DISCUSSION PAPER

REVIEW AND FORECAST OF THE PNG ECONOMY

MID-YEAR 2018 REPORT

Theo Levantis

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Theo Levantis
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(a) the promotion of research into Papua New Guinea society and the economy
(b) the undertaking of research into social, political and economic problems of Papua New Guinea in order to enable practical solutions to such problems to be formulated.

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About the Authors

Dr Theo Levantis is an economist with a depth of experience and expertise across a broad range of development issues. He has experience in a variety of institutional settings — an academic at the Australian National University; a senior economist at ABARES; an economics advisor at AusAID, the former Australian Aid agency; and more recently, a consultant providing advisory services for the Governments of PNG and Fiji. Theo has extensive research and policy experience in PNG and the Pacific including in the themes of Aid policy, development planning, labour market analysis, the economics of crime, infrastructure development, privatisation, tax policy, tourism, mining, agriculture, forestry, energy, climate change, and land policy. He completed his PhD on the PNG labour market at the ANU in 1996 and has published four books and more than 20 articles in refereed journals. Theo also brings considerable experience in economic modelling having developed economy-wide models of PNG, Fiji and Australia.
# Abbreviations and Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>APEC</td>
<td>Asia–Pacific Economic Cooperation</td>
</tr>
<tr>
<td>BBTU</td>
<td>billion British thermal units</td>
</tr>
<tr>
<td>EITI</td>
<td>Extractive Industries Transparency Initiative</td>
</tr>
<tr>
<td>GDP</td>
<td>gross domestic product</td>
</tr>
<tr>
<td>IMF</td>
<td>International Monetary Fund</td>
</tr>
<tr>
<td>K</td>
<td>Kina</td>
</tr>
<tr>
<td>LNG</td>
<td>liquefied natural gas</td>
</tr>
<tr>
<td>MMBTU</td>
<td>million million British thermal units</td>
</tr>
<tr>
<td>MYEFO</td>
<td>Mid-Year Economic and Fiscal Outlook</td>
</tr>
<tr>
<td>OPEC</td>
<td>Organization of the Petroleum Exporting Countries</td>
</tr>
<tr>
<td>PNG</td>
<td>Papua New Guinea</td>
</tr>
<tr>
<td>PNGDSP</td>
<td>Papua New Guinea Development Strategic Plan</td>
</tr>
<tr>
<td>PNG NRI</td>
<td>Papua New Guinea National Research Institute</td>
</tr>
<tr>
<td>PNGGEM</td>
<td>Papua New Guinea General Equilibrium Model</td>
</tr>
<tr>
<td>US</td>
<td>United States</td>
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</table>
Abstract

This report is a snapshot of the economic developments in Papua New Guinea (PNG) around the second part of 2018 and within the context of the global economy. This includes developments in the PNG economy in 2017 and into 2018, a period that was dominated by a devastating earthquake in February 2018. The analysis includes an assessment of the market outlook for PNG’s primary commodities, including 10-year forecasts of commodity prices. The economic modelling results show that the earthquake hit the mining, oil and gas sector very hard as it contracted by 5.9 percent in 2018. A rebound of 12.1 percent growth was forecast for 2019 led by recovery in the oil and gas fields and the Porgera mine, as well as stronger performances at the Lihir, Hidden Valley, and Ok Tedi mines. The new resource operations will boost other sectors of the economy — particularly construction, transport and commerce — with growth forecast across the years to average 9.2 percent (2024 to 2025), 9.8 percent (2025 to 2026) and 8.6 percent (2026 to 2027). Implementation of the Government’s development agenda — road infrastructure, utility infrastructure, education, higher education, and health — would lead to ongoing productivity gains that will lead to a sustained lift in economic growth. As a result, over the years 2019–2027, non-resource GDP is forecast to grow at an average of 5.1 percent a year. As we approach the mid-2020s, the PNG economy will take another step up as the new resource projects come on stream. Significant revenues may not become available until the end of the decade or into the 2030s. But when they do begin to flow, PNG will have the funding boost that will enable it to reach its aspirations of becoming a middle-income country — as articulated in PNG Vision 2050.
Introduction

This report is the latest in the series of economic reviews of Papua New Guinea (PNG) first produced in 2015 at the PNG National Research Institute (PNG NRI). The purpose of the report is to provide a snapshot of the latest economic developments in PNG as it stands in the second part of 2018 and within the context of the global economy. PNG’s economic prospects looking 10 years into the future are analysed and economic forecasts are produced using PNG General Equilibrium Model (PNGGEM), an economic model that is jointly operated by PNG NRI and The University of Queensland (Levantis, 2004).

PNG is intricately connected to the global economy — even in remote Highlands regions where coffee is exported across the globe — so the process of understanding the status of the PNG economy and its outlook begins with a look at what is happening in the world economy, which is focus of Section 2. Section 3 looks at developments in the PNG economy in 2017 and into 2018, which is a period dominated by a devastating earthquake in February 2018. Section 4 analyses the global markets for PNG’s commodities, assesses their outlook, and provides 10-year forecasts of commodity prices. Almost all of PNG’s exports are primary commodities produced by the agricultural, mining, oil and gas sectors.

Section 5 takes a close look at developments in PNG’s mining, oil and gas sector. The scale of individual operations in the sector is very large and developments in any individual operation can have substantial flow-on effects to the rest of the economy. This is no more the case than the upcoming Papua liquefied natural gas (LNG) gas project (hereafter called the Papua LNG project), which is expected to be as large as the existing LNG Project. On the basis of the analysis in Sections 2 to 5, Section 6 provides 10-year economic forecasts obtained using PNGGEM. The focus is on non-resource gross domestic product (GDP) — which is a much better indicator of PNG’s economic performance than GDP — employment, sectoral growth, and fiscal performance. Section 7 draws conclusions.
At the end of the November 2018 Asia–Pacific Economic Cooperation (APEC) summit held in Port Moresby, Prime Minister O'Neill summed up developments on the world stage with eloquence: “the entire world is worried” (Bacon, 2018). The World Bank in its 2018 report flagged an increased probability of a slowdown in global growth (World Bank Group, 2018a). The International Monetary Fund (IMF) stated in their World Economic Outlook report that “Escalating trade tensions and the potential shift away from a multilateral, rules-based trading system are key threats to the global outlook” (IMF, 2018, p. 20).

Over the years 2014 to 2017 and continuing into 2018, the global economy enjoyed a period of stable and solid growth under conditions of low and stable inflation and interest rates. This period therefore marks the end of the global financial crisis and provides the foundation for a positive future.

Economic stability, global trading conditions, and global institutions that uphold the world economic order, including the World Trade Organization, have all come under attack. For the longer term, the attempts by the Trump administration to direct the wrecking ball on global agreements to wind back greenhouse gas emissions will lead to considerable risks to global economic growth and of environmental catastrophe if they succeed. According to the United States (US) Government’s Fourth National Climate Assessment (volume II) released in 2018, “Without substantial and sustained global mitigation and regional adaptation efforts, climate change is expected to cause growing losses to American infrastructure and property and impede the rate of economic growth over this century” (US Global Change Research Program, 2018, p. 25).

More immediately, two key developments pose considerable risk to the global economy. First, the US Government has embarked on a major program of fiscal stimulus that will blow out the budget deficit to 5.0 percent of GDP. Normally, policies of fiscal expansion are implemented in times of recession, but in this case it is implemented in a time when the economy was already robust. The consequences are likely to manifest in inflationary pressures and higher interest rates that will have global ramifications. These impacts were already beginning to be witnessed in the second half of 2018. Looking further ahead, the pro-cyclical economic stimulus will limit any capacity for fiscal expansion in times when the economy is weak as the debt to GDP ratio has now reached 106.0 percent of GDP — more than three times higher than it is in PNG.

Second, the US Government is erecting trade barriers and embarking on trade wars with Europe and especially China. This poses a considerable risk to global trade and is a threat to the sophisticated global value chains that have developed over recent decades. A trade war will threaten the system of global value chains and its future development. Moreover, policy uncertainty is the antithesis of a healthy investment environment, so it is inevitable that trade policy uncertainty among the global giants will have flow-on consequences for investment.

Global economic growth reached 3.7 percent in 2017, which was up from 3.3 percent in 2016 (IMF, 2018). Similar growth (3.7 percent) is forecast in 2018 and 2019, albeit with the downside risks discussed above. In a sign of the newfound stability in the global economy over the past few years, there were no advanced economies in recession in 2017. The lowest growth rates were recorded in Italy (1.5 percent) and Greece (1.4 percent).

The US recorded growth of 2.2 percent in 2017 and is forecast to rise to 2.9 percent in 2018 on the back of the fiscal expansion. But in the face of the risks outlined above, the IMF has downgraded its outlook to forecast that growth will fall to 1.4 percent by 2023. This will drag down the average growth rate among advanced economies to 1.5 percent. If the wrecking ball does enough damage, things could be even worse than this forecast.

Global growth, however, is forecast by the IMF to remain healthy, averaging 3.6 percent over the years 2020–2023 on the back of sustained growth in emerging market and developing economies of 4.9 percent on average (Figure 1). In comparison, growth among advanced economies is forecast to average 1.6 percent. The bias of growth forecasts towards the less advanced economies is in line with the experience of recent decades. During the period 2010–2019, global growth is expected to average 3.8 percent compared with 5.2 percent for less advanced economies and 2.0 percent for advanced economies. This is good news because it means that the divide between
rich and poor countries is closing. In even better news for PNG, growth among its neighbours in the Asia-Pacific region continues to lead the world, averaging 7.1 percent over the years 2010–2019 (Figure 1).

**Figure 1: The uneven pattern of economic growth across the globe: Average annual growth 2000–2023**

Source: Calculated from data in the IMF (2018) report.

The relentless pace of growth among the developing countries of the Asia-Pacific has catapulted the region into a world power. In 2017, the European Union, the US and developing Asia-Pacific all held roughly equal shares of the global economy of 21.6 percent, 24.3 percent and 21.8 percent respectively (Figure 2). The pace of change has been quite remarkable with developing Asia-Pacific making up just 6.9 percent of the world economy in 2000. The focus of the global economy on Asia-Pacific will gather pace so that by 2023 its share of the global economy is forecast to jump to 26.0 percent. The emergence of the Asia-Pacific as a global force has meant that the pieces of the economic pie are distributed more broadly, which should be a good thing for global economic stability.

**Figure 2: The changing distribution of global economic activity, 2000, 2010, 2017, and 2023**

Source: Calculated from data in the IMF (2018) report.
The devastating earthquake of February 2018 is the dominant story for the PNG economy in 2018. Sadly, about 200 lives were lost and many more were injured. The damage to infrastructure was extensive and agriculture was impacted with many food gardens destroyed. Production at the LNG Project and in the Southern Highlands oil fields came to a halt and production at the Porgera gold mine was disrupted. According to PNG Treasury, the economic impact of the earthquake for the 2018 year will be 1.4 percent of GDP (Government of PNG, 2017). It is likely that the economic impact will be greater than this once the full impact on subsistence food gardens is accounted for.

For 2017, PNG Treasury estimates that the economy grew by 3.0 percent (Table 1). The resources sector was the key driver of growth in 2017 with mining GDP growing 13.1 percent and oil and gas GDP growing 8.5 percent. These gains are built on higher resources sector production, which is elaborated upon in Section 6. Ongoing fiscal restraint is holding back the non-resource economy, which is estimated to have grown by just 0.2 percent in 2017. With infrastructure spending being reined in, the construction sector has taken a particular hit, contracting 8.0 percent in 2017. The composition of the PNG economy has altered significantly since 2014 as a result of the LNG Project kicking off. The resource sector has grown in importance to reach 29.7 percent of the economy in 2017, while the non-resource sector has shrunk to just 70.3 percent of the economy, down from 86.4 percent in 2013 (Table 1).

**Table 1: Real growth and composition of GDP in 2017**

<table>
<thead>
<tr>
<th>Real growth</th>
<th>Composition of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, forestry, fishing</td>
<td>1.8%</td>
</tr>
<tr>
<td>Oil and gas</td>
<td>8.5%</td>
</tr>
<tr>
<td>Mining</td>
<td>13.1%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1.5%</td>
</tr>
<tr>
<td>Construction</td>
<td>-8.0%</td>
</tr>
<tr>
<td>Commerce, hotels, restaurants</td>
<td>0.7%</td>
</tr>
<tr>
<td>Government administration</td>
<td>3.0%</td>
</tr>
<tr>
<td>Other services</td>
<td>0.8%</td>
</tr>
<tr>
<td>Total non-resource GDP</td>
<td>0.2%</td>
</tr>
<tr>
<td>GDP</td>
<td>3.0%</td>
</tr>
</tbody>
</table>

*Source: Compiled from PNG Treasury estimates for 2017 GDP reported in Appendix Table 1 of the Budget Papers.*

According to the Mid-Year Economic and Fiscal Outlook (MYEFO) report of 2018 produced by the PNG Treasury, total Government spending reached K13.3 billion in 2017, which left a budget deficit of K1.8 billion or 2.4 percent of GDP (Government of PNG, 2018). This is a moderate budget deficit by international standards, but spending is very low in comparison to other countries at just 17.6 percent of GDP. This is down from 18.3 percent of GDP in 2016 and 20.5 percent of GDP in 2015 and is a mark of the recent austerity program of the Government.

For 2018, MYEFO revised up expectations of spending to K14.9 billion compared with K14.7 billion in the 2018 budget released in November 2017. This is a moderate revision when considered against the resources that have gone into the disaster relief efforts following the February 2018 earthquake and in view of spending for the APEC summit of November 2018. As a share of GDP, spending in 2018 is expected to rise to 18.2 percent of GDP, which is a return to the 2016 level.
The problem behind the tight spending conditions comes from the revenue that was decimated by the collapse in oil, gas, and copper prices over the years 2014–2016. Despite the successful start of the LNG Project in 2014, mining and petroleum taxes amounted to just K86 million in 2016, which compares to K1,239 million prior the LNG Project in 2012 and K2,074 million in 2011. In 2017 and continuing into 2018, mining and petroleum taxes continued to struggle according to the MYEFO: just K114 million was collected in 2017 and an expected K160 million is expected to be raised in 2018.

Tax revenues are by far the most important way for the mining and petroleum sector to contribute to the PNG economy. As such, these low outcomes are remarkable and point to a severe and fundamental problem with the way revenue is raised from the resources sector. These amounts need to be measured against the value of minerals extracted from PNG’s soil and sold abroad. In 2017, mineral exports reached K24,727 million, which means tax revenues accounted for just 0.4 percent of the value of resources extracted. Looked at another way, mining and petroleum taxes amounted to just 1.2 percent of the K9.1 billion in taxes raised in 2017 and to 1.6 percent of the K9.8 billion MYEFO expects to raise in 2018 — despite the mining and petroleum sector accounting for 30.0 percent of PNG’s economy (Table 1).
Crude oil

The only predictable aspect of the global market for crude oil is its unpredictability. Crude oil prices have a long history of extreme volatility. Concurrently, forecasters have a long history of getting oil price forecasts dreadfully wrong. For example, the July 2017 IMF release of commodity price forecasts predicted crude oil prices would average US$49 a barrel in 2018 and the World Bank's Commodity Markets Outlook October 2018 report (World Bank Group, 2018a) predicted US$56 a barrel. In the first three quarters of 2018, average oil prices were US$70 a barrel, barely resembling the forecasts.

At the core of the volatile nature of global oil markets is the Organization of the Petroleum Exporting Countries (OPEC) cartel — a collection of some of the world's leading oil-producing countries — whose function is to constrain the supply of oil in order to force prices to lift above what they otherwise would be in a free market. Prevailing prices are then contingent on how successful OPEC is in enforcing supply constraints. In times of success, prices are high; when cooperation fails and agreements break down, prices collapse. In recent years, the strength of the cartel has weakened as production in the US, Russia and other non-OPEC countries have ramped up. However, in 2017, the cartel's strength was boosted by forging an agreement with a number of non-OPEC countries, including Russia (OPEC, 2017). This agreement has been the basis from which oil prices have surged — rising from an average of US$42.80 a barrel in 2016 to US$52.80 in 2017 and an expected average of US$71.00 in 2018 (Table 2).

Forecasting oil prices is mostly about trying to predict how successful the cartel arrangements will be in enforcing compliance to supply restrictions. It is also about trying to predict the success of ongoing cooperation to forge regular updates to their agreements. So far in 2018, there is no sign of any weakening in the arrangements. It was agreed late in 2018 to increase production among the signatories to counter falls in production in Venezuela and Iran. Venezuela has endured political, social and economic unrest that has spilled over to its oil production. For Iran, the problem lies in US sanctions due to be applied to oil exports late in 2018 that are aimed at wiping out Iran's export market. Exports had already fallen sharply before the sanctions as market players readjusted their arrangements in anticipation of the sanctions.

Perhaps coincidently, oil production in the US has increased as higher oil prices enable idle high cost producers to unlock their capacity. By August 2018, oil production in the US had reached 11.3 million barrels a day compared with an average of 9.4 million barrels a day in 2017 (Energy Information Agency, 2018). If natural gas liquids are included, oil production reached 13.1 million barrels a day in 2017, making the US the world's largest producer of oil. The surge in US production during 2018 — in combination with increased production among the OPEC and non-OPEC cartel countries — is being accommodated in global markets by the falls in production in Venezuela and Iran.

In contrast to the volatile and unpredictable characteristics in the supply of crude oil, demand for crude oil tends to follow a predictable trend of steady growth. In 2017, global consumption of crude oil averaged 98.2 million barrels a day, up by 1.8 percent of the 2016 level of 96.5 million barrels a day. In a remarkable show of consistency, the growth rates in 2015 and 2016 were 1.9 percent and 1.8 percent respectively and there is no reason to expect anything different in 2018.

Behind the consistent growth in global consumption is a changing structure in the composition of demand. Consumption across most developed nations is falling. For example, consumption in Japan — the world's fourth largest consumer — dropped to 4.0 million barrels a day in 2017 compared with 4.4 million in 2010 and 5.5 million in 2000. Most European countries are also seeing falls while consumption in the US of 19.9 million barrels a day compares with 19.2 million in 2010 and 19.7 million in 2000. It is growth in developing countries that is driving global growth. China has accounted for 35 percent of global consumption growth since 2010 and India for 15.0 percent.

The global market for PNG’s commodities
Consumption growth among developing countries is being driven by rapid economic growth that is in turn driving a rapid uptake of motor vehicles — both cars and commercial vehicles. Against this, motor vehicles are becoming increasingly efficient. This explains the falls found in rich nations. Going forward, one would expect that these trends will continue.

However, the global auto industry is at the beginning of a technology-driven revolution — much like the personal computer revolution of the 1980s and 1990s and the smartphone revolution of the past decade — that will shake up the crude oil industry in the years and decades to come. The world’s major manufacturers — including the two biggest, Volkswagen and Toyota, — are beginning a full-scale rollout of electric vehicles. Volkswagen announced they will unveil a new model of electric car almost every month — with 80 new models on sale in 2025, by which time sales are expected to reach 1 million a year (Volkswagen, 2017; Volkswagen, 2018). Toyota announced that electric-only models will soon become available across its range (Toyota, 2017).

In an ominous sign for the global oil industry, China is the focal point for the electric car revolution. With government support, electric vehicle sales in China are expected to reach 1 million in 2018, up from just 40,000 in 2014, and there are cities that have already converted their bus fleet to fully electric. In the meantime, European nations are taking a regulatory approach to fast-tracking the electrification of the vehicle fleet. For example, diesel and gasoline vehicles will be banned in Paris in 2030.

It is inevitable that global consumption of oil will taper within a short number of years. This will present a considerable and perhaps insurmountable challenge to the OPEC and non-OPEC cartel arrangements that will require an ongoing perennial downscaling of production targets. Success on this front will mean prices for crude oil will hold up in the face of declining demand. But success under these circumstances could be a step too far; instead, a breakdown in OPEC arrangements and a collapse in oil prices would be more likely. As it stands, the World Bank is forecasting oil prices will hold up at US$70 a barrel in 2030. However, this forecast should be viewed as having considerable downside risk — in their October 2018 edition of Commodity Markets Outlook (World Bank Group, 2018a) they fail to even acknowledge the electric car revolution. It may be more realistic to expect prices to come down to US$30–US$40 a barrel or even less if the cartel breaks down.

Table 2: Actual and forecast prices for PNG’s commodities, 2013 to 2020 and 2027

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Coffee, Arabica</td>
<td>US$/tonne</td>
<td>3,675</td>
<td>3,610</td>
<td>3,320</td>
<td>2,850</td>
<td>2,890</td>
<td>2,940</td>
<td>3,256</td>
</tr>
<tr>
<td>Cocoa beans</td>
<td>US$/tonne</td>
<td>2,879</td>
<td>2,890</td>
<td>2,030</td>
<td>2,300</td>
<td>2,350</td>
<td>2,400</td>
<td>2,814</td>
</tr>
<tr>
<td>Coconut oil</td>
<td>US$/tonne</td>
<td>1,110</td>
<td>1,468</td>
<td>1,651</td>
<td>1,030</td>
<td>1,057</td>
<td>1,084</td>
<td>1,299</td>
</tr>
<tr>
<td>Palm oil</td>
<td>US$/tonne</td>
<td>767</td>
<td>639</td>
<td>649</td>
<td>570</td>
<td>592</td>
<td>615</td>
<td>806</td>
</tr>
<tr>
<td>Hardwood logs</td>
<td>US$/m3</td>
<td>278</td>
<td>274</td>
<td>265</td>
<td>270</td>
<td>275</td>
<td>281</td>
<td>321</td>
</tr>
<tr>
<td>Copper</td>
<td>US$/tonne</td>
<td>6,569</td>
<td>4,868</td>
<td>6,170</td>
<td>6,536</td>
<td>6,787</td>
<td>7,164</td>
<td>7,481</td>
</tr>
<tr>
<td>Nickel</td>
<td>US$/tonne</td>
<td>14,596</td>
<td>9,595</td>
<td>10,410</td>
<td>13,479</td>
<td>13,605</td>
<td>13,639</td>
<td>16,271</td>
</tr>
<tr>
<td>Cobalt</td>
<td>US$/tonne</td>
<td>29,000</td>
<td>26,000</td>
<td>56,000</td>
<td>67,000</td>
<td>50,000</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Gold</td>
<td>US$/ounce</td>
<td>1,279</td>
<td>1,249</td>
<td>1,258</td>
<td>1,282</td>
<td>1,286</td>
<td>1,281</td>
<td>1,185</td>
</tr>
<tr>
<td>Oil</td>
<td>US$/barrel</td>
<td>83.7</td>
<td>42.8</td>
<td>52.8</td>
<td>71.0</td>
<td>72.0</td>
<td>68.8</td>
<td>69.5</td>
</tr>
<tr>
<td>LNG</td>
<td>US$/MMBTU</td>
<td>14.3</td>
<td>7.4</td>
<td>8.6</td>
<td>10.0</td>
<td>9.7</td>
<td>8.5</td>
<td>9.9</td>
</tr>
<tr>
<td>Natural gas PNG</td>
<td>US$/MMBTU</td>
<td>6.4</td>
<td>7.7</td>
<td>10.3</td>
<td>10.5</td>
<td>10.0</td>
<td>10.1</td>
<td></td>
</tr>
</tbody>
</table>

LNG

Unfortunately, PNG’s biggest export, LNG, will get caught in the crossfire of the developments and possible future breakdown of the crude oil market. The market for PNG’s LNG exports has virtually no connection to the crude oil market. PNG’s LNG is predominantly used for electricity generation in Japan, China, and South Korea — the world’s three largest importers of LNG. Crude oil is mainly used for commercial and private motor vehicles. However, the long-term contracts negotiated with buyers for PNG’s LNG have locked in LNG prices at a fixed ratio to crude oil prices. This is a normal arrangement with East Asian buyers. If oil prices collapse over the next decade in the face of the electric car revolution, then revenue from PNG’s LNG exports will also collapse.

The basis for a buoyant outlook for LNG is that the emission intensity of generating electricity with gas is about half the emission intensity of coal. The Intergovernmental Panel on Climate Change has made it clear that to contain the impacts of climate change, coal will need to be banned worldwide by 2050 (Intergovernmental Panel on Climate Change, 2018). Under these circumstances, the primary energy mix in electricity generation is expected to shift sharply from coal in East Asia and elsewhere across the globe and shift towards renewables and to gas. China has already implemented policies to shift from coal to gas with a target of increasing the use of gas in the energy mix from 5.3 percent in 2015 to about 9.0 percent in 2020, and South Korea has implemented tax measures to encourage a shift from coal to gas (Department of Industry, Innovation and Science, 2018).

The global LNG trade grew by 15.9 percent in 2017 to reach 289.9 million tonnes and is expected to grow a further 11.0 percent in 2018 (Department of Industry, Innovation and Science, 2018). The growth impetus driven by demand is being more than matched by a rapid increase in production capacity. By 2019, Australia will have brought 10 gas projects on stream; this will elevate Australia to become the largest exporter in the world, ahead of Qatar. The US is expected to have six new projects operational by 2020, elevating it to the second-biggest producer. However, the trade war between China and the US may lead to a delay in US production reaching full capacity given the importance of the Chinese market. The forthcoming Total-led Papua LNG project (discussed in Section 5) will also be an important addition to global capacity.

With the rapid rise in capacity more than matched by a surge in demand, prices for LNG have firmed to an average of US$8.60 per million million British thermal units (MMBTU) in 2017 compared with US$7.40 per MMBTU in 2016. Prices are expected to remain firm in coming years according to the World Bank, averaging US$10.00 per MMBTU in 2018, retreating moderately to US$8.50 per MMBTU in 2020, and then firming to US$9.90 per MMBTU in 2027 (Table 2). However, these forecasts are based on an optimistic outlook for crude oil prices. If crude oil prices are lower, then average gas prices will also be lower due to the prevailing contractual arrangements in the market that link gas prices to oil prices. For PNG, the connection between oil and gas prices is even stronger with most future gas sales already locked into contractual arrangements. Forecast LNG prices for PNG therefore track oil prices more closely (Table 2).

Gold

Gold is unique among commodities because it is used as a store of value. Around 40.0 percent of the global supply of gold is used for investment, and reserve banks across the globe are key customers. The nature of gold also means that global production represents only 75.0 percent of global supply. The balance is provided by recycled gold. Multiple factors influence the gold market and gold prices.

Of the 60.0 percent of global gold supply that is not diverted to investment, most is used to produce jewellery. The balance is mainly used in industry and electronics, with about half of that going to jewellery sold in China and India. Rapid economic growth in these countries in recent decades has helped drive demand for gold. Consumption of fabricated gold reached 2,515 tonnes in 2017, up 6.0 percent from 2016. Growth is expected to continue in the coming years backed by the buoyant economies of China and India.

Gold production grew 2.5 percent in 2017 to reach 3,261 tonnes and is expected to continue to follow a path of steady growth in future years. Gains in production in Australia and Russia are expected to make up for weakening production in China, the world’s largest gold producer.
The holdings of gold among central banks and investors dwarfs the amount that is produced each year. Investors and central banks exert the dominant influence on gold prices. The two dominant determinants of investor demand for gold are interest rates and geopolitical stability. Higher interest rates make gold less attractive as an investment, while heightened geopolitical tensions draw investors back to gold as a safe haven.

Gold prices have been stable since 2014, which is a reflection of the stable conditions in the global economy, including persistent low inflation and low interest rates and relatively stable geopolitical circumstances. In 2017, gold averaged US$1,258 an ounce; this price is virtually unchanged from 2016. However, emerging conditions for the investment market for gold look likely to present risk to the gold market — in contrast to the stable circumstances for gold in production and consumption. In the second half of 2018, gold prices began weakening in the face of tightening monetary policy and higher interest rates in the US. Moving forward, an increasingly volatile geopolitical environment led by US–China tensions may see investors return to gold as a safe haven. This is particularly likely if the pessimism and volatility in equity markets that has followed these tensions continues or worsens. As it stands, the forecast average gold price in 2018 is expected to rise marginally to US$1,282 an ounce on the back of higher prices earlier in the year and to remain at US$1,286 an ounce in 2019 (Table 2).

**Copper**

Nearly half of the global supply of copper is used in the construction industry (Department of Industry, Innovation and Science, 2018). The state of the global copper market is highly dependent on the pace of infrastructure development and construction activity around the globe. This is particularly true for China, which is dominant in its infrastructure spending and construction of buildings. Since 2014, China has accounted for exactly 50.0 percent of global copper consumption. However, the pace of growth in consumption has virtually come to a halt, growing just 1.3 percent in China in 2017 and falling 0.6 percent in the rest of the world for total global growth of 0.3 percent. Over the years 2014–2017, the total change has been 4.3 percent (China), 0.3 percent (the rest of the world) and 2.3 percent (globally).

Going forward, two key factors will provide a more optimistic outlook to demand. First, China has announced a stimulus package that will bolster infrastructure spending. This initiative should help drive demand in 2019 and the immediate years thereafter. Second, copper is used intensively in emerging technologies and, in particular, electric vehicles — about 80kg used in each car and 350kg in an electric bus (Copper Development Association Inc., 2018). As discussed earlier, global demand for electric cars will gather pace over the next few years, which should provide an increasing stimulus to copper demand during the 2020s.

Buoyancy in demand is expected to strengthen copper prices to US$6,536 a tonne in 2018 (compared with US$6,170 a tonne in 2017) and increase to US$7,164 a tonne in 2020 (Table 2). This is despite expectations of solid growth in copper production as new capacity comes on stream in South Asia and South America. At this stage it appears that growth in production may struggle to keep pace with growth in demand.

**Nickel and cobalt**

During the 2020s, the electric car revolution will also place significant pressure on the markets for nickel and cobalt due to their use in batteries. Further pressure will come from the renewable energies sector, which is beginning to adopt battery technology as a mechanism to moderate power delivery in times, for example, when the wind stops blowing or the sun stops shining. As an indicator of things to come, a 100MW battery was attached to a wind generation facility in South Australia in 2017; this was by far the largest battery ever installed globally. The share of the global supply of nickel that is used in batteries is expected to double to 6.0 percent by 2020 (Department of Industry, Innovation and Science, 2018).

On the back of both increased battery production and higher stainless steel production, nickel prices reached US$10,410 a tonne in 2017 up from US$9,595 a tonne in 2016, but still well down on the average of US$14,596 for the period 2013–2015 (Table 2). During the first months of 2018, the growth momentum continued but the market became subject to volatility that was largely driven by developments in stainless steel production. Prices are expected to average US$13,479 a tonne in 2018 and continue to steadily rise towards US$16,279 a tonne by
Significant growth in production, especially from Indonesia, is expected to help contain nickel price rises in the face of the surge in demand.

Cobalt has already been subject to a surge in prices driven by battery demand, not only in electric cars but in its use for improving battery performance in smartphones and other technological devices. The average price in 2017 more than doubled to US$56,000 a tonne compared with US$26,000 a tonne in 2016 (Table 2). As the market adapts to the changing environment brought about by the electric car revolution, prices have been highly volatile during 2018, going beyond US$90,000 a tonne before dropping to US$67,000 a tonne. The outlook for 2019 is for further weakening to US$50,000 a tonne, but the current nature of the market means that this is subject to considerable uncertainty.

Cobalt can be substituted for nickel in battery production, putting a limit on how high prices can go. The surge in prices has already led battery producers to reduce their use of cobalt. Another factor that the market is adapting to is the reliability of supply with about half of the globe’s production coming out of war-torn Democratic Republic of the Congo. As long as the Democratic Republic of the Congo remains the main source of cobalt, battery producers will be wary of how much cobalt to incorporate into their production design.

Coffee, cocoa, palm oil and coconut oil markets

In 2018, global consumption of coffee grew steadily at 1.8 percent to reach 162.2 million bags (a bag is 60kg) following an increase of 2.1 percent the previous year (International Coffee Organization, 2018). Against this, global production grew 5.7 percent to 164.8 million bags in 2018. Much of the growth in production comes from strong seasons for the lower grade Robusta variety of coffee in Vietnam and India. For the higher quality Arabica coffee — which is what is produced in PNG — production grew by 2.2 percent to 101.8 million bags with good seasons in Brazil, Ethiopia and Honduras more than offsetting a bad season in Columbia. This follows strong growth of 3.8 percent the previous year (International Coffee Organization, 2018).

Surplus production has influenced prices. Arabica beans fell 8.0 percent in 2017 to US$3,320 a tonne and are expected to drop further in 2018 by 14.2 percent to US$2,850 a tonne, which is a 10-year low (Table 2). Looking ahead, a slow recovery is expected with prices going back over US$3,000 a tonne early next decade. Looking further ahead, global growth in consumption looks likely to accelerate on the back of a rapid uptake of coffee drinking in Indonesia, Vietnam and especially China. Together, these countries make up 7.0 percent of global consumption, surging from 3.0 percent at the beginning of the decade.

For cocoa beans, prices fell heavily in 2017 to US$2,030 a tonne compared to US$2,890 a tonne in 2016 (Table 2). Cocoa prices depend heavily on developments in the Ivory Coast — which produced 43.0 percent of global production in the year ending June 2017 and the year ending June 2018 — and to a lesser extent, neighbouring Ghana, which accounts for 20.0 percent of global production (International Cocoa Organization, 2018). Accordingly, low production in these countries from 2014 to the early part of 2016 led to high prices. A surge in production since then has led to a collapse in prices. The narrow focus in global production means that cocoa prices will remain volatile depending on weather, diseases and other local circumstances in these two countries. Global consumption in the meantime has been growing strongly. However, good growing conditions in these two countries is anticipated to help contain a rise in cocoa prices with a return to 2016 prices not forecast until the second half of the 2020s (Table 2).

The palm oil market is dominated by production in Indonesia and, to a lesser extent, Malaysia. Out of the global production of 69.3 million tonnes of palm oil in the year to June 2018, Indonesia accounted for 38.5 million tonnes and Malaysia 19.7 million tonnes. In comparison, PNG is the world’s seventh largest producer and accounted for less than 1.0 percent of global production at 0.6 million tonnes. Ongoing strong growth in Indonesia and Malaysia has led to global production rising 6.1 percent in the year to June 2018 following growth of 10.8 percent the previous year. Consumption growth has been healthy despite a decrease from the European Union, but this has not been sufficient to meet the growth in production. As a result, prices have weakened and are forecast to drop 12.2 percent to US$570 a tonne in 2018 (Table 2). Prices are expected to recover over the next decade as the market rebalances and return to levels above US$800 a tonne last seen in 2014. In the shorter
term, there may be some upside risk in prices as the US–China trade war could cause some substitution of oil seed purchases from China towards palm oil.

Coconut oil demand has been influenced in recent years by published science literature about health benefits associated with its consumption. Moreover, the growing production of biodiesel using coconut oil is helping to support the market, and surging global demand for coconut water is helping lift prices for coconut products. These factors have contributed to a rise in coconut oil prices from US$941 a tonne in 2013 to US$1,468 a tonne in 2016 and US$1,651 a tonne in 2017 (Table 2). However, more recently the American Heart Association released an advisory warning that coconut oil is in fact counter-productive to heart health (Heart Foundation, 2018). This is in line with the emergence of opposing views of the health benefits of coconut oil in the most recent science literature (Heart Foundation, 2018). Weaker demand coupled with stronger supply has contributed to a forecast drop in prices in 2018 to US$1,030 with only a slow recovery expected over the next decade (Table 2).
As a result of the earthquake, production from the LNG Project was halted for nearly two months from late February to mid-April 2018, and production from the oil fields took until mid-year to recover. Gas production from the LNG Project was down 27.0 percent in the first half of 2018 compared to 2017. This amounts to about K1.6 billion in lost production and export sales. The losses from the oil fields were about K600 million.

This setback in oil and gas production came at a time of great optimism with oil and gas prices surging (see Section 4.1) and the LNG Project continuing to find gains in production efficiency. By the third quarter of 2018, LNG production had reached a level 30.0 percent above its original nameplate capacity. In 2017, gas production in PNG reached 435,100 billion British thermal units (BBTU), which is up 27.0 percent on 2015, the first full year of LNG production, and 4.0 percent in 2016. For the full 2018 year, production is expected to be down 11.0 percent to 386,000 BBTU, but should return to at least the 2017 level in 2019 (Table 3).

Oil production was down in 2017 by 8.0 percent to 19.5 million barrels (Table 3). This fall reflects the depletion of PNG’s oil fields leading to steady declines in production rates. For the full 2018 year, production is expected to decline 25.0 percent to about 14.7 million barrels before recovering to 16.3 million barrels in 2019. About two-thirds of oil and condensate production is coming from the LNG Project. Production at the oil fields that pre-existed the LNG Project has been made possible by the LNG Project. Without the LNG Project, production would have been wound up at about this time, but synergies between the LNG Project and the oil fields have allowed economic production in these fields to be extended by about a decade.

Going beyond 2019, the big news for the oil and gas industry is that it is set to double in size. Three new trains are to be built that will pipe gas to the existing LNG processing facility near Port Moresby. Two of the three trains to be built will come from what is known as the Papua LNG project — a joint venture between Total, ExxonMobil, Oil Search and the PNG Government to develop the Elk-Antelope gas fields. Total is the leading stakeholder with a 31.1 percent share.

Commercial agreements were set in place early in 2018 on the design of the Papua LNG project and its integration into the LNG processing facility alongside the existing LNG Project. A memorandum of understanding with the PNG Government was signed in late 2018 that outlines the terms and conditions of the project. These milestones have laid the platform for the investment phase to commence, most likely by 2020. Two factors underpin confidence in the Papua LNG project: (1) the LNG Project has been highly successful for the joint venture partners, providing a boost in confidence for investors, and (2) LNG is a high growth commodity in the neighbouring East Asian market, as discussed in Section 4.2.

Construction for the original LNG Project commenced in 2009 and the project was commissioned in mid-2014. Construction of the Papua LNG project should be less complex because the LNG processing facility is already built. If the investment phase begins in 2020 it is reasonable to expect that first production will occur by 2025, if not earlier. According to Oil Search (2018a), the three new trains are expected to add 8 million tonnes per annum to LNG production and exports. This is equivalent to 416,000 BBTU, which is close to the existing level of production. By 2027, total production of LNG is expected to reach over 900,000 BBTU (Table 3).
Table 3: Mining, oil and gas — recent and forecast production, 2016-2019, 2023, and 2027

<table>
<thead>
<tr>
<th>Gold production (ounces)</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2023</th>
<th>2027</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lihir</td>
<td>900,000</td>
<td>940,000</td>
<td>957,000</td>
<td>1,000,000</td>
<td>1,000,000</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Porgera</td>
<td>492,600</td>
<td>494,700</td>
<td>415,000</td>
<td>463,000</td>
<td>463,000</td>
<td>463,000</td>
</tr>
<tr>
<td>Ok Tedi</td>
<td>218,000</td>
<td>271,000</td>
<td>271,000</td>
<td>325,000</td>
<td>325,000</td>
<td>325,000</td>
</tr>
<tr>
<td>Hidden Valley</td>
<td>156,200</td>
<td>71,000</td>
<td>160,000</td>
<td>200,000</td>
<td>200,000</td>
<td>200,000</td>
</tr>
<tr>
<td>Simberi</td>
<td>106,000</td>
<td>133,200</td>
<td>130,000</td>
<td>110,000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Frieda River</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>360,000</td>
</tr>
<tr>
<td>Waifi-Golpu</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>266,000</td>
</tr>
<tr>
<td>Woodlark</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>56,000</td>
<td>103,000</td>
</tr>
<tr>
<td>Nautilus (offshore mining)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>41,000</td>
<td>48,000</td>
</tr>
<tr>
<td>Small scale mining estimate</td>
<td>90,000</td>
<td>90,000</td>
<td>90,000</td>
<td>90,000</td>
<td>90,000</td>
<td>90,000</td>
</tr>
<tr>
<td><strong>Total gold</strong></td>
<td>1,962,800</td>
<td>1,999,900</td>
<td>2,023,000</td>
<td>2,188,000</td>
<td>2,175,000</td>
<td>2,855,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Copper production (tonnes)</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2023</th>
<th>2027</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ok Tedi</td>
<td>80,000</td>
<td>105,000</td>
<td>105,000</td>
<td>126,000</td>
<td>126,000</td>
<td>126,000</td>
</tr>
<tr>
<td>Frieda River</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>290,000</td>
</tr>
<tr>
<td>Waifi-Golpu</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>161,000</td>
</tr>
<tr>
<td>Nautilus (offshore mining)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>17,000</td>
</tr>
<tr>
<td><strong>Total copper</strong></td>
<td>80,000</td>
<td>105,000</td>
<td>105,000</td>
<td>126,000</td>
<td>143,000</td>
<td>597,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nickel and cobalt production, Ramu (tonnes)</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2023</th>
<th>2027</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel</td>
<td>22,300</td>
<td>34,700</td>
<td>35,000</td>
<td>35,000</td>
<td>35,000</td>
<td>35,000</td>
</tr>
<tr>
<td>Cobalt</td>
<td>2,200</td>
<td>3,300</td>
<td>3,300</td>
<td>3,300</td>
<td>3,300</td>
<td>3,300</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Oil and gas</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2023</th>
<th>2027</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil (million barrels)</td>
<td>21.2</td>
<td>19.5</td>
<td>14.7</td>
<td>16.3</td>
<td>11.7</td>
<td>7.6</td>
</tr>
<tr>
<td>Gas (million barrels equiv.)</td>
<td>73.3</td>
<td>76.2</td>
<td>67.6</td>
<td>77.7</td>
<td>80.8</td>
<td>157.5</td>
</tr>
<tr>
<td>LNG (BBTU)</td>
<td>418,500</td>
<td>435,100</td>
<td>386,000</td>
<td>443,700</td>
<td>461,000</td>
<td>908,000</td>
</tr>
</tbody>
</table>

Sources: Harmony Gold Mining Co. Ltd. (2018); Highlands Pacific (2018); Kumul Petroleum Holding (2018); PanAust (2018).
Note: BBTU = billion British thermal units. Conversion rate from BBTU to millions of barrels of oil is 5,712.

Oil Search (2018b) recorded a profit in 2017 of K965 million (US$302 million) and paid K445 million (US$139 million) in corporate tax to the PNG Government. This amount does not reconcile well with the amounts discussed in Section 3 of K114 million in total mining and petroleum taxes raised by the Government in 2017 and K160 million expected to be raised in 2018. It may be that much of this is deferred for payment in 2018 and the Treasury had not properly accounted for it in the MYEFO. The December 2017 Extractive Industries Transparency Initiative (EITI) report for the 2016 year stated that about K70 million of the K90 million raised in corporate taxes from mining and petroleum came from Oil Search and its equity partners in the LNG Project, including Kumul Petroleum, the state-owned enterprise holding the Government’s equity. Despite the earthquake in 2018, profits for Oil Search and its LNG partners are on track to exceed profits for 2017 due to substantially higher oil and gas prices (Table 2).
Gold, copper, nickel, and cobalt mining

The Lihir gold mine contains one of the largest commercial gold deposits in the world and is a major mining asset for PNG. The Australian mining company Newcrest Mining Limited (hereafter referred to as Newcrest) owns Lihir. Newcrest's June 2018 annual report explained that the Lihir mine is highly profitable and returned a margin of K900 (AU$370) per ounce of gold on the back of expected production of 957,000 ounces in 2018 (Table 3; Newcrest Mining Limited, 2018). On these statistics, Lihir is providing a surplus of about K850,000 million a year for Newcrest. Unfortunately, the December 2017 EITI report tells us that Lihir pays no corporate tax to the PNG Government (EITI, 2017). However, Newcrest did pay tax of K580 million (US$181 million) for the year to June 2017 and K630 million (US$191 million) for the year to June 2018, and Lihir comprises 40.0 percent of its sales. One can only conclude then that Newcrest has fiscal arrangements that see all its taxes paid to the Australian Government at the expense of the PNG Government.

Gold production at the Lihir mine is higher than the combined total of PNG's three other major gold mines—Porgera, Simberi and Hidden Valley. Production capacity at the Hidden Valley gold mine has been increased to 200,000 ounces a year following a three month shutdown late in 2017 to upgrade facilities. The upgrade followed the Harmony Gold Mining Company Limited (hereafter referred to as Harmony Gold) takeover of the Hidden Valley mine late in 2016 through its acquisition of the 50.0 percent stake held by Newcrest and is anticipated to turn the mine into a profitable operation. Production at the Hidden Valley gold mine in 2017 was 71,000 ounces of gold and is expected to increase to 160,000 ounces in 2018 and 200,000 ounces in 2019 (Table 3).

The Porgera gold mine in Enga Province produced 494,700 ounces of gold in 2017 (Table 3). The February 2018 earthquake slowed production until June due to damage to electricity generation. As a result, production is expected to drop to 415,000 ounces for 2018. The Simberi gold mine in New Ireland Province produced a record of 133,200 ounces of gold in 2017 and is expected to produce 130,000 ounces in 2018 before falling to 110,000 ounces in 2019 (Table 3). The mine is expected to wind up in 2021, although there remains possibility of an extension. Like Newcrest, Simberi is owned by an Australian company, St Barbara Limited, and corporate taxes appear to be paid to the Australian Government with none accruing to the PNG Government (EITI, 2017; St Barbara Limited, 2018). Over the life of the mine, it appears that the PNG Government has gained very little in the way of revenue out of the project.

The Ok Tedi mine was another operation damaged by the February 2018 earthquake. Fortunately, the damage was light and mining was able to continue in a short time following repairs. As a result, production in 2018 is expected to be about the same as 2017 at 271,000 ounces of gold and 105,000 tonnes of copper (Table 3). Copper accounted for about two-thirds of the K3.2 billion in sales in 2017. The PNG Government owns the Ok Tedi mine and the mine's strong profitability has meant that a dividend payment of K100 million was able to be paid in July 2018 despite the earthquake, and an additional K50 million was allocated to the recovery program for the earthquake. Two-thirds of the dividend was diverted to the Fly River Provincial Government. During 2017, Ok Tedi made K380 million in dividend payments. Production in 2019 is expected to increase to 325,000 ounces of gold and 126,000 tonnes of copper as a result of an upgrade in mining capacity (Table 3).

In Section 4.5, it was explained that the electric car revolution and the surge in battery use for renewable energy will lead to a boom in demand for minerals used in battery production, including nickel and cobalt. As a result, the operators of the Ramu nickel and cobalt mine near Madang are planning for a major expansion. The majority owner of Ramu is the Metallurgical Corporation of China, and China will be at the core of the surge in global battery production. Production in 2017 reached record levels of just under 35,000 tonnes of nickel and 3,300 tonnes of cobalt, and much the same is expected in 2018 (Table 3). Surging cobalt prices have helped lift the total value of production to K1.7 billion, with cobalt accounting for one-third of nickel and cobalt production combined.
New resource projects

Newcrest has a 50.0 percent stake in the proposed Wafi-Golpu gold and copper mine and the other half is owned by Harmony Gold, a South African mining company. Annual production is expected to reach 266,000 ounces of gold and 161,000 tonnes of copper in 2027 (Table 3). This would position Wafi-Golpu as one of the world’s leading gold and copper mines. Time will tell whether this translates to significant fiscal benefits for the PNG Government. But the experience of the Lihir gold mine suggests that expectations should be low despite the scale of the mine. A special mining lease application has been submitted, and Newcrest estimates that the mine will begin production five years after approval is granted. At this stage, both Newcrest and Harmony Gold anticipate approval will be forthcoming in 2019, which means first production might be expected in 2024 (Harmony Gold Mining Company Limited, 2016).

Even larger than the Wafi-Golpu project is the proposed Frieda River copper-gold mine in Sandaun Province. The scope and design of the Frieda River project has been subject to substantial revision since 2016. Importantly, PanAust — the Chinese state-owned enterprise leading the project — has changed the project to better integrate it with the Government’s development and infrastructure plans for the region. This is a positive development.

An infrastructure corridor close to PNG’s border with Indonesia will be built as part of the project, connecting the mine — which is located in the mountains not far from the Ok Tedi mine — with Vanimo. Along the infrastructure corridor will be a 300km pipeline to transport the ore to Vanimo for export. A hydroelectricity project will be developed to power both the mine and Sandaun Province more broadly. Expected production rates have been revised upwards to 360,000 ounces of gold and 290,000 tonnes of copper in 2027 (Table 3). As a result of the redesign, the Frieda River project is unlikely to commence construction until around 2021 for production to commence in 2026 or 2027.

The much heralded world-first deep-sea mining venture of Nautilus Minerals in the Bismark Sea was planned to be in production by now. However, financing issues have stalled progress. The mining vessel is 70.0 percent complete, but the contract to complete its construction has been cancelled by the shipbuilder as a result of Nautilus failing to pay its instalments. The financial woes of Nautilus poses considerable risk for the project going ahead. With a 15.0 percent stake, the PNG Government is exposed to this risk. Nautilus is now attempting to secure joint venture partners to progress the project and given the advanced stage of construction, the prospect of the project proceeding is more likely than not. Annual production of about 48,000 ounces of gold and 20,000 tonnes of copper is expected (Table 3).

A gold mining project at Woodlark Island is in the advanced planning stages. The feasibility study is complete and the mine is at the latter stages of securing final Government approval to go ahead. Production is expected to be a total of 500,000 ounces of gold in the first five years with a total mine life of 11 years. The investment required will be K500 million.

Prospects for the reopening of the Bougainville copper mine — which has been shut for 30 years — have taken a turn for the worse. The Bougainville Government decided to not extend the exploration lease of Bougainville Copper Ltd over the Panguna mining area. It is hard to see the mine moving forward before the independence status of Bougainville has been resolved in the forthcoming elections in 2019. If the mine does return to full production, it has capacity to produce about 500,000 ounces of gold and 150,000 tonnes of copper annually — more than Ok Tedi and similar in scale to Frieda River.
Assumptions and methodology for the 10-year forecasts

As in past editions of *Review and forecast of the PNG economy*, 10-year forecasts are generated using PNGGEM, the economy-wide model of PNG. PNGGEM has been used to analyse the PNG economy for over two decades, in which time the model has been subject to ongoing updates and upgrades. It is presently housed at the PNG NRI under a joint arrangement with The University of Queensland. PNGGEM incorporates 44 sectors of the economy and contains detailed depictions of households, government, producers, foreign trade, capital markets and labour markets. More details about PNGGEM are contained in the first edition of *Review and forecast of the PNG economy* (Levantis & Sanida, 2015a).

The forecasts generated by PNGGEM are developed and refined by building into the modelling a range of assumptions about emerging events that PNGGEM would otherwise not be able to foresee. These assumptions are outlined in detail in Table 4 and include the commodity price forecasts described in Table 2 and the forecast production profiles of mining, oil and gas provided in Table 3.

Also incorporated in the modelling are the financial arrangements and tax concessions of the LNG Project. Accelerated depreciation concessions mean that tax revenue gained from the LNG Project is lower than it otherwise would be, but these concessions will be phased out during the forecast period. Existing arrangements with financiers mean that, at present, the bulk of income from the LNG Project is diverted to debt repayments. As debt is paid over the forecast period, interest costs will decrease and hence profits and tax payments will increase. All debt is expected to be paid by 2026 at which time all income will accrue to the stakeholders, including the PNG Government.

The ramping up of tax and income revenue from the LNG Project accruing to the Government over the years 2017–2028 will provide the means for the Government to implement its long-term development agenda. The agenda is articulated in PNG Vision 2050 (Government of Papua New Guinea, 2009), and the *PNG Development Strategic Plan* (PNGDSP), 2010–2030 (Department of National Planning and Monitoring, 2011) and continues to be Government policy. At the core of the development agenda is public investment in the “enablers” for social and economic development — transport infrastructure, utility infrastructure, education, higher education, law and order, health, and land. The key targets and initiatives outlined in the long-term plans are incorporated in the modelling forecasts (Table 4). Health initiatives are excluded because of the difficulty in quantitatively linking health with economic growth. Land is also excluded due to the Government choosing to abandon the implementation of the reform initiatives as articulated in the recent budgets.

### Table 4: Assumptions and modelling methods used to forecast

<table>
<thead>
<tr>
<th>Events</th>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commodity prices</td>
<td>Commodity prices are assumed to move in accordance with the forecasts outlined in Table 2.</td>
</tr>
<tr>
<td>Mining, oil and gas production</td>
<td>Production profiles for gold, copper, nickel, cobalt, oil and gas are assumed to move in accordance with the forecasts in Table 3.</td>
</tr>
<tr>
<td>LNG debt priority and tax concessions</td>
<td>Developments in two key factors affecting the Government’s revenue profile of LNG are incorporated in the modelling over the period 2018–2027: (1) the phasing out of accelerated depreciation concessions, and (2) the end of the diversion of income to debt repayments, assumed to occur in the years 2026 and 2027.</td>
</tr>
<tr>
<td>Fiscal policy</td>
<td>Spending in 2018 is assumed to move in line with MYEFO. Over the years 2019–2022, the budget deficit is assumed to be steadily brought back to balance. For 2023–2027, the budget is kept in balance.</td>
</tr>
</tbody>
</table>
Law and order policy
Law and order resources are increased over the years 2019–2027 in accordance with the development plans of Vision 2050 and PNGDSP — police strength to increase fourfold by 2030 and crime rates to halve. PNGGEM has the capability to link law and order spending to crime levels and cost to businesses.

Education policy
Time-lagged changes are applied to the supply of semi-skilled labour based on changes to the enrolment rate and population growth profiles. These are applied in accordance with the Vision 2050 and PNGDSP targets of universal education by 2020.

Higher education policy
Time-lagged gains are applied in the domestic supply of skilled labour based on the Vision 2050 and PNGDSP target of 215,000 tertiary graduates over 2015–2030.

Electricity infrastructure
Productivity gains are applied to the modelling in accordance with the literature and consistent with the Vision 2050 and PNGDSP target of expanding infrastructure to reach 70 percent of the population by 2030.

Transport infrastructure
Productivity gains are applied to the modelling in accordance with the literature and consistent with the Vision 2050 and PNGDSP target of doubling the national road network.

Macroeconomic growth forecasts, 2018–2027
GDP growth is forecast by PNGGEM to average 5.4 percent over the years 2018–2027 and non-resource GDP — which excludes mining, oil and gas — is forecast to average 5.1 percent (Figure 3). Non-resource GDP growth is by far the more important measure of the health of the PNG economy. This is because most of the GDP generated from the mining, oil and gas sector accrues to foreign interests with only a small fraction being retained in PNG. A good example is the Lihir gold mine referred to in Section 5.2, which is foreign owned, pays no corporate tax, and employs only a small local workforce relative to the revenue it generates. Almost all of the nearly K4 billion in revenue the mine generates each year accrues to the Australian owners, to foreign lenders, and to foreign capital equipment.

Figure 3: Average real GDP and non-resource GDP growth, 1980–2027


The forecast growth in non-resource GDP for 2018–2027 represents a step up from the growth outcomes since 2010, which in turn was a step up from the consistently poor growth outcomes of the previous three decades. The era up until the end of the 2000s was characterised by hopelessness, unambitious policy agendas, and increasing poverty with non-resource GDP growth averaging just 3.0 percent in the 1990s and 2000s (Figure 3). To emphasise how poor this is, the average annual growth among PNG’s Asian neighbours was 8.0 percent in
the 2000s (Figure 1). Against this background, in the late 2000s the Government reset the development agenda by taking an ambitious planning approach inspired by the strategies employed in Malaysia and East Asia, which culminated in PNG Vision 2050 and the PNGDSP.

Average growth in non-resource GDP of 4.2 percent over the years 2010–2017 came despite a dramatic collapse in commodity prices and mineral revenues over the years 2013–2016, which led to unprecedented fiscal austerity. Government spending in 2017 was still below the level of 2014 and only marginally ahead of spending in 2013. Had commodity prices not collapsed, it is most certain that the jump in growth would have been stronger, reaffirming the success of the new development agenda. The step up in forecast growth for 2018–2027 makes sense as budget austerity draws to a close in the face of improved commodity prices and the increasing revenue flows from the LNG Project referred to earlier (Table 4).

For 2018, non-resource GDP growth is forecast to grow just 0.1 percent. Two key factors are driving this poor outcome. First, budget austerity continued in 2018 as spending constraints have continued to be applied to rein in the budget deficit. Second, and perhaps more importantly, the earthquake halted economic activity in a wide area across the Highlands. Agriculture was hit hard as was mining, oil and gas production, as explained in Sections 5.1 and 5.2. Although the disruptions in resource production do not directly impact non-resource GDP, there are considerable flow-on impacts in support services and to subcontractors, as well as to Government revenue — particularly from the Ok Tedi mine and the oil and gas operations. Total GDP is forecast to fall 1.8 percent as a result of the disruptions in resource production.

A rebound in 2019 is forecast with GDP jumping 7.5 percent and non-resource GDP rising 5.5 percent. More moderate non-resource growth of 4.1 percent is expected in 2020 followed by an average of 3.8 percent over the years 2021–2023 and rising to 7.5 percent in the years 2024–2027. The relatively modest growth forecasts for the years 2020–2023 are in part affected by the assumption that fiscal conditions will continue tightening until the budget is brought back to balance (Table 4). However, this remains above the long-term growth outcomes from independence through to the end of the 2000s and is a reflection of the productivity benefits that are captured in the modelling that culminate from the implementation of the Government’s development agenda. The further boost in the middle of the 2020s is provided by the flow-on effects of the investments that are expected in copper and gold mining and from the Papua LNG project (Sections 5.2 and 5.3).

PNG Treasury is more optimistic in its growth forecast for 2018 and less optimistic for 2019 with 3.1 percent expected in both years (Figure 4). It may be that PNG Treasury is underestimating the impact of the earthquake in 2018 and the subsequent rebound for 2019. Alternatively, the midpoint of the PNGGEM and PNG Treasury forecasts for the two years may be more reliable at 1.6 percent (2018) and 4.3 percent (2019) (Figure 4). PNG Treasury is also far more optimistic about growth in the years 2021–2023 and has forecast an average of 7.8 percent. It may be that PNG Treasury is overestimating the impact of the investment phase of the Papua LNG project. It is inevitable that, in percentage terms, the impact compared to the original LNG Project will be much smaller this time because the size of the economy, particularly the Port Moresby economy, is now much larger.

**Figure 4: Comparison of PNGGEM and PNG Treasury non-resource GDP growth forecasts, 2018–2027**

Sources: Compiled from PNGGEM modelling and PNG Treasury data in the budget. The midpoint is the average of the two.
**Sectoral economic performance, 2018–2027**

PNGGEM modelling estimates that the earthquake-hit mining, oil and gas sector contracted 5.9 percent in 2018 (Table 5). A rebound of 12.1 percent growth is forecast for 2019 led by recovery in the earthquake-hit oil and gas fields and Porgera mine and stronger performances at the Lihir, Hidden Valley, and Ok Tedi mines (Table 3). Looking ahead to the first part of the next decade, the mining, oil and gas sector is expected to be largely static with little change in existing operations and no new operations to come on stream during this period. A big turnaround is expected during the period 2024–2027 with average annual growth forecast to reach 15.3 percent, which will be driven by the commissioning of the Papua LNG project and a number of new mines (Tables 3 and 5).

The new resource operations will provide a lift to other sectors of the economy — particularly construction, transport and commerce — with growth forecast to average 9.2 percent, 9.8 percent and 8.6 percent respectively during the years 2024–2027 (Table 5). In contrast, these sectors are all expected to contract during 2018 before recovering in 2019. Manufacturing is also expected to lift, but the rural sector is expected to return more moderate growth over the 2024–2027 period. This is a consequence of what is referred to by economists as “Dutch disease”. The symptom of the “disease” is a weak export sector — in PNG’s case, agricultural exports. The cause of the “disease” is a boom in the mining, oil and gas sector that leads to an appreciation of the real exchange rate. Nevertheless, over the next decade the rural sector is forecast to return solid growth due to the ongoing productivity improvements delivered by the Government’s investment in the economic enablers (Table 5).

**Table 5: Forecast economic growth by sector, 2018–2027**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Rural</td>
<td>2.5</td>
<td>4.3</td>
<td>5.0</td>
<td>5.6</td>
<td>4.1</td>
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<td>Mining, oil and gas</td>
<td>-5.9</td>
<td>12.1</td>
<td>-0.5</td>
<td>0.0</td>
<td>15.3</td>
</tr>
<tr>
<td>Manufacturing</td>
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<td>3.4</td>
<td>3.0</td>
<td>2.7</td>
<td>5.4</td>
</tr>
<tr>
<td>Construction</td>
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<td>7.2</td>
<td>4.9</td>
<td>3.9</td>
<td>9.2</td>
</tr>
<tr>
<td>Commerce</td>
<td>-0.5</td>
<td>6.2</td>
<td>4.3</td>
<td>3.8</td>
<td>8.6</td>
</tr>
<tr>
<td>Transport</td>
<td>0.9</td>
<td>6.2</td>
<td>4.7</td>
<td>4.9</td>
<td>9.8</td>
</tr>
<tr>
<td>Government</td>
<td>4.9</td>
<td>4.2</td>
<td>2.8</td>
<td>2.8</td>
<td>5.2</td>
</tr>
<tr>
<td>Other services</td>
<td>1.2</td>
<td>5.1</td>
<td>3.6</td>
<td>3.7</td>
<td>7.2</td>
</tr>
</tbody>
</table>

*Source: Compiled from PNGGEM modelling.*

**The fiscal outlook, 2018–2027**

As discussed in Section 3, the collapse in commodity prices over the years 2014–2016 and the subsequent collapse in Government revenue from the resources sector led to an unprecedented period of budget austerity. Spending by the Government fell in 2015 to K13.5 billion from K14.5 billion in 2014 and continued at this level through to 2017 when spending was just K13.3 billion. The recovery in commodity prices in 2017 and through to 2018 has enabled an expansion in spending to an estimated K14.9 billion in 2018. As a result, the Government sector was one of the few bright areas for the PNG economy in 2018 expanding by an estimated 4.9 percent according to PNGGEM (Table 5).

Government revenue is forecast to reach K13.6 billion in 2018 according to PNGGEM, leaving a modest budget deficit of K1.3 billion. This compares with the 2018 MYEFO estimate of K12.9 billion in revenue and a deficit of K2.0 billion. Most of the discrepancy between the two is not due to modelling differences but rather to accounting methodology. PNGGEM accounts for all revenue that accrues to the Government. The official budget revenue numbers only account for revenue that accrues to the consolidated revenue accounts. But increasingly, Government revenue is being diverted to places outside of the consolidated revenue accounts and, as a result, the budget numbers do not portray an accurate reflection of the Government’s financial position.
The most prominent mechanism the Government is using to divert revenue off budget is the creation of the entity Kumul Petroleum to hold the Government’s LNG assets and receive income from the LNG Project. The amounts that are transferred to consolidated revenue in the form of dividends then become a matter of discretion at the political level. There are other unclear mechanisms at play as evidenced by the large discrepancies that exist between the amount of tax paid by resources companies and the amount of tax received according to the budget. For example, in Section 5.1 it was explained that Oil Search alone paid K445 million in corporate tax on its 2018 profits, yet the total amount of taxes received from all resources companies according to the 2018 MYEFO was K114 in 2017 and an estimated K160 million in 2018. The proposed Sovereign Wealth Fund is another mechanism that will, if used in the future, underplay the revenue flows received by the Government.

Government revenue is forecast by PNGGEM to jump by K1.9 billion to K15.5 billion in 2019 (Figure 5). Driving this growth will be two key factors: (1) the economic rebound following the earthquake-led recession of 2018 and (2) continued recovery in commodity prices in 2018 and 2019. Over the years 2020–2024, Government revenue is forecast to continue to grow at a steady rate of, on average, 4.4 percent a year in nominal terms (Figure 5). However, in the years immediately beyond this, revenue growth is forecast to accelerate rapidly on the back of stronger economic growth and the ramping up of income flows from the LNG Project.

All categories of revenue are expected to grow over the forecast period except for taxes from the resources sector and foreign aid. The new mines and the Papua LNG project are expected to come on stream around the mid-2020s; however, they are unlikely to contribute any corporate tax revenue during the forecast period. What these projects will do is put upward pressure on the exchange rate, which in turn will squeeze profits and corporate taxes among the existing operations in Kina terms.

Pessimism in the growth prospects for foreign aid are drawn from the budget forecasts, but are likely to prove overly pessimistic. Geopolitical developments are seeing an unprecedented level of interest in PNG from Australia due to China’s increased interest in PNG and the broader Pacific region. As a result, Australia is already taking measures to increase its influence in PNG in competition to China, and the aid budget is likely to be the key beneficiary.

**Figure 5: Forecast Government revenue by source of revenue, 2018–2027**

Source: Compiled from PNGGEM modelling.

**Outlook for employment, 2018–2027**

Over the forecast period 2018–2027, 407,432 jobs are expected to be created. This number includes self-employment in small and micro businesses and in farms and rural gardens. Most employment is in PNG’s rural areas and over the forecast period 194,490 jobs are expected to be created in rural industries; this sector
represents nearly half of all employment creation (Figure 6). Rural employment growth will be underpinned by the productivity improvements and greater opportunities afforded by the public investments in the enablers outlined in the development agenda. The mining, oil and gas sector is expected to be a major source of employment growth; however, all of this growth will come after 2024 when the new mines and the Papua LNG project come on stream. Around 152,000 mainly urban based service jobs are forecast to be created by 2027, including in transport, construction and commerce. As is usual in the pattern of economic development across the globe, this points to a continuation over the coming decade in the rapid pace of rural–urban migration.

On an annual basis, employment growth is expected to be mostly in the range of 30,000–40,000 a year up until 2025 when the new resource operations and stronger economic growth will help drive employment growth to over 60,000 a year. However, in 2018, the earthquake-led recession is expected to have caused a fall in employment of about 7,000 jobs.

Figure 6: Total 10-year full-time equivalent employment creation by sector, 2018–2027

Source: PNGGEM modelling.

Notes: (1) Full-time equivalent refers to the conversion of part-time employment to equivalent full-time numbers. (2) Employment refers to paid jobs and self-employment, including self-employment in farms and rural gardens.
Conclusions

The PNG economy has faced a number of big headwinds since 2014. First came the collapse in commodity prices just as the LNG Project got underway. The damage to the PNG budget was substantial and a period of austerity followed in order to help contain the budget deficit and keep Government debt in check. As we moved from late 2017 into 2018, optimism returned as commodity prices recovered and the outlook for the budget and the Government’s ability to fund its development agenda improved substantially. But then came the devastating earthquake of February 2018.

Barring any unforeseen headwinds, there is good reason for a return to optimism. The Government is continuing to promise to implement its development agenda through public investment in the economic enablers — road infrastructure, utility infrastructure, education, higher education, and health. Doing so will lead to ongoing productivity gains that will lead to a sustained boost to economic growth. As a result, over the years 2019–2027, non-resource GDP is forecast to grow at an average of 5.1 percent a year.

As we approach the mid-2020s, the PNG economy will take another step forward as the new resource projects come on stream. Significant revenues may not become available until the end of the decade or into the 2030s, but when they do begin to flow, PNG will have the funding boost that will enable it to reach its aspirations of becoming a middle-income country — as articulated in Vision 2050. With China accelerating its interest in investing in PNG, and Australia showing interest in re-engaging with PNG and also investing in infrastructure — after scaling back its aid spending in infrastructure following independence in 1975 and especially over the last two decades — things are beginning to look particularly bright for PNG.
References


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