133	118	111	110	-11.3	-6.0	-0.6
– real[b]	US$/t	2,989	2,594	2,385	2,320	-13.2	-8.1	-2.7
	USc/lb	136	118	108	105	-13.2	-8.1	-2.7
Australia	**Unit**	**2017–18**	**2018–19**	**2019–20[f]**	**2020–21[f]**	**2018–19**	**2019–20[f]**	**2020–21[f]**
Mine output	kt	949	1,325	1,480	1,367	39.7	11.7	-7.7
Refined output	kt	474	478	473	475	1.0	-1.2	0.5
Export volume								
– ore and concentrate [c]	kt	1,738	2,098	2,538	2,260	20.7	21.0	-10.9
– refined	kt	417	421	333	336	0.8	-20.7	0.8
– total metallic content	kt	1,164	1,326	1,436	1,319	13.9	8.3	-8.2
Export value								
– nominal	A$m	3,973	4,007	3,524	3,019	0.8	-12.1	-14.3
– real[d]	A$m	4,125	4,093	3,524	2,948	-0.8	-13.9	-16.3

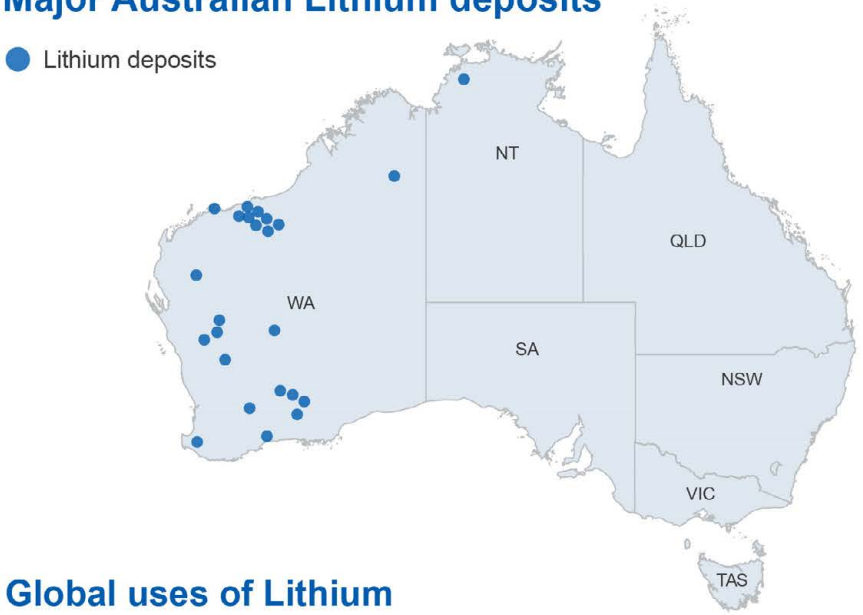
Notes: **b** In 2019 US dollars; **c** Quantities refer to gross weight of all ores and concentrates; **d** In 2019–20 Australian dollars; **f** Forecasts
Source: ABS (2019) International Trade in Goods and Services, Australia, Cat. No. 5368.0; Company reports; Department of Industry, Innovation and Science; International Lead Zinc Study Group (2019); LME (2019); World Bureau of Metal Statistics (2019)

Lithium

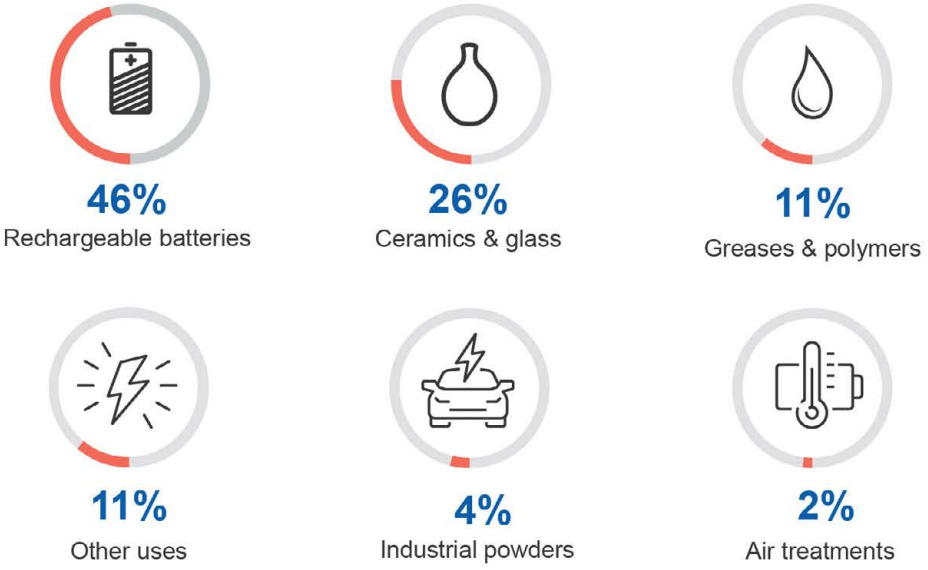
Resources and Energy Quarterly September 2019



Major Australian Lithium deposits



Global uses of Lithium



15.1 Summary

- Surging supply has seen the price of lithium hydroxide fall 33 percent year on year — from $US18,000 a tonne in 2018 to around US$12,000 a tonne in 2019. Further falls are expected over the outlook period.
- Australian lithium production is expected to increase from an estimated 288,000 tonnes in 2018–19 to around 358,000 tonnes by 2020–21, as the Greenbushes mine is upgraded and several newer mines ramp up.
- Export values hit an estimated record high of $1.4 billion in 2018–19 but are forecast to fall to $1.3 billion by 2020–21 due to lower prices.

15.2 Prices

Lithium prices are expected to keep falling

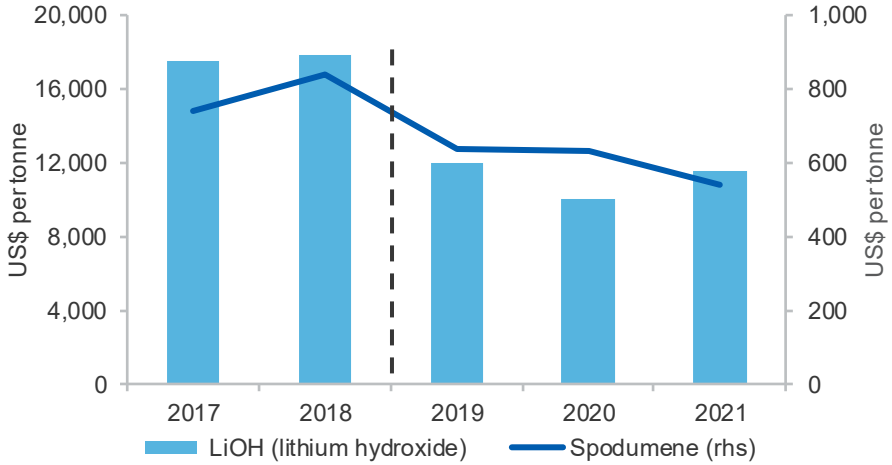
Lithium hydroxide prices have been trending down since their peak in late 2018, particularly in major market China. In recent months, spot prices have fallen more sharply than contract prices, with the latter responding more slowly to growing evidence of oversupply — such as stock gains.

Lithium hydroxide prices are projected to fall by around 33 per cent in 2019, as oversupply persists. Over the outlook period, the supply surplus is projected to gradually decline, with the price rebounding after 2020 (Figure 15.1). Spodumene ore — the precursor material for lithium hydroxide — is expected to face a longer period of oversupply, with prices forecast to remain soft through the whole outlook period.

The present lithium oversupply is challenging for market participants but not wholly unintended — the long term goal of investment in new and expanded mines has been to position businesses to meet future demand. Recent lithium consumption growth has been stellar, with compound annual growth of over 10 per cent a year. A major driver of future growth will be rising sales of electric vehicles (EV).

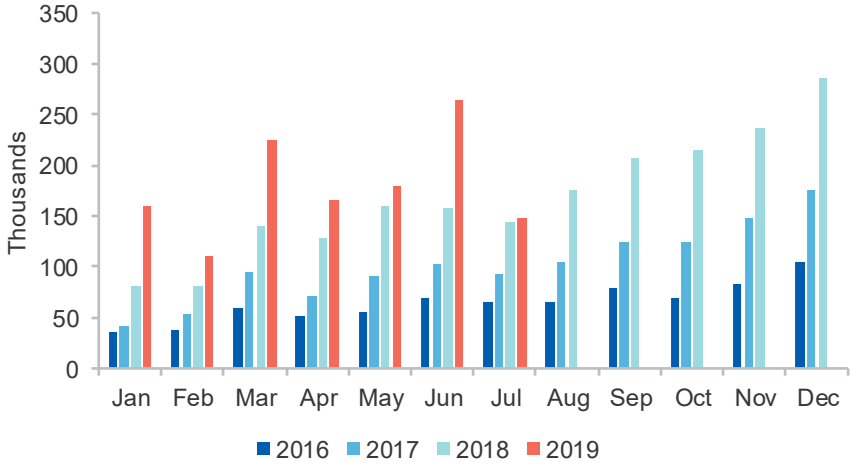
EV sales over the first half of 2019 were 50 per cent higher than the same period in 2018, and the rate of growth is accelerating (Figure 15.2).

Figure 15.1: Price of spodumene ore and lithium hydroxide



Source: Roskill (2019); Department of Industry, Innovation and Science (2019)

Figure 15.2: Monthly worldwide electric vehicle sales



Notes: Based on reconciled monthly or quarterly total sales data reported by major plug–in electric vehicle manufacturers.

Source: Inside EVs (2019) Monthly Sales Scorecard.

With the pricing of EVs expected to become increasingly competitive with internal combustion engine vehicles over the next few years, lithium consumption volumes are expected to catch up with production volumes (based on currently planned mines) as soon as 2021.

15.3 World consumption

A difficult year for lithium, but supply chains continue to mature

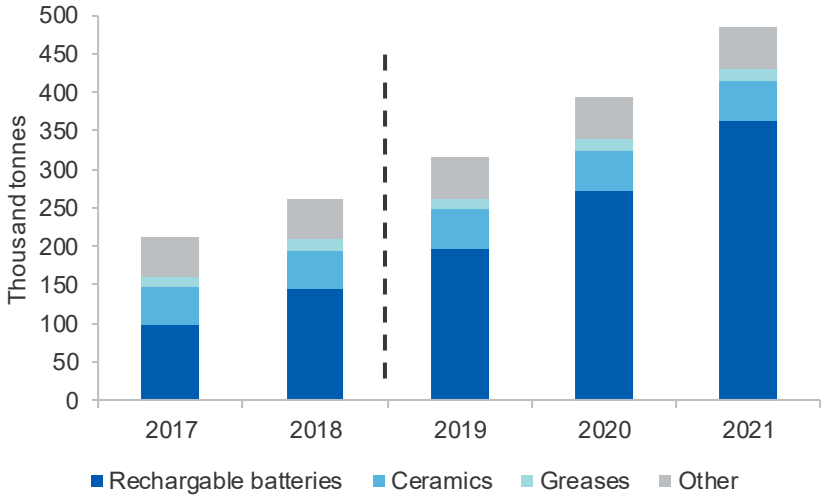
Consumption of lithium in 2018 was almost 12 per cent higher than estimated in the June 2019 *Resources and Energy Quarterly*. Despite short term macroeconomic headwinds, overall world lithium consumption continues its rapid growth of recent years, with an expected increase of 21 per cent in 2019 relative to 2018 levels (Figure 15.3). This growth is primarily supported by increasing EV sales — expected to increase at an annual rate of over 30 per cent during the outlook period, from 2.9 million vehicles in 2018 to 6.6 million vehicles in 2021 (Figure 15.4).

Recently, the growth in world lithium consumption has slowed in response to challenging economic conditions and policy changes in China. Overall vehicle sales have been contracting in China for at least a year, and the Chinese manufacturing sector continues to slow (see section 2.3 and Figure 2.6 in *Macroeconomic* chapter).

Chinese sales of EVs continue to grow, but the growth is slower than 2018. EV sales in July 2019 fell below July 2018 levels due to the cessation or winding back of some Chinese government subsidies for EVs. Lithium use in the Chinese residential housing sector (uses include glass, ceramics and cooking appliances) is also expected to be weak for the time being.

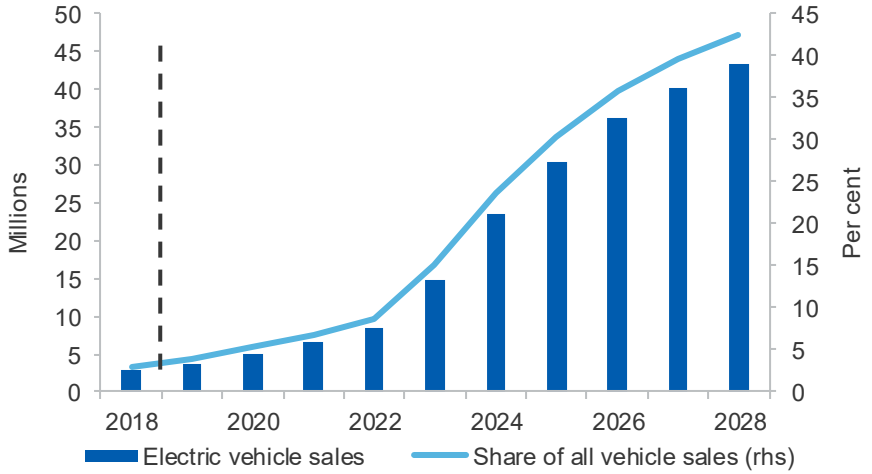
In the face of a shortage of buyers, Chinese companies that convert hard rock lithium into battery chemicals are increasing their levels of stock on hand. China's biggest lithium producer, Ganfeng Lithium Co, recently announced a 59 per cent fall in its first half profit expectations, reflecting weak sales growth and declining margins.

Figure 15.3: Lithium usage by product



Notes: 'Other' includes polymers, glass, pow ders, primary batteries, and air treatments.
Source: Roskill (2019); Department of Industry, Innovation and Science (2019).

Figure 15.4: Long-term electric vehicle sales projection



Source: Department of Industry, Innovation and Science (2019)

15.4 World production

Production chains are growing in volume and complexity

World lithium production ramped up much faster than anticipated in 2018, growing by 22 per cent year on year to 447,000 tonnes (in lithium carbonate equivalent terms). In the June 2019 *Resources and Energy Quarterly*, the estimate was for a 2018 growth rate closer to 5 per cent.

Lithium production chains are evolving rapidly, with a shift in the market towards the use of hard rock deposits. Lithium hydroxide produced from hard rock is more amenable to high-temperature sintering, which makes it more suitable for use in high-nickel products such as batteries. Hard rock production involves pulverising the ore to extract raw material, producing concentrates, and the mixing of concentrates with nickel, manganese and cobalt to produce oxides that combine with electrolytes.

Many countries are investing in facilities to target each of these steps for refining hard rock lithium. European countries have announced an intention to bring as many of these production stages as possible into the EU, with China following a similar path. These investments should reduce the risk of future bottlenecks, and support a more stable and integrated lithium market.

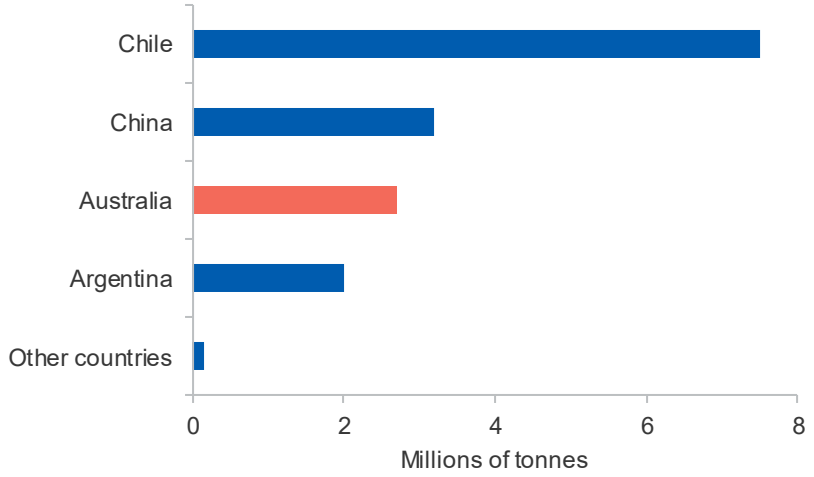
Hard rock lithium production is also benefiting from new problems with brine production, an alternative way of producing lithium. Although large reserves of lithium exist in brine in Chile and China (Figure 15.5), exploitation requires high volumes of water, which has made it contentious in some South American regions. SQM — a large brine producer — has recently been required to submit a $US25 million environmental compliance plan, and has shut down a well that was found to be impacting desert trees and vegetation. Albermarle has also been forced to halt engineering work at its La Negra project in Chile, due to concerns over water usage.

Some brine facilities have progressed in recent months, with SQM receiving environmental approval for construction at Salar de Atacama and Salar del Carmen in Chile. However, final approvals will take more time, and hard rock production is expected to dominate global growth over the outlook period, accounting for virtually all of the projected expansion — from 447,000 tonnes in 2018 to 489,000 tonnes by 2021 (Figure 15.6).

In the longer term, lithium recycling is likely to start substituting for mined production, if technological and cost barriers are overcome. Volkswagen Group plans to start a pilot plant in 2020 at its Salzgitter facility to develop a cost-effective battery recycling process to recover nickel, manganese, cobalt and lithium. This year, the US Department of Energy announced funding of US$15 million to start a research centre to examine lithium-ion battery recycling.

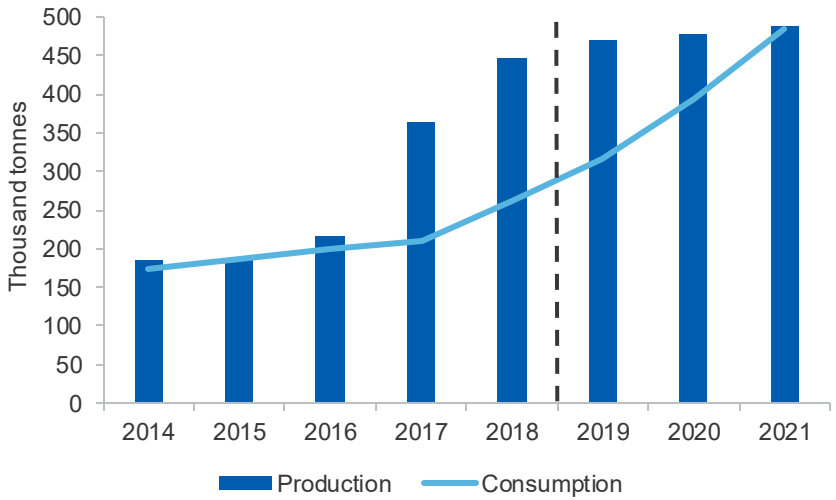
Large-scale lithium recycling is unlikely to occur much before 2030, when batteries start reaching end-of-life in large quantities. However, recycling plants may prove crucial in the long-term; not just as a means to reduce the material and energy cost of electric cars, but also to ensure long-term matching between lithium supply and demand.

Figure 15.5: World lithium reserves



Source: US Geological Survey (2018); Department of Industry, Innovation & Science (2019).

Figure 15.6: Lithium production and use



Source: Roskill (2019); Department of Industry, Innovation and Science (2019).

15.5 Australia

Rapid growth in output from Australian lithium producers

Australia remains the largest producer of mined lithium, producing 58 per cent of total world output in 2018. The Australian mining sector has invested heavily in new mining opportunities, and its output increase amounted to 56 per cent of additions to world production in 2018.

In 2018, production commenced at several sites in Western Australia. These include Pilbara Minerals' Pilgangoora mine, Altura Mining's Pilgangoora mine, and Alliance Mineral Assets' Bald Hill operation. But the largest volume growth in that year came from the expansion of Talison Lithium's existing Greenbushes mine, with an extra 20,000 tonnes.

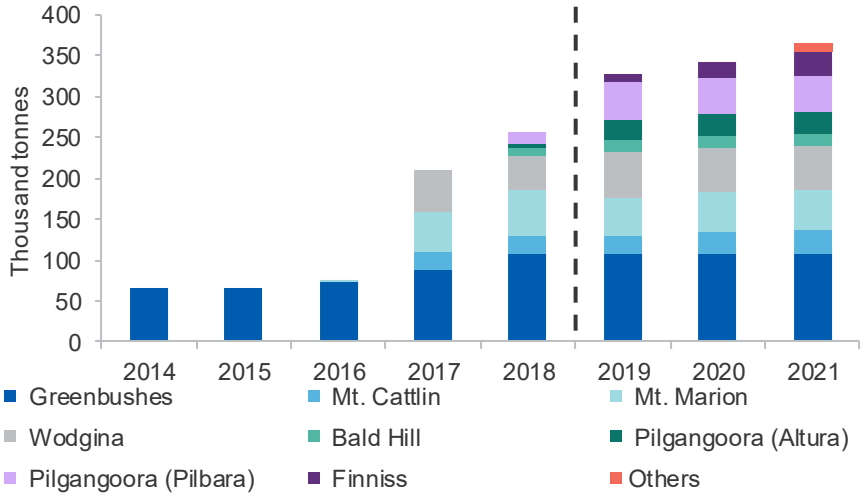
With spodumene prices falling, most exchange-listed Australian producers during 2019 have cut their revenue forecasts and experienced dramatic falls in their share prices — with some down over 50 per cent since January 2019. Producers are reassessing expansion plans, to minimise their risks in the face of declining prices. Even if expansion plans are delayed, the ramp up from mines which started operating in 2018 is expected see output rise over the outlook period (Figure 15.7). Australian lithium production (in lithium carbonate equivalent terms) was 288,000 tonnes in 2018–19, and is forecast to hit 358,000 tonnes by 2020–21.

The surge in production is expected to contribute to growing levels of stock, both in Australia and elsewhere. World stock levels are expected to peak at levels equivalent to almost two years' consumption in 2021.

Exports volumes set to grow strongly over the outlook period

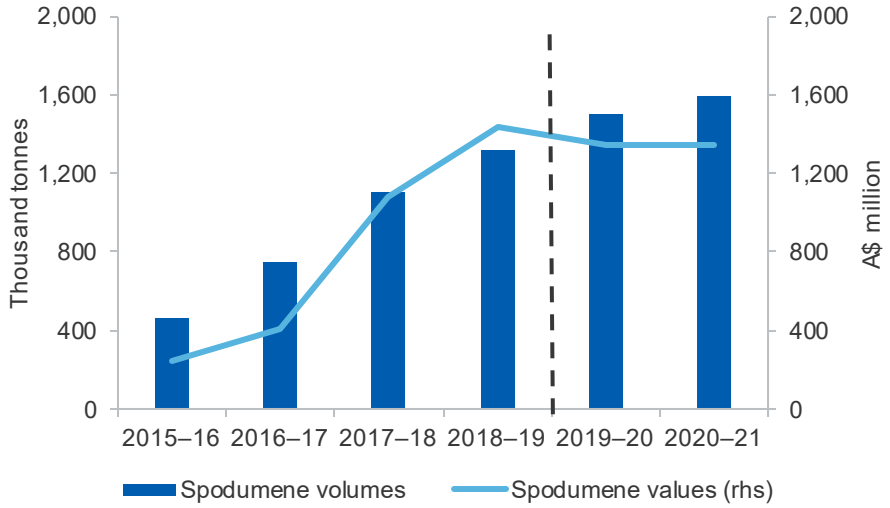
Export volumes are projected to track with production, since Australia currently has no domestic use of spodumene. Falling prices will create headwinds for export values in the short-term, though construction of hydroxide refineries should add to export values late in the outlook period. Export values hit an estimated $1.4 billion in 2018-19 and are forecast to fall to $1.3 billion by 2020–21 (Figure 15.8).

Figure 15.7: Australian spodumene ore production



Notes: Production measured as lithium carbonate equivalent.
Source: Company reports, Roskill (2019); Dept. of Industry, Innovation and Science (2019)

Figure 15.8: Australian spodumene concentrate exports



Source: Roskill (2019); Department of Industry, Innovation and Science (2019).

Revisions to the outlook

Australia's export earnings forecasts have been revised significantly from those in the June 2019 *Resources and Energy Quarterly*, based on updated volume and price data. The 2018–19 export estimate is higher by $107 million, as a result of higher prices (in Australian dollar terms) than expected, the impact of which has been partly offset by lower export volumes. The 2019–20 export forecast has been lowered by $170 million, due to lower prices and a small decrease in volumes.

Table 15.1: Lithium outlook

						Annual percentage change		
World	**Unit**	**2018**	**2019[f]**	**2020[f]**	**2021[f]**	**2019[f]**	**2020[f]**	**2021[f]**
Lithium production [a]	kt	447	470	479	489	5.0	2.0	2.0
Consumption	kt	261	315	393	485	20.6	24.8	23.5
Stocks	kt	638	793	879	883	24.2	10.8	0.4
– weeks of consumption		127.0	130.9	116.3	94.6	3.1	-11.2	-18.7
Spodumene price								
– nominal	US$/t	839	638	630	540	-24.0	-1.2	-14.3
– real [b]	US$/t	857	639	616	517	-25.5	-3.6	-16.1
Lithium hydroxide price								
– nominal	US$/t	17,817	12,000	10,000	11,500	-32.6	-16.7	15.0
– real [b]	US$/t	18,206	12,030	9,775	11,001	-33.9	-18.7	12.5
Australia	**Unit**	**2017–18**	**2018–19**	**2019–20[f]**	**2020–21f[f]**	**2018–19**	**2019–20[f]**	**2020–21f[f]**
Mine production [a]	kt	255	288	342	358	13.2	18.6	4.5
Export volume [c]	kt	1 105	1 324	1 504	1 593	19.7	13.6	5.9
– nominal value	A$m	1,081	1,434	1,349	1,339	32.7	-5.9	-0.7
– real value [d]	A$m	1,125	1,469	1,349	1,307	30.6	-8.1	-3.1

Notes: **a** Lithium Carbonate Equivalent. This is a measure of the quantity of refined product produced from spodumene ore; **b** In 2019 calendar year US dollars; **c** Spodumene concentrates; **d** In 2019-20 financial year Australian dollars; **f** Forecast

Sources: Department of Industry, Innovation and Science (2019); Company reports; Roskill (2019); Government of Western Australia Department of Mines, Industry Regulation and Safety (2019)

At the coal face: mine-level productivity in Australia

Resources and Energy Quarterly September 2019

Australia's resource sector

strong global performers operating at the innovation frontier

Growth in productivity

is the key to higher wages & living standards

Internationally, Australian iron ore producers are world best, with the **highest productivity growth**

Productivity is crucial

in an era of declining ore grades and limited discoveries

Traditional measures show mining productivity falling but mine-level analysis shows:

2007 – 2018 productivity in iron ore mining **grew by 71%**

adjusting for the impact of higher prices

adjusting for the impact of higher prices

2007 – 2018 productivity in metallurgical coal mining **only fell by 2%**

Australian mining company Rio Tinto uses the world's largest robot – a self-driving train – to haul ore from mine to port

Executive summary

Multifactor productivity, the conventional productivity statistic, shows that mining sector productivity fell by 20 per cent between the start of the mining boom in 2003–04 and the peak of the investment phase in 2012–13. Productivity has been rising since the industry transitioned into the production phase, but the recovery appears to be slow.

Falling productivity growth contrasts with the industry's otherwise strong performance. Australia's global share of iron ore trade grew from 33 to 52 per cent between 2001 and 2018. For metallurgical coal, the share rose from 54 per cent in 2001 and reached 61 per cent in 2016, before falling due to weather-related events. Further, the resources sector has been at the global frontier in innovation, introducing fleets of self-driving trucks and a self-driving train that is, effectively, the world's largest robot.

Much of mining's negative productivity performance was driven by impacts of the mining boom. This special topic uses mine-level data for iron ore and metallurgical coal mining to explore some of these impacts on productivity measurement.

A proxy of mine-level productivity, the output-cost index, is calculated using the real costs required for a tonne of production. Direct comparisons with the Australian Bureau of Statistics' (ABS) measure of multifactor productivity should be avoided, yet both are considered reasonable measures of productivity given they capture the major factors driving productivity growth (see the Technical Appendix for more).

The output-cost index analysis considers the impact of the mining boom on productivity growth in two ways.

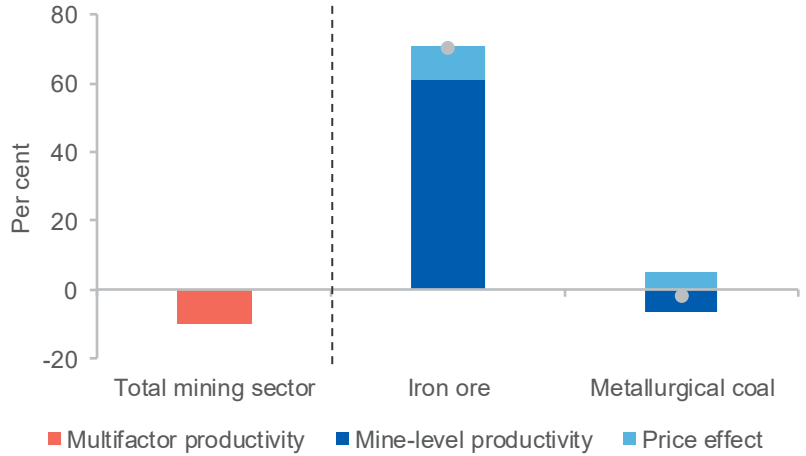
First, the investment boom affected multifactor productivity, given that mines have lags of around five years between turning the first sod and reaching peak capacity. This output-cost index avoids this issue by only analysing producing mines. The results show mine-level productivity in iron ore rose by 61 per cent between 2007 and 2018

Second, the price phase of the boom (beginning in 2003–04) resulted in higher cost mines operating than would have under lower prices. These high cost mines reduced productivity in the resources sector, due to the rapid scaling up and extraction of lower grade deposits.

The effect of higher prices on productivity is approximated by examining a simple counterfactual scenario, where new mines do not operate if their costs are above pre-boom prices. The analysis indicates that between 2007 and 2018, mine-level productivity growth in iron ore mining would be 10 percentage points higher with pre-boom prices. For metallurgical coal, the productivity growth would be 5.0 percentage points higher (Figure 1.1).

Adjusting the output-cost index for the price effect, productivity would be 71 per cent higher for iron ore from 2007 to 2018. For metallurgical coal, productivity would be just 2.0 per cent lower even in the face of considerable headwinds, including tropical cyclone disruptions.

Figure 1.1: Increase in mining productivity, 2007 to 2018



Notes: *Multifactor productivity are the experimental mining productivity measures calculated by the ABS. Other figures are mine-level proxies of productivity using Office of the Chief Economist (OCE) calculations. The ABS and OCE measures of productivity are calculated on different bases but both capture many of the major factors that drive productivity growth.*

Source: *ABS Cat. No. 5260.0.55.002 - Estimates of Industry Multifactor Productivity, 2017–18; OCE calculations using AME Group Cost Modeler database.*

International comparisons of the output-cost index highlight the competitiveness of Australian mining. Australian iron ore miners had the best mine-level productivity performance of major exporters between 2007 and 2018. In metallurgical coal, productivity in Australian lagged behind competitors but retained a competitive advantage due to the high quality and low impurities of its metallurgical coal. Population growth and urbanisation in key Asian economies are likely to buttress strong demand for Australian metallurgical coal.

1.1 The mining boom distorted productivity statistics

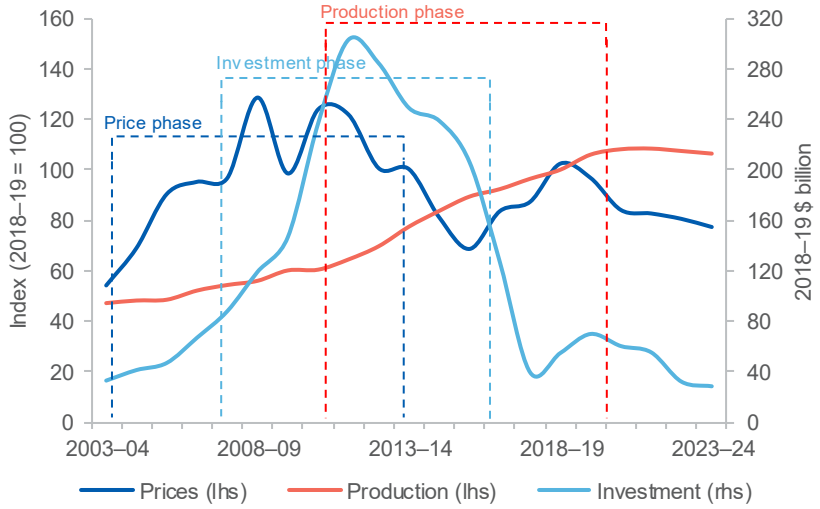
The conventional productivity statistics produced by the ABS show that multifactor productivity in mining declined significantly between the start of the mining boom and the peak of the investment phase. Since the end of the investment phase, productivity growth in mining has been slow.

This decline and weak recovery in mining productivity does not accord with what we know about the industry's strong global performance, the large boost in production capacity, the efficiency measures deployed in the industry and its large-scale technology use. Though multiple factors underpin the competitiveness and global dominance of an industry, productivity growth is a key determinant.

Reconciling the ABS productivity statistic and the developments in the industry, including its strengths, requires some understanding of the three distinctive stages of the mining boom (Figure 1.2). These massive economic events affected the standard productivity measures (Figure 1.3).

- First, the price phase from 2004 to 2012, driven by high economic growth in Asia drove commodity prices to record levels. Australian producers responded by bringing higher cost production online, which reduced productivity.
- Second, the investment phase from 2007 to 2017 saw unprecedented investment in response to higher prices. Higher investment and additional workers were included in the input statistics used to calculate multifactor productivity. Yet there were years of lags between the initial investment and new mines scaling up to full production.
- Finally, during the production phase from 2011 to 2019, investment began to generate large volumes of output. However, the full scaling up of production did not take place until 2019, later than the current productivity statistics which are for 2017–18.

Figure 1.2: The three phases of the mining boom

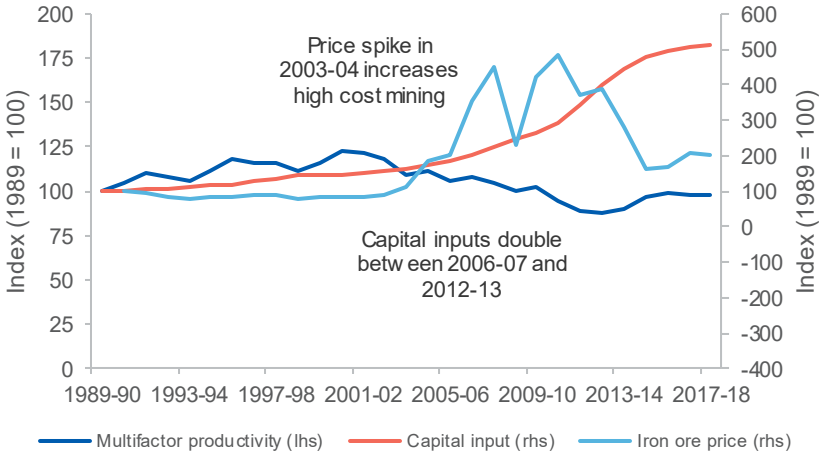


Source: *OCE calculations*

The first two phases of the boom had a strong negative impact on mining productivity. From the start of the price phase in 2003–04 to the peak of the investment phase in 2012–13, multifactor productivity in mining fell by 20 per cent. Since 2012–13, mining multifactor productivity has recovered somewhat but remains below pre-boom levels.

The impact of investment and the corresponding production lag on mining multifactor productivity is temporary. Going forward, multifactor productivity is expected to recover further as production phase peaks and the effect of the lag dissipates.

Figure 1.3: Aggregate mining multifactor productivity and effects of the boom, 1989–90 to 2017–18



Source: *ABS Cat. No. 5260.0.55.002 - Estimates of Industry Multifactor Productivity, 2017–18; World Bank, "Pink Sheet" data, Annual prices, September 2019.*

To overcome issues with the interaction between the mining boom and the productivity statistics, we use a measure of mine-level cost efficiency termed the 'output-cost index'. The index is used as a proxy for productivity changes in the iron ore and metallurgical coal industries.

The output-cost index shows the average change in output per unit of real input cost in Australian mines. Costs associated with extraction, processing, transport and administration and technical support of operational mines are encompassed in the index. As the index reflects the ratio of output to inputs, changes in the index broadly reflect productivity growth and should be similar to changes in the ABS multifactor productivity measure.

Due to the approach used to derive the output-cost index, changes in the index have a more direct link to changes in production costs. Multifactor productivity, on the other hand, is estimated as a residual of the portion of output growth not attributed to the accumulation of capital and labour. As such, growth in the ABS measure of productivity has a much broader interpretation, and includes changes resulting from improvements in knowledge, competition effects, and the effects of policy reform. Multifactor productivity also reflects improved efficiency in input costs, which are particularly important for capital inputs.

The Productivity Commission previously examined issues in measuring mining productivity in their 2008 paper, *Productivity in the Mining Industry: Measurement and Interpretation*. The analysis illustrated that the depletion of mineral and energy resources and investment lags both had negative impacts on measured productivity.

Supporting this finding the ABS have published experimental multifactor productivity estimates for mining, which control for the effect of depletion in the natural resource base. These alternative estimates show productivity growth is significantly higher after accounting for the depletion effect.

Despite both measures having similar interpretations, direct comparisons between the output-cost and the ABS mining multifactor productivity measure should be avoided given their different conceptual bases (see the Technical Appendix for more details).

1.2 Controlling for the investment boom

The level of mining investment during the boom was unprecedented: capital inputs for the mining sector doubled in the six years to 2013–14 and annual investment peaked at just under $100 billion in 2012–13.

Yet the nature of large mining projects is for a long lag between capital investment and production, often taking more than half a decade from commencement to peak production levels. For example, Caval Ridge is an open-cut coal mine located in the northern Bowen Basin. The mine produces 7.5 to 8 million tonnes per annum (Mtpa) of predominately high-quality metallurgical coal for export. The mine took six years to reach its current capacity: construction began in early 2012, full operation was reached in 2015, and an expansion was completed in late 2018.

As another example, Hope Downs 4, an iron ore mine, is one of 16 mine sites operated by Rio Tinto in the Pilbara Region of Western Australia. Iron ore is exported to East Asia via a 412km railway link to the Rio Tinto-

owned export terminal at Dampier Port. Construction began in 2011 and the mine commenced production in 2013 at 6Mtpa. Three years later, the mine reached full capacity of 15Mtpa in 2016 and further improvements boosted capacity to 16.5Mtpa in 2017.

The large influx of investment — combined with the long construction time of mining projects — reduced measured productivity, as the large investment was factored into the productivity statistics but many of the new mines had not commenced the new or expanded production.

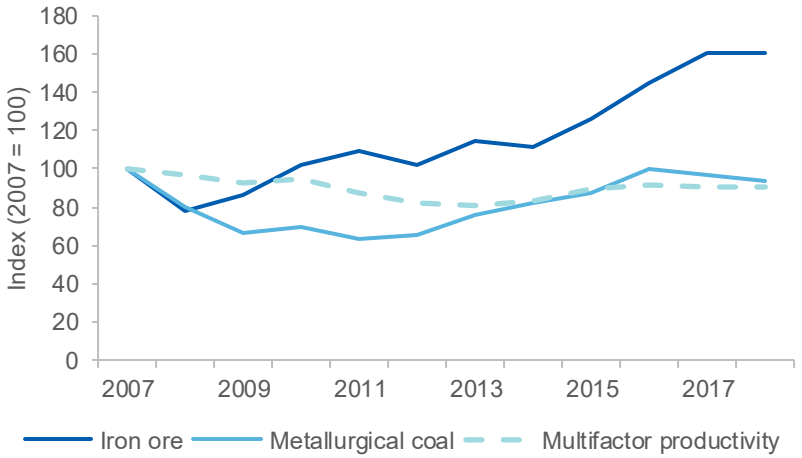
To control for this investment boom effect, this chapter uses mine-level data to look at operational mines only. The mine-level data contains information on the costs of extracting output for every iron ore and metallurgical coal mine in Australia and internationally. For example, the Yandi Joint Venture iron ore mine was the largest producer by volume in 2018, producing about 70 million tonnes at a cost of $16 per tonne.[1]

Delving into the mine-level data of operational mines reveals a difference in growth between the mine-level productivity, measured by the output-cost index and ABS mining multifactor productivity measure (Figure 1.4).

The output-cost index grew by 61 per cent in iron ore mining between 2007 and 2018. This increase was significant and consistent, reflecting cost cutting in the sector achieved through cost cutting in the sector and greater economies of scale, particularly in the sparse Pilbara region.[2] [3]

For metallurgical coal, the output-index performance was more mixed, falling by 37 per cent over the period to 2011. The index then rose steadily by a similar amount from 2011 until 2017, before cyclone events in Queensland disrupted supply. Overall, the output-cost index fell by 7.0 per cent in metallurgical coal mining.

Figure 1.4: Iron ore and metallurgical coal output-cost indices and aggregate mining multifactor productivity, 2007 to 2018



Notes: *Mining multifactor productivity are the experimental estimates calculated by the ABS. Comparisons between the ABS and OCE measures are indicative only.*

Source: *OCE calculations using AME Group Cost Modeler database; ABS Cat. No. 5260.0.55.002 — Estimates of Industry Multifactor productivity, 2017–18*

Several factors underpin the differences in mine-level productivity growth between iron ore and metallurgical coal.

- Compared to iron ore, the metallurgical coal industry is of smaller scale and generally has greater difficulties in scaling up due to the smaller nature of the deposits and their location in more populated areas.
- Capacity constraints relating to rail and port infrastructure — used to move mine production to its final destination or port-of-exit — resulted in significant bottlenecks for coal mining.

[1] Estimates are based on data sourced from AME Group Cost Modeller database.

[2] Humphreys D (2019) Mining productivity and the fourth industrial revolution, Mineral Economics: Raw materials report, 9. pp 1-11

[3] Salisbury C (2018) Delivering the value from flexibility and optionality [power point presentation script] 180618 viewed 19 August 2019, https://www.riotinto.com/documents/180618_Presentation_Chris_Salisbury_Iron_Ore_script.pdf

1.3 Controlling for the price boom effect

The price phase (2004 to 2012) of the mining boom also affected the official productivity statistics. As prices rose — with prices for iron ore increasing by 79 per cent and by 90 per cent for metallurgical coal — producers could mine lower grade deposits at a profit. However extracting lower grade deposits increased costs and lower productivity.

Broadly speaking, the ABS measure of mining productivity is the outputs over inputs but controlling for price effects. Take the example of a mining sector producing 10 million tonnes of iron ore at a price of $45 a tonne. If prices doubled to $90 a tonne but input costs and output volumes otherwise stayed the same, there would be no change in productivity.

However, suppose the higher prices raise the incentive of producers to extract lower grade deposits that are twice as costly to mine. Despite profits rising for the industry, productivity would fall, due to the higher costs of extraction.

In the above example, the mining sector would become less productive, due to the scaling up in response to higher prices. Productivity in mining naturally falls as higher grade deposits are depleted and as new mines extract lower grade deposits. However, the price boom during the early 2000s accelerated this effect.

Disentangling the impact of prices on productivity is difficult, even when using detailed mine-level data. For example, ascertaining whether existing mines experience growing costs due to shifting to lower grade deposits in response to higher prices, or due to natural increases as the mines aged, is difficult. An added complication is that mine-level production and operating costs prior to 2007 — and therefore before the price boom — are not available.

Nevertheless, assessing the impact of higher prices on mining productivity is worthwhile. To do so, a counterfactual scenario was developed, in which iron ore and metallurgical coal mines do not operate if their costs of production exceed the real pre-boom prices for the two commodities. The real pre-boom price is assumed to be the 10-year average of prices from 1990 to 2000, which is $77 for iron ore and $110 for metallurgical coal.

Table 1.1: Hypothetical example of the price boom effect

	Before	After: no production change	After: lower grade deposits extracted
Output	10 million tonnes	10 million tonnes	20 million tonnes
Price (per tonne)	$45	$90	$90
Average extraction cost per tonne	$40	$40	$60
Productivity (tonnes of output per $million)	25,000	25,000	16,667
Profits	$50 million	$500 million	$60 million

Source: *OCE calculations.*

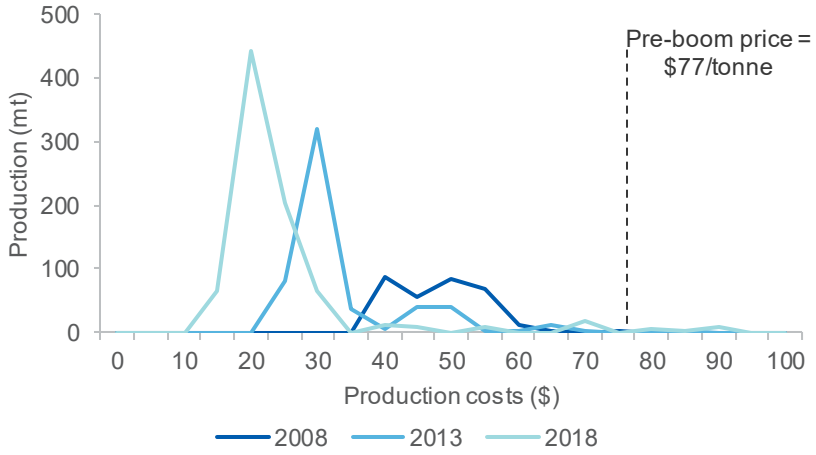
The impact of this assumption can be seen by examining the distribution of mine production costs over time.

In 2008, production costs for most iron ore mines ranged between $40 and $60 per tonne (Figure 1.5). In the next decade, iron ore mines became much more efficient, with the average real production costs falling to a low of $20 a tonne by 2018. The range of production costs across mines also narrowed significantly.

The estimated price effect for iron ore is low: productivity is estimated to be six per cent higher in 2018 if mines with costs above pre-boom prices do not produce.

Iron ore producers greatly improved efficiency over the period, resulting in the assumption having little effect on hypothetical production, with just 48 million tonnes of production (or about one per cent of total production) turned off.

Figure 1.5: Distribution of iron ore real production costs, select years



Notes: *Production costs are in Australian 2018 constant producer prices.*
Source: *OCE calculations using AME Group Cost Modeler database*

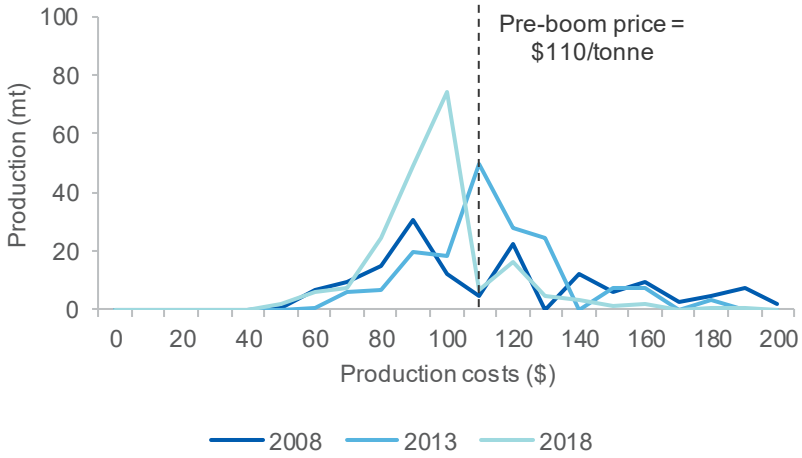
For metallurgical coal, the distributions show mine-level costs were more varied, and were mostly between $60 and $140 per tonne over the same period (Figure 1.6). There were some efficiency gains, as average costs declined and the amount of high-cost production fell. However, costs did not fall as much as iron ore mines, and a long tail of high cost mines remained in operation between 2008 and 2018.

The estimated price effect for metallurgical coal is that productivity would be about 26 per cent higher in 2018. The assumption results in approximately 619 million tonnes of lost production or about 34 per cent of the total production to 2018.

The greater impact of the price boom for metallurgical coal compared to iron ore has two main drivers.

- First, prices for metallurgical coal have almost tripled in real terms above their pre-boom levels, while real iron ore prices have largely returned closer to pre-boom levels (Table 1.2).
- Second, metallurgical coal production is of lower scale compared to iron ore. The industry generally had greater difficulties in scaling up, due to the smaller nature of the deposits and their location in more densely populated areas. Iron ore is predominantly mined in the sparsely-populated Pilbara region. This factor allows the sector to achieve cost reductions through scale. But, concerted efforts to reduce costs and boost productivity in iron ore mining have also contributed.

Figure 1.6: Distribution of metallurgical coal real production costs, select years



Notes: *Production costs are in Australian 2018 constant producer prices.*
Source: *OCE calculations using AME Group Cost Modeler database*

Table 1.2: Iron ore and metallurgical coal prices

	Pre-boom Price (2000)	Peak price (2008)	Post-boom price (2018)
Iron ore	$83	$122	$94
Metallurgical coal	$94	$282	$231

Notes: *Prices are expressed in Australian 2018 constant producer prices. OCE estimates based on data from World Bank and* June 2019 *Resources and Energy Quarterly.*

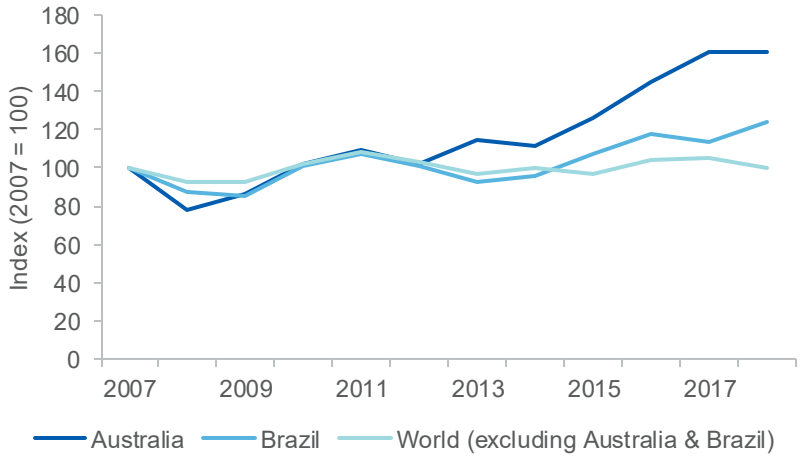
1.4 International comparison

The global demand for iron ore and metallurgical coal, particularly from China, exceeded the growth in global supply. The marked increase in prices led to a substantial expansion of iron ore and metallurgical coal capacity across Australia's key competitors and globally.

Australian mine-level productivity in iron ore — measured by the output-cost index — outpaced Brazil and the rest of the world, as domestic producers drastically reduced costs over the period (Figure 1.7).

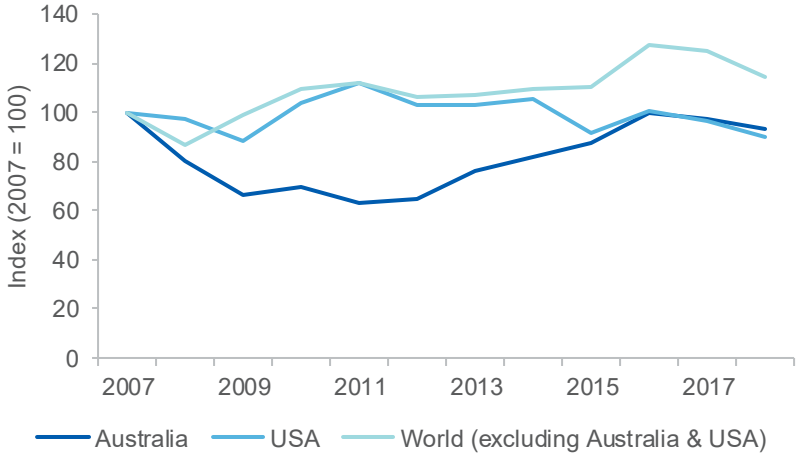
For metallurgical coal, mine-level productivity fell behind international competitors during the price and investment phase of the mining boom (Figure 1.8). However, during the production phase, productivity grew and Australian miners gained ground, catching up to the United States, one of its key competitors. Despite trailing key competitors on cost improvements, Australia has a competitive advantage relative to other producers, in mining high-quality coal. Further, rising incomes and ongoing urbanisation in China and India are expected to support demand for Australia's metallurgical coal.

Figure 1.7: Output-cost index, iron ore, select countries, 2007 to 2018



Source: *OCE calculations using AME Group Cost Modeler database*

Figure 1.8: Output-cost index, metallurgical coal, select countries, 2007 to 2018



Source: *OCE calculations using AME Group Cost Modeler database*

1.5 Technical appendix

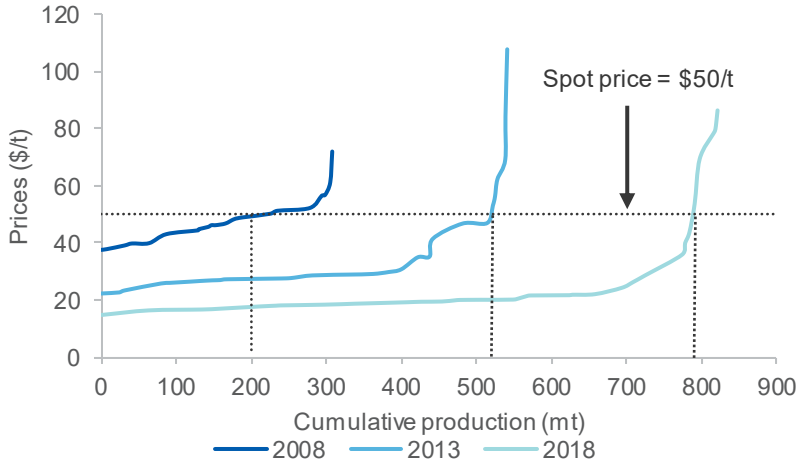
The mine-level data

The analysis is based on data sourced from AME Group's Cost Modeller database, which provides mine-level cost, revenue and output information of key commodities from 2007 onwards. The data can be aggregated by company or country, allowing for comparisons.

AME utilises engineering costing models to calculate costs using a wide range of specific data, including labour rates, production capacities, waste ratios, transport distances, port costs, product recoveries, and state- and country-specific royalty/energy formulae. These modelled results are then reconciled against reported company information.

Combining all mines gives the amount producers are willing to supply at a particular price. These are known as cost curves. Typically, lower cost producers will be at the lower end of the cost curve, while higher cost (and less productive) producers will be at the higher end.

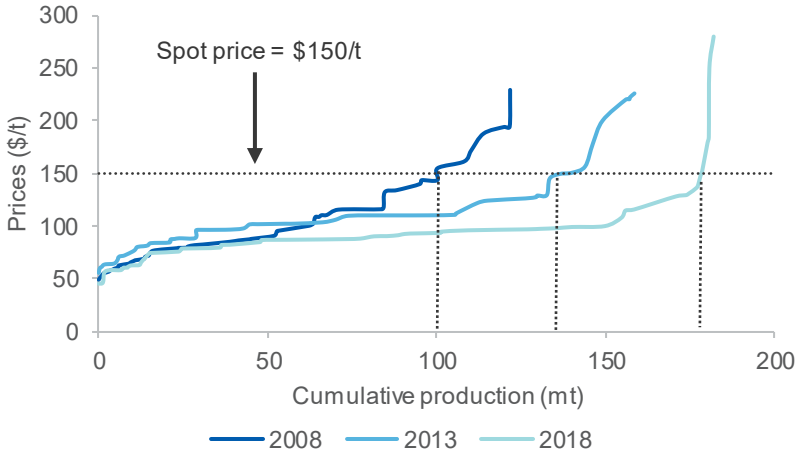
Figure 1.9: Iron ore cost curves, select years



Notes: *The curves were constructed from average variable costs of production of mines. Only includes trade coal production. Prices are expressed in Australian 2018 constant producer prices.*

Source: *OCE calculations using AME Group Cost Modeler database*

Figure 1.10: Metallurgical coal cost curves, select years



Notes: The curves were constructed from average variable costs of production of mines. Only coal production that is traded is reflected. Prices are expressed in Australian 2018 constant producer prices.

Source: OCE calculations using AME Group Cost Modeler database

Changes in the cost curves for iron ore and metallurgical coal reflect the findings in the chapter.

The iron ore cost curve has shifted out and flattened in the decade to 2018 (Figure 1.9). This dynamic reflects the significant increase in iron ore production capacity from substantial new investment, particularly from lower-cost iron ore mines. For example, at a real spot price of $50 a tonne, iron ore mines in 2008 were able to produce around 200 million tonnes of iron ore (the intersection between the $50 spot price and the 2008 cost curve). In 2018, production capacity quadrupled to almost 800 million tonnes.

As with iron ore mines, there have been substantial expansions in metallurgical coal production — leading to an outward shift of the cost curves between 2008 and 2018 (Figure 1.10). Compared to iron ore mining, however, the expansion in production capacity were from higher cost mines and require a much higher real spot price of $150 a tonne to remain profitable. At this spot price, coal mines were able to produce

around 100 million tonnes of metallurgical coal in 2008, almost doubling to 180 million tonnes by 2018. Similar to the distribution analysis in Section 1.3, the cost curves suggest that metallurgical production spans a wider range of low-cost to high-cost mines relative to mines in the iron ore industry.

Scope of commodities considered

The scope of the analysis was limited to Australia's iron ore and metallurgical coal industries.

In 2018–19, these two commodities accounted for 28 per cent and 16 per cent of Australia's resources and energy exports, respectively. Further, these two commodities have dominated the share of resources and energy exports since 2003–04, with shares averaging approximately 30 and 15 per cent, respectively, from 2003–04 to 2018–19.

Liquefied Natural Gas (LNG), thermal coal and gold are also key resource and energy exports. These industries were also affected by the phases of the mining boom and would have been an interesting case study. Extending analysis to these other commodities would be worthwhile in the coming years, however they were exclude from this initial chapter as:

- the ramp up in LNG production has been relatively recent and so largely sits outside the available productivity statistics with implications for data reliability and comparability; and
- thermal coal and gold's share of resource and energy exports were significantly lower than that for iron ore and metallurgical coal at 9.0 and 7.0 per cent, respectively, in 2018–19.

As iron ore and metallurgical coal comprise a large share of mining production, both currently and historically, changes in industry aggregates are likely to be driven heavily by developments in these two commodities.

Output-cost index

A measure of mine-level cost efficiency called the output-cost index was derived for the purpose of this analysis. This metric shows the average change in output per unit of total input cost and is a proxy measure of mine-level productivity. Further, mine production costs were weighted by their level of production and then aggregated across all producing mines to generate the aggregated output-cost index.

The AME production data broadly aligns with industry-level production from the national accounts. Growth in both iron ore and metallurgical coal production in AME data tracks closely with growth in gross value added at chain volume measures (i.e. adjusting for prices) for relevant sub-industries in the national accounts.

The index does not account for intermediate inputs in the production process. Therefore, the measure is akin to a gross output measure of productivity rather than a value add measure. As a result, index changes can be attributed to improvements in both primary capital and labour inputs, and intermediate inputs.

Due to data limitations, the output-cost index does not control for changing input prices and capacity use. For example, lower input costs (such as labour and contract costs) as the mining boom receded could lead to an overestimate of productivity growth.

Significant drivers of productivity — such as cost reductions, better capacity utilisation, efficiency of input use and economies of scale — are reflected in the output-cost index measure.

Box 1.1: ABS Multifactor productivity vs output-cost index

The ABS multifactor productivity measure is the increase in output beyond that stemming from changes in inputs used in production processes. It can be thought of as the efficiency with which inputs such as labour and capital are combined to produce goods and services.

The metric is measured as a residual of the portion of output growth that cannot be attributed to the accumulation of capital and labour. As such, changes in multifactor productivity have a broader interpretation and reflect the effects of changes in management practices, brand names, organisational change, general knowledge, network effects, spill overs from production factors, adjustment costs, economies of scale, the effects of imperfect competition and measurement errors.

The output-cost index represents a composite of broad features of production costs: mining costs, processing costs, administration and support costs and freight and logistics. As a result, changes in the index have a more direct link to changes in production costs, compared to the conventional ABS measure of productivity.

In addition, embedded in and across the broad cost categories used in the output-cost index are capital and labour inputs. These factors of production are not separated. Consequently, growth in the output-cost index cannot be decomposed into changes in labour or capital inputs.

Mine-level data prior to 2007 is not available in the AME Cost modeller database. Therefore, ascertaining whether the output-cost index and the ABS multifactor productivity would track closely in the years preceding the mining investment boom is difficult.

The commodities included in the calculation of each measure also differ. Multifactor productivity is also measured at the entire industry level, whereas the output-cost index has only been calculated for iron ore and metallurgical coal.

As all figures presented in this chapter are weighted by their production, non-operational mines and inputs attached to those mines have no effect on the output-cost index results. On the other hand, the ABS do not use a direct method to exclude the capital of non-operational mines from their estimates of multifactor productivity. Rather, they apply methods to account for age-related depreciation (including foreseen obsolescence), that smooths out the usage of capital over time. As a result of this indirect method of accounting for capital inputs, there is a potential for capital still attached to non-operational mines to be counted in the multifactor productivity calculations.

Direct comparisons between the output-cost index and the ABS productivity measure should avoided due to the different data sources and methodologies used to derive each measure.

Source: ABS (2015) Australian System of National Accounts: Concepts, Sources and Methods, 5216.0, Canberra; ABS (2005) Estimating industry-level multifactor productivity for the market-sector industries in Australia: methods and experimental results, ABS research paper, Canberra

Deflator

The AME database expresses all historic production costs for each year and each mine in that specific year's nominal US dollars. This was done by AME converting local currencies to US dollars through estimates of annual exchange rates.

For the purpose of this analysis and comparability across years, all figures were:

- converted to nominal Australian dollars, based on estimates of the annual Australian-US dollar exchange rate for that year
- deflated and expressed as 2018 prices, using the Australian GDP price deflator.

The ABS publish a coal mining input price index in *6427.0 - Producer Price Indexes*, but do not publish an equivalent index for iron ore. Therefore, to ensure consistency in the analysis and in the absence of more valid and specific iron ore and coal mining input price indices, production costs were deflated using the GDP price deflator. The GDP price deflator with the coal mining input price index track each other closely, suggesting the GDP price deflator is a good indicator of costs in the mining sector generally.

Pre-boom price assumption

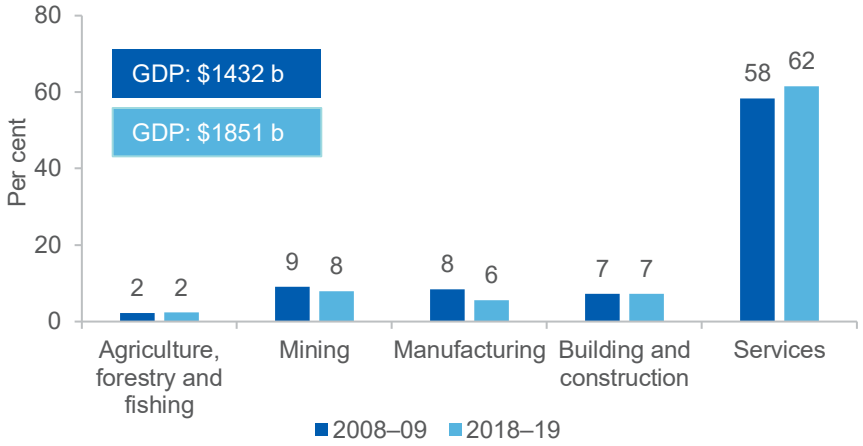
Section 1.3 illustrates a counterfactual scenario that attempts to control for the impact of the substantial increase in commodity prices on mine-level productivity. The counterfactual assumes this price effect does not occur, by simulating production costs of mines under the following assumptions:

- World spot prices for iron ore and metallurgical coal are reduced to and held constant at the 10-year historical average between 1990 and 2000. For iron ore, this was $77 and for metallurgical coal it was $110.
- Mines remain operational if their per tonne production costs remain below the price assumption and shut down when they are above.

The price assumptions is similar to those used by the Reserve Bank of Australia in analysis of the impact of the mining boom in the paper *Tulip P (2014) The Effect of the Mining Boom on the Australian Economy*' and lead to significantly lower production costs in the counterfactual scenario.

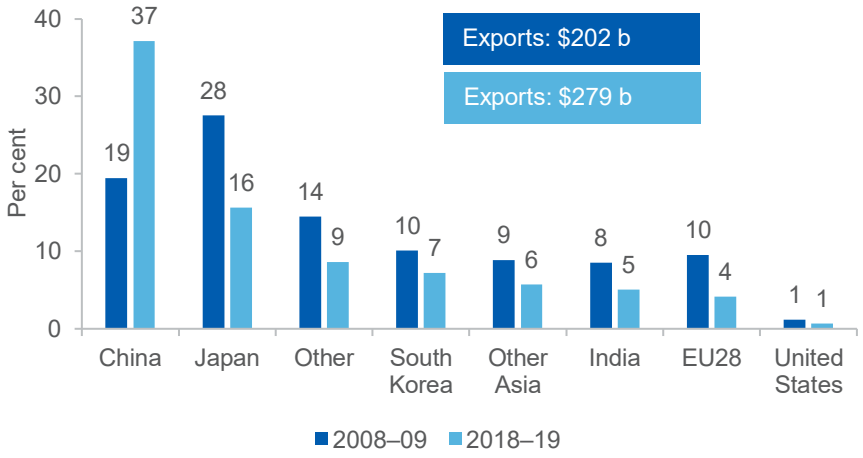
Trade summary charts and tables

Figure 18.1: Industry shares of GDP



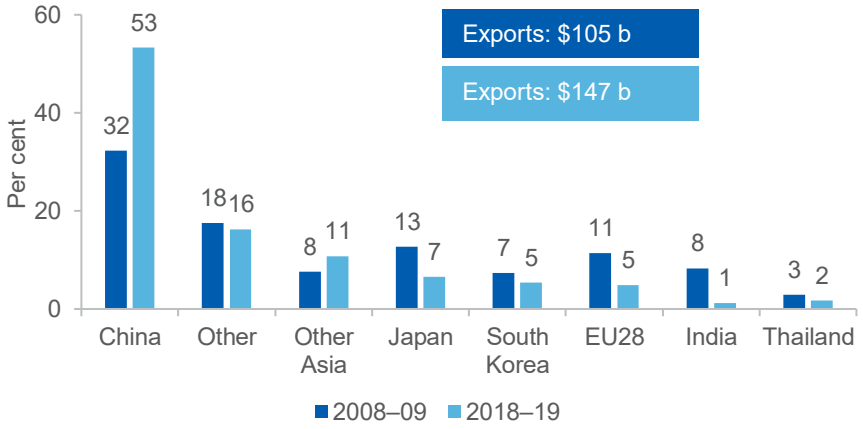
Source: ABS (2019) Australian National Accounts, National Income, Expenditure & Production, 5204.0

Figure 18.2: Principal markets for Australia's resources and energy exports, 2019–20 dollars



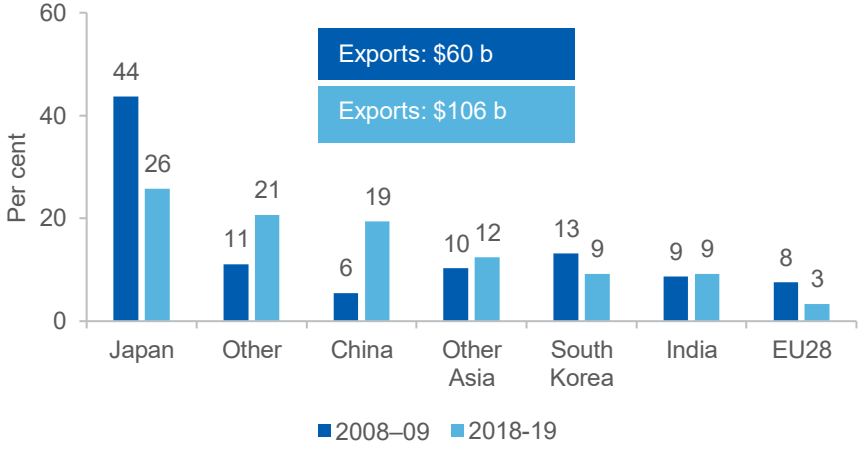
Source: ABS (2019) International Trade in Goods and Services, 5368.0

Figure 18.3: Principal markets for Australia's resources exports, 2019–20 dollars



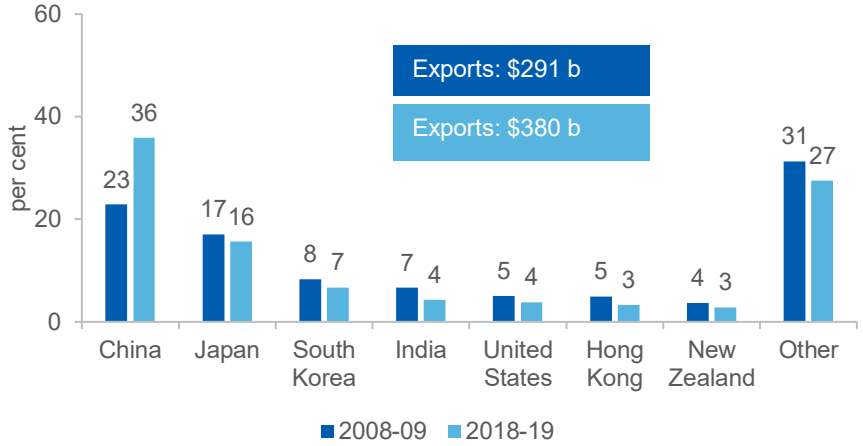
Source: ABS (2019) International Trade in Goods and Services, 5368.0

Figure 18.4: Principal markets for Australia's energy exports, 2019–20 dollars



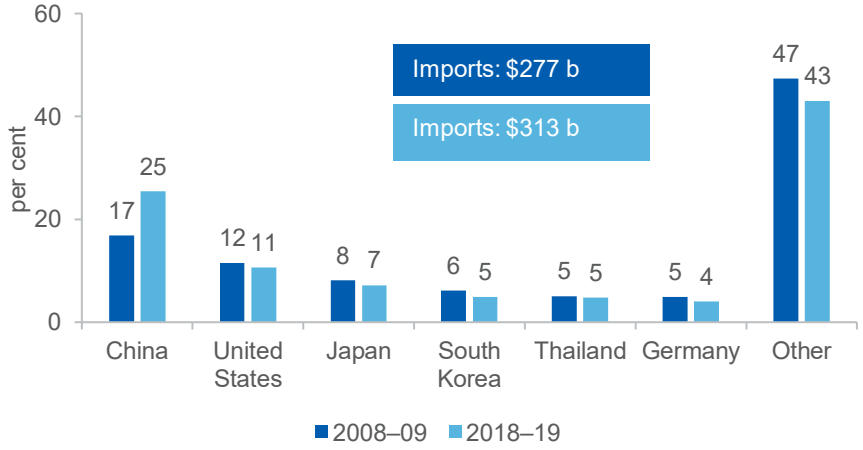
Source: ABS (2019) International Trade in Goods and Services, 5368.0

Figure 18.5: Principal markets for Australia's total exports, 2019–20 dollars



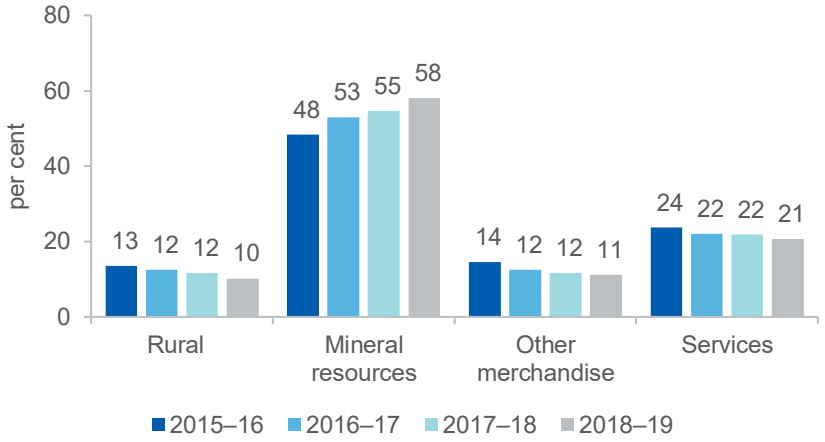
Source: ABS (2019) International Trade in Goods and Services, 5368.0

Figure 18.6: Australia's total imports by country of origin, 2019–20 dollars



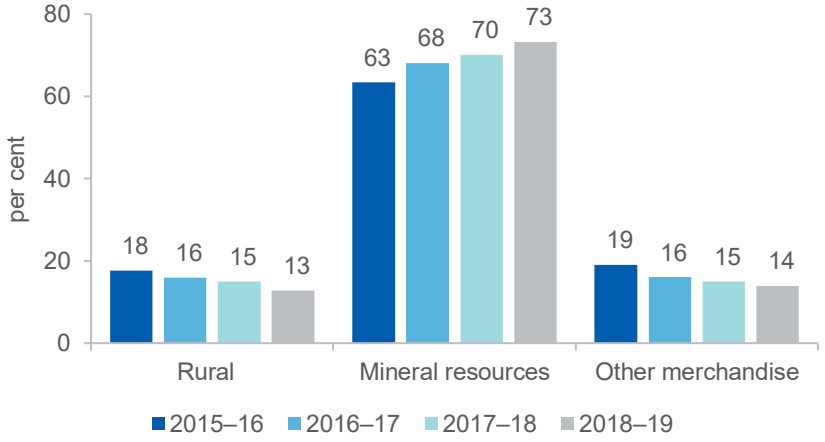
Source: ABS (2019) International Trade in Goods and Services, 5368.0

Figure 18.7: Proportion of goods and services exports by sector



Source: ABS (2019) Balance of Payments and International Investment Position, 5302.0

Figure 18.8: Proportion of merchandise exports by sector



Source: ABS (2019) Balance of Payments and International Investment Position, 5302.0

Table 18.1: Principal markets for Australia's thermal coal exports, 2019–20 dollars

	Unit	2014–15	2015–16	2016–17	2017–18	2018–19
Japan	$m	7,757	7,364	8,715	10,214	11,885
China	$m	2,990	1,865	3,711	4,919	4,319
South Korea	$m	2,916	2,715	2,713	3,085	3,895
Taiwan	$m	1,931	1,696	2,391	2,669	3,235
Malaysia	$m	638	528	681	776	924
Vietnam	$m	4	107	154	133	678
Total	**$m**	**17,557**	**15,878**	**20,003**	**23,450**	**26,524**

Source: ABS (2019) International Trade in Goods and Services, 5368.0

Table 18.2: Principal markets for Australia's metallurgical coal exports, 2019–20 dollars

	Unit	2014–15	2015–16	2016–17	2017–18	2018–19
India	$m	5,581	5,039	9,008	10,035	11,668
China	$m	5,312	4,234	8,238	8,865	10,264
Japan	$m	5,134	4,765	7,469	7,687	7,949
South Korea	$m	2,649	2,281	3,971	3,881	4,177
Taiwan	$m	1,269	1,062	1,961	2,046	2,697
Netherlands	$m	910	985	1,996	1,860	1,831
Total	**$m**	**23,833**	**21,301**	**37,394**	**39,239**	**44,557**

Source: ABS (2019) International Trade in Goods and Services, 5368.0

Table 18.3: Principal markets for Australia's crude oil and refinery feedstocks exports, 2019–20 dollars

	Unit	2014–15	2015–16	2016–17	2017–18	2018–19
Indonesia	$m	1,987	678	1,072	1,219	1,995
Singapore	$m	4	155	452	608	1,675
Thailand	$m	1,378	747	596	1,197	1,144
South Korea	$m	29	759	748	654	1,030
China	$m	1	483	476	718	709
Malaysia	$m	36	381	971	1,358	662
Total	**$m**	**9,632**	**5,949**	**5,894**	**7,224**	**9,273**

Source: ABS (2019) International Trade in Goods and Services, 5368.0

Table 18.4: Principal markets for Australia's LNG exports, 2019–20 dollars

	Unit	2014–15	2015–16	2016–17	2017–18	2018–19
Japan	$m	15,641	11,336	11,971	15,067	22,116
China	$m	1,428	3,164	6,036	9,926	18,347
South Korea	$m	1,039	1,807	2,704	3,829	5,540
Taiwan	$m	44	172	269	776	1,964
Singapore	$m	154	428	1,514	1,179	1,193
Malaysia	$m	122	202	221	377	785
Total	**$m**	**18,459**	**17,841**	**23,608**	**32,089**	**50,835**

Notes: Department of Industry, Innovation and Science estimates based on International Trade Centre data, except for 2016–17 where ABS trade data is available.

Source: ABS (2019) International Trade in Goods and Services, 5368.0; International Trade Centre (2019) International Trade Statistics 2001–2018

Table 18.5: Principal markets for Australia's iron ore exports, 2019–20 dollars

	Unit	2014–15	2015–16	2016–17	2017–18	2018–19
China	$m	62,181	45,133	41,000	53,578	51,117
Japan	$m	10,537	7,178	4,951	5,600	5,438
South Korea	$m	6,648	4,338	3,228	4,063	3,678
Taiwan	$m	1,864	1,391	1,080	1,489	1,259
India	$m	45	117	7	5	306
Indonesia	$m	45	30	57	45	45
Total	**$m**	**81,416**	**58,442**	**50,541**	**65,097**	**62,616**

Source: ABS (2019) International Trade in Goods and Services, 5368.0

Table 18.6: Principal markets for Australia's aluminium exports, 2019–20 dollars

	Unit	2014–15	2015–16	2016–17	2017–18	2018–19
Japan	$m	1,215	1,562	737	969	1,401
South Korea	$m	743	824	1,179	770	861
Thailand	$m	331	307	284	319	382
Taiwan	$m	484	524	315	215	334
Indonesia	$m	213	147	100	158	186
China	$m	254	54	99	53	34
Total	**$m**	**3,896**	**4,168**	**3,474**	**3,292**	**4,093**

Source: ABS (2019) International Trade in Goods and Services, 5368.0

Table 18.7: Principal markets for Australia's copper exports, 2019–20 dollars

	Unit	2014–15	2015–16	2016–17	2017–18	2018–19
China	$m	4,294	3,908	3,792	2,805	3,842
Japan	$m	1,771	2,133	1,510	1,410	1,556
Malaysia	$m	666	565	653	894	888
India	$m	1,030	861	542	710	854
South Korea	$m	637	392	518	464	296
Philippines	$m	311	269	232	413	170
Total	**$m**	**9,493**	**9,078**	**8,576**	**7,868**	**8,619**

Source: ABS (2018) International Trade in Goods and Services, 5368.0

Table 18.8: Principal markets for Australia's gold exports, 2019–20 dollars

	Unit	2014–15	2015–16	2016–17	2017–18	2018–19
Hong Kong	$m	165	203	2,669	9,992	8,202
United Kingdom	$m	698	625	4,165	4,068	3,334
China	$m	8,814	7,454	6,922	2,411	2,997
Singapore	$m	2,478	3,338	1,264	314	1,180
Thailand	$m	485	962	268	553	1,165
Switzerland	$m	376	16	91	234	797
Total	**$m**	**14,185**	**13,987**	**16,587**	**18,726**	**19,264**

Source: ABS (2018) International Trade in Goods and Services, 5368.0

Appendices

Appendix A
Definitions and classifications

A.1 Exchange rates

In this report, the AUD/USD exchange rate (Australian dollar relative to the US dollars) is based on the median of economic forecasters at the time that the report is prepared. The source is the Bloomberg survey of economic forecasters.

World commodity prices are typically denominated in US dollars, and exchange rate movements can have a significant effect on the actual outcomes of commodity prices and export earnings. A change in the value of the US dollar against other floating international currencies can influence movements in world resources and energy prices. A change in the Australian dollar against the US dollar will impact on export earnings for domestic commodity exporters and producers. There is substantial uncertainty surrounding any exchange rate forecast, with changes to exchange rates influenced by changes in financial market sentiment, sometimes resulting in strong volatility.

A.2 Conversion to real dollars

Nominal values and prices are converted to real dollars using on the Australian and US consumer price indexes (CPI). The Australian and US CPI forecasts are based on the median of economic forecasters at the time that the report was prepared. The source is the Bloomberg survey of economic forecasters.

A.3 Time periods

The terms 'estimate', 'forecast' and 'projection' refer to different time periods in this report. Estimate refers to a time period that has passed, but for which full historical data is not yet available, while 'forecast' and 'projection' refer to different periods in the future. It is important to distinguish between different future time horizons, as factors affecting production, consumption and prices in the short-term differ from factors affecting these components in the medium to long-term. Forecasts also become increasingly imprecise over longer time horizons, due to increased risk and uncertainty. For these reasons, the OCE uses different terminology to distinguish between short-term forecasts and medium to long-term projections, as outlined in *Table A2*.

Table A1: OCE terminology for different time periods/horizons

Period	Years	Terminology
Historical	Time period has passed but complete for data for the period is not yet available	Estimate
Short-term	1 to 2 years	Forecast
Medium-term	3 to 5 years	Projection
Long-term	Beyond 5 years	n/a

Source: Department of Industry, Innovation and Science (2019)

A.4 Commodity classifications

The Office of the Chief Economist (OCE) defines exports for each commodity by a selected set of 8-digit Australian Harmonised Export Commodity Classification (AHECC) codes. Where possible, the choice of AHECC codes is based on alignment with international trade data, to ensure that direct comparisons can be made. For example, groupings for various commodities are aligned with classifications used by the International Energy Agency, World Steel Association, International Nickel Study Group, International Lead and Zinc Study Group, International Copper Study Group and World Bureau of Metal Statistics.

In this report, benchmark prices and Australian production and exports are forecast for 21 commodities, as shown in *Table A3*. In estimating a total for Australia's resources and energy exports, the remaining commodities, defined as 'other resources' and 'other energy', are forecast as a group.

Table A2: Resources and energy commodities groupings and definitions

	Resources (non-energy)	Energy
Definition	Resource commodities are non-energy minerals and semi-manufactured products produced from non-energy minerals	Energy commodities are minerals and petroleum products that are typically used for power generation
Australian Harmonised Export Commodity Classification (AHECC) chapters	25 (part); 26 (part); 28 (part); 31 (part); 73 (part); 74; 75; 76; 78; 79; 80; 81	27 (part)
Commodities for which data is published, forecasts are made and analysed in detail in this report	Aluminium; alumina; bauxite; copper; gold; iron ore; crude steel; nickel; zinc, lithium	Crude oil and petroleum products; LNG; metallurgical coal; thermal coal; uranium

Notes: The AHECC chapter is the first two digits of the trade code. Groupings are made at the 8-digit level.

Source: Department of Industry, Innovation and Science (2018)

Appendix B Glossary

Term	Description
A$	Australian dollar
ABS	Australian Bureau of Statistics
AISC	All-In Sustaining Cost — an extension of existing cash cost metrics and incorporates costs related to sustaining production.
Base metals	A common metal that is not considered precious (includes aluminium, copper, lead, nickel, tin, zinc)
Bbl	Barrel
Bcm	Billion cubic metres
Benchmark	A standard specification used to price commodities.
BF and BOF	Blast furnace and basic oxygen furnace — used in an integrated steelmaking process that uses iron ore and coal.
Bulks	Non-liquid and non-gaseous commodities shipped in mass and loose (iron ore, coal, bauxite)
CAGR	Compound annual growth rate
Capex	Capital expenditure
CFR	Cost and freight — Seller clears exports, and pays freight.
Coal Seam Gas (CSG)	Natural gas found in coal seams. Also known as Coal Bed Methane (CBM)
Coke	Made by heating coal at high temperatures without oxygen, and used to reduce iron ore to molten iron saturated with carbon, called hot metal
Conventional gas	Natural gas that can be produced from reservoirs using traditional techniques. Contrasts with unconventional gas.
CPB	CPB Netherlands Bureau for Economic Policy Analysis

CPI	Consumer Price Index — measures quarterly changes in the price of a basket of goods and services which account for a high proportion of expenditure by the CPI population group (i.e. metropolitan households).
Crude steel	Steel in the first solid state after melting, suitable for further processing or for sale.
DES	Delivered Ex Ship — price of LNG including shipping and insurance.
DMO	Domestic Market Obligation — a policy to reserve energy commodities for domestic usage
ECB	European Central Bank
Economic growth	An increase in the capacity of an economy to produce goods and services, compared from one period of time to another. It is measured in nominal or real gross domestic product (GDP).
EIA	The United States Energy Information Administration
EAF	Electric arc furnace — a furnace that melts steel scrap using the heat generated by a high power electric arc.
ETF	Exchange Traded Fund — an exchange traded fund that allows investors to invest in gold on the exchange.
EUV	Export unit value — export value/volumes exported
f	Forecast — a two year outlook
FID	Final investment decision
FOB	Free on board — seller clears export, buyer pays freight.
GAD	Gross air dried basis — For measuring coal quality.
GAR	Gross as received basis — For measuring coal quality.
GBP	Great Britain Pounds
GDP	Gross Domestic Product — measures the value of economic activity within a country/group.
GFC	Global Financial Crisis — the period of extreme stress in global financial markets and banking systems between mid-2007 and early 2009.
Gj	Gigajoule

GST	Goods and Services Tax — a value-added tax levied on most goods and services sold for domestic consumption.
GST	Goods and Services Tax
HCC	Hard coking coal — The best grade of metallurgical coal used in the steel production process. Australian hard coking coal is regarded as the industry benchmark.
IEA	International Energy Agency
IMF	International Monetary Fund — an international organisation that promotes international financial stability and monetary cooperation.
IMO	International Maritime Organisation
IP	Industrial Production — measures the output of the industrial sector that comprises mining, manufacturing, utilities and construction.
ISM	US Institute for Supply Management
ISM	Institute of Supply Management
JCC	Japan Customs-cleared Crude (or Japan Crude Cocktail) — average price of crude oil imported by Japan and a common price index in long-term LNG contracts.
JFY	Japanese fiscal year
kcal/kg	Kilocalories per kilogram
kt	Thousand tonnes
ktpa	Kilotonnes per annum
LBMA	London Bullion Market Association
LCE	Lithium Content Equivalent
Li OH	Lithium Hydroxide
LME	London Metal Exchange
LNG	Liquefied natural gas

LPG	Liquefied petroleum gas
LVPCI	Low volatile pulverised coal injection — a type of low volatile coal used in the PCI process
m	Million
MMbtu	Million British thermal units
Mt	Million tonnes
mtpa	Million tonnes per annum
Nameplate capacity	The theoretical maximum annual production capacity
NAR	Net as received basis — For measuring coal quality
NDRC	China's National Development and Reform Commission
NEV	New energy vehicle — term used for plug-in electric vehicles eligible for public subsidies (battery electric vehicles and plug-in hybrid vehicles)
OECD	Organisation for Economic Co-operation and Development
OPEC	Organisation of Petroleum Exporting Countries, a formal alliance of 14 countries to collaborate to manage the world oil market
OPEC+	Informal term for agreements between OPEC and ten other oil-producing countries (which are not members of OPEC)
Oz	Ounce
PCE	Personal Consumption Expenditure — a measure of the changes in price of consumer services and goods.
PCI	Pulverised coal injection — PCI coal is used for its heat value and injected directly into blast furnaces as a supplementary fuel, which reduces the amount of coke required.
PCI	Pulverised coal injection — a process used in blast furnace operations
PM	The afternoon price of gold set at 3.00pm each business day at the London Bullion Market Association
PMI	Purchasing Managers Index — an indicator of economic health for manufacturing and service sectors.

PPP	Purchasing Power Parity — a way of measuring economic variables in different countries that equalise the purchasing power of different currencies
RoW	Rest of world
s	Estimate — Incomplete data or subject to revision
Shale gas	Natural gas found in shales
SDR	Special drawing right
SHFE	Shanghai Futures Exchange
SSCC	Semi-soft coking coal — A type of metallurgical coal used in the steel production process alongside hard coking coal, but results in a lower coke quality and more impurities.
Tariff	A tax on imports or exports that is used by governments to generate revenue or to protect domestic industries from competition.
Tight gas	Natural gas found in low quality reservoirs
TWI	Trade Weighted Index — a measure of the foreign exchange value of the US dollar against a basket of major foreign currencies.
UK	United Kingdom
Unconventional gas	Natural gas that is more difficult to extract, including coal seam gas, shale gas and tight gas. Contrasts with conventional gas.
US	United States
US$	United States dollar
WEO	The International Energy Agency's World Energy Outlook
WTI	West Texas Intermediate crude oil price
z	Projection — a five year outlook

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