Microeconomics of Competitiveness - Application of cluster theory to an emerging export-based Australian industry.
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Australia

Introducing Australia and its Clusters

Australia is the world’s smallest continent but the sixth largest country in the world. It is located in Oceania, and between the Indian Ocean and South Pacific Ocean. (CIA, 2016) It occupies a total area of 7,741,220 km², of which 7,682,300 km² is land and 58,920 km² is water. Australia consists of six states — New South Wales, Western Australia, Queensland, South Australia, Tasmania, and Victoria. Canberra is Australia’s Capital city. Other top cities include Sydney, Melbourne, Brisbane, Perth, and Adelaide.

As of 2015, the population of Australia was 23,860,100. (Australian Bureau of Statistics, 2016) In 2011, around 26% of Australia’s population was born overseas, most of them coming from United Kingdom, New Zealand, China, and India. A majority of the population of Australia are English (25.9%), followed by Australian (25.4%), Irish (7.5%), Scottish (6.4%), Italian (3.3%), German (3.2%), Chinese (3.1%), and Indian (1.4%). (CIA, 2016) (Statista, 2016) The population of Australia is predominantly Christian (61.1%). 22.3% do not have any religious affiliation, while 2.5% practice Buddhism, 2.2% Islam, 1.3% Hinduism, and 0.5% Judaism. (Australian Bureau of Statistics, 2012)

Australia has centuries of aboriginal history and colonial legacy. Records mention exploration by mariners in the early 1660s. Originally established as a British penal colony, the earliest British settlement dates back to January of 1788, when Captain Arthur Phillip and the First Fleet landed “at Camp Cove, known as ‘cadi’ to the Cadigal people.” (Australian Government, 2015) Other colonies would subsequently be established — Western Australia in 1827, Van Diemen’s Land or Tasmania in 1825, South Australia in 1836, Victoria between 1834-1837, Queensland in 1824, and Northern Territory in 1825.

Formally known as Commonwealth of Australia, “Australia is both a representative democracy and a constitutional monarchy with Queen Elizabeth II as Australia’s head of state.” (Australian Government, 2016) It is a federation of the six states. Each state government has its own constitution, as well as “structure of legislature, executive and judiciary branches.” (Australian Government,
Australia also has ten territories that have the right of self-government as defined in the Commonwealth law. The Australian Parliament consists of two Houses (the House of Representatives and the Senate) and the Queen (represented by the Governor General). (Parliament of Australia, 2016)

Australia’s Recent Performance Trends

Australia as a whole is performing comparatively well in many aspects. According to the 2015 Human Development Index (HDI) report, Australia’s HDI value for 2014 was 0.935, which puts Australia 2nd in the world following Norway. “Between 1980 and 2014, Australia’s life expectancy at birth increased by 8.0 years, mean years of schooling increased by 1.4 years and expected years of schooling increased by 2.8 years. Australia’s GNI per capita increased by about 70.9 percent between 1980 and 2014.” (United Nations Development Programme, 2015) Exhibit 1 illustrates trends of the country’s HDI component indices.

Although Australia has seen some decrease in GDP per capita from $67,473.03 in 2013 to $61,886.96 in 2014, it still is above U.S and Canada. Please refer to Exhibit 2 to see these countries historic GDP trends.

How is Australia doing?

The economy of Australia is made up of 45 diverse industries which can be seen in the bubble chart in Exhibit 3. The economic landscape is dominated by mining and oil & gas production. Australia’s coal mining and metal mining industries make up 34% and 33.5% of world exports, respectively. To put these massive numbers into perspective, livestock processing is next on the list with a global export share of 6.5%, followed by agricultural products and inputs with a share of 3.6%. While the coal and metal mining industries are also Australia’s largest exporters in Australian Dollar terms, hospitality and tourism (2.6% of global exports) and oil & gas production and transportation (1% of global exports) would follow as second and third using this metric.

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1 The ten territories include Australian Capital Territory (ACT), Northern Territory (NT), Ashmore and Cartier Islands, Australian Antarctic Territory, Christmas Island, Cocos (Keeling) Islands, Coral Sea Islands, Jervis Bay Territory, Norfolk Island and Territory of Heard Island and McDonald Islands.
2 Retrieved from Google Public Data: https://www.google.com/publicdata/explore?ds=d5bncppjo189&met_y=ny_gdp_pcap_cd&dim=country:AUS;USA;CAN&hl=en&dl=en
Only eleven out of Australia’s forty five industries have gained world export market share from 2000-2014. In order of share gained they are: metal mining (+9.9%), coal mining (+3.2%), hospitality and tourism (+.5%), aerospace vehicles and defense (+.3%), forestry (+.3%), livestock processing (+.2%), financial services (+.2%), paper and packaging (+.2%), business services (+.1%), construction services (+.1%), and production technology and heavy machinery (+.01%). Oil & gas production and transportation lost .24% over this period. (Porter, 2014)

**Australian Endowments**

Australia is rich with natural resources that are spread throughout the country and it remains “one of the world’s biggest untapped minerals exploration markets.” (Geoscience Australia, 2016) Australia’s mineral commodities are very significant contributors to the country’s economic performance, representing nearly 10% of its GDP in 2012-2013. (Geoscience Australia, 2013) According to Geoscience Australia, “Australia is the world’s leading producer of rutile, zircon, bauxite, iron ore and ilmenite, the second largest producer of alumina, gold, lithium, manganese ore, lead and zinc, the third largest producer of uranium, and the fourth largest of silver, nickel and black coal.” (Britt, et al., 2015)

Australia also has large deposits of non-renewable energy resources, derived from fossil fuels, which include “crude oil, condensate, liquefied petroleum gas and shale oil; conventional gas, coal seam gas, tight gas and shale gas; and black and brown coal, as well as the nuclear energy fuels uranium and thorium (potential).” (Geoscience Australia and BREE, 2014) Mostly found in Western Australia and central Australia, natural gas is the country’s “third largest energy resource after coal and uranium.” (Geoscience Australia, 2013)

**Australian Macroeconomic Policies**

Given how large several commodity-related industries are in Australia, the recent collapse in commodity prices, particularly oil & gas, has severely damaged the country’s finances. Australia is projected to run fiscal deficits for the foreseeable future at the rate of 4-5% of GDP. Several other reasons for the projected deficits include higher-than-normal unemployment benefit expenditures and overall lower economic growth. (Reserve Bank of Australia, 2015)
Like many other central banks around the world, Australia’s central bank (titled the Reserve Bank of Australia) has lowered their interest rates to spur spending and investment to try and keep the economy growing. More specifically, the goals have also been to maintain price stability in their country, improve employment conditions, and enhance the overall prosperity of their people by hitting an inflation target of 2-3%. (Reserve Bank of Australia, 2016)

**Australian Social Infrastructure and Political Institutions**

Overall, Australia is strong from a human development perspective. It was ranked second globally in human development in 2014 and first globally in gender development. (United Nations Development Programme, 2015) It has a very strong education system with 96.8% of children enrolled in primary schools, 85.3% enrolled in secondary schools and overall access to advanced education was 5th globally in 2015. (Routledge Taylor and Francis Group, 2014) (The Social Progress Imperative, 2015) All of this educational strength is provided to citizens with low government spending. In 2010 Australia was 56th in terms of percentage of GDP spent on education. (CIA, 2016) Part of this is probably due to the fact that many Australian students attend private schools. Only 65% of Australian students attend public schools vs. 85% in the US. (Routledge Taylor and Francis Group, 2014) Finally, immigration is widely encouraged in the country. In 2015, Australia was ranked 23rd in the world for net immigration, while birthrate ranked only 162nd globally. (CIA, 2016)

While very strong in human development, Australia still has room to improve in this area. The population has relatively little diversity with 74% of citizens in 2011 having European ancestry, 77% having English as their native language, and 61% having Christianity as their religion. (CIA, 2016) While recently strong in gender development, that development still has a way to go as Australia was only ranked 19th in the world for gender equality in 2014, and the average woman gets fewer years of education than the average man. (United Nations Development Programme, 2015) (The Social Progress Imperative, 2015)

Australia also has very strong political institutions with a high degree of transparency. In 2010 Australia was in the world’s 95th percentile in terms of voice of its citizens and their ability to keep the government accountable. In the same year, Australia was ranked in the 96th percentile in terms of control of corruption. However, as in most countries, there is still some
corruption present and the OECD Anti-Bribery Convention rates Australia’s anti-bribery enforcement as only “moderate” in strength. (Transparency International, 2010)

The rule of law in Australia is strong. The country was ranked 8th in the world in 2015, along with 8th in the world for property rights. (IMD World Competitiveness Online, 2015) During the same year, Australia was ranked 11th in the world in terms of personal safety of its citizens. (The Social Progress Imperative, 2015) The downside to a strong rule of law is that the laws can sometimes be too burdensome as in the case of labor regulations, where Australia was only ranked 50th in the world in 2015. (IMD World Competitiveness Online, 2015)

**Australian National Business Environment**

Overall, Australia is a well-developed country with an attractive business environment and is an attractive place for foreign investment. It has high levels of FDI and is ranked 21st in the global competitiveness index for 2015/2016 due to several factors already mentioned including strong rule of law, low corruption, strong property rights, and a high credit rating. (World Economic Forum, 2015) The government is generally supportive of FDI. It, however, sometimes steps in with regulation such as with LNG, mandating that 15% of domestic supply must be sold in Western Australia. (The Government of Western Australia, 2016)

Australia’s overall human capital is in good shape. The country was ranked 13th in the World Human Capital Index in 2015 due to the high literacy rate, the strong education system, and access to specialized higher education. (World Economic Forum, 2015) A downside to this is that the human capital is expensive and adds to the cost of projects like LNG projects.

Australia has an extensive infrastructure within the country. It was ranked 4th in infrastructure in the Global Innovation Index in 2015 due to the basic infrastructure in place mainly due to the mining industry, and the fact that the government is supportive of the LNG industry. (Dutta, Lanvin, & Wunsch-Vincent, 2015) The government is generally supportive of economic growth and was ranked 5th in the 2016 Index of Economic Freedom due to low trade barriers and good trade relations. (The Heritage Foundation, 2016) Some hold the view that the government could become even more supportive by cutting down on the high levels
of regulation which can sometimes cause bottlenecks in environmental and construction approvals. Also, due to the LNG domestic supply rules, this could potentially cap profits of LNG producers.

**Western Australia**

*Introducing Western Australia*

With its aboriginal history and colonial legacy, Western Australia shares much of its rich legacy with other states of Australia and with Australia in general. Its history of modern growth begins with the establishment of a Colony at Swan River in 1829. The establishment of this Colony was, however, “largely in response to enthusiastic marketing by Captain James Stirling of opportunities for business and profits”. (Department of Treasury and Finance, 2004)

Western Australia is Australia’s largest state geographically and has a population of 2.60 million as of September 2015. (Government of Western Australia, 2016) It is the fourth largest division in Australia in terms of population, and the second-largest country subdivision or administrative territory in the world in terms of land mass. It makes up nearly one-third of the Australian continent, has a population density of 0.94/km² (2.4/mi²), and is about the size of Western Europe. (WorldAtlas, 2016) Western Australia “is bordered in the east by South Australia and the Northern Territory and in the west by the Indian Ocean, with the Timor Sea to the north.” (World Travel Guide, 2016) Western Australia’s capital city Perth, founded on 12th of August 1829, is estimated to have more than three quarters (78%) of Western Australia’s population. (Australian Bureau of Statistics, 2014) Western Australia’s other big cities include Albany and Bunbury.

Considered the “powerhouse” of Australia’s economy because of its mining wealth, Western Australia’s gross state product (GSP) was 249 billion AUD in 2014-215, which accounts for 15% of Australia’s gross domestic product (GDP). Mining accounted for 26% of this GSP, market services for 29%, and construction for 13%. (Government of Western Australia, 2016) Primarily a commodity-based economy, Western Australia’s largest commodity sectors include iron ore, crude oil, LNG, and gold. It has the largest gas basin in the country and accounts for two thirds of Australia’s gold production.

Western Australia’s economic development has been shaped by its geography, “with the ‘tyranny of distance’ having had
a large influence on both its economic development and culture”. (Department of Treasury and Finance, 2004)

**Quality of Life in Western Australia**

Despite high economic growth in Western Australia, there is high cost of living and high economic inequality. According to figures collected by the website Numbeo, the quality of life in Perth is high in absolute terms (190.73), but relatively low compared to four other Australian cities such as Canberra (233.78), Melbourne (209.33), Adelaide (206.74), and Brisbane (201.74). It, however, ranks highest in the cost of living index among these cities, even ahead of Sydney. (Numbeo, 2016)

The mining boom does not equally benefit everyone. Particularly those “with relatively fixed incomes, such as public servants, teachers, police officers and nurses, have mostly seen increasing food prices and big jumps in the cost of rent.” (Pash, 2014) According to the Western Australian Council of Social Service “between 13% and 17% of children are living in poverty,” which is said to be “much higher for children in some Aboriginal and migrant communities.” (WACOSS, 2011)

Congestion is another issue that Western Australia (primarily Perth) is struggling with. It is estimated that traffic congestion in Perth will cost the Western Australian economy “$16 billion a year in lost productivity by 2031.” (Anderson, 2015)

Because Western Australia is highly dependent on the world commodity prices, the mining job market is highly volatile. Of around 5,000 jobs lost in the first 11 months of 2015, mining had the second largest number of lost jobs, following retail trade. (Glenn, Polygenis, & Masters, 2016)

Western Australia is “one of the most diverse of all the states and territories.” (Office of Multicultural Interests, 2013) As of 2011, almost 31% of Western Australians, and 35% of Perth residents, were born abroad. (Robertson, 2014) More than half (56%) of Western Australian residents were Australian citizens. This makes Western Australia “home to people from 190 countries, speaking approximately 270 languages and dialects,” and following “more than 130 religious faiths.” (Office of Multicultural Interests, 2013)
“Migration and diversity have given WA a competitive edge in a globalized world. Migrants create ties connecting their new home with their old. They create unique opportunities that have contributed to the development of our economy and social harmony.” (Office of Multicultural Interests, 2013)

Questions, however, remain about how this diversity is affecting policymaking in Western Australia and how people are integrating into Western Australia’s diverse population. Despite these questions, there are ample reasons to live in Western Australia.

Western Australia is home to five universities such as Curtin University, Edith Cowan University, Murdoch University, University of Notre Dame, and University of Western Australia. It also has more than one thousand schools and colleges. As the study by .id found, migrants to Western Australia are young people (18-24) who seek educational and job opportunities in Perth. The trifecta of “baby boomer generation, a young adult generation, and an infant generation moving through the system” points to new opportunities and new market sectors. In fact, mining is not the only sector that provides employment. There are available jobs in diverse sectors such as healthcare and social assistance, construction, and retail trade. (.id the population experts, 2016)

In addition to quality education and availability of jobs in diverse sectors, Western Australia provides ample facilities for recreation and leisure - to swim, sail, water ski, fish, cycle, walk and run. The following two quotes from the website of the Department of Health sum up why everyone should want to live in Western Australia.

“WA is a great place to live! We have clean air, beautiful beaches, wide open spaces and a relaxed lifestyle. Moving to WA can be a great choice for you and your family, and it can also help your career.”

“Our schools and universities provide a quality education. Housing comes in all sizes, from large houses with a back yard and swimming pool to brand new inner-city apartments.” (Department of Health, 2016)

**Western Australian Business Environment**

The Western Australia business environment is dynamic with many strengths, including sophisticated port infrastructure, a supportive government and great supporting industries and institutions. That said, it also has its weakness including railway and
telecom systems that are lacking along with other influential industries that are inherently cyclical. (Engineers Australia, 2010) A summary of WA’s business environment is shown in Exhibit 6 and further analysis is provided below.

**Factor conditions**

Western Australia boasts a high level of qualified labor as well as strong port and energy infrastructure. (Engineers Australia, 2010) Further, the WA government is highly invested in the region’s industries. Although mostly positive, this high level of government interest can result in overburdening regulations. Some of the weaker components of infrastructure include WA’s roads and water systems. Particularly in need of attention is the region’s rail and telecommunications infrastructure. (Engineers Australia, 2010) These factors coupled with the cyclical nature of labor availability and the vast distances required to travel to industry sites pose inhibiting restrictions on the pace of development in the region. (Wang, 2016)

**Context for firm strategy and rivalry**

High levels of transparency, relatively low barriers to trade, strong laws and investor protection make WA an attractive region for domestic and international investment. (IMD World Competitiveness Online, 2015) As such, the WA region is ripe with competition in many sectors. In other industries that have historically been owned by the government, such as banking and telecom, there are a few large firms that dominate the majority of the market (e.g. Telstra in Telecom).

**Demand conditions**

Western Australia has a heavily-concentrated industrial product focus as a result of significant natural endowments (e.g., natural gas, gold). (Government of Western Australia, 2016) As such, its customers are sophisticated in nature whether they be engineers working within global firms or professional purchasers. The government is also acutely aware of the domestic natural gas needs of Western Australia. As such, they have imposed a requirement that 15% of gas produced be sold into WA markets. This creates somewhat of an issue because the majority of demand comes from ASEAN countries and not from the low population of WA or the industrial companies in the region. (Ledesma, Henderson, & Palmer, 2014)
Related and supporting industries

The related and supporting industries in WA are a definite strength of the region when it comes to supporting the LNG cluster. There is a strong presence from large engineering and procurement firms due to mining and oil & gas activities in the regions. Further there is a strong construction industry, as well as operations and maintenance services. (Wang, 2016) Collaborative institutions for collaboration and academic institutions in WA (e.g., University of Western Australia) are also in place and well established. (The University of Western Australia, 2016)

LNG Cluster

Introducing the Global LNG Market

The world market for LNG comprised 241.1 million tons (MT)\(^1\) in 2014. Australia was the world’s 3rd largest LNG exporter in 2014 with 23.3 MT, following Qatar (76.8 MT) and Malaysia (25.1 MT) and overtaking Indonesia that used to occupy the 3rd place through 2012/2013. (International Gas Union, 2015)

Asia/Asia Pacific is the world’s largest LNG destination, consuming estimated 60% of global LNG production in 2014. Japan (88.9 MT), South Korea (38 MT), China (20 MT), India (14.6 MT), and Taïwan (13.6 MT) were the leading net importers in the region in 2014. Europe, with 33 MT of net imports in 2014, was the world’s second largest LNG consumer, with Latin America coming in 3rd with 15 MT in 2014. Interestingly, United States that led North America with 5.9 MT in net imports in 2011 has reduced that number to 1.2 MT by 2014, with imports expected to decline further and eventually turn into exports as regulators begin to approve LNG export projects, thus relieving domestic shale gas supply glut.

Global LNG imports are expected to rise by 44%, or 107 MT, by 2020. Most of that growth, or 68 MT, will come from demand in Non-OECD Asia (with China making up 29 MT and India 9 MT of that number), while OECD Europe will be the 2nd largest growth region with an increase of 32 MT. (International Energy Agency, 2015)

\(^1\) For consistency, all LNG volumes have been converted to tonnes using a conversion table found in April 2014 Argus Media report https://www.argusmedia.com/~media/files/pdfs/samples/argus-global-lng.pdf?la=en
Introducing Australian LNG

Having overtaken Indonesia as the world’s 3rd largest LNG exporter in 2012/2013, Australia continues the march towards its ambitious goal of becoming the world’s largest LNG exporter by 2020. In 2015, Australia shipped a whopping 30.4 MT of LNG to its overseas clients, taking over Malaysia as the world’s 2nd largest exporter. LNG production in Q4 of 2015 alone was 48% greater than in Q4 of 2014. (Australian Petroleum Production & Exploration Association, 2016)

As if the 2020 top worldwide LNG exporter goal were not ambitions enough, Australia aims to focus almost exclusively on the Asian market. (Australian Petroleum Production & Exploration Association, 2016) For instance, the country shipped 78% of its LNG exports to Japan, 17% to China and 4% to South Korea in 2014. (International Gas Union, 2015)

In addition to geographic proximity, Asian market is attractive because most of the LNG volume purchased there is sold under long-term contracts. In fact, 72% of Asian LNG imports were under long-term contracts in 2014 (with the number ranging from the high of 80% in China and South Korea to the low of 54% in India), while 90% of Australia’s new LNG capacity is under short-term on long-term contracts. (International Energy Agency, 2015)

Unfortunately, softening demand in Asia may unmake the region as the perfect destination for LNG. China showed a 1% drop in demand for LNG in 2015. (Russell, 2016) Prompted by cooling of the economy, this was the first decline in the country’s LNG consumption since the first imports were shipped back in 2006. Similarly, consumption growth in both Japan and South Korea did not materialize in 2015. Rather, both countries experienced a slight drop in demand. (Woolrich, 2016)

Cluster History and Timeline

In the 1970s, vast quantities of natural gas were discovered on northwest coast of Australia. As early as the 1980s, serious investments to find and produce gas in the northwest shelf (NWS) began. In 1984, the first pipeline gas production from NWS occurred. It was five years later in 1989 when the first shipment of LNG from NWS was sent on its way. This first shipment was destined for Japan and very much foreshadowed the exporting nature of this endowment. (Woodside Energy, 2009)
Shipments and expansion continued until 1997 when the Asian financial crisis took hold of demand in ASEAN region. No other projects were initiated during this period until 2003. CNOOC then started investing in numerous WA LNG projects. Two years later in 1995, the Pluto gas field was discovered. It was more than a decade until this resource was opened up for LNG exploitation. In 2006, the WA government announced that 15% of gas produced from the NWS must be sold to domestic markets. In 2007, the Pluto LNG facility was granted approval and its first shipment set sail in 2012. To highlight how important ASEAN demand was and is, in 2012, 56% of China to Australia FDI was focused on the WA region. (KPMG, The University of Sydney, 2013) Since then expansion continues as the Gorgon project was completed in 2015 after starting construction in 2009. (Australian Petroleum Production & Exploration Association, 2016) With this project alone, $34 billion was spent on local goods helping to bolster the WA economy. (Chevron, 2016)

Currently, there are two producing LNG facilities in WA. A total of $135 billion has been invested in 20.6 MTPA of production. Extensive production is set to come online in the relatively near future with 2016 marking the planned completion of the Wheatstone Project in WA, followed by the Prelude project in 2017. (Department of Industry, Innovation and Science, 2011) (Chevron, 2016) This new production brings to light a serious concern with regards to potential overcapacity in the global LNG market. (Ledesma, Henderson, & Palmer, 2014)

**State of Cluster Development**

As one thinks about the state of cluster development in WA, it’s important to distinguish what each stage looks like. A cluster in its infancy would have minimal investment and infrastructure, no IFCs or research institutions and small impact locally. (This would have been an accurate description of the cluster in the 1980s/1990s.) In a ‘developing’ cluster, investment is costly due to lack of resources but it still occurs, talent must largely be imported, and the cluster plays a small but meaningful role in the local economy. A mature cluster has focused R&D, many IFCs, overlapping industries, and is a main driver of local prosperity.
As such, it’s clear that WA is in the development stage of its sophistication. It currently leverages resources from other industries, such as mining, for labor and equipment. Existing academic institutions are developing LNG programs. And specific knowledge and talent (science and engineering) are still imported from abroad.

**LNG Products**

Australia’s natural gas reserves can be broken down into 3 types: conventional, tight & shale, and coal seam gas. Conventional reserves are the smallest by volume, measuring at 3,428 MT in 2014, yet least expensive to extract, despite being found in offshore formations. 92% of conventional gas deposits are located in Western Australia. Tight & shale gas reserves are the largest of the 3 types, with up to 9,024 MT in estimated reserves as of 2014. (Geoscience Australia and BREE, 2014) However, they are expensive to produce and located in the relatively undeveloped interior of the country. Thus, no production of viable quantities of tight & shale gas is expected to come online until mid-2020s. (Kelly, 2014) Finally, coal seam gas reserves are found in certain coal deposits. All are located in the eastern part of the country and, despite reserves amounting to 4,192 MT (or 20% greater than conventional reserves), coal seam gas accounted for only 13% of production in 2014. (Geoscience Australia and BREE, 2014)

After natural gas is extracted from one of these 3 types of deposits, it is processed to extract moisture and valuable natural gas liquid (NGLs), such as ethane, propane and butane. This processing results in “dry” methane, which is then transported via pipeline to a liquefaction facility. Once there, it is cooled to a brisk -161 °C (-258 °F), which compresses its volume to 1/600 of that of gaseous methane, thus turning it into Liquid Natural Gas. LNG is then loaded onto specially-designed carriers. A carrier has an average capacity of 71,500 to 143,000 m³ (52 to 104 tonnes). (Australian Petroleum Production & Exploration Association, 2016) However, new technology is enabling construction of carriers with exceedingly larger capacities. Currently, the world’s largest LNG carrier with a capacity of 260,000 m³ (189 tonnes) was commissioned and is operated by Qatargas. (Lloyd’s Register, 2008) After the carrier completes the journey to its destination, LNG is pumped out, re-gasified and transported via pipelines to the end consumers, destined for residential, commercial, or industrial use. (Australian Petroleum Production & Exploration Association, 2016)
LNG Cluster Map

At its highest level, the Australian LNG cluster is made up of exploration & production and transportation & storage, and is tangentially bordered by the mining, construction, logistics, and oil clusters and can be seen below in Exhibit 4.

Exploration and production

The exploration and production part of the cluster is made up of eight different cluster elements: geophysical analysis of potential LNG production sites, specialty equipment providers such as LNG production rigs and the equipment used on them, engineering services for a myriad of items including LNG production, rig building, ship building, and transportation, construction and rig building when a good LNG production site is found, site preparation services in order to get the rigs in place, drilling services for efficient drilling and compliance with environmental regulations, maintenance and repair of the rigs, drilling equipment and ships, and well completion and wrap up for when the LNG production site is no longer viable.

Transportation and storage

The transportation and storage part of the cluster is made up of six different cluster elements: ship building as the ships are custom-made for LNG transportation, liquefaction plants as the gas needs to be compressed to reduce its volume so that it can be transported properly, shipping the actual LNG to its end market, regasification plants to turn the LNG back into its natural gas form, pipeline operations which transport the gas over land to its final users, and petrochemicals as the LNG is used as an input to that. (Siemens, 2015)

The cluster is supported by the government, institutions for collaboration, and research institutions.

Government

well as enforcing environmental regulation. (National Offshore Petroleum Safety and Environmental Management Authority, 2016)

Along with these national agencies, there are state and local agencies that also enforce various regulations.

**Institutions for collaboration**

The Petroleum Exploration Society of Australia is a national organization that represents all of the professionals and practitioners in the industry. (Petroleum Exploration Society of Australia, 2016) The Australian Petroleum Production & Exploration Association has 70 member companies and represents the entire Australian oil & gas exploration and production industry. (Australian Petroleum Production & Exploration Association, 2016) The Centre for Energy Geoscience works on advancing knowledge of geology and energy, while the Australian Pipelines and Gas Association represents the interests of anyone involved in pipelines, including operators, owners, and engineers. (Centre for Energy Geoscience, 2016) (Australian Pipelines and Gas Association, 2016)

**Research institutions**

The North Australian Centre for Oil and Gas is located at Charles Darwin University and works to educate workers in the industry. (North Australian Centre for Oil and Gas, 2016) The Australian Research Council Centre of Excellence for Geotechnical Science and Engineering works to improve the science around geotechnical engineering and the Deep Exploration Technologies Cooperative Research Centre is a research cooperative between industry participants and research institutions. (Australian Research Council Centre of Excellence for Geotechnical Science and Engineering, 2016) (Deep Exploration Technologies Cooperative Research Centre, 2016)

**Cluster Performance**

Western Australia has been experiencing impressive growth since its inception in late 1980s, particularly ballooning after mid-2000s. LNG export capacity has increased from 5 MTPA (million tonnes per annum) in 1989 to 20.6 MTPA in 2015, or a tri-fold increase. Meanwhile, annual LNG export revenue has grown at a 12% CAGR between 2011 and 2014 alone: from $11.1 billion to $15.6 billion. (Department of State Development, 2015)
However, this impressive growth may be marred by several looming issues. At the forefront are the large costs incurred by LNG exporters in Western Australia. Australian wages have historically significantly exceeded those in other major LNG-producing countries. For instance, average weekly wage in Australia in 2013 stood at $1,003 USD — almost 19% higher than in Canada ($843 USD), 26% higher than in US ($798 USD), 41% higher than in Qatar ($713 USD), and full 396% higher than in Russia ($202 USD). This gap has closed somewhat by 2015, when Australian wages were 1% higher than in US, 18% higher than in Canada, 5% higher than in Qatar, but full 591% higher than in Russia. However, this reduction, as evidenced by remaining gaps vs. Canadian and Russian wages, was driven mainly by weakening exchange rates of resource-exporting countries. Indeed, Australian dollar has dropped ~20% relative to USD within the same time-frame.4

To make the country’s wage position worse, it seems that, despite higher compensation, LNG labor productivity in Australia is lagging behind other global LNG producers’. An independent LNG industry study conducted in 2013 found that it took 1.3 hours in Australia to conduct a task that would take 1 hour to complete in the US Gulf Coast. That disparity is even greater in Western Australia where, due to long travel times to remote locations, the same task took 1.35 hours. (Ledesma, Henderson, & Palmer, 2014)

Finally, in addition to wages and productivity concerns, frenzied LNG export project development in Western Australia has led to capacity build-up that is only expected to continue in the future. In 2013, LNG capital expenditures hit a record high of $50 billion. And while such fixed asset build-up is expected as the cluster is developing and is set to taper off after 2017, it will coincide with increases in operating costs that would kick in once LNG projects start coming online. While operating expenditures were $1.3 billion in 2014, they are expected to more than triple to $4.9 billion by as early as 2020. Although this means steady,
well-paying jobs for the local economy, it does not bode well for the Western Australia LNG export cluster, since its cumulative capital & operating investment is likely going to hit a whopping $750 billion by 2040. (Accenture, 2015)

Sheer dollar value aside, worldwide LNG export capacity build-up, of which Australia is the main culprit, is already starting to ring supply glut alarm bells. For instance, projected LNG export capacity increase in Australia, Canada and US between 2015 and 2025 is going to exceed the demand growth in Asia (which, as we have seen, is going to be by far the largest recipient of LNG in the world) by as much as 60%. (Frost & Sullivan, 2015). Although some of that additional capacity can be expected to serve Europe’s growing demand, it is hard to imagine a scenario where all of LNG produced a decade from now is able to find a buyer if current global capacity expansion plans remain in place.

Top Competitors

When looking at main current and potential LNG exporters globally, it would appear that Australia might be relatively well positioned in the next 5 to 10 years.\(^5\)

First let’s take a look at current major suppliers to the Asian market. Qatar, the world’s leading LNG exporter with the 3\(^{rd}\) largest global natural gas reserve stock of 18,275 MT as of 2014 is, to say the least, a formidable presence. However, the future of this titan as the dominant LNG exporter is uncertain, as Qatari government has imposed a moratorium on all new LNG developments through 2020, thus helping pave the way for Australia’s march towards its ambitious goal of becoming the world’s top LNG export leader. (International Energy Agency, 2015)

Malaysia, despite having relatively small reserves of 1,714 MT as of 2014, still stands as the world’s 2\(^{nd}\) largest LNG exporter. However, that position is expected to erode in the future as the country actually started importing LNG into certain regions in 2013 in order to replace declining peninsular reserves. With expectations of growing domestic demand in the near future, Malaysia intends to keep a larger share of its production for domestic use. (International Energy Agency, 2015)

\(^5\) Natural gas reserve data that appears in this section is taken from the databases of US Energy Information Administration (https://www.eia.gov/dnav/ng/ng_enr_shalegas_dcu_NUS_a.htm and http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=3&pid=3&aid=6)
Indonesia has already slipped from its place as the world’s 3rd largest LNG exporter, giving way to Australia in 2012/2013. It would seem that the country’s LNG export position is due to worsen even more. In light of domestic natural gas demand growth fueled by the booming West Java industrial sector, Indonesia’s net exports are expected to decline by 4 MTPA by 2020. However, it is unclear whether a larger share of domestic consumption would be kept within the country, or if LNG imports would be used to satisfy increasing domestic demand. In fact, in 2015 Indonesia completed conversion of the Arun LNG liquefaction terminal in North Sumatra to a regasification facility with annual import capacity of almost 3 MTPA. (International Energy Agency, 2015)

Meanwhile, new players that may challenge Australia in the Asian LNG markets are emerging, although their ultimate impact remains unclear. US, with its massive shale gas reserves of over 4,130 MT, is poised to become the world’s 3rd largest LNG exporter by 2020. (International Energy Agency, 2015) Although anti-export regulatory climate has been slow to change, recent LNG export project approvals by the DOE are making the country’s ambitions more likely to come to fruition. (Pedersen, 2016) However, current suppressed prices for natural gas and, particularly, oil (which still underlies pricing in most of the dry natural gas and LNG contracts worldwide) have all but eliminated the cost advantage US LNG was set to enjoy in Asia just over a year ago. Due to the shorter distance, Australia is currently much better positioned as a supplier to Asian markets, and US LNG exports are likely to be bound for Europe unless world markets change significantly. (International Energy Agency, 2015)

Finally, East Africa is an emerging region that could threaten Australia’s strengthening grip on the Asian LNG import markets. With roughly 3,500 MT in reserves in conventional on-shore deposits, cheap labor, and, most importantly, relative proximity to Asian markets, it indeed has the potential to pose a credible threat. However, that potential is compromised by the remote location of gas deposits and sites of potential LNG export terminals, lack of basic infrastructure and undeveloped legal framework, making it unlikely that any real developments would come online until after 2020. (International Energy Agency, 2015)

Applying The Diamond to the Cluster

Overall, Australia has a very strong LNG cluster which can be seen by applying the diamond framework to the cluster. The diamond for the LNG cluster is illustrated in Exhibit 7.
**Factor conditions**

The cluster has strong universities with dedicated centers for oil & gas research including the University of Western Australia. There is strong collaboration between universities and the LNG industry. For example, there is the University of Western Australia Energy and Minerals Institute and the Western Australian Energy Research Alliance. (Energy and Minerals Institute, 2016) (Western Australian Energy Research Alliance, 2016) Australia has a strong pipeline infrastructure and recently made plans to invest billions of AUD into upgrading the infrastructure. Due to the strong educational system and universities, Australia has a qualified labor force for LNG work, however, this qualified labor is in short supply because the industry is growing so rapidly. There is also a large regulatory burden on the LNG cluster as there are many intertwining and overlapping state and federal laws that must be upheld. (Australian Petroleum Production & Exploration Association, 2013)

**Context for firm strategy and rivalry**

The cluster is very competitive as many of the world's largest oil & gas exploration and production firms operate there. The PRRT Tax is generally viewed as fair because it taxes exploration and production firms based on their profits and not on their production, like in many other countries. (Australian Petroleum Production & Exploration Association, 2016) A negative aspect includes the fact that the LNG cluster will require massive amounts of future capital expenditures to maintain itself. This is estimated to be a cumulative $500B through the year 2040 in CAPEX alone. (Accenture, 2015) Another negative is the many inconsistent and overlapping regulations from many laws and regulators that firms face. Finally, pay for Australian LNG workers is very high due to the limited supply and productivity is lower than it is in the U.S., worsened by vast geographical distances between LNG projects.

**Demand conditions**

Overall demand conditions are positive. There is strong demand from Asian nations including China and Japan. Domestic demand is increasing in absolute terms but not relative to oil or renewables. (Office of the Chief Economist, 2015) There are strong
federal, state, and local regulations and authorities such as the National Offshore Petroleum Safety and Environmental Management Authority. A negative aspect here is that there is increasing competition from other regions of the world such as the United States.

Related and supporting industries

The related and supporting industries to the cluster are very strong. There is a strong presence of exploration and production firms not directly linked to LNG, such as oil producers. There is a strong construction industry as well as operations and maintenance firms. There is a high availability of specialized training and education through universities such as the University of Western Australia. Finally, there are strong cooperative organizations like the Australian Petroleum Production and Exploration Association.

Why Invest in Western Australia?

No geography is perfect but WA has some outstanding benefits and reasons to invest in the region. These reasons include its developed legal framework, investor protection, and institutions. Further, WA has fantastic ports, as well as air and road infrastructure that are in good shape. (Engineers Australia, 2010) The local government is supportive of industry and open to dialogue. (Wang, 2016) The region is rich with the key endowment for LNG production — natural gas. It is also very close to key global demand from ASEAN countries while concurrently being close to domestic industrial demand that is more prevalent in WA than in other parts of Australia. Lastly, WA is an attractive place to live for workers and executives alike. It has “endless blue skies, white sandy beaches, [a temperate climate,] and an easy-going lifestyle.” (Government of Western Australia, 2016) Although the actual LNG projects are located remotely, a short flight puts you in Perth where a significant population lives. (Pash, 2014)

Issues and Recommendations

As outlined during the course of this paper, Western Australia LNG cluster, despite its many advantages, faces several challenges. These issues, as well as our recommendations to address them, are presented below:

1. **Low productivity vs. other markets, as well as potential lack of the right skills.** A study has shown that productivity in Australian LNG is 30% lower than in the US, and as much as 35% lower when considering Western Australia specifically.
Recommendations:

- Sponsor cooperation between industry, government, and academia to increase the supply of qualified workers. This would be an action carried out by individual companies. The main risk would be incurring an increased financial burden for projects that already have high CAPEX.

- Improve worker quality of life (encourage construction of restaurants, entertainment venues, etc.). This could be an action carried out by the government to ensure that improvements are inclusive, and not reserved for employees of specific companies. The main risk would be seeing uncertain returns on taxpayer dollars.

2. **Overlapping and complex environmental regulations.** A typical LNG export project with offshore gas production and on-shore liquefaction terminal has to navigate as many as 8 extensive pieces of legislation upheld by 3 independent jurisdictions (Exhibit 5 illustrates this complexity). (Australian Petroleum Production & Exploration Association, 2013)

Recommendation:

- Empower Department of Sustainability, Environment, Water, Population and Communities (which currently enforces the main piece of environmental legislation in Australia) to convene all federal and state environmental regulators and task them with streamlining the regulatory process. This would be an action carried out by Institutions for Collaboration. The main risk would be of seeing progress being delayed and an underwhelming end result having a minimal impact on cluster environment.

3. **High wages with strong unions and a weak exchange rate.** As discussed earlier in this paper, Australia’s historically high wages have been recently brought down by weakened exchange rate. However, the underlying issue of high and rising wages still remains, as local-currency wages in Australia grew YOY 58% faster than those in the US and 51% faster than those in Canada between 2007 and 2015. Moreover, Australia has the highest minimum wage in the world. (Petroff, 2015) In addition, Australia Council of Trade Unions is currently lobbying the government to raise the minimum wage by 4.6%, indicating that wages in Australia are likely to continue rising in the future. (Courrier Mail, 2016)
Recommendations:

- Use poor oil and gas environment to engage proactively in collective bargaining agreements (e.g., emphasize pay based on seniority to decrease new employee wages). This would be an action carried out by individual companies. The main risk would be that it could stall construction & operations if negotiations prove to be unfavorable.

- Pass tax reform to alleviate corporate financial burden and increase investment attractiveness. This would be an action carried out by the government. The main risk would be criticism due to perception of the government “picking favorites”.

4. Increasing international capacity coming online (especially from US) causing potential overcapacity in international market.

Australia, US, Canada and several countries in the East Africa region are pursuing ambitious plans of LNG export capacity build-ups, while Asian demand, slated as the main driver of LNG market growth in coming decades, is proving softer than expected.

Recommendations:

- Increasingly co-opt ASEAN demand partners by developing LNG-specific trade clusters, since alignment on industry standards between supplier/buyer is likely to ensure that Australian LNG continually meets required specifications as well as or better than other suppliers’. This would be an action carried out by individual companies. The main risk would be seeing international agreements and ties with buyers falter if Australia can no longer provide LNG supply at a favorable price.

- Maintain/improve port infrastructure to attract the best international logistics partners, since, as fuel prices increase in the future, efficient logistics may become a competitive advantage. This would be an action carried out by the government. The main risk would be difficulty justifying further investment in already well-developed, world-class ports, while other parts of the infrastructure, like freight, rail and telecommunications in Western Australia are faltering or limited. (Engineers Australia, 2010)

5. Low domestic natural gas consumption. In 2013/2014, 43% of Australian Natural Gas production was exported, while that share was as high as 85% in Western Australia. (Bureau of Resources and Energy Economics, 2014) Natural gas accounted for 24% of total energy use in Australia in 2014, while it amounted to 27% of all energy use in the US in the same year. (U.S. Energy
Information Administration, 2015) Per-capita natural gas consumption\(^4\) in Australia was relatively low (53 thousand ft\(^3\)/person vs 84 thousand ft\(^3\)/person in US in 2014), with most of the usage shortfall coming from residential (accounting for 11% in Australia vs. 19% in the US in 2014) and commercial (making up 3% in Australia vs. 13% in the US) customers. (U.S. Energy Information Administration, 2015)

**Recommendations:**

- Develop and build downstream LNG industries in Western Australia. This would be an action carried out by individual companies. The main risk would be financial, in the form of uncertain returns.

- Provide tax incentives for building downstream LNG industries (e.g., petrochemical facilities). This would be an action carried out by the government. Again, the main risk would be drawing criticism due to perception of the government “picking favorites”.

- Promote residential and commercial gas consumption (e.g., marketing campaigns). This would be an action carried out by individual companies. The main risk would be financial, as advertising return would be highly uncertain and may be a poor use of investor dollars.

- Lobby for carbon trading system to be reinstated (will make gas much more competitive vs. coal). This would be an action carried out by individual companies. The main risk would be new carbon regulation backfiring on natural gas producers as renewables become more affordable and widely available.

**Required Disclosures**

Channce Fuller worked as an intern for the Boston Consulting Group and lived in Melbourne, Australia during the Australian winter of 2015 (summer break between RC and EC years).

Exhibit 1: Trends in Australia’s HDI indices 1990-2014

Exhibit 2: Australia, US and Canada historic GDP per capita

Exhibit 3: Australia’s Industry Cluster Map

Australia’s Export Portfolio by Cluster, 2000 - 2014

Exhibit 4: Western Australia Cluster Map

Exhibit 5: Summary of environmental regulations that apply to a typical LNG export project

Exhibit 6: Western Australia Regional Cluster Diamond

Factor Conditions
- High levels of qualified labor force tied to economic cycles
- Strong port and energy infrastructure
- Very involved government
- Roads, water and energy infrastructure aging
- Cyclical labor costs, currently very high
- Distance from other major centers makes WA less attractive for talent
- Lack of telecommunications coverage in many parts of WA
- Almost no rail system for heavy goods transport

Context for Firm Strategy and Rivalry
- High levels of transparency
- Relatively low barriers to trade
- Strong laws and investor protection
- Many firms and partnerships increase competitive innovation
- Many industries dominated by leading firms (e.g., banks, telecom)

Demand Conditions
- Sophisticated customers (with variation across clusters)
- Strong governmental regulations regarding quality, environment, etc.
- WA domestic energy needs are a key concern for governments
- Small concentrated population means weak domestic demand

Related and Supporting Industries

Exhibit 7: Western Australia LNG Cluster Diamond

Factor Conditions
- Strong universities with dedicated centers for oil & gas research
- Strong university industry collaboration
- Strong pipeline infrastructure & recent planned investment of billions of AS into transportation infrastructure
- Qualified labor force
- Qualified labor in short supply
- Large environmental regulatory burden

Context for Firm Strategy and Rivalry
- Extremely competitive with many of the world's largest E&P firms
- "Fair" PRR Tax based on profits
- Will require massive amounts of future Capex to maintain
- Many overlapping or inconsistent regulations cause inefficiencies
- High pay and low productivity

Related and Supporting Industries
- Strong presence of large E&P firms (i.e., strong supplier quantity and quality)
- Strong construction industry as well as operations and maintenance services
- High availability of specialized training and education
- Strong cooperative organizations like APPEA

Demand Conditions
- Strong demand from Asian nations including China and Japan
- Strong federal, state, and local regulations and authorities (NOPSEMA)
- Increasing absolute domestic demand, but not relative to oil or renewables
- Increasing competition from other producing regions like the US
Bibliography


