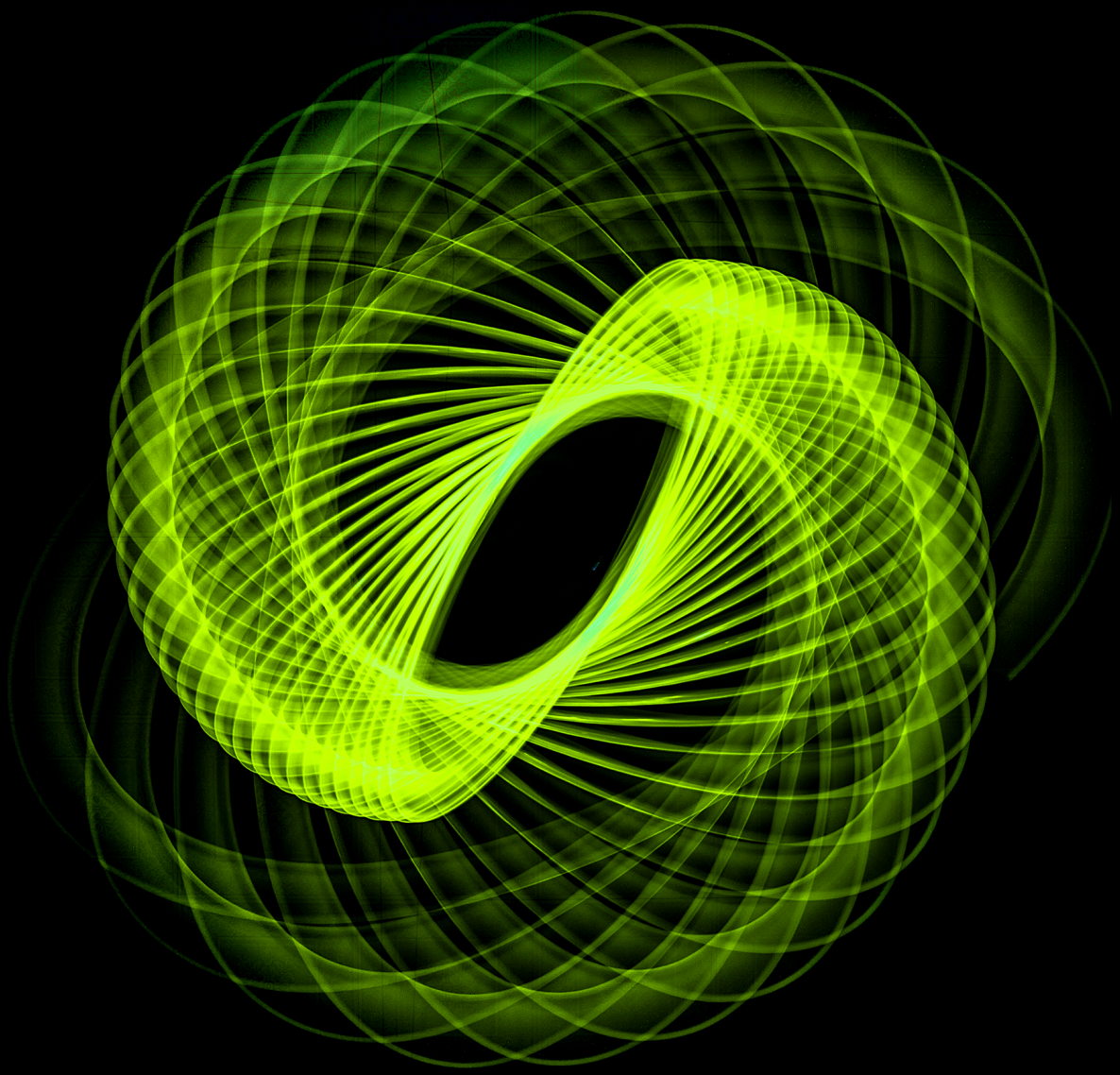
Deloitte.



Connected Nation

Communications Alliance

2019

Deloitte
Access Economics

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Executive summary

A world without modern telecommunications services and infrastructure is all but impossible to imagine. Access to the internet, rich multi-media content, GPS, voice calls, texts, social and messaging platforms – and much more – has become integral to the lives of all Australians. The Productivity Commission has recognised:[1]

> "Telecommunications is fundamental to any modern society. It plays an increasingly important role in the delivery of private and public sector services across the economy."

Australia has a well-developed and sophisticated telecommunications industry, which today provides services through 24 million mobile handset subscriptions and over 15 million broadband internet subscriptions, and which supported over 5 million terabytes of downloads in the year ending December 2018.

Communications Alliance engaged Deloitte Access Economics to quantify the economic benefits of the telecommunications industry and examine the efficiency of its current regulatory framework. This report finds that the industry makes a significant contribution to Australia's economy, both through its own activities and by providing the infrastructure that underpins productivity growth. In addition to being an important industry vertical, telecommunications is a key 'horizontal enabler', facilitating innovation and enterprise in every other industry and sector.

A significant industry

As our use of telecommunications has increased, so too has the 'economic footprint' of the industry as it generates value, employs people, and buys goods and services from other industries.

Deloitte Access Economics' analysis finds that the industry in its own right contributed **$51.5 billion to Australia's Gross Domestic Product (GDP) in 2017-18** – before even considering the productivity benefits telecommunication services generate for other industries.

The industry employed over **87,300 full time equivalent (FTE) roles directly, and supported a total of over 267,000 roles across the economy during 2017-18.***

Australian consumers have benefited from high levels of investment by, and competition in, the telecommunications industry. Telecommunications has **the second highest investment rate of any industry in the economy**, which contributes to the development and deployment of innovative technology. Competition has also meant the price of services has fallen significantly in real terms over the past decade, while connectivity, data, speed, and the diversity of products and services have all improved – often dramatically.

1 Productivity Commission 2017, Telecommunications Universal Service Obligation, https://www.pc.gov.au/inquiries/completed/telecommunications#report.

* An error in a previous version of this report has been corrected in this edition of the report. The previous version stated that the telecommunications industry supported 267,000 FTE roles elsewhere in the economy rather than the total number of roles in the economy.

Supporting productivity across the economy

With Australia having experienced slowing productivity over the past two decades, telecommunications infrastructure and services have made an important contribution to improving our living standards. The infrastructure does this by making it faster, cheaper and easier to access information as well as to create new products and even new markets.

Deloitte Access Economics estimates that as a result of these productivity benefits, the **Australian economy (GDP) is 6.5%, or $126 billion, larger in 2019 than it would have been without the impact of telecommunications.** This is equivalent to an additional $5,000 per person each year.

Telecommunications technology also provides access to international markets for all Australian industries. While Information and Communications Technology (ICT) inputs' share in Australia's exports was 7% in 2016, the social nature of trade means that telecommunications technology facilitates nearly every international transaction.

1 State of play

The telecommunications industry provides essential infrastructure that powers economies and societies globally. In Australia, it provides the means for connecting people and allowing the flow of information, irrespective of distance. Mobile phones, fixed-line services, laptops, tablets, wearable devices and satellites all rely on the infrastructure provided by the industry. As a result, telecommunications services today are classed as 'critical infrastructure' in Australia.[2] The Productivity Commission has described the role of telecommunications as "fundamental to any modern society".[3]

A range of businesses make up the telecommunications ecosystem that collaborates to deliver communications services in Australia. These can be broadly categorised into retailers and infrastructure providers.

- **Retailers** produce or distribute hardware or purchase network access to sell to consumers. Hardware includes consumer equipment such as mobile phones or wearable devices. Retail service providers include Mobile Virtual Network Operators (MVNOs) and fixed-line and data service providers that sell plans to consumers using network access from carriers through agreed wholesale arrangements.
- **Infrastructure** providers, such as carriers, own the infrastructure that transmits both fixed and mobile telecommunications which are sold to wholesale customers (retailers) or directly to consumers. Infrastructure providers include those Internet Service Providers (ISP) which own infrastructure necessary for the provision of access to the internet.

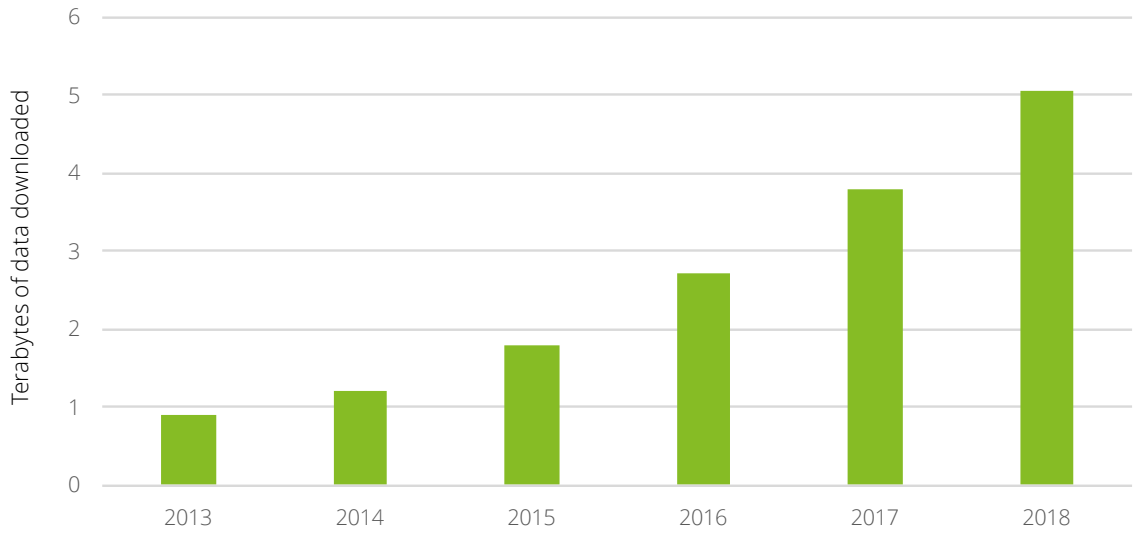
While many businesses fall into one of the above categories, some undertake activities in both. This is particularly true for larger businesses such as Telstra, Optus and Vodafone that both own and maintain networks while selling to other telecommunications businesses and directly to consumers.

1.1 The use of telecommunications

Telecommunications services have long been a part of everyday life for households and businesses. Over 97% of Australian businesses, and nearly 90% of Australian adults, have access to the internet.[4] In a clear sign of the now ubiquitous nature of technology, there are more mobile subscriptions than people, with 136.4 subscriptions per 100 Australians,[5] while the volume of data downloaded through broadband and mobile handsets was nearly six times greater in the three months to December 2018 than in the three months to December 2013 (see Chart 1.1).[6]

2 Australian Government 2019, Safeguarding critical infrastructure, https://cicentre.gov.au/infrastructure;
3 Productivity Commission 2017, Telecommunications Universal Service Obligation, https://www.pc.gov.au/inquiries/completed/telecommunications/report.
4 ABS 2017, 8166 – Summary of IT use and innovation in Australian Business, 2016-17 and ACMA 2018 Communications report 2017-18, https://www.acma.gov.au/-/media/Research-and-Analysis/Report/pdf/Communications-report-2017-18-pdf.pdf?la=en.
5 OECD 2018, Key ICT indicators, https://www.oecd.org/sti/broadband/oecdkeyictindicators.htm. .
6 ABS 2018, 8153 – Internet activity, Australia.

Charts 1.1: Volume of data downloaded by Australians



Source: ABS (2018)
Note: The volume of data downloaded is for the three months to December for each year.

The growing use of telecommunications has fuelled the development of the telecommunications industry. Overall, total revenue for the industry has grown, yet it has varied for different industry segments. For example, ISP revenues increased 30% over the five years to 2017-18 (average 5.4% per year),[7] yet revenues specifically from fixed-line services have declined almost 1% in total over the past five years.[8]

This varied revenue growth for some industry segments can be explained by strong competition across the industry as well as technological change. The past decade has seen falling real prices for telecommunications services alongside greater connectivity, speed, a range of new products and services and lower latency.[9] The Australian Competition and Consumer Commission (ACCC) has documented this trend and found the cost of fixed broadband plans has decreased by 1.5% in real terms over the past year, while the proportion of plans including unlimited data reached 40%, up from 5% five years ago.[10] In the past year mobile phone plan prices decreased by 8.3% in real terms, with a total decrease of nearly 30% over the past five years. Meanwhile, average download speeds for mobile phones increased 21.2% between 2016 and 2017.[11]

1.2 Current key market players

Since the 1990s, the telecommunications industry has evolved from a dominant, vertically integrated fixed line service provider (Telstra) to a much more diverse ecosystem. Today, there are five major businesses, as well as a significant number of smaller industry participants.[12]

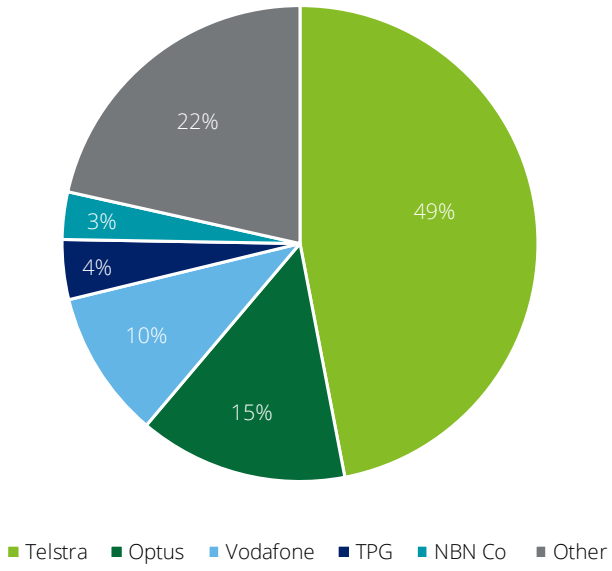
7 IBISWorld 2018, J5911- Internet Service Provers in Australia 2018.
8 IBISWorld 2018, J5800 – Telecommunications Services in Australia 2018.
9 Bureau of Communications and Arts Research 2017, Trends and drivers in the affordability of communications services for Australian households, https://www.communications.gov.au/documents/trends-and-drivers-affordability-communications-services-australian-households-0.
10 ACCC 2019, Communications Market Report 2017-18, https://www.accc.gov.au/system/files/ACCC%20Communications%20Market%20Report%202017%E2%80%9318%E2%80%94February%202019.pdf.
11 Aitken, N Look at how fast the cost of mobile phone data is falling Australia 2019, https://whatphone.com.au/sim-only-byo-plans/top-data-plans-in-australia/look-at-how-fast-the-cost-of-mobile-phonedata-is-falling-in-australia/.
12 IBISWorld 2018, Industry report J5800 Telecommunications Services in Australia.

The five largest telecommunications players by revenue are:

- **Telstra Corporation Limited** is Australia's largest telecommunication business, with a 49% market share based on revenue.[13] It offers a variety of telecommunications services to consumers and businesses such as fixed and mobile telephony and internet access, data services and content services.
- **SingTel Optus Pty Limited** has the next biggest market share, with 15% of industry revenue. It is owned by Singapore Telecommunications Limited, and has built and operates a network in addition to providing mobile, fixed, satellite and subscription television services.
- **Vodafone Hutchison Australia Pty Limited** is a joint venture between Vodafone Group and CK Hutchison Holdings. It has a market share of just over 10% of industry revenue,[14] and builds and operates mobile networks. In addition, it offers mobile services on its own network and wholesale services to MVNOs, and broadband services to customers.
- **TPG Telecom Limited** accounted for 4% of industry revenue and offers a variety of telecommunications services including broadband internet, Voice over Internet Protocol (VoIP) and landline phones, and resells mobile services.
- **nbn Co Limited** is a wholesale-focused player with a 3% share of industry revenue and was established in 2009 as a government-owned Australian company to build and operate a high-speed broadband network in Australia.

Beyond these five businesses, which account for 78% of industry revenue (see Chart 1.2), a large number of smaller businesses comprise 22% of the industry's total revenue. These smaller businesses account for 92% of the number of telecommunication businesses in Australia and and reflect the relatively low barriers-to-entry for carriage service providers in Australia.

Charts 1.2: Industry revenue shares for telecommunications



Source: Publically available financial statements, ABS IO tables

13 This is based on the latest publicly available data for major players and industry revenue based on ABS IO tables for telecommunications services and Internet Service Providers.

14 IBISWorld 2018, Industry report J5800 Telecommunications Services in Australia.

1.3 Investment in new technology and infrastructure

The high level of industry investment in developing new products and services, and building and maintaining networks, enables businesses and consumers to access new and innovative technologies.

The telecommunications industry had the **second highest investment rate in the national economy, with 70.5% of total industry value added invested in 2017-18 (approximately $18.3 billion).**[15] This high investment rate indicates the industry allocates a significant amount of resources to improving existing infrastructure, research and deployment of new technology to the market, even after accounting for the size of the industry. While the investment rate in telecommunications is lower than the investment rate in oil and gas extraction industry (83.4%), it is higher compared to 92 other industries in the economy – including electricity supply (46.3%) and agriculture (43.7%). This investment includes significant spending on research and development (worth $320 million in 2015-16).[16]

This investment supports the development of new products and technologies such as:

- **5G networks**, the next generation of mobile technology currently being rolled out across Australia, which will enhance consumer and business user experience through improvements in speed, latency, capacity and reliability. These improvements will boost GDP significantly. In just the first decade after implementation, 5G is expected to generate $50 billion in additional GDP for the Australian economy through increased labour market participation, productivity benefits to businesses, and new ways of creating value.[17] 5G will also bring other benefits for business, with 78% of businesses saying faster telecommunications services would benefit their work through increased flexibility and better customer engagement.[18]
- Continued evolution of the **Internet of Things (IoT)**, with the network connectivity of devices extending to items not traditionally connected to the internet, such as increasingly common wearables, sensors and appliances for data exchange and interactions.[19] In 2018, the average Australian household had 18 internet-connected devices, up from 14 in 2017.[20] IoT also has growing industrial applications, such as use of sensors for monitoring and responding to changing conditions in agriculture.
- New projects are underway to build additional **submarine communication cables** connecting Australia to other countries. These transmit the bulk of international voice and data traffic.[21] A current project undertaken jointly by Google, RTI Connectivity and AARNet involves connecting Australia (via Sydney) to Japan and Guam through a 9,600 kilometre long cable which will also provide additional connections to China and the United States.[22]

There is also large scale investment taking place across the nation through the National Broadband Network (NBN). The NBN is being built to increase the speed and quality of internet across the country, and ensure that all Australians have access to reliable internet. As of March 2019, almost nine million premises were ready to connect to the network, and the rollout is expected to be completed in 2020. The NBN already generates $1.2 billion annually in economic activity by creating new jobs, facilitating new business products and business models and by improving productivity of existing businesses, and these benefits are expected to reach $10.4 billion annually by the end of the rollout. The NBN will also help bridge Australia's regional divide in communications infrastructure, with an estimated 20,000 jobs expected to be created through greater connectivity in regional Australia by 2021.[23]

15 ABS 2018, Catalogue no. 5206, Seasonally Adjusted Industry Contribution to Gross Value Added, December 2018; ABS 2018, Catalogue no. 81550.0, Australian Industry, 2016-17

16 ABS 2017, Catalogue no. 8140.0, Research and Experimental Development, Businesses, Australia, 2015-16

17 Deloitte 2018, 5G mobile technology, https://www2.deloitte.com/au/en/pages/economics/articles/5g-mobile-technology.html.

18 Ibid.

19 Deloitte 2019, The Internet of Things, https://www2.deloitte.com/global/en/pages/technology/topics/internet-of-things.html.

20 Telsyte 2018, Smart speakers send Australian IoT@home market skyward, https://www.telsyte.com.au/announcements/2018/5/15/smart-speakers-help-send-australian-iothome-market-skyward.

21 ACMA 2019, About submarine cable protection, https://www.acma.gov.au/Industry/Telco/Infrastructure/Submarine-cabling-and-protection-zones/submarine-telecommunications-cables-submarine-cable-zones-i-acma.

22 AARNET 2018, Construction begins on Japan-Guam-Australia Cable System, https://news.aarnet.edu.au/construction-begins-on-the-japan-guam-australia-cable-system/

23 NBN Co 2018, Connecting Australia, https://www.nbnco.com.au/content/dam/nbnco2/2018/documents/media-centre/nbn-connecting-australia-economic-report-4.pdf.

2 Economic contribution

The growth in use of telecommunications by both households and businesses has increased the economic contribution of the industry itself, which consists of the value added by its operations, including gross operating surplus (returns to capital owners), wages paid to labour and employment across the economy. This is distinct from the benefits to the economy from telecommunications services improving productivity in the broader economy, discussed in Chapter 3.

Key findings

The total value added to Australia's GDP by the telecommunications industry was $51.5 billion in 2017-18. This comprises $21.7 billion supported directly by the telecommunications industry, and $29.8 billion supported through indirect activity in supplier industries across the economy.

In total, the industry supported over 267,000 full time equivalent (FTE) employees in the economy, with more than 87,300 directly employed. This means that for every FTE employed in the telecommunications industry, approximately 2 other FTE roles were supported elsewhere in the economy.

The industry generates value added and employment both directly and indirectly:

- **Direct value added** captures the wages and gross operating surplus of the industry's own operations
- **Indirect value added** captures the flow-on economic activity associated with purchases of intermediate goods and services by the industry.

Further details on the methodology used to estimate the economic contribution of the industry are in Appendix A.

For the purposes of this economic contribution analysis, the scope of the industry includes both telecommunication retailers and infrastructure providers as defined in Chapter 1.[24]

We estimate that the telecommunications industry supported $51.5 billion of economic activity in 2017-18, as shown in Table 2.1.

24 The telecommunication industry is defined in this report as including telecommunications services and ISPs as defined by the ABS.

The industry itself directly contributed $21.7 billion and supported 87,365 FTE roles, roughly equivalent to the number of FTE roles in insurance and superannuation funds in Australia at May 2018.[25]

The mobile component of the industry is an increasingly important market segment. Deloitte Access Economics has previously calculated that the mobile sector's direct contribution was $8.2 billion, and it supported almost 25,000 FTE roles in 2017-18.[26] This means mobile makes up nearly 40% of the value added of the broader telecommunications industry, and employs just under 30% of FTE roles, with wired services, carriers, and ISPs making up the rest of the industry's economic contribution.

The industry also indirectly supports economic activity in other industries in the economy through purchases of intermediate outputs. For instance, payments for electrical equipment or construction services are considered revenue for these sectors. These purchases underpin the indirect value add of the industry, which equated to $29.8 billion of economic activity in 2017-18.

These purchases supported more than 179,600 FTE roles in other sectors of the economy in 2017-18, so for every FTE role in the telecommunications industry, two FTEs are employed in other industries.*

Table 2.1: Total economic contribution, 2017-18

	Direct	Indirect	Total
Gross operating surplus ($billion)	14.1	14.6	28.7
Labour income ($billion)	7.6	15.2	22.9
Value added ($billion)	**21.7**	**29.8**	**51.5**
Employment (full time equivalent roles)	**87,365**	**179,663**	**267,028**

Source: Deloitte Access Economics using industry and IBISWorld data

25 Australian Bureau of Statistics 2016, Census – Employment, income and Education.

26 Deloitte Access Economics 2019, Mobile Nation, https://www2.deloitte.com/au/en/pages/economics/articles/mobile-nation.html.

* An error in a previous version of this report has been corrected in this edition of the report. The previous version stated that the telecommunications industry supported 267,000 FTE roles elsewhere in the economy rather than the correct 179,600 figure.

3 Productivity benefits

This section seeks to quantify the broader value of the telecommunications sector, focusing on the productivity benefits the technology and services provided offer to the broader economy. These also improve the performance of the broader economy by facilitating international trade and investment.

Key findings

In 2019, we estimate that the Australian economy is 6.5%, or $126 billion, larger because of productivity benefits brought about by telecommunications.

This is equivalent to approximately an additional $5,000 per person each year.

By comparison, the productivity benefit of the telecommunications sector is larger than the value added to the economy from the entire construction industry in a given year.[27]

The benefits outlined in this chapter are not additive to the economic contribution of the industry because they are different concepts. The economic contribution is a snapshot of the size of industry as measured by the resources used by it. The productivity benefit from telecommunications, by contrast, is a measure of how much more all industries are able to produce because they are connected via telecommunications.

The productivity impacts of national infrastructure such as telecommunications make a critical contribution to improving Australian living standards.[28] Philip Lowe, Governor of the Reserve Bank of Australia, noted that "lifting productivity is the key to building on our current prosperity and ensuring sustained growth in wages and incomes".[29] There has been growing attention on increasing productivity, as productivity growth has been weaker in the last two decades.[30]

Telecommunications contribute to productivity growth in the economy through:

- facilitating better, more efficient allocation of resources in the market (allocative efficiency)
- improving the efficiency of physical inputs to production (productive efficiency)
- increasing productive capacity over time through new production processes (dynamic efficiency).

3.1 Forms of telecommunications enabled productivity enhancements

3.1.1 Operation of markets

Telecommunications technology has enhanced productivity by supporting more efficient markets and reducing market failures. This is primarily because the internet makes it faster, cheaper and easier to access information. Telecommunications also improve businesses' communications with customers, their own supply chains and with their employees who may be spread across different countries or time zones.

27 ABS 2018, 8155.0 - Australian Industry, 2016-17.

28 Commonwealth Treasury, 2015 Intergenerational Report Australia in 2055, https://treasury.gov.au/sites/default/files/2019-03/2015_IGR.pdf.

29 Reserve Bank of Australia 2018, Productivity, wages and prosperity, https://www.rba.gov.au/speeches/2018/sp-gov-2018-06-13.html.

30 Productivity Commission 2017, Shifting the dial: 5 year productivity review.

Mobile-accessed internet enables the availability of terabytes of information instantly from almost anywhere and the rapid increase in access to information online has reduced the time and effort required to find, review and compare products. As far back as 2009, search engines alone generated US$780 billion in value worldwide, by improving the speed with which information was found and shared.[31]

Increasing access to information through the internet has also led to increased competition, and better outcomes for consumers. Described as the "Amazon effect", online competition has considerably dampened retail price mark-ups across stores spread geographically across a country.[32]

Australian businesses are also using telecommunications to improve customer experience. More than half of surveyed small to medium sized businesses (SMBs) believe the ideal response time to customer enquiries is less than an hour, with 20% thinking the ideal is less than 10 minutes. Strategic use of telecommunications can allow SMBs to meet these expectations without compromising other priorities. SMBs that actively use social media as part of their customer service strategy are able to respond to customer queries nearly six hours faster on an average.[33]

Not only has telecommunications benefited existing markets, it has also catalysed and supported the development of new products and industries. The Australian Government's Bureau of Communications and Arts Research found that by 2030, 5G mobile networks could be adding between $1,300 and $2,000 in additional GDP per person after the first decade of the rollout, partly due to the creation of new products and industries, such as making autonomous vehicles or drones practical for mainstream use by businesses or consumers.[34]

3.1.2 Enabling efficiency

Telecommunications infrastructure has generated efficiency by enhancing the ability of individuals and businesses to communicate and collaborate, as well as reshaping our relationships with physical assets and work environments.

It enhances the use of space in multiple ways. For example, increasing use of cloud for storage and filing reduces the need for physical infrastructure in-house. It also allows people to work from anywhere, reducing the need for centralised offices, reducing overhead costs, travel times and creating job opportunities.

In Mackay (970km north of Brisbane), the introduction of the NBN has created 50 new businesses, 80 new digital jobs (including programming and software development) and 50 new self-employed workers from greater connectivity in 2017.[35]

The ability to work remotely not only improves spatial efficiency but also encourages greater participation in the workforce. Allowing people to work when and where it suits them means more people who face multiple time or geographic constraints can work. In 2015, 59% of employees said they regularly worked from home compared to 24% in 2008.[36] Furthermore, online communication and collaboration tools boost workplace productivity by between 25% and 35%.[37]

Telecommunications infrastructure also helps enhance the productivity of capital, including machines and equipment. Rio Tinto's Productivity Program hopes to generate $5 billion of value through increasing the efficient use of physical assets by using mobile infrastructure.[38]

31 McKinsey 2011, The impact of internet search technologies, https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/High%20Tech/PDFs/Impact_of_Internet_technologies_search_final2.aspx.
32 Alberto Cavallo 2018, More Amazon effects: online competition and pricing behaviours, NBER working paper no. 25138
33 Deloitte Access Economics 2016, SMBs in the digital race for the customer, https://www2.deloitte.com/au/en/pages/economics/articles/salesforce-digital-smbs.html.
34 BOCAR 2018, Impacts of 5G on productivity and economic growth, https://www.communications.gov.au/departmental-news/impacts-5g-productivity-and-economic-growth.
35 NBN Co 2018, Connectivity projected to spur Mackay business boom, https://www.nbnco.com.au/corporate-information/media-centre/media-statements/Mackay-business-boom.
36 Australian Bureau of Statistics, Characteristics of Employment, Australia 2015, 6333.0
37 McKinsey 2012, The social economy: Unlocking value and productivity through social technologies, https://www.mckinsey.com/industries/high-tech/our-insights/the-social-economy.
38 Rio Tinto 2017, Rio Tinto to expand autonomous fleet as part of $5 billion productivity drive, https://www.riotinto.com/media/media-releases-237_23802.aspx.

Telecommunications has provided time savings for individuals. It has reduced travel costs and made transactions like banking and shopping easier and faster. While not captured by traditional quantitative measures, other benefits include improved leisure time and quality of life.[39]

3.1.3 Dynamic efficiency

An innovative telecommunications sector can also help an economy be more dynamically efficient; that is, to respond to changing market conditions and implement new production processes to keep costs down. For example, in agriculture, anything from changing demand in overseas markets to changing local weather conditions can mean that farmers need to respond quickly. Telecommunications-enabled applications such as IoT sensors can reduce the cost and improve the efficiency of crop yields. Telecommunications-enabled information applications can provide farmers with real time data on market conditions overseas so that businesses can change production levels more efficiently than in the past.[40] Other sectors where production techniques are frequently updated include mining, manufacturing and media and entertainment.[41] Telecommunications would enable these sectors to change production processes faster, leading to greater dynamic efficiency.

3.2 Econometric modelling

As infrastructure has improved and adoption has increased, the benefits of telecommunications to the broader economy have continued to grow.

Between 2005 and 2019, telecommunications services have increased Australia's steady state GDP per capita by 6.5%, with the productivity benefits worth $126 billion (real GDP, in 2018-19 dollars). By comparison, this is $10 billion larger than the annual GDP contribution from the construction industry.[42]

This report uses an index approach to measure telecommunications infrastructure in 37 countries between 2005 and 2017. The index is comprised of three digital variables, including mobile phone penetration, percentage of individuals with internet access, and fixed broadband penetration. This index was then modelled alongside other factors that contribute to growth, to isolate the productivity impact of telecommunications infrastructure on GDP per capita over time.

Further details regarding the methodology and econometric modelling can be found in Appendix B.

It is important to note the limitations of this modelling when interpreting these results. Chiefly, the approach relies on proxies for the entire contribution of digital technologies to GDP per capita, namely mobile penetration, fixed broadband penetration and percentage of the population with internet access.

We also cannot explicitly include growth areas of telecommunications enabled technology, such as IoT, in our index, due to data limitations. However, the proxies are intended to capture all current elements of the digital economy.

The productivity impacts of national infrastructure such as telecommunications make a critical contribution to improving living standards. Productivity benefits from these investments in infrastructure have mitigated the slowdown in productivity growth experienced in Australia over the past two decades. The role of telecommunications in enhancing productivity will be critical in the future as productivity and living standards are expected to grow even slower (see Chart 3.1). Chart 3.1 shows that in the decade to 2023, an increasing share of growth in living standards are expected to be provided by growth in productivity compared to prices we receive for exports compared to prices for imports (our terms of trade) and increasing participation in the market economy.

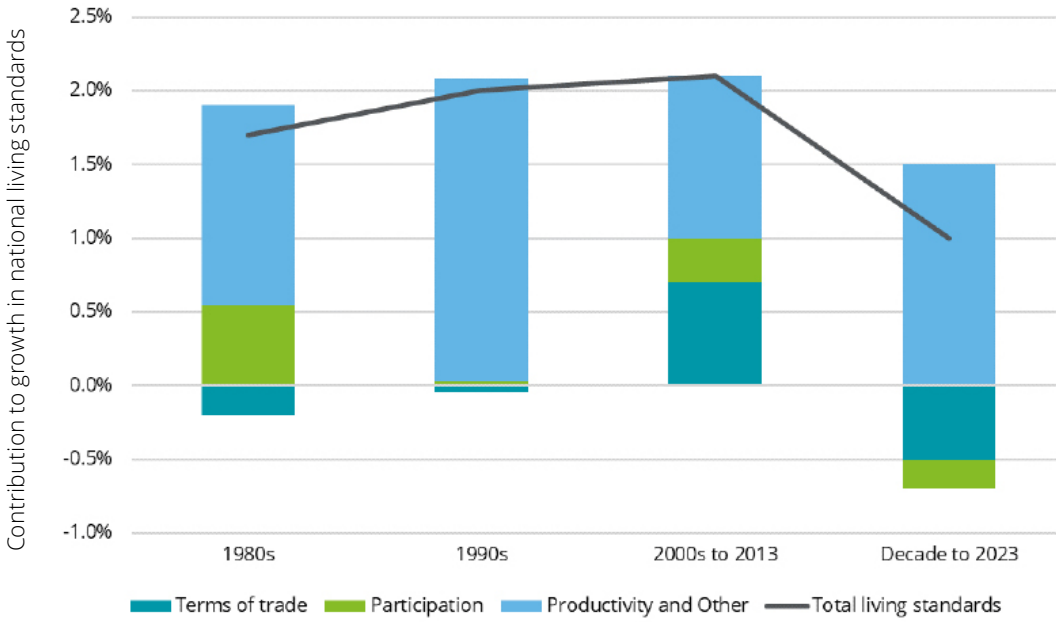
39 Deloitte Access Economics 2013, Benefits of high-speed broadband for Australian households, https://www2.deloitte.com/content/dam/Deloitte/au/Documents/finance/deloitte-au-fas-benefits-highspeed-broadband-v2-240914.pdf.

40 CSIRO 2019, Digital agriculture, https://www.csiro.au/en/Research/AF/Areas/Digital-agriculture.

41 See trends in Department of Industry, Innovation and Science 2019, Industry growth centres, https://www.industry.gov.au/strategies-for-the-future/industry-growth-centres.

42 ABS 2018, 8155 - Australian Industry, 2016-17.

Chart 3.1: Drivers of national income and living standards



Source: Productivity Commission (2017)

3.3 Facilitating international benefits for Australia

Telecommunications technology also affects the broader economy by facilitating trade and investment for other domestic industries.

Australia is geographically isolated, and this can make it difficult for businesses to form international linkages. Telecommunications enables businesses to communicate across geographies with ease, streamline supply chains, and transact easily with customers through digital channels. The importance of international interactions is demonstrated by the size of the global e-commerce trade, with this market estimated to reach US$3.5 billion in 2019.[43] Conversely, **a temporary internet shutdown is estimated to cost Australia almost $60 million per day in lost productivity and transactions.**[44]

Digital goods and services are only a small portion of Australia's **exports**. While Information and Communications Technology (ICT) service exports, which contain a significant share of telecommunications exports, have grown at an average 15% per year to reach $3.78 billion in 2017-18 (Chart 3.2), they only make up 1% of the value of all of Australia's exports.[45] However, this measure does not capture the ICT inputs also embedded in other goods exports. Deloitte Access Economics analysis found that the share of ICT components in Australia's goods exports had increased from 4% in 2013 to 7% in 2016, reflecting the growing uptake of new technologies across a range of economically significant industries in Australia.[46]

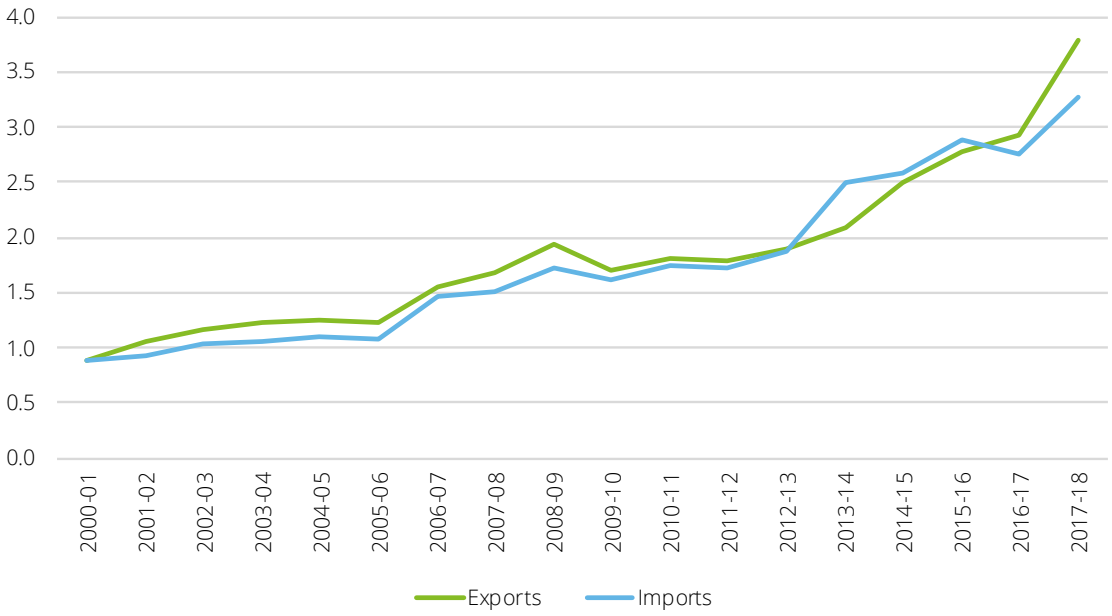
43 Statista 2019, Retail e-commerce sales worldwide from 2014 to 2021, https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/.

44 Calculation based on Deloitte 2016, The economic impact of disruptions to Internet connectivity, https://www2.deloitte.com/global/en/pages/technology-media-and-telecommunications/articles/the-economic-impact-of-disruptions-to-internet-connectivity-report-for-facebook.html.

45 ABS 2019, International trade in goods and services.

46 Deloitte Access

Chart 3.2: ICT service exports and imports ($b)



Source: ABS cat no. 5368.0 (2019)

Telecommunications infrastructure also influences **foreign investment**.[47] An international survey of business executives found that a quarter believe good physical infrastructure such as telecommunications is a "critically important" factor affecting investment decisions.[48]

Foreign investment provides needed capital for Australian businesses. International businesses had invested $3.5 trillion, at the end of 2018, in Australia. This is the 13th highest level of foreign investment in the world,[49] and it is growing each year.[50] Investment in telecommunications infrastructure will be critical to improving the ability of domestic businesses to raise this high level of capital required for investment.

The productivity benefits of the trade and investment facilitated by telecommunications emphasise the importance of the industry. The infrastructure and innovation created by the industry affects the performance of the broader economy and the living standards enjoyed by Australians.

47 Pradhan et al. 2017 Telecommunications infrastructure and usage and the FDI–growth nexus: evidence from Asian-21 countries, Information Technology for Development, 23:2, 235-260

48 World Bank 2018, Global Investment competitiveness report 2017-18, http://pubdocs.worldbank.org/en/651751510251223013/GIC-execsum.pdf.

49 Ibid.

50 DFAT 2018, Statistics on who invests in Australia, https://dfat.gov.au/trade/resources/investment-statistics/Pages/statistics-on-who-invests-in-australia.aspx.

Appendix A Economic contribution methodology

Economic contribution studies are intended to quantify measures such as value added, exports, imports and employment associated with a given industry or firm, in a historical reference year. The economic contribution is a measure of the value of production by a firm or industry.

A.1.Value added

Value added is the most appropriate measure of an industry's economic contribution to gross domestic product (GDP) at the national level, or gross state product (GSP) at the state level.

Other measures, such as total revenue or total exports, may be easier to estimate than value added, but they 'double count'. That is, they overstate the contribution of a company to economic activity because they include, for example, the value added by external firms supplying inputs or the value added by other industries.

A.2.Measuring the economic contribution

There are several commonly used measures of economic activity, each of which describes a different aspect of an industry's economic contribution:

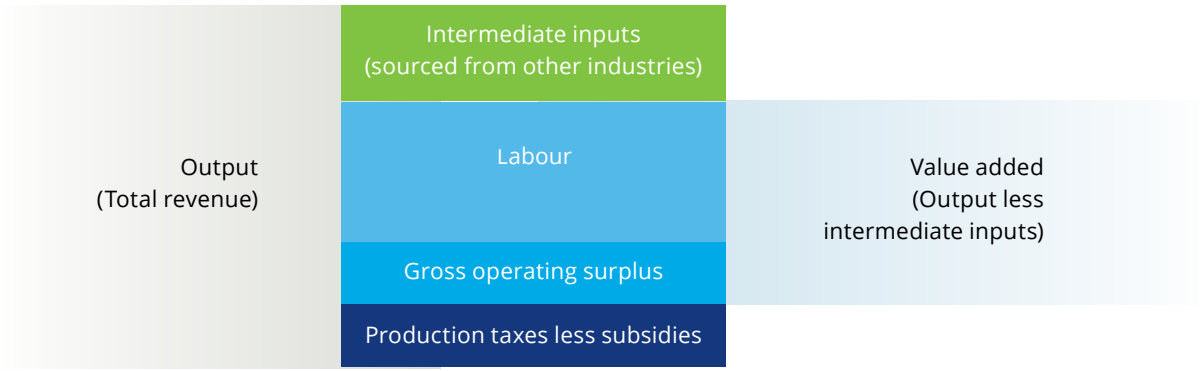
- Value added measures the value of output (i.e. goods and services) generated by the entity's factors of production (i.e. labour and capital) as measured in the income to those factors of production. The sum of value added across all entities in the economy equals GDP. Given the relationship to GDP, the value added measure can be thought of as the increased contribution to welfare.

  Value added is the sum of:

  - Gross operating surplus (GOS), which represents the value of income generated by the entity's direct capital inputs, generally measured as earnings before interest, tax, depreciation and amortisation (EBITDA)
  - Labour income, which represents the value of output generated by the entity's direct labour inputs, as measured by the income to labour
  - Tax on production less subsidy provided for production, which generally includes company taxes and taxes on employment (given the returns to capital before tax (EBITDA) are calculated, company tax is not included or this would double count that tax).
- Gross output measures the total value of the goods and services supplied by the entity. This is a broader measure than value added because it is an addition to the value added generated by the entity. It also includes the value of intermediate inputs used by the entity that flow from value added generated by other entities
- Employment is a fundamentally different measure of activity to those above. It measures the number of workers that are employed by the entity, rather than the value of the workers' output.

Figure A.1 shows the accounting framework used to evaluate economic activity, along with the components that make up gross output. Gross output is the sum of value added and the value of intermediate inputs. Value added can be calculated directly by summing the payments to the primary factors of production, labour (i.e. salaries) and capital (i.e. GOS, or profit), as well as production taxes less subsidies. The value of intermediate inputs can also be calculated directly by summing up expenses related to non-primary factor inputs.

Figure A.1: Economic activity accounting framework



Source: Deloitte Access Economics

A.3.Direct and indirect contributions

Direct economic contribution is a representation of the flow from labour and capital within the sector of the economy in question.

Indirect contribution is a measure of the demand for goods and services produced in other sectors as a result of demand generated by the sector in question. Estimation of the indirect economic contribution is undertaken in an input-output (IO) framework using Australian Bureau of Statistics input-output tables, which report the inputs and outputs of specific sectors of the economy (ABS 2010).

The total economic contribution to the economy is the sum of the direct and indirect economic contributions.

A.4.Limitations of economic contribution studies

While describing the geographic origin of production inputs may be a guide to a firm's linkages with the local economy, it should be recognised that these are the type of normal industry linkages that characterise all economic activities.

Unless there is significant unused capacity in the economy (such as unemployed labour) there is only a weak relationship between a firm's economic contribution as measured by value added (or other static aggregates) and the welfare or living standard of the community. Indeed, the use of labour and capital by demand created from the industry comes at an opportunity cost as it may reduce the amount of resources available to spend on other economic activities.

This is not to say that the economic contribution, including employment, is not important. As stated by the Productivity Commission in the context of Australia's gambling industries:

"Value added, trade and job creation arguments need to be considered in the context of the economy as a whole ... income from trade uses real resources, which could have been employed to generate benefits elsewhere. These arguments do not mean that jobs, trade and activity are unimportant in an economy. To the contrary they are critical to people's well-being. However, any particular industry's contribution to these benefits is much smaller than might at first be thought, because substitute industries could produce similar, though not equal gains."

In a fundamental sense, economic contribution studies are simply historical accounting exercises. No 'what-if', or counterfactual inferences — such as 'what would happen to living standards if the firm disappeared?' — should be drawn from them.

The analysis — relies on a national input-output table modelling framework and there are some limitations to this modelling framework. The analysis assumes that goods and services provided to the sector are produced by factors of production that are located completely within the state or region defined and that income flows do not leak to other states.

The IO framework and the derivation of the multipliers also assume that the relevant economic activity takes place within an unconstrained environment. That is, an increase in economic activity in one area of the economy does not increase prices and subsequently crowd out economic activity in another area of the economy. As a result, the modelled total and indirect contribution can be regarded as an upper-bound estimate of the contribution made by the supply of intermediate inputs.

Similarly, the IO framework does not account for further flow-on benefits as captured in a more dynamic modelling environment like a Computable General Equilibrium model.

A.5.Input-output analysis

IO tables are required to account for the intermediate flows between sectors. These tables measure the direct economic activity of every sector in the economy at the national level. Importantly, these tables allow intermediate inputs to be further broken down by source. These detailed intermediate flows can be used to derive the total change in economic activity for a given sector.

A widely used measure of the spill over of activity from one sector to another is captured by the ratio of the total to direct change in economic activity. The resulting estimate is typically referred to as 'the multiplier'. A multiplier greater than one implies some indirect activity, with higher multipliers indicating relatively larger indirect and total activity flowing from a given level of direct activity.

The IO matrix used for Australia is derived from the ABS IO tables. The industry classification used for input-output tables is based on ANZSIC, with 111 sectors in the modelling framework.

Appendix B Productivity modelling and forecasting approach

Theoretical modelling framework

This report follows previous Deloitte Access Economics and OECD research in taking a panel approach to identify the growth effects of digital technology usage with consideration to policy and institutional influences. The econometric methods employed largely follow the approach of Qu, Simes and O'Mahony (2016), and *Bassanini* et. al. (2001).

The model adheres to previous research with the some changes in the main variable of interest. The underlying modelling framework is based on a standard neo-classical growth model derived from a constant returns to scale production function. Output at time t is given by:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} \big(A(t)L(t)\big)^{1-\alpha-\beta}$$

Where Y, K, H and L are respectively output, physical capital, human capital and labour, α and β are the partial elasticity of output with respect to physical capital and human capital, and $A(t)$ is a composite measure of technical progress $\Omega(t)$ *and economic efficiency* $I(t)$**:**

$$A(t) = I(t)\Omega(t)$$

Economic efficiency can include a range of 'enabling services', such as the digital economy, trade, transport and logistics, professional and support services and innovation. These enabling services provide support to firms at all stages of production.

In addition to measures of ICT and the digital economy, this report controls for several other widely recognised policy and institutional variables $V_j(t)$**,** which contribute to economic efficiency. These are urbanisation, total research and development (R&D) expenditure and exposure to trade.

$$\ln I(t) = p_0 + \sum_j p_j \ln V_j(t)$$

Other technological progress is assumed to be exogenous and to grow at rate $g(t)$**.**

$$\dot{\Omega}(t) = g(t)\Omega(t)$$

The following equations can be used to describe the path of factors of production over time.

$$\dot{k}(t) = s_k(t)A(t)^{1-\alpha-\beta}k(t)^{\alpha}h(t)^{\beta} - \big(n(t) + d + g(t)\big)k(t)$$

$$\dot{h}(t) = s_h(t)A(t)^{1-\alpha-\beta}k(t)^{\alpha}h(t)^{\beta} - \big(n(t) + d + g(t)\big)k(t)$$

$$\dot{L}(t) = n(t)L(t)$$

These equations are used to derive the steady-state values of physical capital and human capital. In turn, the steady-state values of physical and human capital can then be used to express the steady state output per capita as:

$$\ln y^*(t) = \ln A(t) + \frac{\alpha}{1-\alpha}\ln s_k(t) + \frac{\beta}{1-\alpha}\Big(\ln h(t) + \frac{1-\psi}{\psi}\Delta\ln\Big(\frac{h(t)}{A(t)}\Big)\Big) - \frac{\alpha}{1-\alpha}\ln\big(g(t) + d + n(t)\big)$$

Adding convergence dynamics and expanding the productivity term **A** yields the transitional equation for output per capita.

$$\Delta \ln y(t) = \phi\left(-\ln y(t-1) + \frac{\alpha}{1-\alpha}\ln s_k(t) + \frac{\beta}{1-\alpha}\ln h(t) + \sum_j p_j \ln V_{j,t} - \frac{\alpha}{1-\alpha}\ln(g(t)+d)\ln n(t) + g(t)t + (p_0 - \ln\Omega(0))\right) + \frac{1-\psi}{\psi}\frac{\beta}{1-\alpha}\Delta \ln h(t) + \left(1 - \frac{\phi}{\psi}\right)g(t)$$

This last equation represents the functional form that was empirically estimated in this report. The coefficient estimate ϕ represents the convergence parameter, which reflects the speed in which countries converge to their new steady-state output.

Limitations

It is important to recognise that under the conditional convergence model used in this paper, various forms of capital as well as policies and institutions are assumed to have a permanent impact on cross-country differences in GDP per capita levels but only temporary effects on growth rates. This means the observed growth in output in any given period, abstracting from cyclical fluctuations, can be seen as the combination of three different forces:

- Exogenous growth in other technological progress;
- A convergence process towards the country-specific steady-state path of output per capita; and
- Shifts in the steady-state that can arise from changes in policy and institutions, digital technology adoption as well as investment rates and changes in population growth rates.

It should also be noted that the framework is derived under the assumption of equilibrium employment and hence that variations in the intensity of labour utilisation are not explicitly taken into account.

Empirical approach

The empirical work in this report employs a pooled mean group estimator (PMG). The PMG approach provides an effective middle ground between imposing homogeneity on all slope coefficients when using a dynamic fixed effect estimator (DFE), and the imposition of no restrictions when using a mean group approach (MG). Both DFE and MG estimators have significant drawbacks when dealing with samples similar to the one analysed in this report when compared with PMG (Qu, Simes & O'Mahony, 2016).

It is worth noting the PMG approach is not without its limitations. Chiefly, PMG requires the estimation of a large number of parameters, which can cause likelihood convergence issues and estimates sensitive to model specification changes (Qu, Simes & O'Mahony, 2016). In practice, this means considering more than three policy and institutional variables can be difficult.

Index motivation

We employed an index approach to capture the effect of multiple digital variables, for theoretical and empirical reasons. Firstly, it is difficult to separate fixed and mobile networks as there are increasing crossovers between the two. For example, dongles use the mobile network on PCs and other devices that are usually considered to be part of the fixed network, such as when using fixed broadband penetration as a proxy. Estimating the combined impact of mobile and fixed through an index allows us to partly capture this integration.

Empirically, an index of mobile and fixed variables also accounts for the limitations of the PMG estimator, through the ability to simultaneously control for, and measure, the impact of several digital variables. Including multiple explanatory variables of interest in the same model often resulted in convergence problems or estimates highly sensitive to model specification changes.

The index of digital variables measures the contribution of the entire digital industry.

Index methodology

The methodology underlying the creation of the digital index in this report largely follows that of the ICT Development Index (IDI) developed by the International Telecommunications Union (ITU) (2019).

To capture the effect of digital technology on productivity growth, we use a combination of three digital variables; mobile phone penetration, percentage of individuals with access to the internet, and fixed broadband penetration. It is important to note that these variables do not provide a perfect measure of changes in the digital industry. However, in the absence of reliable data that could reflect these underlying changes in technology over a sufficient time period, these variables serve as a good starting point to measure the impact of fixed and mobile technologies in Australia.

In order to combine the three variables into a single index, each is first normalized following methods outlined by the ITU. The reference value for fixed broadband is defined as 60 connections per 100 inhabitants; for mobile penetration, 120 per 100 inhabitants; and for the percentage of individuals with internet access, 100% of the population. Following normalization, the following weights are used to combine the three variables.

Table B1: Index weights 2004-2017

Parameters	Index
Fixed-broadband internet subscriptions per 100 inhabitants	0.3
Percentage of individuals using the internet	0.3
Mobile-cellular telephone subscriptions per 100 inhabitants	0.4

Source: Deloitte Access Economics and International Telecommunications Union (2019)

Data and modelling results

The modelling in this report uses a sample of 37 countries between 2005 and 2017. Where appropriate, data is converted to constant 2010 US dollars using constant Purchasing Power Parity, consistent with OECD standards.

Table B2: Country list

Country list			
Australia	France	Korea	Slovak Republic
Austria	Germany	Luxemburg	Slovenia
Belgium	Greece	Mexico	South Africa
Canada	Hungary	Netherlands	Spain
Chile	Iceland	New Zealand	Sweden
China	Ireland	Norway	Switzerland
Czech Republic	Israel	Poland	Turkey
Denmark	Italy	Portugal	United Kingdom
Estonia	Japan	Russia	United States
Finland			

Source: Deloitte Access Economics

Table B.3 outlines the parameters used in the econometric modelling. In addition to primary factors of production, including physical capital accumulation, human capital and labour, the model also takes into account the contribution of other productivity enhancing variables, such as openness to trade and urbanisation of the population.

Table B.3: Data sources

Parameter	Variable	Source
$y(t)$	Gross domestic product per capita	OECD
$h(t)$	Tertiary education attainment (% of 15+ population)	Barro-Lee
$n(t)$	Total population growth	OECD
$s_k(t)$	Gross capital formation (% of GDP)	Worldbank
V_1	Urbanisation (% of population in urban areas)	Worldbank
V_2	Exports and imports of goods and services (% of GDP)	Worldbank
V_3	Index of mobile and fixed variables (see above)	ITU & Worldbank

Source: Indicated in table

Table B.4: Model results

Parameter	Variable	Coefficient
Long-run coefficients		
$ln\, h(t)$	Tertiary education attainment (% of 15+ population)	0.319^{***} (7.27)
$ln\, n(t)$	Total population growth	-0.426 (-0.94)
$ln\, s_k(t)$	Gross capital formation (% of GDP)	0.477^{***} (19.4)
$ln\, V_1$	Urbanisation (% of population in urban areas)	0.933^{***} (4.69)
$ln\, V_2$	Exports and imports of goods and services (% of GDP)	0.080^{**} (2.68)
$ln\, V_3$	Index of digital variables	0.127^{***} (3.79)
Implied share of physical capital	32.30%	
Implied share of human capital	21.60%	
Implied share of Labour	46.11%	

Source: Deloitte Access Economics
Notes: t-statistics are reported in parenthesis.

The results presented here are consistent with the academic literature with respect to the estimated shares of capital and labour. Further, there are no estimated coefficients for the included controls are all statistically significant at the 5% level.
The coefficient on the digital index, V_3, can be interpreted as follows. If the index increases by *x%* and if *y* represents the resultant percentage change in long-run steady state GDP per capita then,

$$y=V_3*x=0.127*x$$

Put another way, a 1% increase in the digital index leads to an approximate 0.127% increase in steady state GDP per capita.

Sensitivity analysis and robustness tests

To address any potential issues created by the construction of the digital index and assess the validity of the main results, we performed the following tests.

Firstly, we tested a number of alternate index specifications to determine whether the results are driven by index weighting decisions. Small adjustments of any of the three variable weights had a minimal effect on the results.

Alternate specifications including other digital variables were also run, but they encounter convergence problems or produce nonsensical estimates of control variables. This is could be due to many of these variables being available for only a limited time series and often with patchy data across all 37 countries.
As a final general test, alternate model specifications including different combinations of control variables were run. The main results are statistically and economically consistent across all tested specifications, with the estimated contribution larger and more significant in most.

Limitation of our work

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