

Australia's freight and supply chain performance against international comparators¹

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Executive summary

This paper shows that in general Australian supply chains do not suffer from the “tyranny of distance”. For the most significant export chains, in particular iron ore and Liquefied Natural Gas (LNG), Australia enjoys geographical advantages over its main competitors. For the containerised, vehicle and product oil (refined petroleum products) import chains, Australia benefits from the demographic advantage that most of the population is concentrated in the coastal capital cities. These are within easy reach of ocean shipping, which is by far the most efficient and environmentally friendly mode of freight transport.

The high degree of urbanisation in Australia (two thirds of the population live in five coastal cities) promotes competition between products, the supply chains delivering these products, and the logistics providers serving the supply chains. The primary obstacle to more efficient logistics is congestion in urban areas, rather than missing links in interstate networks, suggesting that this is where infrastructure investment should be concentrated.

Regarding interstate networks, coastal shipping is currently a missed opportunity, as shipping is more efficient and environmentally friendly than competing rail or road modes. Coastal shipping currently serves specific supply chains, for example iron ore from Port Hedland to Kembla, bauxite from Weipa to Gladstone or product oil to 55 product oil terminals around the Australian coast, but is in decline for containerised cargo. The 2012 Coastal Trading (Revitalising Australian Shipping) Act is hastening this decline, so is in urgent

¹ This paper is a contribution to the enquiry into National Freight and Supply Chain Priorities and has been commissioned by the Department of Infrastructure and Regional Development (DIRD). The views expressed are the author's own and are intended to provoke reflection and debate.

need of reform, but ultimately the coastal shipping of containers can only be rescued by a technological revolution (discussed in the next paper). Such a technological revolution could, however, put into question the case for expensive interstate infrastructure investment, such as the Inland Rail project.

Australia's primary import and export chains

As Table 1 shows, the top export in 2016 is iron ore, shipped mainly from the Western Australia (WA) ports of Port Hedland and Dampier. This is followed by coal, shipped mainly from the east coast, in particular Newcastle in New South Wales (NSW) and ports in Queensland. The demand for metallurgical coal depends on the demand for steel, which will also affect the demand for iron ore. Thermal coal, however, has an uncertain future as China and other countries switch to cleaner sources of power. LNG is currently the fifth largest export, but is rising rapidly in importance with new liquefaction plants in Queensland and off the northwest coast coming on stream. This is straining east coast gas supplies, as opposition to coal seam gas extraction is currently curtailing output. As gas from Australia's northwest shelf cannot currently be piped to the east coast, and long-term LNG export contracts must be honoured, a scenario whereby the east coast is simultaneously increasing the export and import of LNG is possible.

Table 1: The value and share of Australia's primary exports in 2016²

Rank	Commodity	Value	% share
1	Iron ores & concentrates	53,703	16.3
2	Coal	42,326	12.8
3	Education-related travel services	21,966	6.7
4	Gold	18,857	5.7
5	LNG	17,911	5.4
6	Personal travel (excl education) services	17,412	5.3
7	Beef	7,401	2.2
8	Aluminium ores & conc (incl alumina)	6,460	2
9	Wheat	4,853	1.5
10	Professional services	4,782	1.4

Table 2 reveals that Australia's top imports are vehicles, refined petroleum and containerised cargo. Both imports and exports conform to the principle that the largest quantity (or parcel) of cargo should travel the longest distance in any supply chain, to extract maximum benefit from the economies of scale. Hence exports are shipped from ports close to their sources (iron ore from WA, coal from east coast ports, LNG from the northwest shelf, WA, NT and Queensland), which are typically far from the capital cities, where the population is concentrated. By contrast, containers and vehicles are imported through ports either in or near the capital cities, close to consumer markets. Refined petroleum is imported through 55 product oil terminals located around the Australian coast to meet local demand.

² Source: <http://dfat.gov.au/trade/resources/trade-at-a-glance/pages/top-goods-services.aspx>

Table 2: The value and share of Australia's primary imports in 2016³

Rank	Commodity	Value	% share
1	Personal travel (excl education) services	28,594	8.4
2	Passenger motor vehicles	21,403	6.3
3	Refined petroleum	14,829	4.3
4	Telecommunication equipment & parts	11,970	3.5
5	Freight transport services	8,792	2.6
6	Crude petroleum	7,953	2.3
7	Medicaments (incl veterinary)	7,617	2.2
8	Goods vehicles	7,535	2.2
9	Gold	7,468	2.2
10	Computers	7,349	2.1

The main export markets for iron ore are China, Japan and South Korea (see Table 3), while the main competitor is Brazil (see Table 4).

Table 3: The value and share of main iron ore importers in 2016⁴

Rank	Country	Value	Share
1	China	\$57.1 billion	67.80%
2	Japan	\$7.3 billion	8.70%
3	South Korea	\$4 billion	4.80%
4	Germany	\$2.4 billion	2.90%
5	Netherlands	\$1.8 billion	2.10%
6	Taiwan	\$1.3 billion	1.60%
7	France	\$765.6 million	0.90%
8	Malaysia	\$756.1 million	0.90%
9	Turkey	\$697.7 million	0.80%
10	United Kingdom	\$572 million	0.70%

³ Source: <http://dfat.gov.au/trade/resources/trade-at-a-glance/pages/top-goods-services.aspx>

⁴ Source: <http://www.worldstopexports.com/iron-ore-imports-by-country/>

Table 4: The value and share of the main iron ore exporters in 2016⁵

Rank	Country	Value	Share
1	Australia	\$39.5 billion	55%
2	Brazil	\$13.3 billion	18.50%
3	South Africa	\$3.6 billion	5%
4	Canada	\$2.9 billion	4%
5	Ukraine	\$2.3 billion	3.20%
6	Sweden	\$1.6 billion	2.20%
7	Netherlands	\$1.1 billion	1.50%
8	India	\$1 billion	1.40%
9	Iran	\$834.7 million	1.20%
10	Chile	\$828.6 million	1.20%

Australia is around half the distance to the main export markets than Brazil, giving Australia a significant competitive advantage on shipping cost. Any competitive disadvantage resulting from the relatively high cost of labour in Australia is countered by landside economies of scale (length of iron ore trains, for example) and, in the case of Rio Tinto, automation of dump trucks, trains, stacker reclaimers and shiploaders.

In 2016, China topped the league of coal importers (see Table 5), but this may change as it switches to cleaner sources of energy for electricity generation. The other main coal importers may also switch from coal to reduce CO₂ output and take advantage of the falling cost of renewable energy and LNG, but with differing timelines. While thermal coal faces an uncertain future, metallurgical coal will remain in demand for steel production, which in turn will be required for infrastructure and residential construction. Australia's principle competitor for coal is Indonesia (see Table 6), which has a distance advantage to the main markets. Coal in Australia is increasingly seen as a stranded asset and new projects, like the Adani mines in Queensland, are finding it difficult to attract capital funding.

LNG is widely seen as the cleaner alternative source of energy, both for propulsion and for electricity generation. Australia has been rapidly building up its exports of LNG, with the construction of liquefaction plants in Queensland and the installation of the first floating liquefaction plant (the Prelude FLNG) at sea on the northwest shelf. Most LNG is sold on long-term contracts to the main markets of Japan, South Korean and China (see Table 7). Australia is currently the second largest exporter of LNG after Qatar.

⁵ Source: <http://www.worldstopexports.com/iron-ore-exports-country/>

Table 5: The top 10 coal importers by quantity in 2016⁶

Rank	Country	Net tons
1	China	360,415.00
2	Japan	211,162.00
3	India	182,369.00
4	Korea, Republic of	139,454.00
5	Taiwan, Province of China	74,998.00
6	Germany	55,678.00
7	United Kingdom	54,456.00
8	Russian Federation	32,655.00
9	Turkey	29,358.00
10	Netherlands	28,465.00

Table 6: The top 10 coal exporters by value and share in 2016⁷

Rank	Country	Value	Share
1	Australia	\$28.3 billion	38.30%
2	Indonesia	\$12.9 billion	17.40%
3	Russia	\$8.9 billion	12%
4	United States	\$4.4 billion	6.00%
5	Colombia	\$4.4 billion	5.90%
6	South Africa	\$3.9 billion	5.20%
7	Canada	\$3.4 billion	4.50%
8	Netherlands	\$2.3 billion	3.20%
9	North Korea	\$1.2 billion	1.60%
10	Mongolia	\$992.6 million	1.30%

⁶ Source: <http://www.indexmundi.com/energy/?product=coal&graph=imports&display=rank>

⁷ Source: <http://www.worldstopexports.com/iron-ore-exports-country/>

Table 7: The top LNG importers by million tonnes per annum in 2016⁸

Rank	Country	MTPA	Share
1	Japan	83.3	32.30%
2	S. Korea	33.7	13.10%
3	China	26.8	10.40%
4	India	19.2	7.40%
5	Taiwan	15	5.80%
6	Spain	9.9	3.80%
7	UK	7.4	2.90%
8	Egypt	7.3	2.80%
9	France	5.6	2.20%
10	Turkey	5.6	2.20%

Table 8: The top LNG exporters by million tonnes per annum in 2016⁹

Rank	Country	MTPA	Share
1	Qatar	77.2	29.90%
2	Australia	44.3	17.20%
3	Malaysia	25	9.70%
4	Nigeria	18.6	7.20%
5	Indonesia	16.6	6.40%
6	Algeria	11.5	4.50%
7	Russia	10.8	4.20%
8	Trinidad	10.6	4.10%
9	Oman	8.1	3.20%
10	PNG	7.4	2.90%

Demography and the efficiency of maritime transport

Of the freight modes, shipping is the most efficient in terms of cost per tonne-km and also the cleanest in terms of emissions per tonne-km. Australia's population is highly urbanised by international comparison, with 90% of Australians living in urban areas in 2016, as compared to 82% in the US and 75% in the EU, according to the World Bank. Moreover, two thirds of Australians live in five large port cities (see Table 9). Hence a large proportion of the Australian population is easily and efficiently reached by ocean shipping. The concentration of the population in the large port cities provides consumers with a wide

⁸ Source: https://www.igu.org/sites/default/files/103419-World_IGU_Report_no%20crops.pdf

⁹ Source: https://www.igu.org/sites/default/files/103419-World_IGU_Report_no%20crops.pdf

choice of products, facilitating lively competition between products, their supply chains and supporting landside logistics providers.

Table 9: Australian port city populations in 2016¹⁰

Rank	City, State	Population	Share
1	Sydney , New South Wales	5,029,768	20.74%
2	Melbourne, Victoria	4,725,316	19.24%
3	Brisbane , Queensland	2,360,241	9.74%
4	Perth, Western Australia	2,022,044	8.56%
5	Adelaide, South Australia	1,324,279	5.50%

Maritime transport has great potential to be even cleaner and more energy efficient than it is today through electrification, hybrid technology and alternative fuels. The new Maasvlakte II terminal in Rotterdam (Box 1) is electrifying all quay and yard cranes and is using a fleet of battery powered vehicles to move containers around the terminal. The electricity is being sourced renewably, hence the claim of near zero emissions.

Box 1: Maasvlakte II aims for zero emissions

- APM Terminals has signed a 2-year contract with NV Nuon Energy for wind generated electricity to power the new cranes and handling equipment at the new Maasvlakte II terminal.
- Maasvlakte II will thus achieve zero emissions through the electrification of all of its quay and yard cranes and the use of 37 battery powered Lift-Automatic Guided Vehicles (Lift-AGVs) to transport containers between the yard and quay.



Source: www.greenport.com, 16/12/14

In addition to landside electrification, ships at berth are increasingly able to plug into a landside electricity supply, enabling them to switch off onboard generators, a process referred to as 'cold ironing' (Box 2). The same technology may be used to recharge electric or hybrid ships.

¹⁰ Source: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup>

Box 2: Onshore power supply

- German energy expert Stemmann-Technik has completed onshore power supply projects for cruise ship terminals at the ports of Hamburg and Shanghai.
- Power and data to cruise ships is supplied from an onshore vehicle which moves along an underground cable channel.
- Stemmann-Technik also supplied a charging system for an electric ferry.
- Source: www.greenport.com, 21/7/16



Where full electrification may not be appropriate, hybrid technology can significantly reduce fuel consumption. When containers are lowered by a rubber tyred gantry crane (RTG) or straddle carrier, some of the energy expended in lifting can be regenerated (Box 3).

Box 3: Environmentally friendly hybrid RTGs

- Approximately 10% of the diesel fuel emissions from cargo handling equipment at ports are emitted by rubber tyred gantry cranes (RTG), so the retrofitting of battery hybrid technology to RTGs will substantially improve efficiency and reduce harmful fossil fuel emissions.
- The hybrid technology can result in fuel savings of up to 65%, it is claimed by Corvus Energy.



Source: www.greenport.com, 21/01/16

Kalmar claim that hybrid technology can reduce fuel consumption by straddle carriers by 40% (Box 4). Tug boats are another candidate for hybrid technology, because of the requirement for intermittent power output (Box 5). During idle periods, the batteries can be recharged to boost output when power is required.

Box 4: Hybrid straddle carriers

- The Kalmar hybrid straddle carrier's regenerative energy system converts electrical braking and spreader lowering energy into electric power that is stored by the state-of-the-art battery technology.
- The new system can deliver a 40% decrease in fuel consumption compared to existing machines in the market while meeting the most stringent engine emission regulations worldwide.
- Source: www.kalmarglobal.com, 4/11/17



Box 5: Hybrid tugs on the Thames

- The hybrid tugs 'RT Ambition' and 'RT Evolution' towed the Cruise Ship 'Viking Star' into the Port of London.
- Hybrid tugs generate 50% less harmful emissions, less noise, and substantial maintenance savings.
- These tugs have three electric motors, a battery pack and are managed by an intelligent Hybrid Propulsion System.
- Source: www.greenport.com, 4/11/17



In addition to electrification, sulphur oxides (SOx), particulates and some nitrus oxides (NOx) can be removed from exhaust gases by switching from conventional, high sulphur fuels to LNG. This is particularly attractive for the cruise ship industry, because of the need to berth close to port cities and promote a green image to customers (Box 6).

Box 6: Cruise ships clean up their operations



- AIDAsol cruise ship from Carnival Corporation was the first to be powered by LNG while in port.
- In May 2016, the AIDAsol and AIDAprima both berthed in Hamburg and were simultaneously powered by LNG; the Sol from a barge and the Prima from an LNG truck on the quay.
- By 2019, Carnival Corporation will use LNG to power cruise ships both in port and in the open seas, with a dual fuel engine.
- Source: www.greenport.com, 28/09/16

Logistical efficiency and market power

Let p be the price of a product, MC be its marginal cost of supply, and ϵ_D be the elasticity of demand for the product. Economic theory tells us that when competition is less than perfect between alternative products:

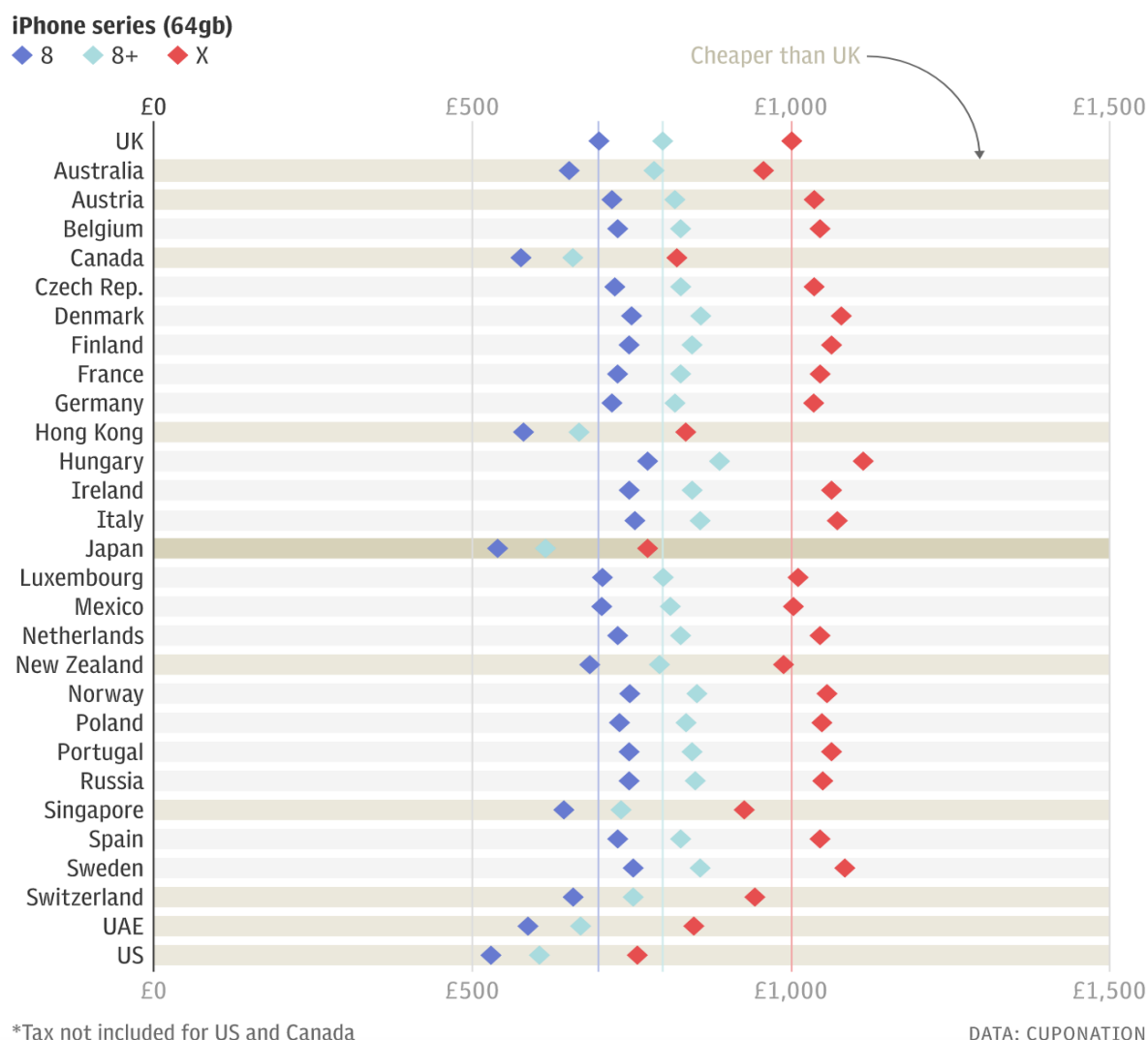
$$p = \frac{MC}{(1 + 1/\epsilon_D)}$$

As the size of the market increases, the elasticity of demand increases as consumers have more choices, leading the price to fall toward the marginal cost of supply. We have argued that the concentration of Australians in the five large port cities promotes competition between products, their supply chains and supporting logistics providers. Hence, Australia's reputation for high prices is unlikely to be due to a low elasticity of demand or a high marginal freight cost. It is more likely to be a reflection of the high cost of services associated with products and rent for land or facilities.

Figure 1 presents an international price comparison for three Apple iphone models. The only places that are cheaper than Australia can be characterised as 'global marketplaces', namely North America, Japan, Hong Kong, Singapore, Switzerland and the UAE, where the market for smartphones is large and competitive. The most expensive locations to buy iphones are smaller and more peripheral markets, like Hungary and Sweden. While some of these differences are accounted for by sales taxes (not included in the case of the US), this

comparison does provide at least anecdotal evidence that Australia is benefiting from its demographic concentration and good access to maritime and air logistics.

Figure 1: An international price comparison for three iphone models from Apple¹¹



Conclusions

The “tyranny of distance” does not typically apply to Australian import or export chains. Regarding bulk export chains, Australia is closer to the main markets for iron ore and LNG than its principal competitors, while coal faces an uncertain future. Regarding import chains, most Australians are concentrated in a few large port cities, readily accessed by maritime and air freight carriers.

Although Australia has no hub ports, container shipping is efficient and getting more so as larger ships are cascaded on to Australian services. However, larger ships offloading larger batches of containers (possibly less frequently) require more yard space and equipment to handle and move containers in the yard. The primary bottleneck to import chains are the

¹¹ Source: <http://www.telegraph.co.uk/technology/2017/09/14/much-does-iphone-x-cost-around-world/>

hinterland transport links, which are often congested. There is a need to shift more containers from road to rail and to open more intermodal terminals close to the freight destinations. In Sydney, the planned Moorebank Intermodal Terminal and associated investment in the suburban rail network will allow a significant increase in rail freight leaving the port. In parallel, the Westconnex tunnel will increase the road capacity on the approach to Port Botany.

Shipping is the most efficient and cleanest freight mode, with considerable potential to be even cleaner through the electrification of port equipment, the introduction of hybrid port equipment and ships, and the switch to cleaner fuel, in particular LNG for cruise ships. However, cabotage restrictions enshrined in the 2012 Coastal Trading (Revitalising Australian Shipping) Act are hastening the decline of coastal shipping, particularly for container traffic. At present, coastal shipping of containers does not compete on price or speed with rail or truck, but the advent of greater automation in shipping could make it more competitive. If there were a relaxation of cabotage restrictions and/or the introduction of autonomous ships, coastal shipping could offer an attractive option for interstate logistics. This topic is dealt with in greater depth in the second paper.