DIGITAL INNOVATION:
AUSTRALIA'S $315B OPPORTUNITY

SEPTEMBER 2018

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AUSTRALIA'S DATA INNOVATION NETWORK, PART OF THE NATIONAL SCIENCE AGENCY THE COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION (CSIRO)

I'm pleased to present 'Digital Innovation: Australia's $315b Opportunity', a report by AlphaBeta Advisors, commissioned by CSIRO's Data61, which details the economic opportunity that Australia can capture with the emergence of data-driven industries by building on our core strengths as a nation.

The world is entering a new phase of economic development as every sector of the economy is re-defined as a result of digital science and technology and the extensive use of data. It is a $10-15t global opportunity, referred to by the World Economic Forum as the Fourth Industrial Revolution and characterised by the intersection of digital science and technology with the physical world.

While Australia offers world class research expertise and a skilled workforce, our nation is currently lagging its OECD peers in digital innovation. A critical message in this report is that this next science and technology driven economic cycle is ours to capitalise on, but the opportunity is perishable if leaders across the national innovation ecosystem don't take action now.

This is about the digital transformation of our economy and the global shifts taking place today in all of our primary industry sectors. 'Digital Innovation: Australia's $315b Opportunity' has been commissioned by CSIRO's Data61 to outline the strategic areas where Australia can succeed in creating new digital products and services to seed the next generation of globally competitive industries resulting in economic growth and jobs. It helps to frame the pathways to success for Australia to realise this potential, which involve building on the strengths and values that make us uniquely Australian.

CSIRO's Data61 is Australia's data innovation network and part of the national science agency. We are helping to create Australia's data driven future by partnering with others to solve Australia's largest data driven challenges through science and technology. 'Digital Innovation: Australia's $315b Opportunity' is a must read for leaders of organisations: governments, businesses and public and private researchers across industries. We hope it provides you with some ideas to help transform your organisation and guide your people to capture the value of digital innovation at this critical juncture for the country.

Adrian Turner, CEO of CSIRO's Data61

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ALPHABETA IS A STRATEGY AND ECONOMIC ADVISORY BUSINESS SERVING CLIENTS ACROSS AUSTRALIA AND ASIA FROM OFFICES IN SINGAPORE, SYDNEY, CANBERRA AND MELBOURNE.

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EXECUTIVE SUMMARY

Digital innovation can deliver $315 billion in gross economic value to Australia over the next decade, making it a critical ingredient in the nation's ongoing economic success.[1] The economic opportunity is great. However, there is a risk Australia will not fully realise it. New analysis shows that in the past, aside from some pockets of success, Australia has failed to capture the same economic value from digital innovation as other countries. The productivity gain from technology in our economy has been below that of our peers, and we have not managed to build our own digital industries at the same scale.

"The next wave of digital innovation will be driven by technologies that collect, manage, analyse and use large amounts of data."

To ensure Australia achieves the full economic benefit of digital innovation in the future, we need a new vision for digital success. This means actively developing new digital opportunities in industries where Australia is already globally competitive, and improving the innovation system's ability to support Australia's areas of competitive advantage.

The next wave of digital innovation will be driven by technologies that collect, manage, analyse and use large amounts of data. These big data technologies are set to transform a wide range of industries from mining to agriculture and health – much like personal computers and the internet have transformed the retail, information, and media sectors over the past two decades.

Australian businesses will become more productive if they adopt these new technologies. For example, oil and gas companies have already begun to use sensors and data analytics to reduce costs in their operations, to increase output, and to improve worker safety. At the same time, the rising demand for data technologies is a growth opportunity for Australia's own digital industries. Australian firms could build on existing strengths in agriculture or healthcare and develop new digital products and services, such as remote monitoring of infrastructure or crops, or improved diagnostic methods for genetic diseases, for domestic use or for export.

However, as a mid-sized market, it is critical that Australia defines its own path to success at digital innovation, rather than attempting to emulate the breadth of Silicon Valley or the scale of China. Australia is most likely to succeed if it focusses on producing new digital products and services for industries in which it already has a global competitive advantage – thanks to its natural resources endowment, strong institutions, diverse and highly skilled workforce, and existing infrastructure and customer base.

1. Estimate based on Australia improving productivity growth, ICT capital investment, fostering domestic digital industries, and improving export performance. See Chapter 1 for further detail and Appendix for methodology.

How does digital innovation add economic value?

"Digital innovation" refers to new digital technologies and services and the innovative ways of doing business that they enable. Examples of these technologies include autonomous robots, artificial intelligence, remote sensors, and the basic information and communication technologies (personal computers, software platforms, internet connectivity) that already fuel our economy.

Digital innovation adds economic value by improving the productivity of existing industries and by creating revenue from new industries, products and services (see below). Chapter 1 reviews the economic evidence to assess Australia's performance to date.

TOTAL ECONOMIC VALUE FROM DIGITAL INNOVATION

IMPROVEMENT OF EXISTING INDUSTRIES

1. IMPROVED PRODUCTIVITY DUE TO INVESTMENTS IN **DIGITAL CAPITAL**
2. IMPROVED PRODUCTIVITY DUE TO RELATED **INNOVATIONS OF BUSINESS PROCESS**

+

GROWTH OF NEW DIGITAL INDUSTRIES

3. GROWTH OF **DOMESTIC DIGITAL INDUSTRIES**
4. GROWTH OF **DIGITAL EXPORTS** AS DIGITAL INDUSTRIES CAPTURE NEW MARKETS

This report identifies eight strategic areas where Australia can succeed in creating new digital products or services. These opportunities are precision healthcare, digital agriculture, data-driven urban management, cyber-physical security, supply chain integrity, proactive government, legal informatics and smart exploration and production.

For example, it is estimated that the market for precision healthcare solutions in the Asia-Pacific will generate annual revenues worth $30–50 billion within a decade.[2] Australian firms could build on the country's research strength in biotechnology and genomics and use data from Australia's strong public healthcare system to become significant providers of precision healthcare products and services. Digital agriculture is another important opportunity: the regional market for digital agriculture is estimated to be $10–25 billion by 2028, fuelled by pressure to increase agricultural productivity to meet challenges from population growth and climate change. Chapter 2 provides more details on the eight opportunities.

EIGHT HIGH-POTENTIAL OPPORTUNITIES FOR AUSTRALIA IN DIGITAL INNOVATION TOGETHER REPRESENT A $85-155B REGIONAL MARKET BY 2028

EMERGING OPPORTUNITIES	2028 ASIA-PACIFIC EXPORT MARKET OPPORTUNITY	DESCRIPTION
PRECISION HEALTHCARE	$30-50b	Using connected healthcare data across systems to enable personalised monitoring, treatment and illness management
DIGITAL AGRICULTURE	$10-25b	Employing mobile sensors, robotics and machine learning techniques to improve resource planning and use in agricultural production
DATA-DRIVEN URBAN MANAGEMENT	$5-10b	Using geospatial and sensor data on people movement and construction to better design and operate infrastructure and cities
CYBER-PHYSICAL SECURITY	$10-15b	Ensuring the protection of key physical assets and infrastructure from potential cyber security vulnerabilities
SUPPLY CHAIN INTEGRITY	$10-15b	Applying connected sensors and distributed ledger technologies to build trust in transactions and verify product provenance
PROACTIVE GOVERNMENT	$5-10b	Harnessing greater data availability and data science to improve policy development, agility and strategic decision making
LEGAL INFORMATICS	$10-15b	Utilising AI and machine learning to automate certain legislative, compliance and administrative tasks
SMART EXPLORATION & PRODUCTION	$5-15b	Applying machine learning techniques and greater automation to improve the efficiency of resource discovery and production

SOURCE: AlphaBeta analysis, expert interviews, literature review

2. Asia-Pacific in this report refers to East, South and South East Asia, as well as Oceania. It excludes the USA and Russia.

THE INNOVATION SYSTEM CAN HELP AUSTRALIA CAPTURE THESE OPPORTUNITIES BY ADDRESSING FOUR POLICY PRIORITIES

R&D PERFORMANCE	1. Develop scale in a limited number of areas by focussing research capabilities	To compete with the growing quantum of global investment in digital innovation, Australia can better focus its resources on achieving scale in a limited number of strategic areas of research. Almost 90 per cent of our current public expenditure on R&D is distributed through indirect channels such as tax incentives, which makes it harder for government to prioritise its investments.
	2. Strengthen connections between researchers and with industry	Australia can improve the effectiveness of its limited investments by increasing coordination and ensuring industry participation and collaboration. At present, just 11 per cent of total private expenditure on R&D goes to ICT-related research, and coordination is hampered by investments spread thinly across the system to many institutions.
USE OF INNOVATION	3. Increase rate of product innovation and speed-to-market	Australia can convert research expertise into industry leadership by improving its rate of product innovation. Just 2 per cent of surveyed Australian firms released products which were new to the world – the remainder engaged in no product innovation or simply adopted products that were new locally but adapted from elsewhere.
	4. Lift global market awareness and connectivity	Australia can better capture global opportunities by increasing its market awareness and international collaboration. Only 15.8 per cent of Australia's ICT-related patents come from international co-inventions, which is significantly lower than in other comparably sized advanced economies.

Australia is well-positioned to deliver against these policy priorities due to the quality of our domestic research and skilled workforce. Australian research publications on computer science and artificial intelligence are cited at a higher rate than any other country in the world – including innovation giants like the USA and China. And the application of this digital know-how to industry solutions will be aided by Australia's long-standing reputation for innovations in areas such as healthcare, agriculture, mining and professional services. The challenge is to convert this potential into a global advantage. Chapter 3 explores the current performance of our innovation system against each policy priority.

CSIRO's Data61 and its network can play a key role in supporting Australia's competitiveness in the data-driven economy by: delivering and coordinating high-quality research, including by leveraging the leading domain expertise of all of the CSIRO; bringing together technical invention with engineering and product management expertise; and helping drive Australia's connection with regional economies. Chapter 4 provides an overview of how Data61 can contribute to the national effort to realise the full potential of digital innovation.

> ***"The application of this digital know-how to industry solutions will be aided by Australia's long-standing reputation for innovations in areas such as healthcare, agriculture, mining and professional services. The challenge will be to convert this potential into a global advantage."***

1

AUSTRALIA CAN CAPTURE $315 BILLION IN GROSS ECONOMIC VALUE FROM DIGITAL INNOVATION OVER THE NEXT DECADE

Digital innovation has created enormous value globally and now accounts for around 11 per cent of GDP in the advanced economies.[3] However, Australia lags other countries in capturing the full economic potential of digital innovation. Our technology-driven increase in productivity has been lower than our peers, and we have not built domestic digital industries at the same scale. The next wave of digital innovation will be powered by data-driven technologies and can provide significant economic value if Australia acts now. At a time when our national productivity growth and export performance has weakened, the opportunity for our firms from this next wave of digital innovation is too great to miss. If Australia catches up to its peers, it can unlock $315 billion in gross economic value over the next decade.

1.1 SUCCESSIVE WAVES OF DIGITAL INNOVATION HAVE CREATED MAJOR ECONOMIC OPPORTUNITIES IN RECENT DECADES

Successive waves of digital innovation have reshaped the global economy. The economic transformation began in earnest with the widespread adoption of personal computing in the 1980s and '90s, followed by a second wave of innovation that introduced mobile and wireless networking technology and increased connectivity through the expansion of the internet. These advances in digital innovation have created enormous economic opportunities (Exhibit 1). Firms worldwide adopted new digital technology to get work done faster and more cheaply. They developed innovative business models enabled by this new technology to reshape existing industries, from online retail to ridesharing. Economies also benefited from growing digital industries. For example, East-Asian countries such as South Korea and Taiwan experienced rapid economic growth after fostering their electronic equipment manufacturing industries, while Silicon Valley in the US became world renowned for online platforms and software development. India has emerged as a popular location for internet-enabled outsourcing of business processes.

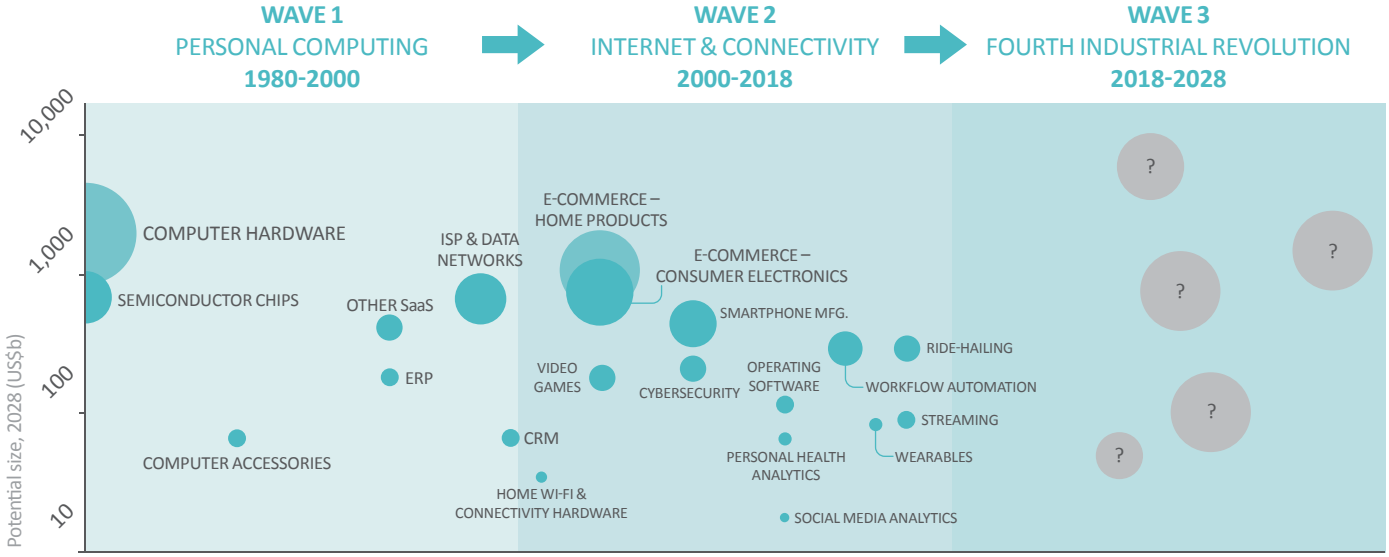
3. Analysis of economic data from ABS and OECD. See Appendix 1 for methodology.

EXHIBIT 1

WE ARE ENTERING THE THIRD WAVE OF DIGITAL INNOVATION, WITH LARGE INDUSTRY OPPORTUNITIES YET TO EMERGE

Digital industries build on the success of each previous wave of innovation

Size of bubble reflects current global size of industry as of 2018, US$b



SOURCE: AlphaBeta analysis, desktop research of market and company information.

The first two waves of digital innovation have been built on technical breakthroughs, but also on innovation in business models, production processes and development of new sources of value. For example, technical inventions such as new semiconductor chips and WiFi protocols led to the development of new devices such as mobile phones and tablet computing, and created widespread Internet connectivity.[4] Meanwhile, innovative business models enabled the growth of the e-commerce and sharing economy. Other industries unlocked new sources of value, including social media and online advertising platforms which generate new forms of social interaction and engagement.

The next wave of digital innovation, sometimes referred to as the Fourth Industrial Revolution, could provide an even more significant economic catalyst than waves of digital innovation to date.[5] This is because it will be enabled by technologies which represent a convergence of information and communication technology with physical sciences and biology, and which are applicable across a broad cross-section of industries. Data-driven technologies which capture, store, analyse and deploy data can be just as revolutionary in traditional goods-based industries – mining, agriculture and manufacturing – as in service-based industries – healthcare or law – or information-based industries such as media and communication. The Fourth Industrial Revolution will be just as dynamic as previous waves of digital innovation. Firms which embrace rapid innovation are most likely to succeed, replacing entire industries which do not adopt new technological and commercial models.

4. The use of fast Fourier transforms (FFT) to improve the functionality of wireless connections was a CSIRO innovation in the 1990s and has since become the basis of WiFi technology.
5. See, for example, Schwab, Klaus (2016), The Fourth Industrial Revolution, World Economic Forum.

1.2 DIGITAL INNOVATION IS AN ESSENTIAL INGREDIENT TO AUSTRALIA'S CONTINUED PROSPERITY

Australia is in a strong economic position having experienced 26 consecutive years of economic growth.[6] This growth was catalysed in part by microeconomic reform and a productivity boost in the 1990s. Later, in the years after 2000, a terms-of-trade boom fuelled Australia's growth, as a global rise in resources prices increased the value of our commodity exports.[7] However, Australia's terms of trade have fallen by over 30 per cent since their peak in 2011 and our productivity growth is below what is required to sustain strong economic growth.[8] Australia needs to find new ways to lift its productivity and identify new sources of export competitiveness to ensure our economy's future prosperity.

Digital innovation has contributed to Australia's growth story in the past, although it never took centre stage. Now, digital innovation offers Australia the opportunity to drive the next wave of economic growth. This is because the next wave of digital innovation – the Fourth Industrial Revolution – plays to many of Australia's existing competitive strengths and economic imperatives.

The Fourth Industrial Revolution will create new markets, products and services in industries where Australia has a significant presence. Digital innovation over the next decade will have a broader economic impact because the core technologies,such as autonomous systems, remote sensors, machine learning and artificial intelligence, can be applied across many industries. The latest wave of digital innovation will now revolutionise traditional industries from mining to agriculture just like past waves of innovation have reshaped the information and media industries.

The next wave of digital innovation demands Australian attention now. There is global evidence that some firms are already reaping the productivity benefits of digital innovation. Leading firms, especially in ICT-dependent industries, are increasing their productivity at a much higher rate than the rest of the economy (Exhibit 2).[9] Australian firms must embrace the kinds of digital innovation that will allow them to keep up with global leaders – or risk falling far behind.

6. Australia has recorded 26 years with no recession, see: ABS Catalogue Number 5204.0 (Australian System of National Accounts) 2016 – 17.
7. At the same time, the goods Australia imported became cheaper. See: RBA (2017) Where is the Growth going to Come from? Available at: https://www.rba.gov.au/speeches/2017/sp-ag-2017-11-15.html
8. Gruen, D. (2017) How has Australia responded to the terms of trade decline https://www.pmc.gov.au/news-centre/domestic-policy/how-has-australia-responded-terms-trade-decline; Campbell and Withers (2017) Australian productivity trends and the effect of structural change. Available at: https://static.treasury.gov.au/uploads/sites/1/2017/08/p2017-t213722-Roundup_Productivity_trends_and_structural_change.pdf
9. This divergence in growth between leading and other firms is often missed when considering just the overall average productivity growth. Andrews, Criscuolo and Gal (2016) The Global Productivity Slowdown, technology divergence and public policy: A firm level perspective (OECD Background Paper). Available at: https://www.oecd.org/global-forum-productivity/events/GP_Slowdown_Technology_Divergence_and_Public_Policy_Final_after_conference_26_July.pdf

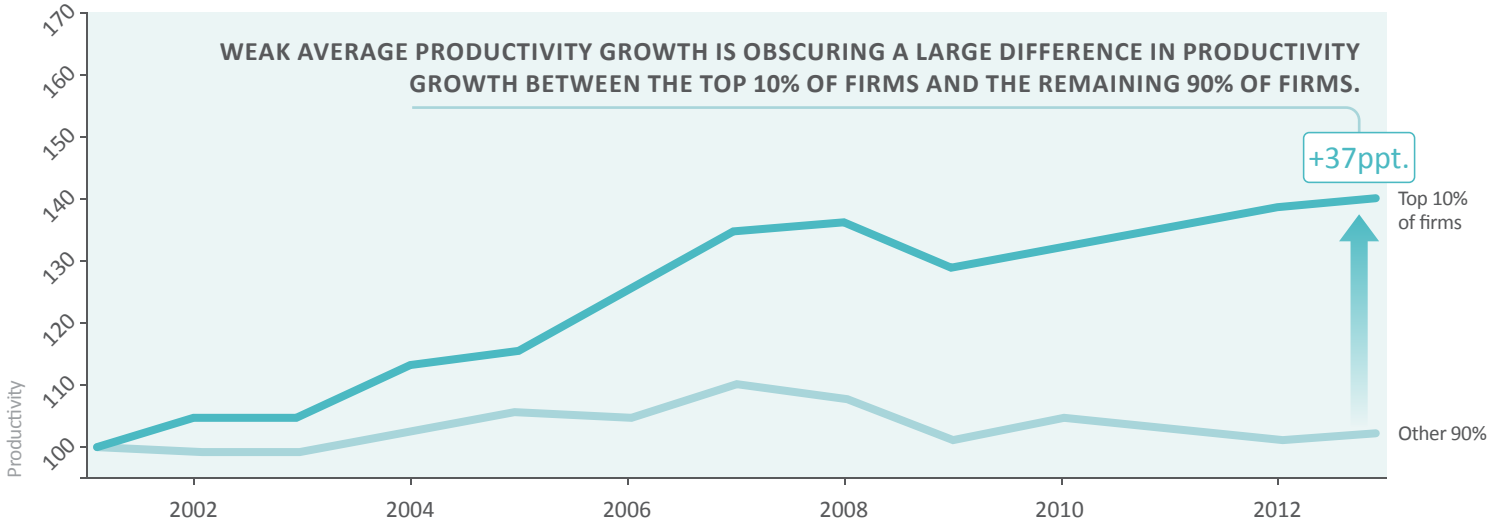
EXHIBIT 2

THERE IS A GROWING DIVERGENCE IN PRODUCTIVITY GROWTH BETWEEN LEADING FIRMS AND THE REST OF THE ECONOMY

The productivity of the top 10% of firms has grown significantly faster than the remaining 90% of firms…

Non ICT-intensive service industries[1]

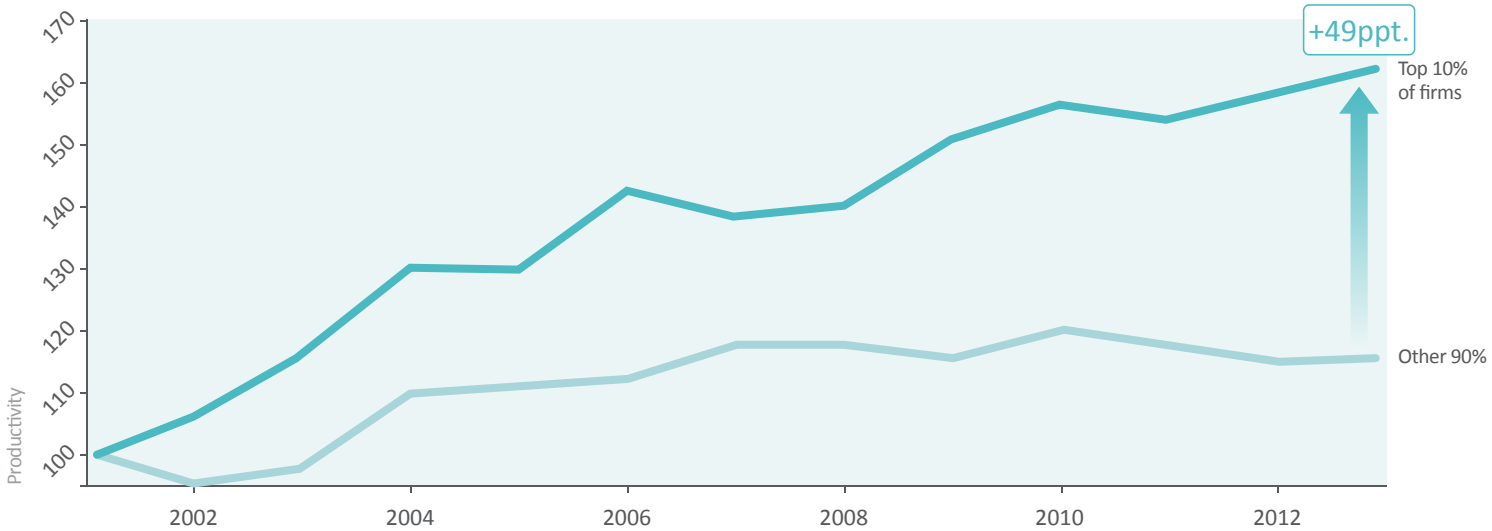
Multifactor productivity by firm cohort (Index 2001=100)



… and this gap is even larger in ICT-intensive industries, suggesting that digital innovation is supporting strong productivity growth of leading firms

ICT-intensive service industries[2]

Multifactor productivity by firm cohort (Index 2001=100)



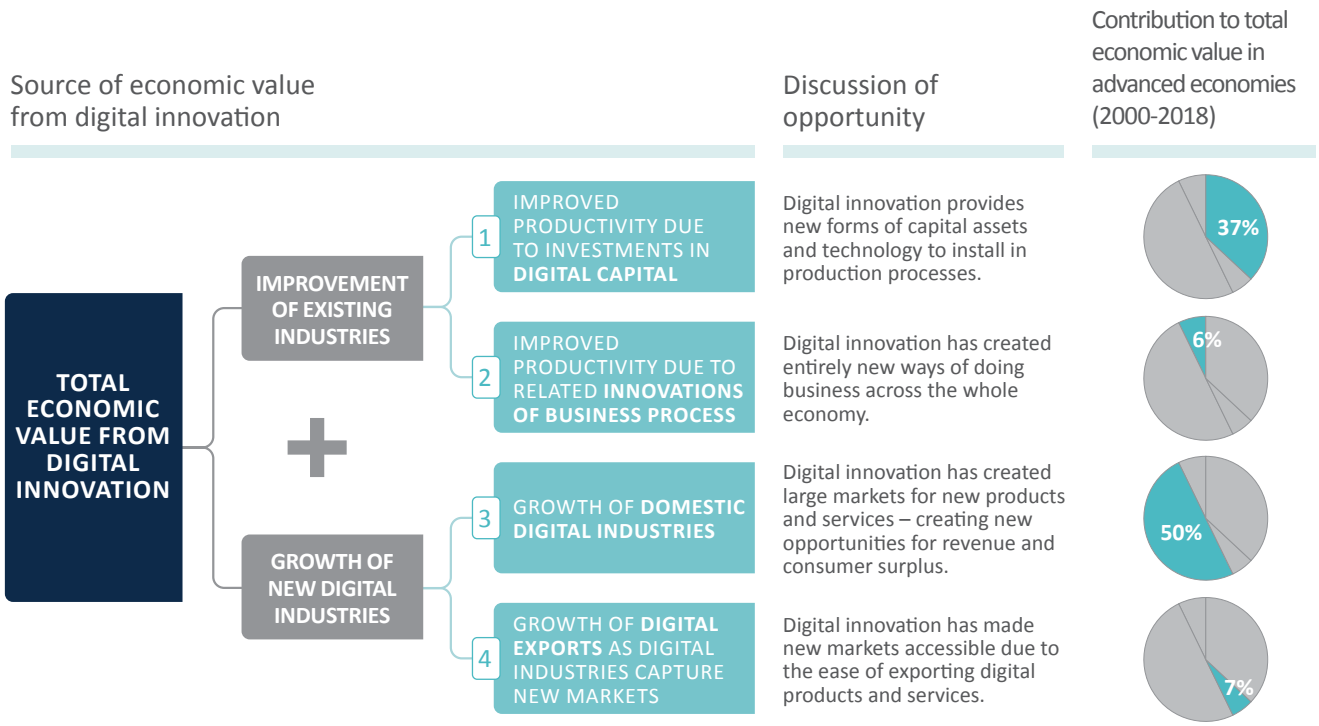
NOTE: 1 Refers to non-financial business services 2 Defined as information and communications sectors
SOURCE: Andrews, D et al. (2016) The Global Productivity Slowdown.

1.3 THE ECONOMIC VALUE OF DIGITAL INNOVATION IN ADVANCED ECONOMIES ACCOUNTED FOR 11 PER CENT OF GDP

Digital innovation can create substantial benefits for an economy: by improving output and productivity of existing industries and by spurring the growth of entirely new industries (Exhibit 3). Economic analysis suggests both sources are significant. Digital innovation is not just about creating the next Google or Samsung, or creating the next Silicon Valley. Rather, almost half the economic benefit from digital innovation comes from the adoption of new technology across existing industries.

EXHIBIT 3

THE ECONOMIC BENEFITS OF DIGITAL INNOVATION INCLUDE GREATER PRODUCTIVITY IN EXISTING INDUSTRIES & GROWTH OF NEW INDUSTRIES



The combined value of digital innovation is estimated to be approximately 11 per cent of GDP in advanced economies.[10] This amounts to an annual value of $6 trillion.
This measurement is calculated by aggregating the four sources of economic value from digital innovation.

1. The **first source of value** comprises any increase in output at companies that invest in **digital capital**.[11] For example, a manufacturer may install a new automated production line, or a farmer may use sensors to better monitor crops in order to improve yield. New investments allow firms to produce more things faster or at less cost. Over the past two decades, digital capital investments accounted for just over a third of the total economic value generated by digital innovation in advanced economies.

2. The **second source of value** is the productivity improvements in companies that adapt their business models to **make better use of digital technology.** Their productivity gains are also referred to as improvements in **"multifactor productivity".** For example, a manufacturer may go beyond the simple automation of a production line and also change the product development and marketing strategy to better capture the benefits of the automation. These marginal improvements accounted for 6 per cent of the total economic value generated by digital innovation in advanced economies between 2000 and 2018.

3. The **third form of value** has been the most significant and is perhaps the most intuitive – it is the output generated by new **domestic digital industries.** It captures the contribution from new industries such as social media and software to GDP.[12] Since the start of the millennium, this new output from digital industry growth accounted for half of the total value of digital innovation in advanced economies.

4. **Fourth**, countries can create economic value from digital innovation by **exporting new digital products and services.** For example, India has harnessed the benefits of outsourced software engineering services. China's economy has benefitted from exports of digital manufactured goods, including smartphone components. Such exports account for approximately 7 per cent of the total economic value generated by digital innovation in advanced economies between 2000 and 2018.

> ***"Digital innovation can create substantial benefits for an economy: by improving output and productivity of existing industries and by spurring the growth of entirely new industries."***

10. Analysis of economic data from ABS and OECD. See Appendix 1 for methodology.
11. 'Capital' in economic terminology refers to machines, technology and other investments in the productive capacity of an economy. Digital capital includes computer hardware, software and communications technology.
12. For this analysis, 'digital' industries were defined broadly to include information, communication and technology firms. This is likely to capture most of what we would intuitively think of as digital industries but might exclude some increasingly cross-sectoral industries. For example, an agricultural company that predominantly relies on proprietary software and data analytics to analyse crop production is likely to be recognised in economic statistics as belonging to the Agriculture sector rather than the ICT sector.

1.4 AUSTRALIA HAS CAPTURED A THIRD LESS VALUE FROM DIGITAL INNOVATION THAN LEADING GLOBAL ECONOMIES

Australia has captured significant value from digital innovation in the last twenty years, but it has not performed as well as many other advanced economies. Australia has captured a third less value than its advanced economy peers: the total economic value derived from digital innovation in Australia represents 7.4 per cent of the country's total GDP over the past two decades. This compares to 11.2 per cent of GDP in advanced economies (Exhibit 4).

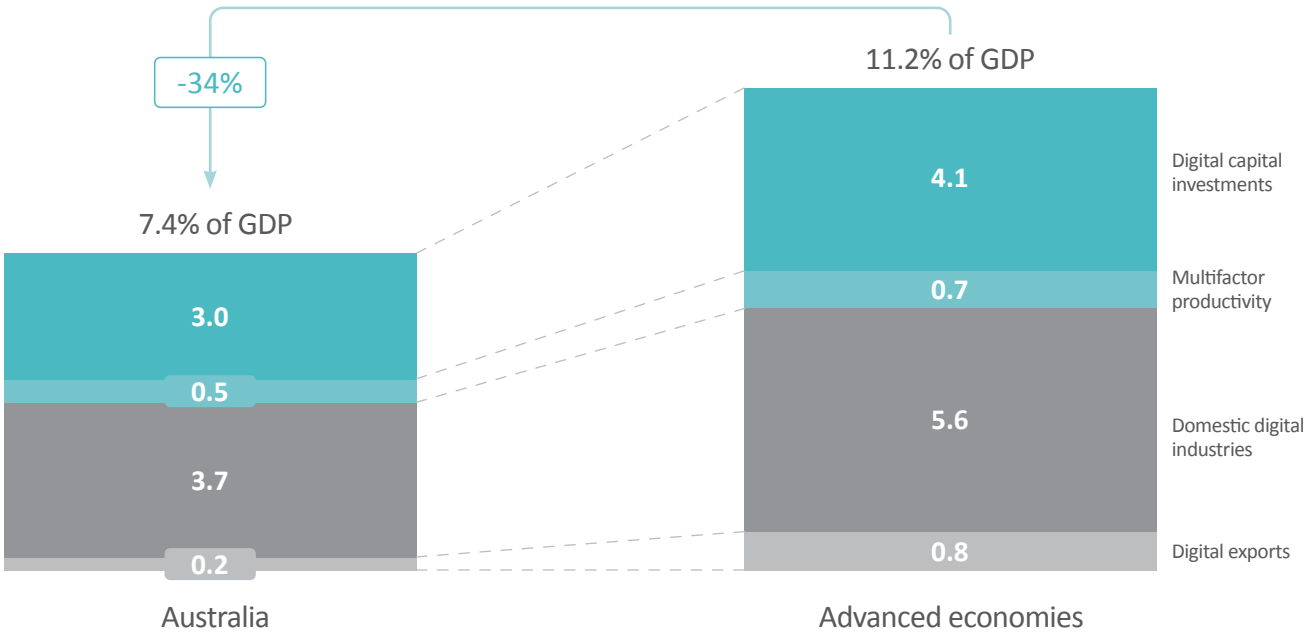
The Australian economy has had an uneven experience in capturing economic value. It has so far performed well at lifting its economic productivity by adopting technology in existing industries. However, it has notably lagged global peers in creating new digital industries.

EXHIBIT 4

AUSTRALIA HAS BENEFITED FROM DIGITAL INNOVATION BUT HAS CAPTURED LESS VALUE THAN ITS ADVANCED ECONOMY PEERS

Economic impact of digital innovation: Australia compared to advanced economies

Impact as a share of GDP, %, 2000 – 2018



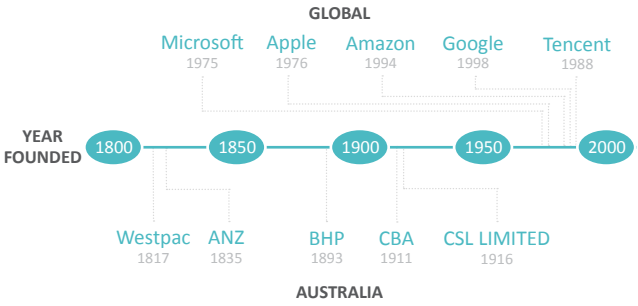
SOURCE: ABS, OECD, AlphaBeta analysis. See Appendix 1 for methodology.

EXHIBIT 5

AUSTRALIA HAS NOT MANAGED TO GROW STRONG DOMESTIC DIGITAL INDUSTRIES

Globally, digital has enabled the rapid growth and scale of new firms…

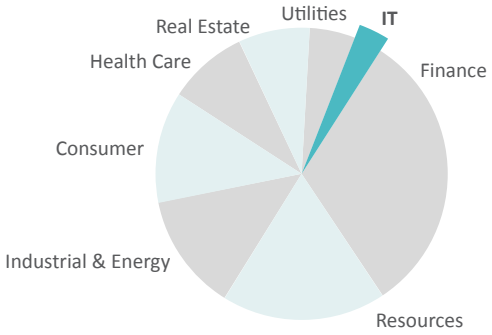
Largest global and Australian firms by market capitalisation and their year of foundation, September 2018



SOURCE: ASX, S&P Global, literature review.

…but IT still occupies a very small share of our domestic market

ASX200 market capitalisation by industry, $b, 2018



SOURCE: ASX, AlphaBeta analysis.

1 **Investments in new digital capital:** Australian capital investment in general is high compared to other advanced economies, but it has below-average focus on ICT investments. Just 8 per cent of capital investments in Australia since 2000 have been in information and communication technology (ICT).[13] Capital investments in the Australian economy are instead likely to be in areas such as construction equipment, mining trucks, and logistics networks such as rail connections to ports. Digital capital investments are dominated by investments in software, especially in professional services industries such as finance.[14] Australia is estimated to have captured output improvements from digital capital that account for 3 per cent of GDP, compared to 4.1 per cent in other advanced economies.

2 **Improved multifactor productivity:** Total Australian multifactor productivity has grown by 8.2 per cent since 2000. While this productivity growth is above that of advanced economies such as Canada and New Zealand, it significantly lags global leaders such as South Korea and the USA.[15] The comparably weak rate of Australian investment in digital capital suggests that a lower share of our multifactor productivity growth is driven by digital innovation. As such, Australia also appears to have underperformed global peers in creating economic value through this channel.

3 **Growth of domestic digital industries:** Digital innovation has led to thriving new social media and Software as a Service (SaaS) industries, dominated by global behemoths such as Tencent, Google, and Microsoft (Exhibit 5). In America alone, the market capitalisation of the four largest technology companies exceeds $4 trillion.[16] Australia's own digital industry is less visible on a global scale. The Australian digital industry's share of economic output over the past two decades has lagged other advanced economies by one-third. Our digital sector mainly creates value in niche areas. For example, Australia is a leading global provider of software solutions for the mining and resources industry. Countries such as the US, with global leaders like Google and Amazon, demonstrate how to reap the rewards of creating a fertile ground for domestic digital industry growth.

4 **Growth of digital industry exports:** In the past, Australia has particularly underperformed other advanced economies in generating value with digital exports. While the low focus on digital innovation in our goods exports is likely due to our strength in resource exports, Australia also severely underperformed in ICT services exports. In services, ICT exports accounted for less than 18 per cent of our total services exports, which ranked us 78th in the world. Since 2000, our global position has dropped by 13 ranks, with our focus on digital service exports lagging as other advanced economies moved to capture the new opportunity.[17]

13. OECD Digital Economy Outlook (Figure 5.2) and OECD.stat database.
14. ABS Catalogue Number 5206.0.55.002 (Estimates of Industry Multifactor Productivity, 2016 – 17) Released January 2018, Table 12.
15. OECD (2018), Multifactor productivity (indicator).
16. Combined market capitalisation (A$) of Apple, Alphabet, Intel and Microsoft, per public sources (2018).
17. World Bank Open Data (2018), ICT exports.

1.5 AUSTRALIA CAN CAPTURE $315 BILLION IN GROSS ECONOMIC VALUE OVER THE NEXT DECADE IF IT CATCHES UP TO GLOBAL PEERS

Digital innovation can provide Australia a further $315 billion in gross economic value over the next decade if we match the performance of our global peers.[18] This assumes that Australia progressively closes the gap to other advanced economies in developing its digital economy over the next decade. To do this, Australia will need to increase the accumulation of digital capital and application of digital technology to drive up productivity, and capture new digital markets.

Australia can increase the value it generates from digital productivity improvements by investing in more and sophisticated digital capital. Autonomous systems, advanced software solutions and remote data sensors are all examples of this. It must then boost its multifactor productivity. This involves not just purchasing and implementing new digital investments, but optimising production processes and business models to gain the maximum value from those investments.

Australia can also catch up to its advanced peers by facilitating the growth of new digital industries. This includes creating strong domestic markets and suppliers for digital innovation, as well as extending our presence in export markets.

The growth of our digital economy need not follow the same path as our advanced economy peers. Indeed, over the past two decades each country has found its own path: whilst countries like the USA and China have built booming domestic digital industries, economies like Singapore and India have relied on digital export markets, while economies like Korea, Japan and the Netherlands have built up their application of digital capital to drive up productivity. The Australian recipe for success in the Fourth Industrial Revolution should instead build on our own strengths. Whatever path Australia adopts, the experience of the past and the attention being paid to digital innovation by our peer economies affirms that the importance of embracing digital innovation could not be clearer. Australia must act now to support its firms to compete in the global economy by applying digital innovation.

This is an ambitious agenda, but Australia has significant advantages it can build on. To capture this opportunity, Australia should focus on improving its digital technology performance in areas that play to its existing strengths (Chapter 2). Australia should also seek to improve its performance on the key drivers of competitiveness in digital innovation (Chapter 3).

18. This estimate is the Net Present Value of the total economic uplift over the 10 years, assuming a discount rate of 10%. It assumes that Australia closes the gap progressively over the next 10 years. It is a gross value figure and does not discount where the digital economy might replace traditional sources of value.

2

AUSTRALIA CAN FOCUS ITS DIGITAL INNOVATION ACTIVITY IN AREAS OF EXISTING COMPETITIVENESS

The biggest opportunities in digital innovation for Australia are likely to be found in areas where technical and process advances combine with our existing industry expertise, where we already have key drivers of competitiveness such as strong local demand and high quality basic research. This report identifies eight high-potential opportunities for Australia in digital innovation: precision healthcare, digital agriculture, data-driven urban management, cyber-physical security, supply chain integrity, proactive government, legal informatics, and smart exploration and production. Together, these opportunities could develop into markets worth a total of $155 billion annually in our region over the next decade, driving significant economic potential for Australia.

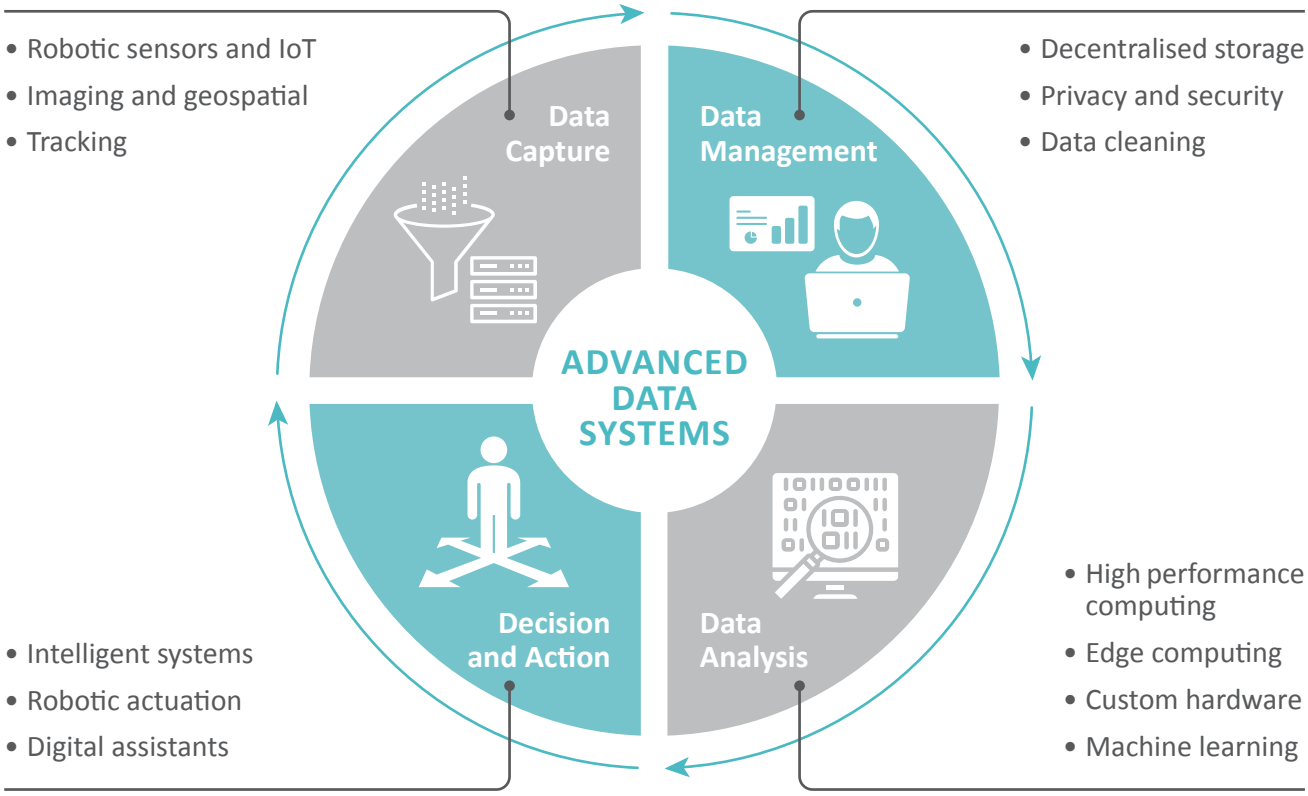
2.1 THE EMERGING WAVE OF DIGITAL INNOVATION WILL CREATE OPPORTUNITIES ACROSS ALL INDUSTRIES – AND AUSTRALIA MUST COMPETE WHERE IT IS BEST-SUITED

The Fourth Industrial Revolution will create bigger opportunities across a wider range of industries than previous waves of digital innovation. The data-driven technologies which are ushering in this wave of innovation are applicable in more sectors than in previous waves. Exhibit 6 identifies some key technologies. Advanced data-capture technology including tracking systems, the "Internet of Things", and geospatial sensors allow once analogue sectors to become digital. Cutting edge technologies such as quantum sensors allow for highly precise sensory systems. The management, analysis and application of this data to decision-making allows everything from farms to mines, logistics chains to construction sites to gain from digital connectivity and innovation. New possibilities in automation, driven off new forms of data, will disrupt many traditional industries. For leaders, these technologies represent the building blocks for capturing the value of digital innovation.

"The biggest opportunities in digital innovation for Australia are likely to be found in areas where technical and process advances combine with our existing industry expertise, where we already have key drivers of competitiveness such as strong local demand and high quality basic research."

EXHIBIT 6

DATA INNOVATION RELIES ON SPECIALISED SYSTEMS FOR DATA CAPTURE, MANAGEMENT, ANALYSIS, AND ACTION



Some of the emerging digital opportunities will be particularly well-suited to Australian industry. In previous waves of digital innovation, the emphasis was on consumer-facing industries such as retail trade and entertainment media. The growth of Facebook, eBay, Netflix and other Silicon Valley success stories depended on a large domestic market and pre-existing competitive strength in those industries, both of which Australia lacked. Australia now has the opportunity to leverage its strength in industries such as healthcare, agriculture and mining to drive forward digital innovation in those areas.

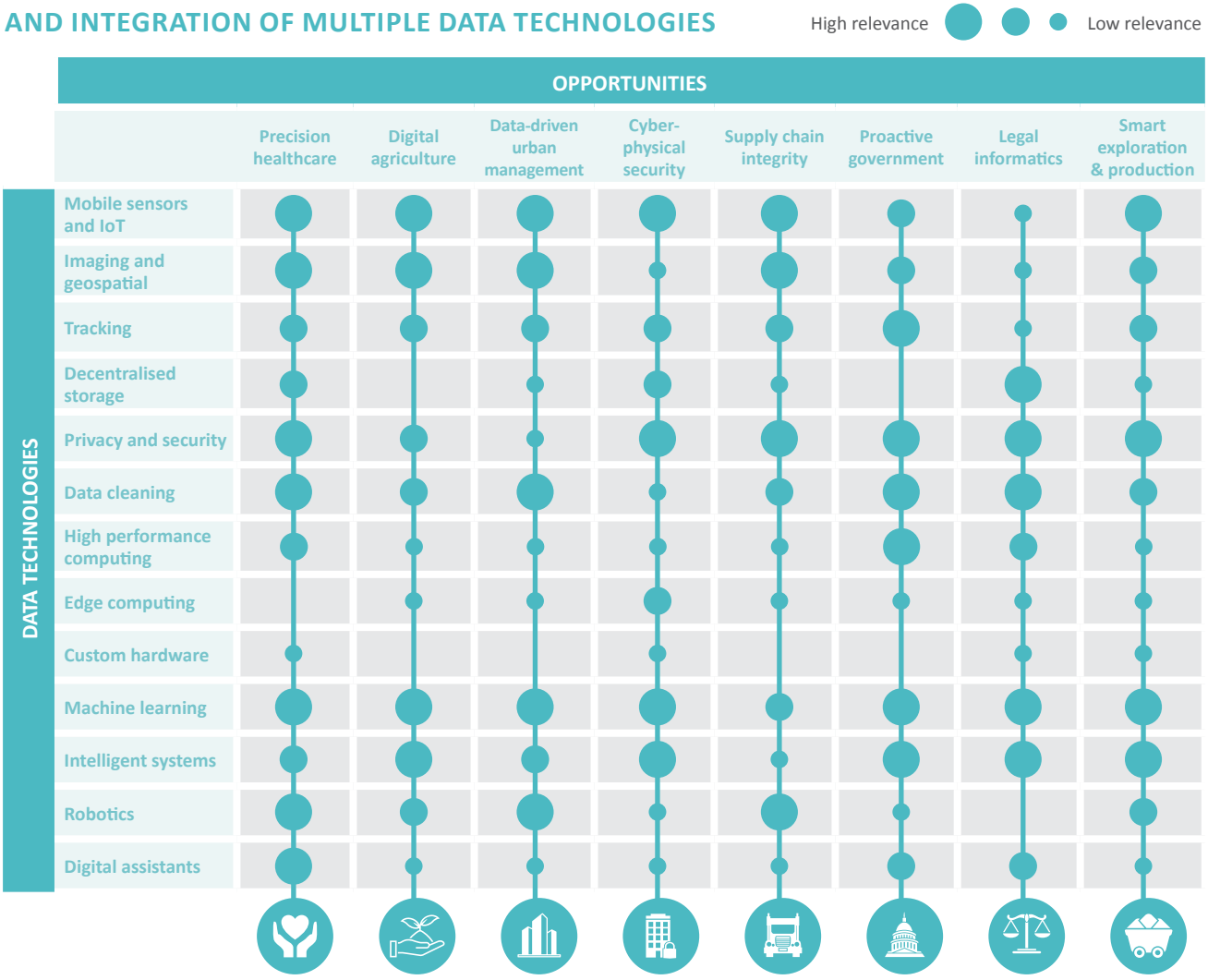
Emerging opportunities across the economy can be identified and assessed by considering how these advancing technologies can help address economic and social imperatives in existing industries. For example, one of the most significant opportunities over the next decade is likely to be the growing demand for better urban planning – especially as rapid urbanisation continues across much of Asia. Australian expertise in infrastructure and data management can be combined to deliver lucrative digital innovations in this area. Similarly, climate change and rising resource input costs will require industries like agriculture to develop technology which can track, measure and manage the use of resources.

2.EIGHT HIGH-POTENTIAL OPPORTUNITIES COULD BECOME SIGNIFICANT MARKETS FOR AUSTRALIAN FIRMS OVER THE NEXT DECADE

Eight major opportunities for Australian leadership in digital innovation represent a potential $155 billion regional market for Australian firms to capture.[19] These opportunities have been chosen from a much longer list based on comparative assessment of their significance, their feasibility, and their compatibility with Australia's existing strengths. First, they are likely to be economically sizeable or relevant to our regional strategic context. Second, the feasibility of each opportunity eventuating within the next decade was considered, given the level of development of the technology involved. Finally, opportunities were prioritised for compatibility by assessing the ability of Australia to develop a foothold in the industry given our existing strengths on the key drivers of competitiveness. The process for selection involved desktop research, industry analysis, and engagement with experts at Data61, CSIRO more broadly, and with other industry experts.

EXHIBIT 7

EACH OF THE EIGHT OPPORTUNITIES IS BASED ON THE APPLICATION AND INTEGRATION OF MULTIPLE DATA TECHNOLOGIES



SOURCE: AlphaBeta analysis; expert interviews; desktop literature review.

19. This assessment of the regional market is based on estimates of the Asia-Pacific market revenue for each of the eight opportunities in 2028, expressed in nominal terms. These estimates were developed based on a range of sources, including market research reports and industry modelling.

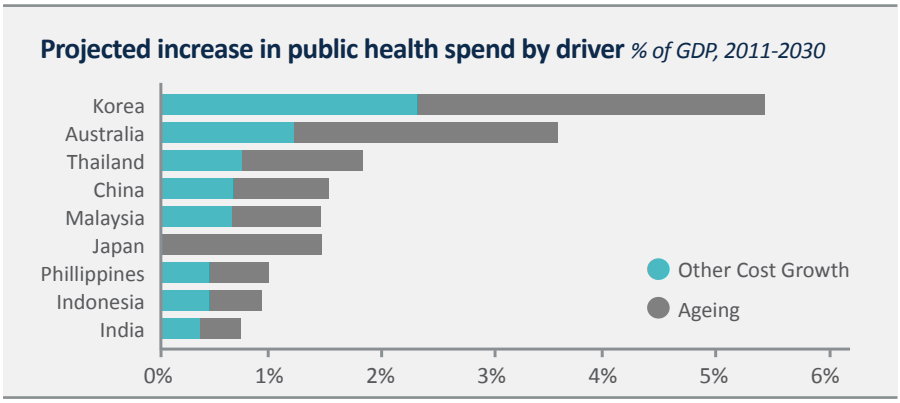
SAFE AND SECURE PRECISION HEALTHCARE

Using connected healthcare data across systems to enable personalised monitoring, treatment and illness prevention

$140-190b
2028 GLOBAL MARKET REVENUE

$30-50b
2028 ASIA-PACIFIC MARKET REVENUE

Countries across the region will increase their healthcare spending, primarily due to the impacts of ageing



SOURCE: Centre of Excellence in Population Ageing Research (2013).

The ageing population in Australia and Asia is expected to increase the strain on the healthcare system. The share of global over-60s is set to increase from 13% in 2017 to 21% by 2050.[20] By 2030 Australia's ageing population could increase public health expenditure between 1-4% of GDP.[21]

To ensure costs remain sustainable, greater emphasis will be required on prevention, personalised care and out of hospital treatment.

ADVANCES IN GENETICS AND ANALYTICS ARE MAKING NEW FORMS OF HEALTHCARE POSSIBLE

Advances in genomics and laboratory testing give doctors a clearer understanding of a person's individual genetic makeup and risk to develop complex diseases such as tuberculosis and cancer, and are enabling early diagnosis, the development of more targeted treatments and improving approaches to disease prevention.

Estimates suggest that despite advanced machine learning tools, as much as 80% of healthcare data is unstructured, making it difficult to analyse.[22] This can make it difficult to assess which data is useful, and even more difficult to capture that value. These tools could analyse clinical trials, pick up early warning signs and facilitate personalised and preventative care.

Why Australia?

Australia's excellent biotech and medical research capabilities, combined with a strong public healthcare system, can make Australia an early adopter of health data innovation – if the policy environment is supportive. Australia is also well placed to foster its own precision medicine market, building on a global leadership position in genomic research and its clinical application.

Potential challenges

The personal and sensitive nature of healthcare data raises concerns over the potential security and misuse of this data – building security and privacy into systems, of data sharing will be essential to developing the trust necessary for precision healthcare.

Benefits of precision healthcare

Connecting data across a range of sources will enable individuals to take ownership of their healthcare. Healthcare professionals will be better able to service individual needs as they change and develop, leading to more precise illness prevention, early diagnosis and improved wellbeing.

20. United Nations (2017), World Population Ageing. Available at: http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2017_Highlights.pdf.
21. Centre of Excellence in Population Ageing Research (2013), Asia in the ageing century. Available at: http://cepar.edu.au/sites/default/files/Asia_in_the_ageing_century_Part_III.pdf.
22. IBM (2015), Data-driven healthcare organisations use big data analytics for big gains. Available at: https://www-03.ibm.com/industries/ca/en/healthcare/documents/Data_driven_healthcare_organizations_use_big_data_analytics_for_big_gains.pdf.

DIGITAL AGRICULTURE

Harnessing mobile sensors, robotics and machine learning techniques to improve resource planning and use in agricultural production

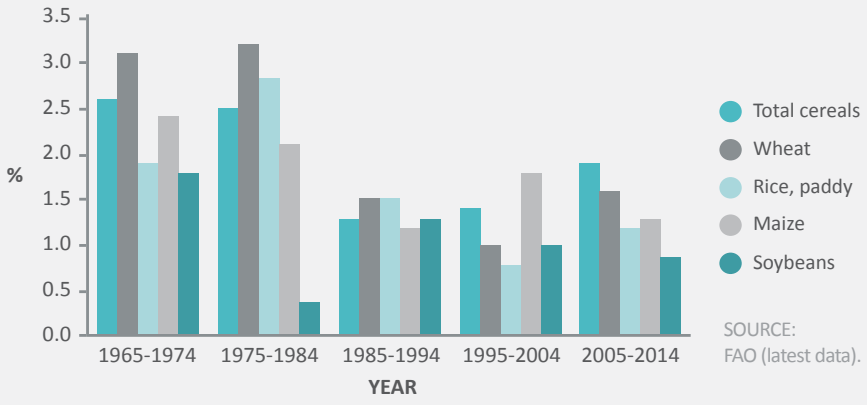
$25-60b
2028 GLOBAL MARKET REVENUE

$10-25b
2028 ASIA-PACIFIC MARKET REVENUE

To feed the world in 2050, global food production will need to increase by 50%.[23]

The combination of population growth and climate change is raising concerns about food security. While such increases have been achieved before, conditions today are more challenging. Yield growth in most major crops has slowed in the last few decades, and climate change is predicted to threaten 10-25% of global crop yields.[24] The availability of new agricultural land has also declined, and much existing farmland is degraded from overuse.

Average annual global growth rates for selected crop yields



SOURCE: FAO (latest data).

DIGITAL AGRICULTURE CAN LIFT PRODUCTIVITY BY IMPROVING USE OF SCARCE RESOURCES

Data-driven solutions, utilising remote sensors, robotics and machine learning techniques to monitor and improve production and decision making, can improve productivity. For example, data from regular monitoring of plant and soil conditions can be used to make planting decisions and more accurately manage water inputs.

Vertical farming techniques enable low resource intensive food production:[25]

- **Use up to 95% less water**
- **Use over 90% less land**
- **80% increase in yield**

Why Australia?

Australia's harsh climate and historically higher labour costs have led Australian scientists to be at the forefront of research into agricultural innovations, such as automated systems and drought-resistant crops.[26] Our reputation for sustained innovation in agricultural technology, our experience dealing with a resource-constrained environment and proximity to rapidly urbanising Asian countries put Australia in an ideal position to tap into markets with growing demand for digital agriculture products and services.

Potential challenges

While Australia has a strong pedigree in the development of agricultural technologies, our climatic conditions and crop mix are markedly different from those in most parts of Asia, reducing the compatibility of some domestically developed innovations.

Benefits of digital agriculture

Digital agriculture can improve the resource efficiency of agricultural production, reducing the environmental cost of our food, and improve food security through supporting stronger yields.

23. FAO (2017), The Future of Food and Agriculture: Trends and Challenges. Available at: http://www.fao.org/3/a-i6583e.pdf.
24. FAO (2018), The State of Food and Agriculture: Climate Change, Agriculture and Food Security. Available at: http://www.fao.org/3/a-i6030e.pdf.
25. McKinsey (2016), Empowering Japanese agriculture for global impact. Available at: https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Asia%20Pacific/Strengthening%20Japanese%20agriculture%20to%20maximize%20global%20reach/Empowering-japanese-agriculture-FULL-REPORT.ashx.
26. ABC (2017), Scientists make accidental breakthrough to drought-proof crops. Available at: www.abc.net.au/news/2017-06-28/scientists-make-accidental-breakthrough-to-drought-proof-crops/8659918.

DATA-DRIVEN URBAN MANAGEMENT

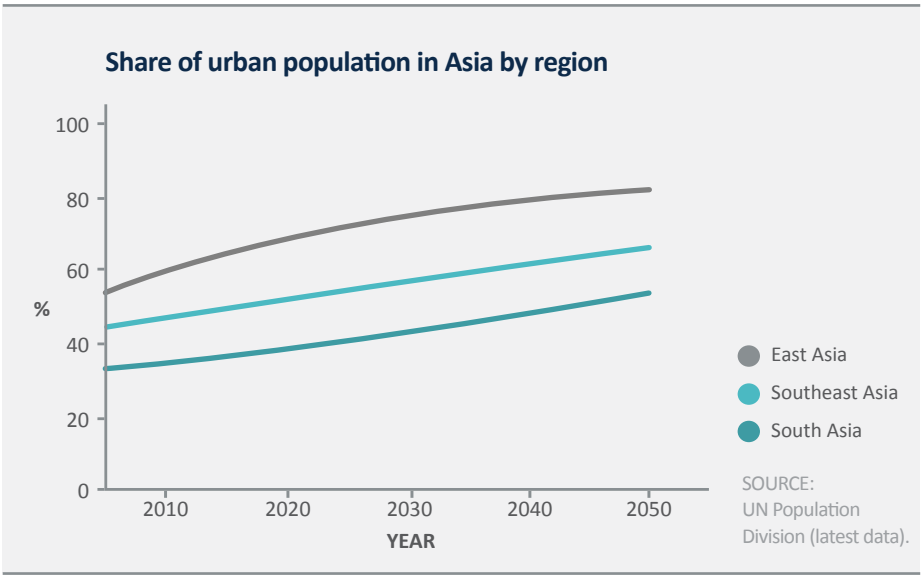
Using geospatial and sensor data on people movement and construction to better design and operate infrastructure and cities

$20-30b
2028 GLOBAL MARKET REVENUE

$5-10b
2028 ASIA-PACIFIC MARKET REVENUE

Asia's population is expected to continue its rapid urbanisation

More than 600 million additional people are expected to move to the cities of Asia by 2030.[27] Better urban planning is needed to ensure resources and infrastructure are used sustainably, and cities remain liveable. Poorly managed urban growth can lead to the inexhaustible demand for infrastructure and increase travel times, road congestion, and air pollution.[28]



NEW MAPPING TECHNOLOGIES AND USE OF CONNECTED SENSORS CAN ENABLE BETTER DECISION MAKING IN URBAN PLANNING AND MANAGEMENT

The increasing affordability and quality of satellite and drone technologies enable geospatial mapping and building information modelling (BIM) that improve asset management and cost efficiency. BIM is expected to reduce the lifetime cost of an asset by 20%.[29]

Connected sensors enable collection of a mass of transport data, including pedestrian movements and vehicle density, that can be used to measure and predict the impact of urban sprawl. For example, Singapore's Urban Redevelopment Authority currently use a range of analytical and data-driven tools to reduce transport congestion and improve public safety.[30]

Why Australia?

As one of the world's most urbanised nations, Australia has a great domestic incentive to strengthen its focus on data-driven urban design and management solutions. Australia is also well-positioned to export high-tech urban management solutions to meet growing demand in Asia's stretched cities, where Australian firms have already enjoyed some success in infrastructure planning and financing.

Potential challenges

Although Australia's capabilities are proven and respected in the region, competitors such as Singapore have demonstrated significant capacity in data-driven urban design. Despite competition, the size of the anticipated market is likely to generate ample opportunity for many providers.

Benefits of data-driven urban management

Data-driven urban management has the capacity to improve the wellbeing and quality of life for urban populations, assist governments with their most difficult planning challenges and also better manage environmental impacts of urban life.

27. DFAT (2017), Foreign Policy White Paper. Available at: https://www.fpwhitepaper.gov.au/
28. World Bank (2017), Global Mobility Report. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/28542/120500.pdf.
29. BCG (2016), Digital in Engineering and Construction. Available at: http://futureofconstruction.org/content/uploads/2016/09/BCG-Digital-in-Engineering-and-Construction-Mar-2016.pdf.
30. Inter-American Development Bank (2016), International Case Studies of Smart Cities. Available at: https://publications.iadb.org/bitstream/handle/11319/7723/International-Case-Studies-of-Smart-Cities-Singapore-Republic-of-Singapore.pdf?sequence=1.

CYBER-PHYSICAL SECURITY

Ensuring the protection of key physical assets and infrastructure from potential cyber security vulnerabilities.

$30-40b
2028 GLOBAL MARKET REVENUE

$10-15b
2028 ASIA-PACIFIC MARKET REVENUE

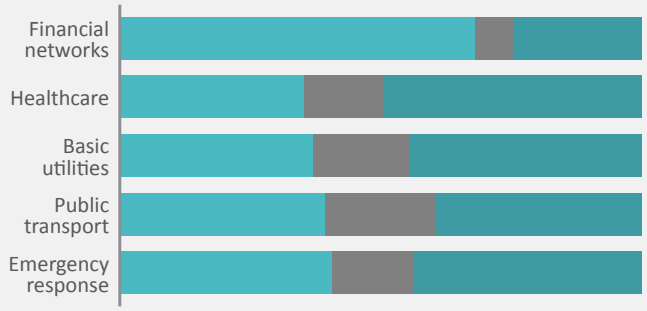
Physical systems are increasingly vulnerable to cyber attacks

By 2020, estimates suggest that 20-30 billion objects will be connected to the Internet of Things.[31] Given many of these devices will be physical, operational technologies such as vehicles, factories and infrastructure assets, security will be paramount.

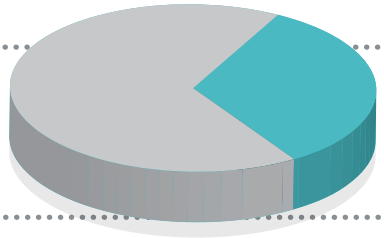
Cyber-attackers are constantly developing more sophisticated methods of exploitation. Every year, hackers produce some 120 million new variants of malware.[32] Unlike with traditional software systems which receive frequent updates and patches, cyber-physical systems are updated much less frequently, leaving them more vulnerable.

The rapid pace of digital transformation in Asia has not been matched by appropriate investment in cyber security readiness, leaving many countries more vulnerable to attacks. Asian companies spent almost 50% less on cyber security than North American firms and take 1.7 times longer to respond to data breaches than the global median.[33]

Likelihood of select services being the target of a cyber-attack



SOURCE: Centre of Excellence in Population Ageing Research (2013).



NEARLY ONE-THIRD OF LARGE ORGANISATIONS GLOBALLY REPORT THAT THEY HAVE ALREADY EXPERIENCED CYBER SECURITY ATTACKS ON THEIR OPERATIONAL TECHNOLOGY INFRASTRUCTURE.

A further third say that they expect attacks to move from IT to OT within the next year.[34]

Why Australia?

Cyber-physical capabilities such as remote monitoring and management, developed in the mining sector, provide a good foundation to build expertise in cyber-physical security. Australian companies and governments alike have signalled their commitment to building cybersecurity capabilities, with the release of a national cybersecurity strategy and significant investment in industry development.

Potential challenges

The constrained supply of trained cyber security professionals is a challenge for growing this industry in Australia, with surveys and job market evidence all suggesting difficulty filling existing positions. Strong investment in skills development will be critical for capturing this opportunity.

Benefits of cyber-physical security

Strong cyber-physical security protects nations' critical infrastructure from attacks, and preserves public confidence in digital connectivity and technology more broadly.

31. McKinsey (2014), The Internet of Things: Sizing up the opportunity. Available at: https://www.mckinsey.com/industries/semiconductors/our-insights/the-internet-of-things-sizing-up-the-opportunity.
32. McKinsey (2018), A new posture for cybersecurity in a networked world. Available at: https://www.mckinsey.com/business-functions/risk/our-insights/a-new-posture-for-cybersecurity-in-a-networked-world.
33. Marsh (2017), Cyber Risk in Asia-Pacific. Available at: https://www.marsh.com/content/dam/marsh/Documents/PDF/asia/en_asia/Cyber%20Risk%20in%20Asia%20Pacific%20-%20The%20Case%20for%20Greater%20Transparency.pdf.
34. Cisco (2018), Annual Cybersecurity Report. Available at: https://www.cisco.com/c/en/us/products/security/security-reports.html.

SUPPLY CHAIN INTEGRITY

Applying connected sensors and distributed ledger technologies to build trust in transactions and verify product provenance

$30-45b
2028 GLOBAL MARKET REVENUE

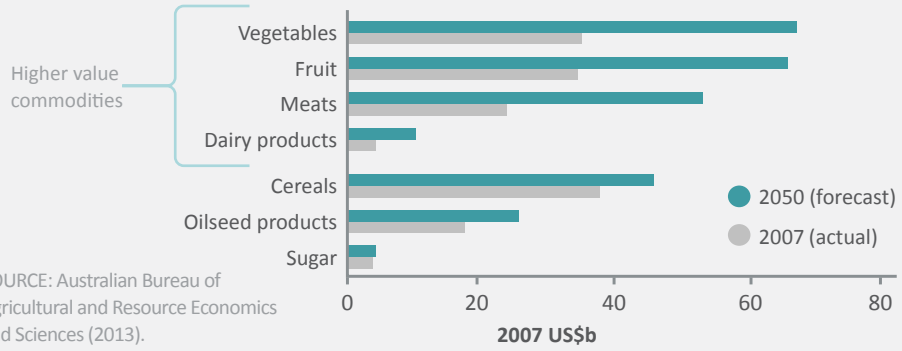
$10-15b
2028 ASIA-PACIFIC MARKET REVENUE

Asia's growing middle class is increasingly concerned with the provenance of food and pharmaceuticals

Asia-Pacific's consuming class is expected to more than double to 1.2b households by 2030, up from 552m in 2017.[35] Increased development and income is expected to create significant demand for high-value agricultural and pharmaceuticals products. However, premium products can often be forged or corrupted. For example, currently around 10% of all medical products sold in low- and middle-income countries are substandard or falsified.[36]

Lower regulatory and agricultural standards in many Asian countries raise concerns over biosecurity, quality and provenance. In China, for example, the share of consumers that assess the safety of food and medicine as a major problem has tripled over the last decade to more than 40%.[37]

ASEAN's demand for high-value agriculture will significantly increase by 2050



SOURCE: Australian Bureau of Agricultural and Resource Economics and Sciences (2013).

FOOD PROVENANCE TECHNOLOGY CAN VALIDATE THE ORIGINS AND CHARACTERISTICS OF PREMIUM PRODUCTS

Blockchain technology can verify a chain of supplier relationships to give each purchaser a reliable understanding of the origins of a product – allowing particular factories, geographical regions or countries to better market premium products.

Automated monitoring systems can help independently verify production processes: for example, video surveillance combined with computer vision can automate quality assurance and certification.

Why Australia?

Australia has a global reputation as a supplier of clean and green food and medicine, from fresh Tasmanian salmon to organic infant formula. However, there is growing concern among Australian exporters over counterfeited products. Digital technologies that verify a product's provenance could sustain and lift the export revenues generated by our food and pharma industries by securing the price premium that our high quality products currently attract.

Potential challenges

Although many Asian nations currently do not have the regulation and standards to support higher-value production, rapid economic development, technological innovation and strengthening institutions are expected to improve the quality of domestic goods across the region. However, this will likely take some time to eventuate.

Benefits of supply chain integrity

Strong supply chain integrity can help protect consumers across the region from the health risks of consuming counterfeit products, and improve public confidence in both the food supply and medical system.

35. McKinsey (2015), No Ordinary Disruption: The Forces Reshaping Asia. Available at: https://www.mckinsey.com/~/media/McKinsey/Locations/Asia/Singapore/Our%20insights/No%20ordinary%20disruption%20the%20forces%20reshaping%20Asia/No_Ordinary_Disruption_The_Forces_Reshaping_Asia.ashx.
36. WHO (2017), WHO Global Surveillance and Monitoring System for Substandard and Falsified Medical Products. Available at: http://www.who.int/medicines/regulation/ssffc/publications/GSMS_Report.pdf.
37. Pew Research Center (2016), Rising concerns about the safety of food, medicine. Available at: http://www.pewglobal.org/2016/10/05/chinese-public-sees-more-powerful-role-in-world-names-u-s-as-top-threat/10-4-2016-9-38-34-am-2/

PROACTIVE GOVERNMENT

Harnessing greater data availability and data science to improve policy development, agility and strategic decision making

$25-40b
2028 GLOBAL MARKET REVENUE

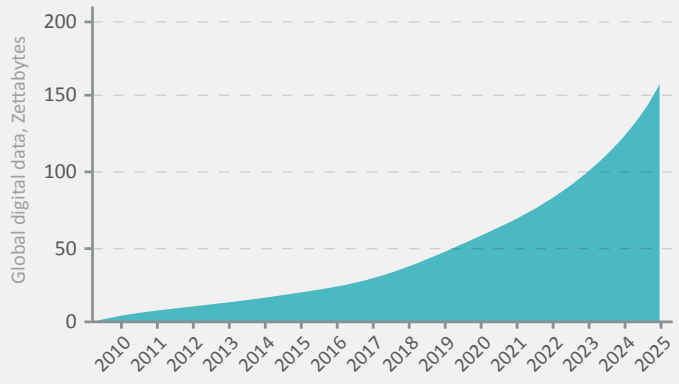
$5-10b
2028 ASIA-PACIFIC MARKET REVENUE

Proactive government can improve the efficiency and effectiveness of public sector decision making

Low institutional trust, rising civil expectations, accelerated decision cycles and greater strategic uncertainty are forcing organisations to become more responsive and evidence based.

The increased availability of data, combined with greater analytic capabilities, has the potential to increase the effectiveness of policy and decision making and reduce expenditure.

Global data production is increasing exponentially



SOURCE: IDC (2017).

Actor and strategy	Benefit
Singapore: Use data and analytics to drive policy decisions and optimise public services. [38]	Reduced crowdedness issues on bus services by 92% and waiting times on popular services from 7 to 3 minutes.
Large national-defence organisation: Used data-analytics to increase equipment and weapons-systems readiness.[39]	Reduced the country's overall military operations and maintenance expenses by 10-12%.
Australian government: Using Multi-Agency Data Integration Project (MADIP) to link Medicare, government payments, personal income tax, and Census data.[40]	Has generated insights into the effectiveness of policies and led to improved targeting of services, such as health and early childhood services.
Chicago police department: Using predictive-policing software to predict and prevent violence crime.[41]	Has led to a steeper decline in crime rates compared to districts that are not using the software.

Why Australia?

Australian government services already generate and capture a large and diverse amount of digitised data. Initiatives such as BLADE and MADIP connect and integrate separate data sources to generate insights and improve policy delivery. Combined with Australia's strong professional services sector, which is rapidly developing sophisticated data analytical capabilities, this provides a good foundation for Australia to lead on the growth of proactive government technology.

Potential challenges

Sustainable proactive government approaches rely on building confidence amongst citizens that their data is being used by governments for public good and is leading to improvements in service provision. A strong regulatory and ethics framework and the development of privacy-preserving data technologies will be important to generating that trust.

Benefits of proactive government

Proactive government approaches can lead to improved efficiency of government spending through more evidence-based, agile policy development. Higher quality policy analysis can also help to support stronger economic development in our regional neighbours

38. Smart Nation Singapore (2018), Open Data and Analytics for Urban Transportation. Available at: https://www.smartnation.sg/initiatives/Mobility/open-data-and-analytics-for-urban-transportation.
39. McKinsey (2016), Policy in the data age: Data enablement for the common good. Available at: https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/policy-in-the-data-age-data-enablement-for-the-common-good.
40. ABS (2017), MADIP Case studies. Available at: http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Statistical+Data+Integration+-+MADIP+Case+Studies.
41. City of Chicago (2018), CPD Continues Expansion of Predictive Technology to Support Strategic Deployments, Reduce Crime. Available at: https://www.cityofchicago.org/city/en/depts/mayor/press_room/press_releases/2018/march/CPDPredictiveTech.html

LEGAL INFORMATICS

Using AI and machine learning to automate certain legislative, compliance and administrative tasks

$25-40b
2028 GLOBAL MARKET REVENUE

$10-15b
2028 ASIA-PACIFIC MARKET REVENUE

Governance, risk management and compliance are become increasingly expensive

The cost of regulatory compliance and administration has ballooned in recent years as governments have responded to the lessons of the financial crisis. In Australia, it is now estimated to cost $250bn a year.[42] Governance, risk management and compliance (GRC) account for 15-20% of total banking costs.[43] As Asian economies grow and develop, their legislative and regulatory activities are also likely to become more complex and expensive.

DIGITAL TECHNOLOGY CAN HELP ALLEVIATE SOME OF THESE COST PRESSURES

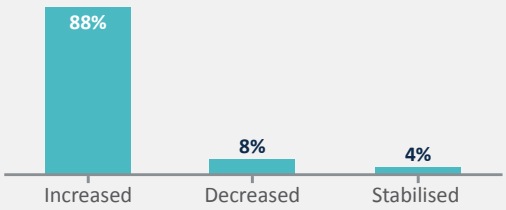
Laws, contracts and other regulatory documents can increasingly be converted into machine-readable format, allowing automation of auditing and compliance.

Automating the compliance process can reduce costs, while machine learning techniques can reduce human error and improve the surveillance and detection of fraud.

One global bank achieved a 26% reduction in identifying fraudulent false positives after applying machine learning to improve transactions monitoring.[44]

Assessment of the change in regulatory cost of risk for financial institutions over the past 5 years

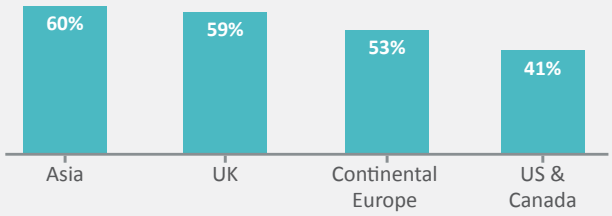
% of survey respondents, 2017, n=26



SOURCE: McKinsey (2017).

Asian firms expect time with regulators to increase more than peers in Europe and the US

Expectation of whether time spent liaising and communicating with regulators will increase *% of survey respondents, 2017, n=850*



SOURCE: Thomson Reuters (2017).

Why Australia?

Australia's research institutions are world leaders in the field of computational law. This high level of technical capability, combined with the Federal Government's openness to new regulatory platforms, create favourable enabling conditions for the development of legal informatics. Australia's strong financial sector has already begun investing in this space – their investment capability and commitment to innovation will be important.

Potential challenges

Currently the cost of translating legislation into a digital format is time consuming and expensive, but improvements in technology will likely bring this down over time. Continued, strong government support will be critical to allow for replacement of outdated, manual regulatory reporting methods.

Benefits of legal informatics

Legal informatics can lead to enhanced productivity for both government and the private sector through a reduction in the cost of regulatory compliance. It can also improve regulatory accuracy and outcomes through more reliable and consistent processes.

42. Deloitte (2014), Get out of your own way: Unleashing productivity . Available at: https://www2.deloitte.com/content/dam/Deloitte/au/Documents/Building%20Lucky%20Country/deloitte-au-btlc-get-out-your-own-way-230217.pdf.
43. Bain (2016), Banking Regtechs to the rescue? . Available at: https://www.bain.com/insights/banking-regtechs-to-the-rescue
44. McKinsey (2017), The future of risk management in the digital era. Available at: https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Risk/Our%20Insights/The%20future%20of%20risk%20management%20in%20the%20digital%20era/Future-of-risk-management-in-the-digital-era-IIF-and-McKinsey.ashx.

SMART EXPLORATION AND PRODUCTION

Applying machine learning techniques and greater automation to improve the efficiency of resource discovery and production

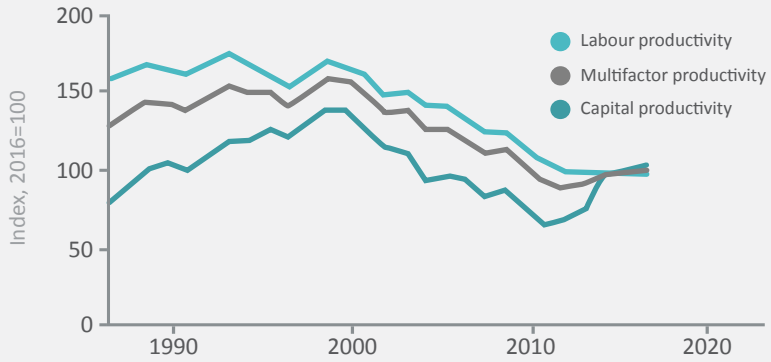
$25-40b
2028 GLOBAL MARKET REVENUE

$5-15b
2028 ASIA-PACIFIC MARKET REVENUE

Extractive industries are struggling to turn around declining productivity

Over the last twenty years, the productivity of resource extraction worldwide has declined dramatically. Undisciplined capital investment and shortages of experienced workers have both been important factors in this decline. Deterioration in the grade of ores has also contributed, as miners are forced to exploit more remote, lower-quality resource deposits. In copper, for example, ore grade declined by around 25% in the decade to 2013.[45] Australia has not been immune from this productivity collapse, with a steady decline since the late 1990s and only a slight recovery in recent years.

Productivity in the Australian resource sector



SOURCE: ABS (latest available data).

INNOVATION IN THE USE OF DATA AND AUTOMATION CAN HELP MEET THIS PRODUCTIVITY CHALLENGE

Technology to improve efficiency of exploration and production is developing rapidly. Sensors are already capturing vast quantities of data about ore bodies, equipment and vehicle movements, enabling the application of new analytical techniques.

Rio Tinto's Mine of the Future uses autonomous trucks, drilling systems and trains to reduce costs and improve production efficiency. BHP also use machine learning to analyse exploration datasets to discover untapped reserves.[46]

Research suggests that data analytics and robotics could lower costs in resources extraction globally by up to US$390 billion per year by 2035 due to more efficient equipment and energy use.[47]

Why Australia?

Australia is well-positioned to spearhead the global trend towards digital innovation in the resource sector. Firms such as Rio Tinto and BHP Billiton are world leaders in using advanced exploration and mining technology, including autonomous trucks, trains and drilling systems. Australia's mining equipment, technology and services sector is already well established, and there is scope to strengthen our exports of mining technology to rapidly developing nations in Asia and elsewhere.

Potential challenges

While technology innovation should yield long-term cost reductions, it does require upfront investment in both R&D and deployment. Many resource companies are cutting capital and operational expenditure to focus on driving performance of existing assets, and are reluctant to invest in technological transformation of their operations.

Benefits of smart exploration and production

Smart exploration and production can improve resource efficiency, and reduce the environmental footprint of extractive activities. It can also advance safety for workers through automation that reduces the exposure of workers to the most hazardous activities.

45. Calvo et al (2016), "Decreasing Ore Grades in Global Metallic Mining: A Theoretical Issue or a Global Reality?" in Resources, Vol 5 No 36. Available at: https://pdfs.semanticscholar.org/0fb2/3ed97e4675abcf94f6b3debc8a49acc60e50.pdf,
46. Rio Tinto (2018), Mine of the Future. Available at: https://www.riotinto.com/australia/pilbara/mine-of-the-future-9603.aspx
47. McKinsey (2017), Beyond the Supercycle: How technology is reshaping resources. Available at: https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Sustainability%20and%20Resource%20Productivity/Our%20Insights/How%20technology%20is%20reshaping%20supply%20and%20demand%20for%20natural%20resources/MGI-Beyond-the-Supercycle-Full-report.ashx.

2.3 OTHER OPPORTUNITIES WILL ALSO EMERGE AS NEW TECHNOLOGIES DEVELOP AND MATURE

The digital innovation opportunities described in this section are just a sample of those open to Australian businesses. World-leading research in quantum technologies by Australian universities could make possible quantum computing or highly precise measurement through quantum sensing. Australia is already among world leaders in facilitating this technology and could use this technological leadership to create global industries. A less speculative set of digital technologies could help boost energy management and efficiency – including better pre-emptive demand response management. Environmental services are an area of growing importance. As resource limitations and climate change impact all parts of the economy, digital innovation is likely to play a central role in both predicting and addressing our environment challenges. Digital technologies are also allowing Australia to enhance its participation in the global space economy. The Square Kilometre Array is a next-generation radio telescope project enabled in part by advanced computing technologies. In education – an industry that is already critical to our economy and export performance – a range of opportunities are emerging for technological innovation, but it is not yet clear which are likely to be most significant. These and other examples offer ample evidence of the abundance of digital-enabled industry opportunities for Australia to capture.

3

AUSTRALIA CAN BUILD ON ITS R&D STRENGTHS AND BOOST FIRMS' USE OF INNOVATION TO IMPROVE ITS GLOBAL COMPETITIVENESS

Australia can leverage its research strengths to improve its innovation performance by addressing four policy imperatives. First, Australia can compete against the scale of global investments by focussing its capacity in strategic areas. Second, improving the effectiveness of its limited investments by increasing coordination and business investment activity will be critical to success. Third, Australia can convert research expertise into industry leadership by improving its rate of product innovation. Finally, Australia can better capture global opportunities by increasing its market awareness and international collaboration.

3.1 AUSTRALIA CAN COMPETE ON A GLOBAL STAGE BY FOCUSSING ITS RESEARCH ATTENTION TO DEVELOP SCALE IN STRATEGIC AREAS

Global investment in digital innovation is rapidly growing. Whilst Australia is likely to remain outmatched on the quantity of available investment for emerging technology, we can compete by developing scale in strategic areas. This means identifying technical and domain research strengths in the areas that are necessary to the industries where Australia has a competitive advantage, and then directing funding to them. For example, aggregating and building world-class research strengths in biomedical research, machine learning and optimisation, and sensor technology will be essential to lead the world in precision healthcare.

Countries around the world are engaged in a global innovation race to cement their competitive advantage in the next wave of digital innovation. Many countries have announced major investments in artificial intelligence (AI) research that dwarf Australia's capacity.[48] China has committed to becoming a world-leader in AI by 2030, envisioning a $210 billion domestic industry. In 2016 alone, North America attracted $15-23 billion in private sector AI investments. The European Union has set a 2020 target for a $20 billion investment program in AI. In addition, countries like France and Germany have separately announced significant national investments in AI. The United Kingdom has launched a $1.8 billion program which adds to significant private sector investment. In Asia, economies such as Japan, Korea and Singapore are also making large investments into AI technology.

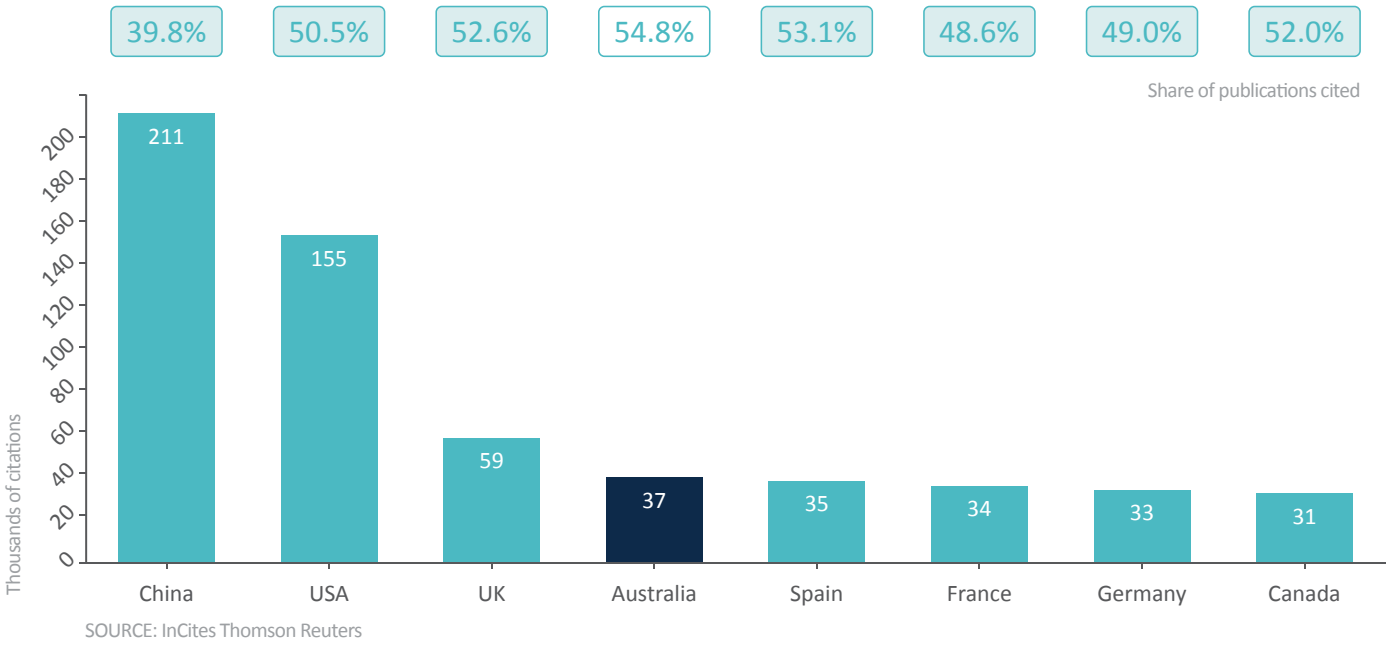
This explosion in funding has been accompanied by strategic focus. The USA, China, UK, France, the European Commission, Russia, Korea, Japan and Singapore have all announced multi-year strategies to strengthen their innovation in artificial intelligence and data analytics.

48. The Australian government announced in its *Budget 2018 – 2019* that it is investing $29.1 million to support the development of AI and machine learning technology. This funding includes support for a Technology Roadmap and a new national Ethics Framework and Standards Framework. See: https://www.budget.gov.au/2018-19/content/business.html

EXHIBIT 8

AUSTRALIA IS AMONG THE LEADING COUNTRIES IN BOTH VOLUME AND QUALITY OF ITS PUBLISHED AI AND COMPUTER SCIENCE RESEARCH

Top ranked countries by thousands of citations in the area of computer science and artificial intelligence, 2013-2015



SOURCE: InCites Thomson Reuters

Australia can compete against the scale of this investment by identifying strategic research areas where we are globally competitive and developing competitive scale in them. Australia is well placed to do this because of excellent quality of our research. Our key research strengths include fields like geology, environmental science, clinical sciences and materials engineering. And we are among the global leaders in digital research. For example, a higher share of Australian research papers on computer science and AI receive citations than for any other country (Exhibit 8). The 2017 QS World Rankings for Universities by subject placed four Australian universities in the world's Top 50 universities for Computer Science and Information Systems.[49]

However, our system of public funding for research is not designed for prioritising this kind of strategic investment. Almost 90 per cent of Australian public expenditure on R&D is through indirect channels such as tax incentives, where government has very limited ability to prioritise and generate scale. Just 13 per cent comes from direct investments. By contrast, half the comparable R&D expenditure is through direct investments in the UK, and three-quarters in the United States.[50]

There are some examples of strategically focussed public investment in digital innovation which can help guide further investment. For example, the Australian Research Council (ARC) has a funding stream called Supporting Responses to Commonwealth Science Council Priorities that is specifically focussed on IoT, AI and machine learning, and Next Generation Agriculture. Similarly, the Australian government committed $500 million over the next 10 years in an Australian Genomics Mission to drive forward genomics research in Australia.[51]

49. Quacquarelli Symonds (QS) World University Rankings (2017). Available at: https://www.topuniversities.com/university-rankings/university-subject-rankings/2017/computer-science-information-systems
50. OECD R&D Tax Incentives Indicators, based on 2013 OECD-NESTI data collection on tax incentives support for R&D expenditures and OECD, National Accounts and Main Science and Technology Indicators, 15 December 2014.
51. Australian Government (2018), National Health and Medical Industry Growth Plan – Australian Genomics Health Futures Mission. Available at: http://health.gov.au/internet/budget/publishing.nsf/Content/A45A13D61F8BCA22CA25826D0004B0F8/$File/065_FINAL_FS_LSJCMR_GenomicsMission.pdf

3.2 AUSTRALIA CAN IMPROVE THE EFFECTIVENESS OF ITS LIMITED INVESTMENTS BY INCREASING COORDINATION AND ENSURING INDUSTRY PARTICIPATION

The limited scale of Australia's public-sector funding also places a premium on better coordinating existing funding and ensuring active participation of industry in the innovation system. However, the tendency to spread funding thinly across many small institutions makes coordination even more challenging and hampers attempts to generate scale. In cyber security, for example, a national strategic priority, analysis of ARC grants between 2010 and 2017 reveals that no single institution received more than 15 per cent of funding allocated for cyber security research, and 11 different institutions received 4 per cent or more.[52] In some cases the answer might be more concentrated funding. In all cases, closer coordination will help deliver research that is better aligned.

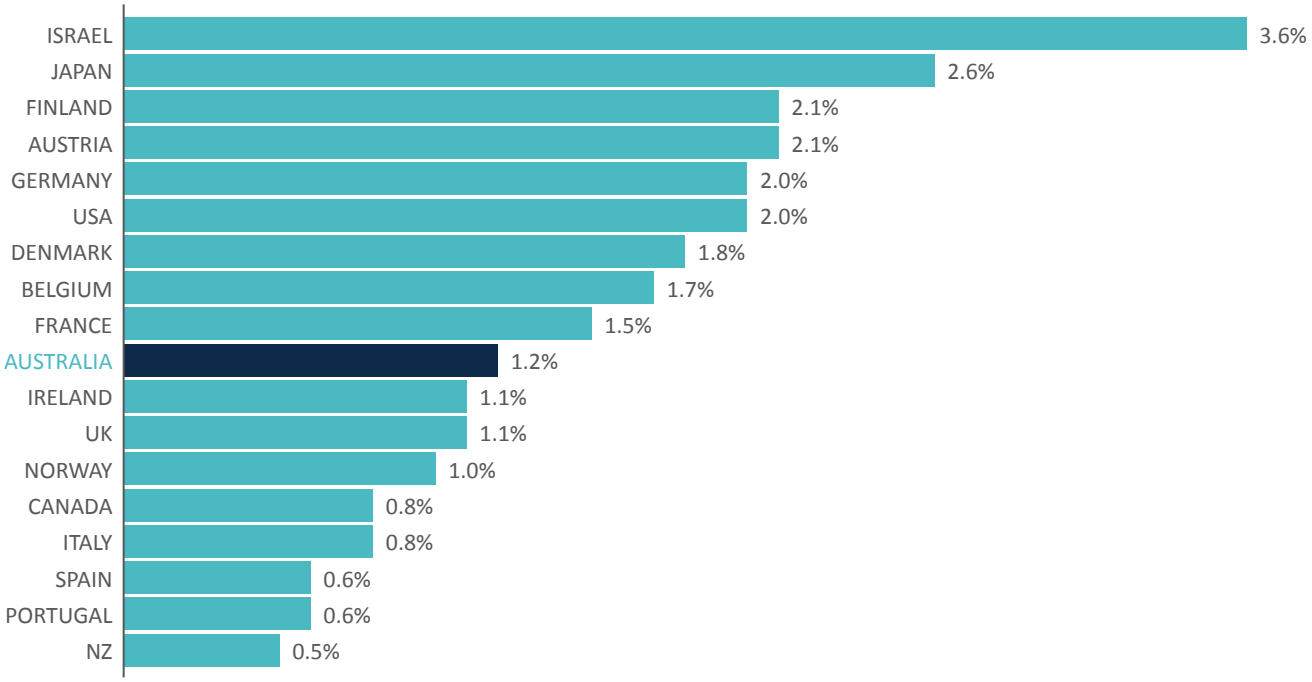
Research shows that R&D investments are much more effective if businesses are involved. Unlike academics, businesses often know exactly which innovations will find enough customer demand. They can also strengthen the power of R&D by injecting private-sector funding. Weak levels of collaboration between industry and research has been identified by Innovation Science Australia as one of the primary flaws in the Australian innovation system.[53] Similarly, low levels of business expenditure on R&D give reason for concern. Overall, businesses in Australia invest 1.2 per cent of GDP in research and development. However, just 11 per cent of this total business R&D investment is allocated to ICT research – much lower than the share businesses in most other advanced economies invest (Exhibit 9).

52. AustCyber (2017), Cyber Security Sector Competitiveness Plan. Available at: https://www.austcyber.com/cyber-security-sector-competitiveness-plan/challenges-australias-cyber-security-industry/
53. Innovation and Science Australia (2017) Australia 2030: Prosperity through innovation. Available at: https://industry.gov.au/Innovation-and-Science-Australia/Documents/Australia-2030-Prosperity-through-Innovation-Full-Report.pdf

EXHIBIT 9

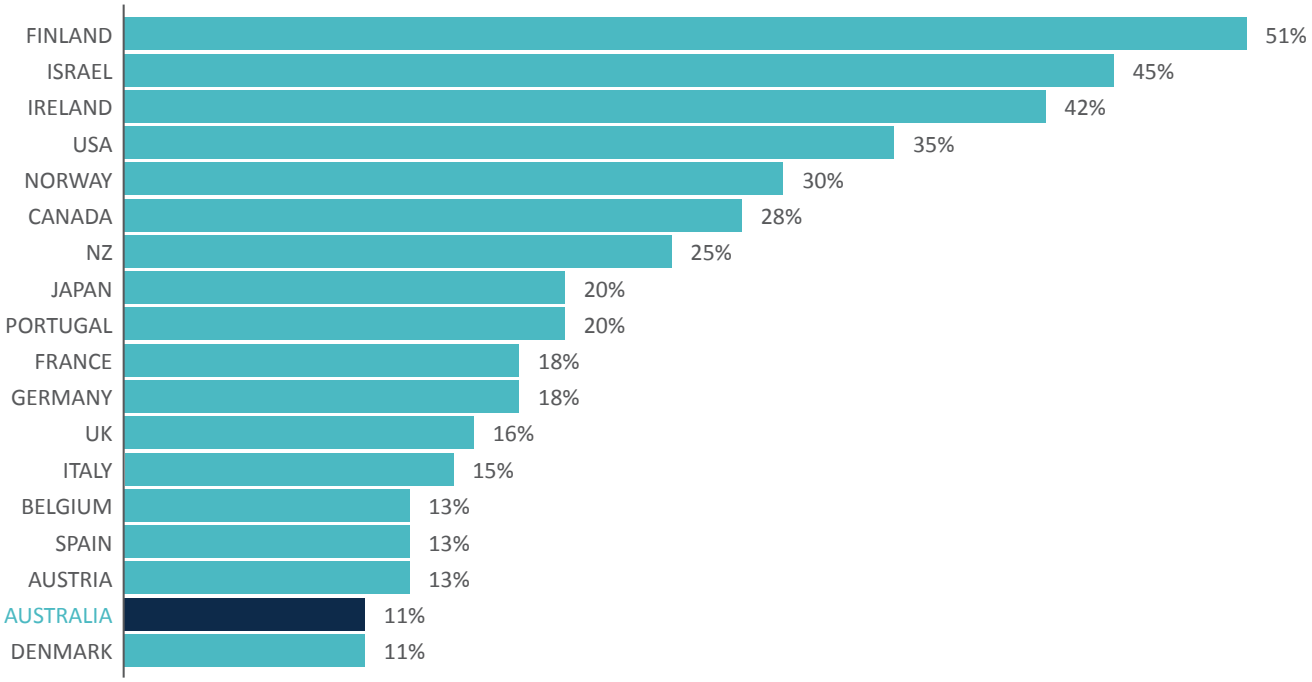
AUSTRALIAN BUSINESS EXPENDITURE ON R&D IS RELATIVELY LOW...

Business expenditure on R&D (BERD) as a share of business revenue, selected OECD countries, 2015



...AND ESPECIALLY LOW IN ICT-RELATED RESEARCH

ICT share of BERD, selected OECD countries, 2015



SOURCE: OECD.stat database, ICT indicators

3.3 AUSTRALIA CAN CONVERT RESEARCH EXPERTISE INTO INDUSTRY LEADERSHIP BY IMPROVING ITS RATE OF PRODUCT INNOVATION

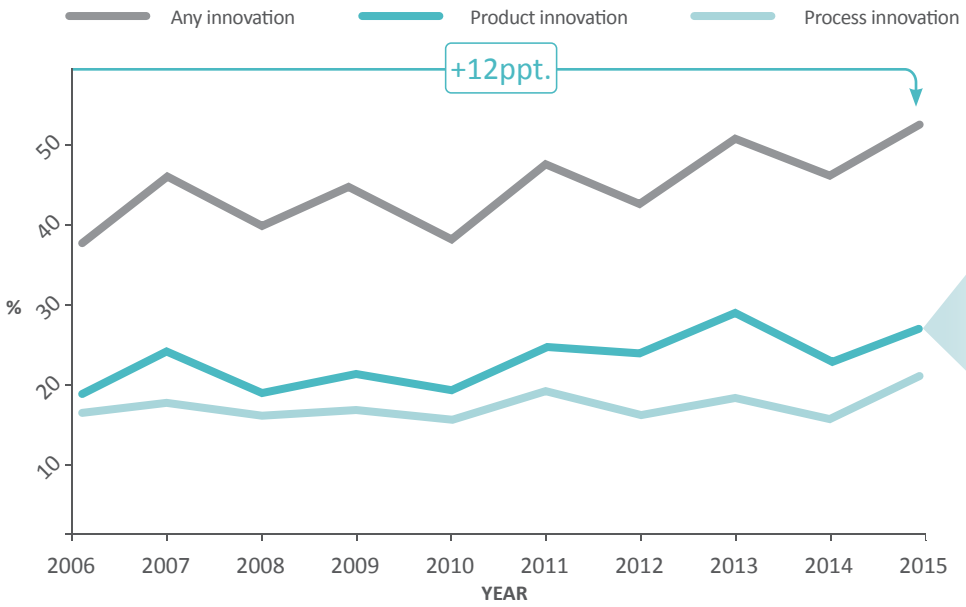
The success of the Australian economy in harnessing digital innovation will be limited unless businesses can increase the rate of product innovation. Annual surveys indicate that only a small share of Australian firms are producing innovation that is truly new to the world (Exhibit 10). Around one-quarter of firms introduced an innovative product to their business. Of this quarter of firms, just 8 per cent introduced a product that was new to the world – most product innovative firms were simply applying existing innovations to their business or market. There is economic value in being a fast adopter of innovative goods that were developed elsewhere in the world.[54] However, Australian firms will be unable to build a distinctive global advantage without becoming better at developing their own world-leading innovative products.

EXHIBIT 10

WHILE AUSTRALIAN FIRMS HAVE BECOME MORE INNOVATIVE-ACTIVE, THEY STILL STRUGGLE TO COMMERCIALISE NOVEL INNOVATIONS

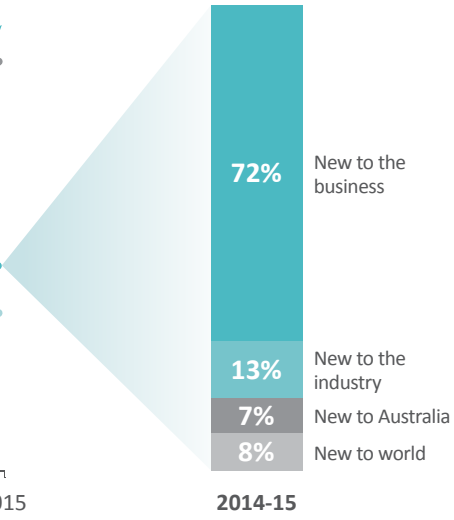
Innovation activity by Australian firms

Share of innovation-active firms by type



Degree of novelty of product innovations

Share of degree of novelty of introduced innovations



SOURCE: OECD; AlphaBeta analysis

The Australian economy can improve its product innovation performance through bringing together research expertise and commercial expertise more effectively. Australia ranks 40th in the world, behind most advanced economies, for the share of researchers embedded within business.[655] Similarly, the number of commercialisation staff in research centres has been flat for the past 15 years, with some indications of declining numbers over the past few years.[56] The education system also has an important role to play in building capabilities in key disciplines, such as product management.

54. Economic evidence suggests that firms in a country become faster adopters of new technology once leading firms in that country adopt it. Adoption of innovation actively encourages remaining firms to catch-up. See: RBA (2017) Where is the Growth Going to Come From? https://www.rba.gov.au/speeches/2017/sp-ag-2017-11-15.html
55. Cornell, INSEAD & WIPO (2017), Global Innovation Index 2017. Available at: https://www.globalinnovationindex.org/gii-2017-report
56. National Survey of Research Commercialisation (2015) Understanding Australia's Research Commercialisation. Available at: https://industry.gov.au/innovation/NSRC/Data-analysis/Documents/Understanding-Research-Commercialisation-2015.pdf.

3.4 AUSTRALIA CAN CAPTURE GLOBAL OPPORTUNITIES BY INCREASING ITS MARKET AWARENESS AND INTERNATIONAL COLLABORATION

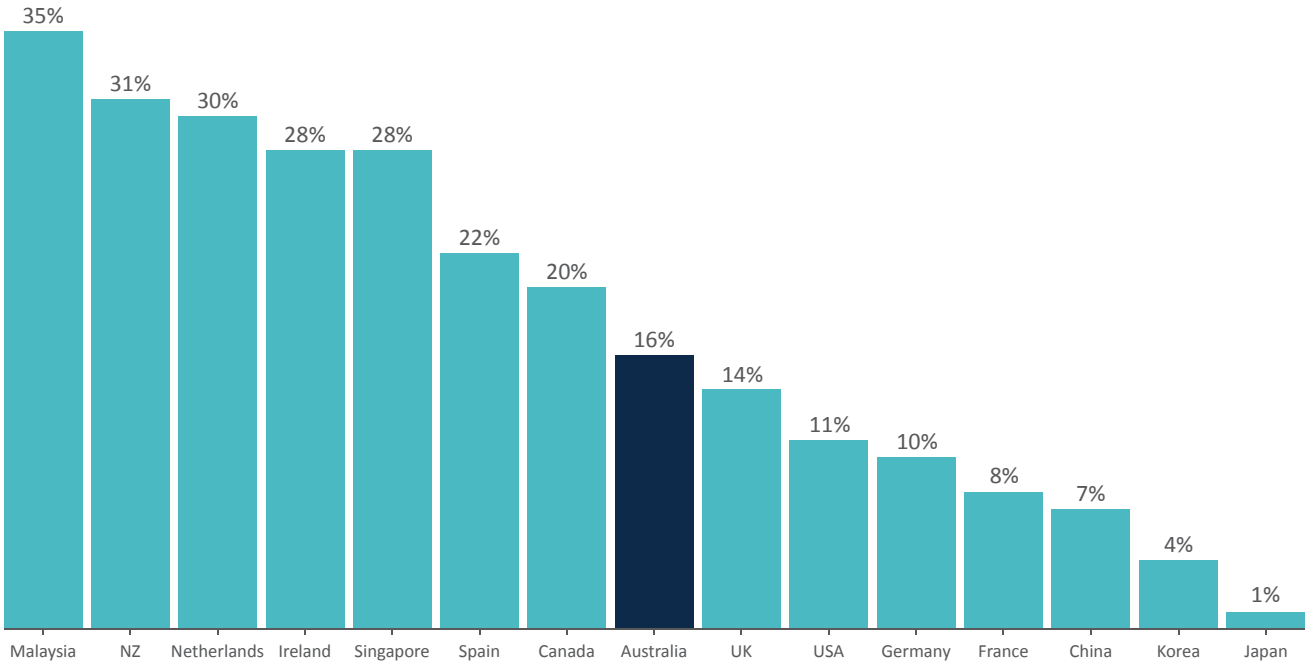
Smaller economies like Australia can use international collaboration to overcome scale disadvantages and improve their innovation performance. However, only 16 per cent of Australia's ICT-related patents come from international co-inventions (Exhibit 11). Economies with a lower share of international collaboration are all larger economies with significant domestic innovation systems, while smaller economies such as Canada and Singapore have been more effective in international collaboration. Australia too can take advantage of its research expertise, its proximity to booming economies in Asia, and its historically close relationship with economies such as the UK and USA to be a stronger international collaborator when it comes to developing new digital technologies.

EXHIBIT 11

AUSTRALIA DOES NOT HARNESS INTERNATIONAL COLLABORATION EFFECTIVELY FOR DEVELOPMENT OF ICT TECHNOLOGIES

Australia performs poorly in collaboration compared to other smaller economies

Share of international co-inventions in ICT-related patents, selected OECD countries, 2015



SOURCE: OECD.stat database

Collaboration can both increase market awareness to guide research prioritisation and provide new avenues for the commercialisation of Australian inventions. Prominent Australian discoveries in the past may have had more significant impact if applied to address global problems, not just domestic needs. For example, Australia has long pioneered the development of autonomous vehicle technology in the context of mining and resource extraction. Many of the technologies that enabled this – from computer vision to detect objects and improved safety – are pertinent to the development of commercial self-driving cars and could have been more broadly commercialised. However, Australia did not translate these technical inventions into applications for the commercial self-driving market or the supply chain serving it, and therefore other countries developed the capability and products and now dominate the commercial autonomous vehicle market. Taking technical inventions out of a limited domestic context to finding global markets can help drive up Australia's digital innovation performance.

4

DATA61 CAN SUPPORT NATIONAL EFFORTS TO STRENGTHEN AUSTRALIAN COMPETITIVENESS IN DIGITAL INNOVATION

CSIRO's Data61 is well placed to help address the key policy priorities in our innovation system and lift national competitiveness. By applying its own research and commercialisation capabilities, and harnessing its partnerships with other CSIRO Business Units and a global network of R&D partners, Data61 can pursue a range of initiatives to improve focus and coordination in our R&D performance, boost research translation and commercialisation, and strengthen regional connections.

Strengthening national competitiveness in digital innovation requires active participation from the broad array of actors that contribute to a national innovation system: governments, businesses, and public and private researchers. Government plays a critical role as both an investor and providing policy leadership, but it can also model digital innovation in its own practices. Businesses are at the forefront of driving adoption of technology and investment in digital R&D. Researchers can engage with industry to ensure that their output addresses market challenges.

CSIRO's Data61 has an important role to play in these efforts. It was established in July 2016 from merger of CSIRO's Digital Productivity flagship and the National ICT Australia Ltd (NICTA), and the subsequent integration of the combined entity into CSIRO. Data61 works with its network to deliver digital innovation solutions for government and industry. It operates with a dual mission: pursuing fundamental and applied research that is new to the world; and working collaboratively with others in the nation's innovation system to reimagine and seed new industries in a data-led world.

As part of the CSIRO, Data61 is in a trusted, privileged position, sitting between academia, industry and government. Its distinctive mix of core capabilities – research expertise, capabilities in development and commercialisation, partnerships with other CSIRO Business Units ('Digital + Domain'), and a growing global network of R&D partners ('D61+') – provide it with a unique opportunity to support national competitiveness. Since its formation, Data61 has commenced a range of programs to drive digital innovation. By focussing on four broad initiatives, Data61 could both maintain and advance its existing work in improving Australia's performance in digital innovation (Exhibit 12).

EXHIBIT 12

INITIATIVES FOR DATA61

<table>
<tr><td></td><td></td><td colspan="4">Australian policy priorities in digital innovation</td></tr>
<tr><td></td><td></td><td colspan="2">R&D performance</td><td colspan="2">Use of innovation</td></tr>
<tr><td></td><td></td><td>Develop scale in a limited number of areas by focussing research capabilities</td><td>Strengthen connections between researchers and with industry</td><td>Increase rate of product innovation and speed-to-market</td><td>Lift global market awareness and connectivity</td></tr>
<tr><td rowspan="4">Data61 core capabilities</td><td>Research expertise
700 research staff and affiliates across core areas of data-driven and digital innovation</td><td rowspan="3">1b
Focus its own research program on breakthrough innovations to support national challenges</td><td rowspan="3">2
Work with its network to support the development of customers' digital capabilities across Australian industry</td><td rowspan="3">3
Accelerate translation of research to production-ready systems to assist the take-up and commercialisation of digital innovation</td><td rowspan="4">4
Help Australia connect to key regional economies by developing research and commercialisation pathways into ASEAN</td></tr>
<tr><td>Development & commercialisation
Engineering, licensing IP and creating new and joint ventures</td></tr>
<tr><td>Digital & Domain
Collaboration with domain expertise across other CSIRO Business Units</td></tr>
<tr><td>D61+ Network
Access to strong network of R&D partners, including universities and industry</td><td colspan="3">1a Establish and coordinate a national digital challenges program to focus digital innovation</td></tr>
</table>

"Establishing a program of national challenges will help focus national research priorities on a select number of specific areas where Australia can develop a world-leading R&D performance and drive commercial outcomes for Australian firms."

1. **National digital challenges program** – Data61 can establish and coordinate a national digital challenges program to focus digital innovation and focus its own research program on breakthrough innovation to support national challenges.

   Establishing a program of national challenges will help focus national research priorities on a select number of specific areas where Australia can develop a world-leading R&D performance and drive commercial outcomes for Australian firms. This focus is especially important given the limited scale of our research investments and the current fragmentation of funding across the innovation system. Challenges seek to identify large-scale societal and business problems while building new technology platforms and software to solve them. International experience and research points to the important role of mission-driven innovation policy.[57]

   Data61 could support challenges through mobilising its internal research capability, built on over 700 research and affiliates staff, as well as expertise in engineering and technology development. It can also use its relationships with other participants in the innovation system to rally their investment and participation into crucial innovation challenges. Data61 is planning to introduce its first national digital challenge in 2018, focussed on enabling high-value food exports through improved supply chain integrity.

2. **Support digital capabilities** – Data61 can continue to work with its network to support the development of customers' digital capabilities across Australian industry.

   Data61's customers range from industry, to government bodies to other CSIRO entities. These organisations partner with Data61 to develop new digital technologies and their applications, and to solve research problems. Consistently delivering digital innovation for these customers is vital as Australia's future competitiveness will be based on stronger digital capabilities across the economy.

   Data61 can deliver this through managing, nurturing and growing its global network, often described as the Data61+ network, which enables it to rapidly assemble multi-disciplinary teams to respond to customer needs. Data61 has completed 97 corporate projects in the first 24 months of operation with another 44 currently underway. It has built a searchable capabilities database called Expert Connect which contains profiles of 45,000 research and engineering experts from research organisations in Australia.

   Data61 can also expand its contribution to improving digital literacy and skills more broadly. Through its Scholarship Program, Data61 supports over 300 PhD students. It has also established a partnership with the Australian Institute of Company Directors (AICD) to lift the digital and cyber literacy of directors and company boards across Australia. These efforts help ensure that companies have the understanding of digital market opportunities, and are able to access the skills base to capture those opportunities.

   Data61, as a public research organisation, is tasked with creating the kind of breakthrough general-purpose technologies that can drive growth and innovation throughout the economy. Advances in machine-learning, data storage and verification and cyber-security can all be applied in diverse industrial contexts.

57. See: Mazzucato, M (2013) The Entrepreneurial State; European Commission (2018), Mission-Oriented Research & Innovation in the European Union https://ec.europa.eu/info/sites/info/files/mazzucato_report_2018.pdf

3. **Boost technology commercialisation** – Data61 can accelerate the translation of research to production-ready systems to assist the take-up and commercialisation of digital innovation.

   The application of technology to drive further innovations in products, business models and business processes is an important component of harnessing the economic value from digital innovation. However, Australian excellence in AI and computer science research has not been accompanied by similar successes in commercialising technology.

   To improve our performance in commercialisation, Data61 can develop its existing engineering and design capabilities, as well as dedicated Product Development and Business Development teams that have been established to improve the transfer of research and technology to product development for commercialisation. It can also continue and build on its existing Technology Programs (in Regulatory Technology ("Reg Tech"), Investigative Analytics and Secure Data Sharing). These Programs are vehicles to integrate activities around a technology vision and market need. They allow Data61 to accelerate the development of technology and scale-up solutions. Each Program has an advisory group and a clear technology roadmap to drive progress.

4. **Regional connections** – Data61 can help Australia connect to regional economies by developing research and commercialisation pathways into ASEAN.

   This initiative can help Australia better harness opportunities for international collaboration in the research and use of innovation, mitigating the limitations of our smaller domestic market size and R&D investments. ASEAN is already the world's seventh largest economy and projected to be the fourth largest by 2050; as our closest regional neighbour it is also strategically critical to Australia. However, innovations systems across the region are still developing, with limited levels of government funding and less robust institutional structures. As economies in ASEAN grow and transition, there is significant potential for Australian industry to commercialise data-driven innovations into the region, and for Australian research to support growing customer need.

   Data61 can contribute in building regional connections by working closely with regional researchers and contributing thought leadership. For example, Data61's Sunrise Industries report identified key industry opportunities in the ASEAN region. Similarly, in collaboration with Australia's Department of Foreign Affairs and Trade (DFAT) and Vietnam's Ministry of Science and Technology, Data61 will be examining how digital technology will enable the rise of new 21st century industries and transform the Vietnamese economy. Indeed, global collaboration is in the DNA of Data61 with its current team of researchers and engineers being drawn from 70 countries.

Data61 has the mission and key capabilities to support Australia in embracing digital innovation. However, the ultimate success of the national effort will depend on a concerted and coordinated effort across the economy. There is clear evidence that Australia has the potential to reap significant benefits from digital innovation. Leaders across the innovation system must invest in these efforts now if we are to keep up with our global peers and secure our continuing prosperity.

5

APPENDIX METHODOLOGY

1. DEFINING DIGITAL INDUSTRIES

For the purposes of estimating their economic impact, digital industries are defined narrowly as the contribution of industry sectors directly related to the creation of computer hardware, software and communications technology. This includes the information, communications and technology industry, as well as the manufacturing of computer equipment and software engineering services.

2. ESTIMATING THE CONTRIBUTION OF DIGITAL INNOVATION TO GDP

The impact of digital innovation on four channels of economic value was estimated to understand its contribution to total GDP. These four channels reflect the conventional economic understanding of how new technologies contribute to growth: the direct impact on productivity through digital technologies, the indirect impact on productivity through flow-on changes to business models, the increased economic activity from selling new technologies in domestic markets, and from selling into export markets.

Once the total contribution of productivity growth to economic output is observed based on ABS and OECD data, it is allocated to digital and non-digital sources with reference to the level of digital capital investment in an economy. This estimate relies on an assumption that the stock of digital capital has an impact on productivity that is proportional to other capital stock, which is defensible when tested against anecdotal industry examples and existing economic research – in fact, it likely understates the impact of some digital capital investments.

The value of domestic digital industries is collected from national and OECD data on industry-level activity, and then adjusted to account for the latest estimates of the value of digital industries. This adjustment is guided by the methods of the US Bureau of Economic Analysis in their latest estimates of digital industries.[58] An adjustment is necessary to account for the fact that existing industry-level economic data does not sufficiently differentiate between digital and other industries.

The value of exports from digital industries is estimated based on the total size of the digital industries and tested against officially reported data on digital industry trade flows. However, trade data is likely to underestimate the total value of digital industry exports. This is because some of the value of digital industry exports are in services provided locally by foreign subsidiaries.

3. ESTIMATING THE GROSS ECONOMIC VALUE OVER TEN YEARS OF AUSTRALIA CATCHING UP TO ADVANCED ECONOMIES.

Australia is estimated to be 34% behind global peers in realising the economic benefits of digital innovation. The estimate of the $315 billion opportunity in closing this gap is based on a scenario where Australia progressively closes the gap over a decade so that it is at par with the average of advanced economies in 2028.

The approach assumes that Australian GDP increases slightly higher than current rates each year for the next 10 years due to digital innovation and calculates the net present value (NPV) of these ten years of increased GDP. A discount rate of 10% has been applied in estimating the NPV.

This approach also assumes conservative growth rates in both the acceleration of benefits of digital innovation and economic growth. As digital innovation advances it is possible that there will be step changes in its impact on economic output. However, as this is speculative, we adopt more conservative estimates.

This estimate is a “gross” amount. It does not reflect other economic activity that the impacts of digital innovation may displace. For example, automated soil management systems in agriculture may improve resource yields and reduce demand for energy and water to grow a given amount of crops. This reduced demand for inputs is not modelled.

58. US BEA (2018) Defining and Measuring the Digital Economy. Available at: https://www.bea.gov/system/files/papers/defining-and-measuring-the-digital-economy.pdf

αlphaβeta

strategy x economics