

ARTIFICIAL INTELLIGENCE AND THE FUTURE OF WORK

ADAM SLONIM

WITH NICK DYRENFURTH

John Curtin Research Centre Policy Report No. 4, 2019

Labor ideas for a better Australia

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Executive Summary

Artificial intelligence is here and is having a major impact on the jobs market and how we all work.

Australia has a choice: to benefit from this major industrial transformation, or let it wash over us as a country and see the majority of the benefits go to overseas companies and workers. Ignoring or resisting the technological change of AI will only disadvantage Australian workers.

Governments have a vital role to play to ensure the benefits of AI are shared broadly across all sectors of our society. The Report outlines a number of recommendations to ensure Australia rightly takes advantage of the opportunities in front of us. We recommend nationally coordinated investments and focus on Education, Regulation, Security, and Research & Development to ensure the future of work for all Australians is rewarding, safe and just.

“The productivity-enhancing potential of AI is real but the specific characteristics of this new technology require policy responses that differ from those given during previous waves of technological change in order to generate shared benefits for the world of work.”

(‘The economics of artificial intelligence: implications for the future of work’,
International Labour Organisation, 2018)

Introduction

After a series of tumultuous shearers’ strikes in the late nineteenth and twentieth centuries, the labour organisation covering workers in the pastoral industry, the Australian Workers’ Union, successfully fought for the industry-wide adoption of a ground-breaking federal Pastoral Industry Award (1907) set down by the Commonwealth Arbitration Court. A revised version of the Award (1926) included, among a raft of guaranteed minimum wages and conditions, a specific clause that banned the use of ‘wide combs’ (which had been an official AWU rule from 1910 and was also banned by Western Australian and Queensland industrial law until the 1980s). Australian shearers were to only use narrow combs of not more than two and a half inches. The shearers and their union were motivated by a fear of the wide combs creating an opportunity for sheep station owners and contractors (contracting being the dominant employment model of the industry) to employ less shearers and a cultural belief that wide combs undermined union solidarity by prioritising individualism. Decades later, New Zealand shearers were imported by contractors to shear sheep much faster using, ironically, Sydney-manufactured wide-combs. The confrontation between Australian and New Zealand shearers boiled over in the sometimes violent 1983-84 ‘wide comb’ dispute, after the Arbitration Commission ruled in December 1982

that wide combs could be used by any shearer working in Australia. Following strikes and a full-scale inquiry into the combs the ruling was upheld by the court in June 1985. The narrow combs disappeared from the industry. Revealingly, in mid-1987, advertisements for wide combs appeared in the AWU's official newspaper, the *Australian Worker* – an iconic paper itself eventually outsourced to private contractors and finally ceasing print production.

In June 2007 Apple released the iPhone onto the market, dubbed the 'Jesus Phone' by *The Economist*. Twelve years after its debut, a staggering 1.5 billion iPhones have been sold globally. The production of the iPhone has not been without controversy – there have been documented cases of child labour exploitation, notably in China, and reported human rights violations in Apple's supply chain – but there is no doubting the technology's ubiquity, nor success.

These two stories paint starkly different pictures of the release and uptake of technology. The former tells us that the introduction of simple technology has the potential to generate fear and anger, while the story of the iPhone is a dramatic example of how some technological change unleashes radical changes to the way in which we live yet is overwhelmingly accepted. Smart phones, most dramatically seen in the iPhone, are an instructive example of human change and technology because the acceleration of technological change demands that we think through how we deal with the introduction of artificial intelligence (already embedded in our phones). As Mike Quigley and Labor Shadow Treasurer Jim Chalmers have written: "There is tremendous upside to technological change. It has the potential to improve lives and wellbeing, save time and effort and help combat, if not overcome, so many of the obstacles to a good life in a thriving society. But agreeing that technological changes can improve living standards does not mean dismissing the real fears that people have about where, or *whether*, they fit in a workforce increasingly dominated by machines."¹

Now that artificial intelligence is accepted as a desired feature of (some) technology, the discussion has shifted from 'do we want AI' towards how shall we have the best say over control of its dispersal and use. As part of this conversation five general fears have emerged: (1) fear of singularity (an event whereby AI exceeds human intelligence and escapes human control with disastrous consequences); (2) fear of machines turning into Terminator-style beings and, literally, threatening human life; (3) fear of social control (authoritarian regimes using AI to monitor and control citizens); (4) AI leading a new industrial revolution which allows machines to disrupt and replace humans in almost every sphere of work and society, destroying traditional forms of employment and creating inequality; and (5) AI's ethical implications for humanity.²

The singularity event, if it occurs, and that is a significant 'if', is a considerable distance – at least decades if not centuries away. Humanity faces more immediate existential threats.

AI, like most tools, can be used for many purposes. The idea that humanity only develops tools that can exclusively be used for benign purposes has obvious shortcomings. The use of AI as part of a current exercise in social control in China has been widely reported. The extent to which this program is AI-enabled is debatable, given that many of the pilot programs are based on pen and paper. It is true that AI is now capable of facial recognition, but humans have been similarly capable for millions of years and haven't always used this capability ethically. The Chinese system thus does not depend on AI, but AI makes it cheaper. The Chinese system might be AI-enabled, but what distinguishes such systems is their intent, not the technology used.

It is the fourth theme – that AI will destroy more jobs than it will create – that generates most fear in society today and informs the concerns of this report. For Australia, two decades after the devastating effects of the shift of the textile industry to China (to reduce costs, not because of automation), the fear of mass job displacement touches a raw nerve. The future of work is now, and as this report argues, AI represents both a threat and, if properly grasped, enormous opportunity for Australia's social cohesion, jobs and economic prosperity.

1 Jim Chalmers and Mike Quigley, *Changing Jobs: the Fair Go in the Machine Age*, Redback Quarterly, Melbourne, 2017, p. 6.

2 On the ethical challenge see D. Dawson, E. Schleiger, J. Horton, J. McLaughlin, C. Robinson, G. Quezada, J. Scowcroft, and S. Hajkowicz, *Artificial Intelligence: Australia's Ethics Framework*, Data61 CSIRO, Australia, 2019.

New wine in old bottles

One of the challenges in discussing AI is that there is no single definition of the term. One working definition, however, is the study and application of how to enable computers to do tasks that have, until recently, been achieved by people. What is important about this definition is that it is distinct from data collection, data processing, computerisation, digitisation and similar. This is significant because these technologies have been applied to tasks previously performed by workers, in some cases, for generations. This process has occurred without AI and will continue. This definition of AI differs from its application. For example, Amazon's 'Fulfillment Centres' sees workers despatched and directed by an algorithm precisely because a human would be able to be reasoned with. Likewise, the despatch system used by Uber, where a human interaction would give rise to the possibility of empathy. AI here is a business model which removes the possibility of empathy, and is therefore more predictable and reliable.

The distinctive feature of AI is its ability to make predictions on the basis of complicated data, which has traditionally been one of the hallmarks of human intelligence. A good example of this predictive capability are call centres (acknowledging their problematic labour relations). When you ring to have a query answered, or an order fulfilled, a call centre agent will advise you what to do based on the script they have been given, the technical knowledge they have been trained to understand, and their experience answering similar calls. This process is largely computerised, but with a human undertaking the main conversation and doing the final information processing. When an AI agent answers such a call, it has been given information on all the calls ever made to the centre and is in possession of the required technical information. It uses this information to predict the specific answer the caller requires based on their request, their history and all calls ever made to the organisation. An AI agent, if based on deep (machine) learning technology, which it frequently is not, increases the chance of customer satisfaction and has the capacity to learn constantly from human feedback to improve outcomes.

Given the vastness of data and knowledge at its disposal, AI is also used to create goods and services beyond human capabilities. Examples include identifying fraudulent credit card transactions, the services that enable you to search the web, and identifying stories of interest on social media. We use these services invisibly every day and much of our standard of living depends on them. The cost of such services would be prohibitive if AI were not used.

AI is here to stay, and its use will inevitably increase. The productivity benefits of AI, and the services it underpins, means that irrespective of the actions of individual nations, AI's impact will only expand. Its impact on employment may have been overstated, but it is real, and growing. One of the key questions this report addresses is, therefore, what happens to real people – and the jobs and tasks people perform – when AI can perform them as well. The immediate economic, social and human challenge of AI is the disruption it poses to work patterns, the challenge to full-time secure employment and the dislocation of jobs and de-skilling that the introduction of such technology is creating and will create. This is because AI, a term first coined in 1955, is closely associated with an industrial process that has been working its way through production and supply chain operations over a far longer historical period, namely automation.

Automation – the ability of machines to perform jobs humans have typically performed – has been steadily increasing since the 1st Industrial Revolution of the eighteenth century in Britain, continental Europe, and North America. In the century and a half since the American inventor Eli Whitney invented the cotton gin, which separated cotton seeds from their fibres, manual tasks, what we conceive of as jobs, have been allocated to machines to undertake in replacement of human labour. The invention of the steam engine by the Scottish mechanical engineer James Watt in 1776 is another good

example. With the replacement of the horse and carriage, mass employment sectors were eventually phased out. Carriage manufacturers, blacksmiths and farriers exist today only as small-scale specialist or craft industries. It is important to note that far more people are employed building and maintaining cars and roads than ever worked with horses and related industries, however.

History is filled with examples of how the introduction of new technologies create anxiety around job losses. Most famous is the example of the Luddites, groups of skilled English workers who in the early 1800s destroyed machinery, especially in cotton and woollen mills, which they saw as threatening their jobs, spawning the derogatory term for people who opposed the uptake of new technology. The advent of Artificial Intelligence is no exception. While AI is unquestionably beginning to transform our society, the debate around its applicability and use has created a climate of fear and manufactured columns of ill-informed opinion. Yet this trend obscures both the risks and opportunities AI can bring to the Australian economy. We need a more mature, holistic conversation around the role of AI that recognises that while adapting to technological change is constant in human history, so too is the desire of working people to enjoy meaningful, purposeful lives underpinned by secure, well-paying jobs. We must begin from the position that work isn't just a source of income but provides dignity and hope.

A workless future?

As we have seen, automation of work and changes to the labour process has been occurring since the Industrial Revolution. We can summarise its effect on employment in four ways:

1. Displacement Effect

New technologies lead to a substitution of jobs and tasks currently performed by workers.

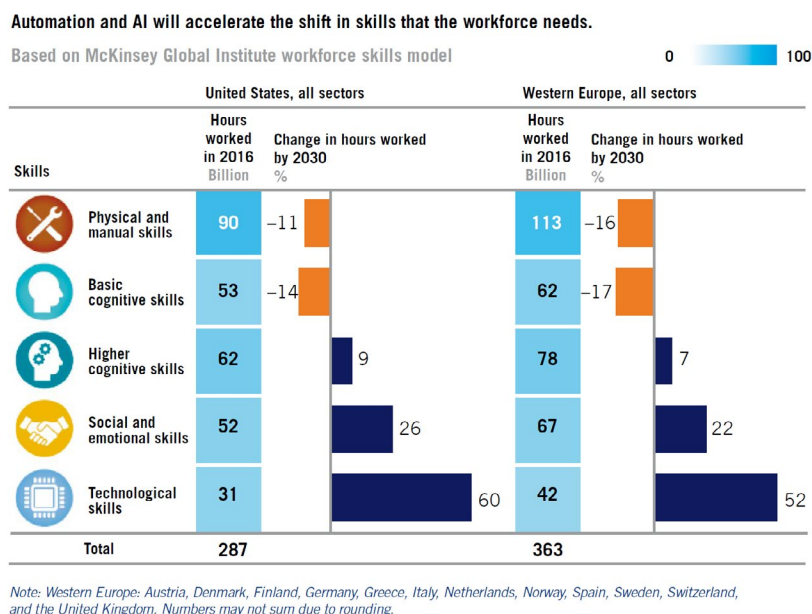
While job and task substitution acts to replace human labour, this displacement effect is not absolute. The displacement effect does not account for the re-assignment or re-grouping of tasks into new jobs or new, higher-value capabilities based on the new technology. For example, AI is increasingly able to provide doctors with faster and more accurate diagnoses which means the doctor's role in a person's health maintenance will be less about ascertaining patient history and diagnostic testing, and more about overseeing the patient's wellness and wellbeing.

While AI reduces the need for some labour-intensive occupations (and hence the fear of widespread job losses), it has the potential to create the need for new job tasks, which are often higher paid. For example, since the 1980s, spreadsheet software has automated many of the tasks previously done by traditional bookkeepers, accounting clerks and auditing clerks. The number of these jobs in the United States has declined by 44 per cent. Yet the new spreadsheet technology has created added value and driven an increase in the number of accountants and auditors of 41 per cent. The number of management analysts and financial manager jobs has also increased four-fold.³ The Internet has been blamed for job losses in journalism but has given rise to entirely new industries that employ millions. For an indication of the major shifts in skill sets occurring across the United States and Western Europe see Figure 1. As an advanced economy, Australia generally mirrors this trend. The OECD predicts that 14 per cent of jobs may be 'completely automated' and thirty-two per cent will 'change significantly'. Yet it also warns that many adults do not have the rights skills for the jobs of the future – 6 out of 10 lack basic ICT skills or have no computer experience. This despite the number of 'highly-skilled

3 Capgemini, Digital Transformation Review: Artificial Intelligence (11th ed.), 2018, <https://www.capgemini.com/service/digital-transformation-review-11-artificial-intelligence-decoded/>

jobs increasing by 25 per cent over the last two decades.⁴

Figure 1. Predicted shifts in skill sets, United States vs. Western Europe, 2016-30.



2. Skill-Complementarity Effect

There is a complementary increase in jobs and tasks necessary to use and/or supervise new technologies.

The classic case study where this effect played out was the twentieth century transition of the German economy from coal mining to coal machine manufacturing. This resulted in a high-wage, export-oriented industrial base, which continues to expand and underpin the strength of the German economy today. There are many factors behind this success story, not the least being the more cooperative industrial relations model between capital and labour in Germany evinced by Codetermination and Works Councils (outlined in an earlier JCRC report).⁵ It is also true that the amount of supervisory high-skill jobs created by automation has not always and everywhere compensated for the low-skilled jobs lost to automation. The relationship is complex. Some sectors of an economy may make up a lower or reduced proportion of the labour market but that doesn't necessarily translate into higher unemployment. Instructive cases here are the hi-tech start-up cultures of California and Israel. According to the Israel Innovation Authority, hi-tech goods and services produced in Israel constitute 50% of all non-industrial exports, which equates to 15% of the country's GDP. Yet this sector only employs 10% of the labour market.⁶ However, the same presentation concludes with an assessment that the next mission of the Innovation Authority is to generate more hi-tech employment as a strategic national goal: from Startup Nation to Scaleup Nation.

3. Productivity Effect

Lower prices and higher disposable income drives increases in consumer demand.

In advanced economies, automation displacement means rises in productivity in certain sectors. While productivity improvements, and the additional income generated, are not uniform across the economy, a number of sectors have benefited from a substantial rise in employment, such as health care, education, social assistance, aged care, infant care, casual retail sectors, the fitness industry, and of course the services and techno-scientific sectors generally speaking (Fig. 2).⁷

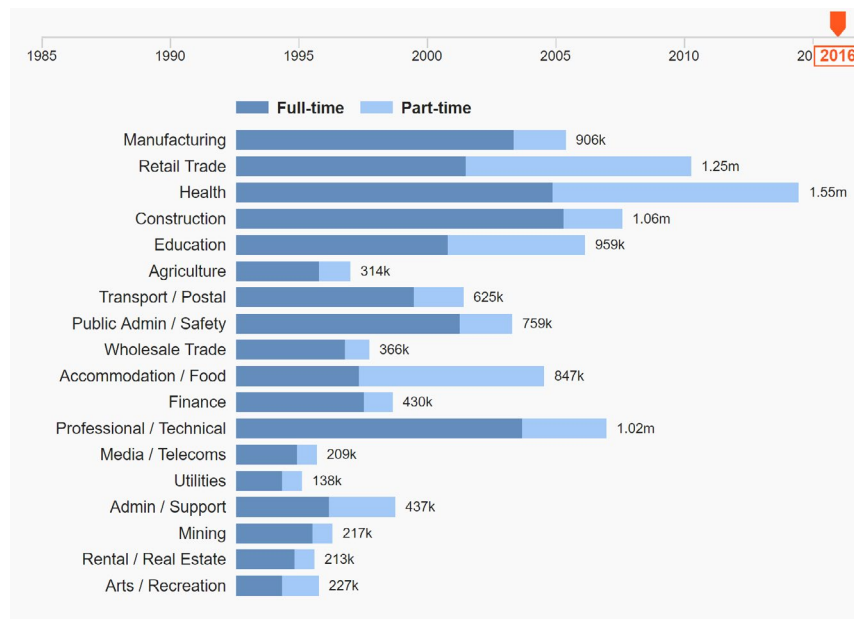
⁴ OECD, 'The Future of Work', <https://www.oecd.org/employment/future-of-work/>

⁵ Nick Dyrenfurth, *Make Australia Fair Again: the Case for Employee Representatives on Company Boards*, John Curtin Research Centre, Melbourne, 2017, <https://bit.ly/2xvYoUJ>

⁶ Avi Luton, 'Israel Innovation Authority: Building Innovation Ecosystems: Presentation to the Australia Israel Labor Dialogue Mission', Melbourne, 2017.

⁷ Jane Norman, 'Australians landed almost 1 million new jobs in five years — so what kind of jobs are they and is that a big deal?', *ABC News*, 16 April 2018, <https://www.abc.net.au/news/2018-04-16/australia-on-track-1-million-new-jobs-since-2013-where-are-they/9597470>

Figure 2. 'Job changes by industry over time'⁸



On the other hand, the wages and salaries these jobs deliver have been a growing concern. These changes in the quality and quantity of work, including the casualisation of jobs, is argued to be one of the major causes of growing income inequality.⁹ But others have argued that mechanisms such as industrial relations and taxation and transfer policies have been the main driver.

4. Low Cost of Capital Effect

Automation and AI is increasingly embodied in newer, cheaper products accessible to more people than ever before.

The steep fall in the cost of technology is driving an increased diffusion in access to technology and enlarged possibilities for innovation, thereby driving new forms of higher productivity. Every time you look at an app on your smart phone, you are seeing this effect in production. That is, an idea easily and very cheaply converted into a globally accessible application.

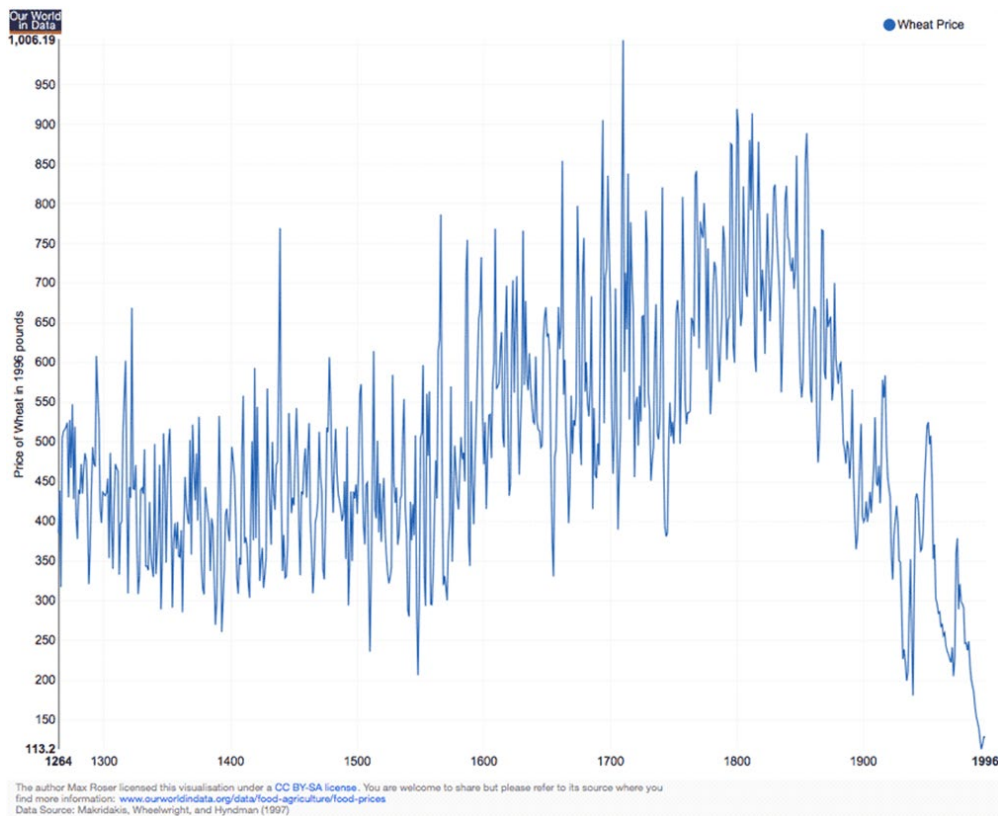
This is particularly beneficial for some economic sectors such as farming, where the application of technology has delivered enormous increases in crop yields at much lower costs of production. One US study of the relationship between economic growth and AI suggests that as sectors of the economy are automated, their relative price declines, and their subsequent share of GDP also declines.¹⁰ The relative cost of wheat (and food in general), for example, has fallen significantly since the nineteenth century as farmers became more efficient through automation, plant breeding and nutritional management. And yet while the relative price of wheat has declined, the net income of farmers has increased enormously over the last century (Fig. 3).

⁸ Jane Norman, 'Australians landed almost 1 million new jobs in five years — so what kind of jobs are they and is that a big deal?', *ABC News*, 16 April 2018, <https://www.abc.net.au/news/2018-04-16/australia-on-track-1-million-new-jobs-since-2013-where-are-they/9597470>

⁹ David Rotman, 'From rust belt to robot belt: Turning AI into jobs in the US heartland', *MIT Technology Review*, 18 June 2018, <https://www.technologyreview.com/s/611412/ai-could-wreak-economic-havoc-we-need-more-of-it/>

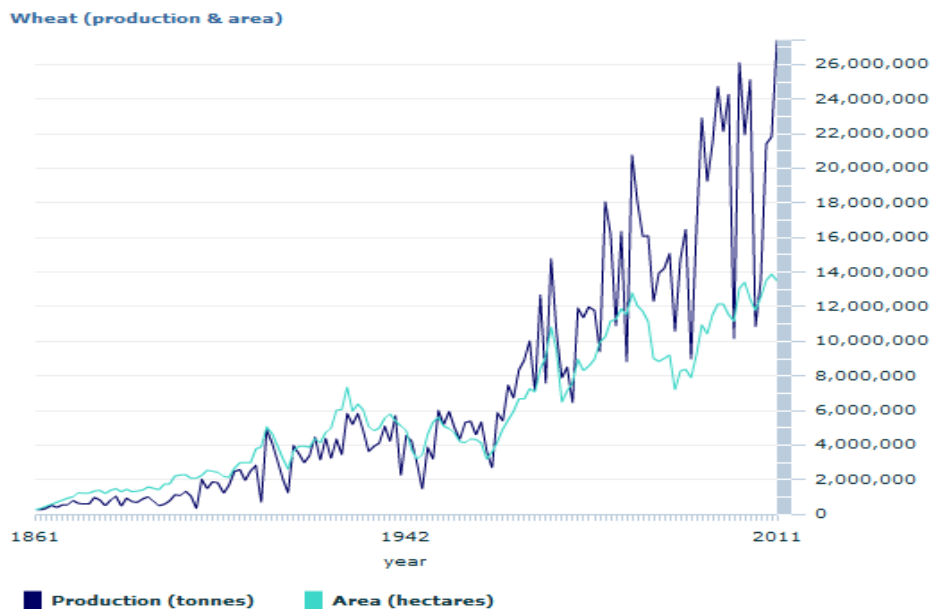
¹⁰ Philippe Aghion, Benjamin F. Jones and Charles Jones, 'Artificial Intelligence and Economic Growth', NBER Working Paper No. w23928, September 2017, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3053718.

Figure 3. Relative price of wheat from 1264 to 1996¹¹



Processes of automation, until now, have been concentrated on robotisation, that is, the automation of mechanical tasks traditionally performed by human labour. Automation of Australian wheat production for example has created a massive boom in productive output with a relatively stable land acreage, especially in the last forty years, doubling yields (Fig. 4).

Figure 4. ‘Australian Wheat prices, 1861-2011’¹²

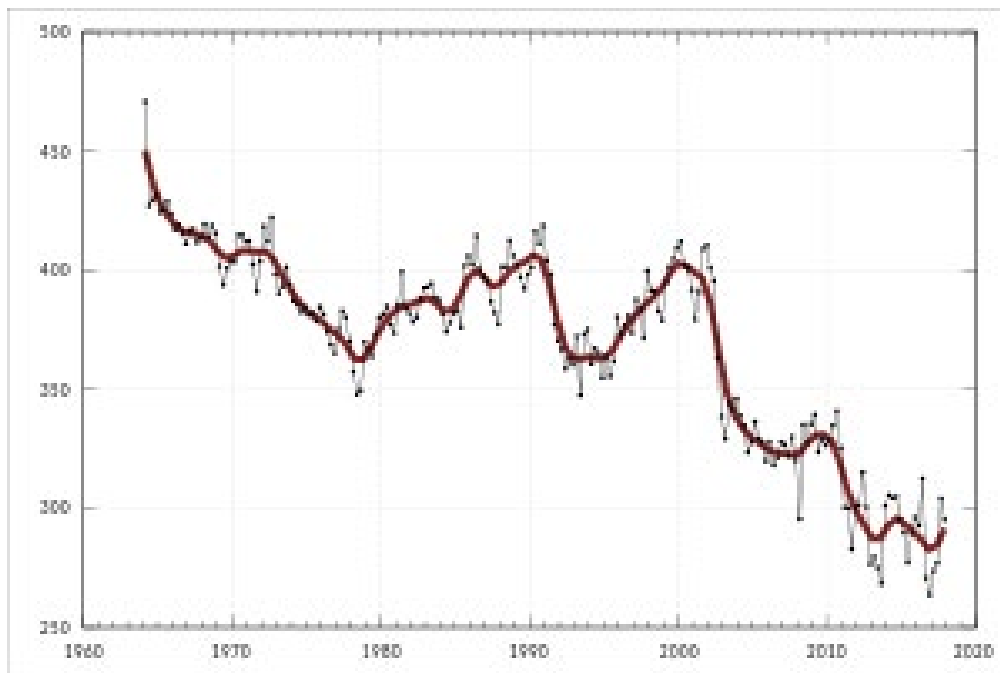


This dramatic increase in productive capacity has of course occurred during a period of severe decline in farming employment – a clear example of the Displacement Effect (see Fig. 5).

¹¹ Max Roser and Hannah Ritchie, ‘Food Prices’, *Our World in Data*, <https://ourworldindata.org/food-prices>

¹² Australian Bureau of Statistics, ‘Historical Selected Agriculture Commodities, by State (1861 to Present), 2010-11’, 6 March 2013, <https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/7124.0Chapter72010-11>

Figure 5. 'Decline in farm employment (thousands of persons) since 1959'¹³



Economic threat or opportunity?

Let us turn now to the present-day, real-world implications of AI for working people and the real economy. With the mass adoption of pervasive digital infrastructure, online search and commerce, and ubiquitous mobile internet, jobs in the services sector, which are essentially non-mechanical and information-based, are seemingly most vulnerable to a new AI-enabled Displacement Effect.

Yet Australia has been here before. In the 1970's through to the 1990's Australia faced worker displacement through the transfer of jobs to low cost Asian countries, primarily China. The basis of displacement was a drive toward input cost reduction, but also the federal government's sweeping tariff reductions. It mostly affected the textile, clothing and footwear as well as many manufacturing industries. While the lag in developing Skill-Complementarity and Productivity Effects was considerable, Australia has and will see significant employment growth in the services sector (Fig. 6), which is now 61 per cent of GDP.¹⁴ This is the case even if as Chalmers and Quigley remind us we lag behind Western countries such as the US, UK and Germany in terms of proportion of GDP based on service industries.¹⁵ The contribution of digital technologies, a subset of the services sector, to the economy is forecast to be \$139 billion: seven per cent of GDP.¹⁶

13 Australian Bureau of Statistics, 'Seasonally Adjusted Farm Employment, 1959-2018', <https://www.abs.gov.au/Ausstats/abs@.nsf/exnote/1364.0.15.003>

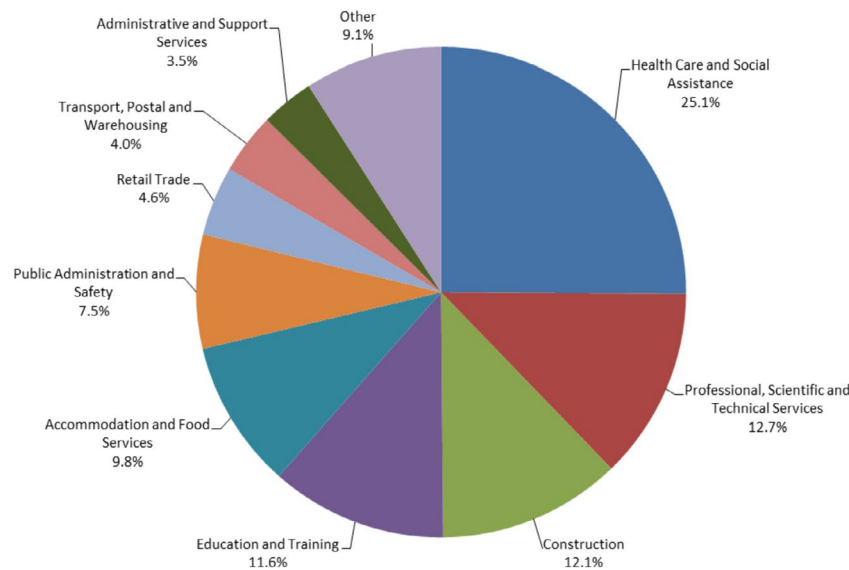
14 Department of Innovation, Industry and Science, 'Professional, scientific & technical services industry fact sheet', Commonwealth of Australia, 7 June 2017, <https://www.business.gov.au/planning/templates-and-tools/industry-factsheets/professional-scientific-and-technical-services-industry-fact-sheet>

15 Chalmers and Quigley, *Changing Jobs*, p. 16.

16 Deloitte Access Economics, 'Australia's Digital Pulse 2017: Policy priorities to fuel Australia's digital workforce boom', Australian Computer Society, 2017, <https://www.acs.org.au/content/dam/acs/acs-publications/Australia's%20Digital%20Pulse%202017.pdf>

Figure 6. 'Share of projected employment growth, by industry – five years to May 2022'¹⁷

Share of projected employment growth, by industry - five years to May 2022.



Department of Employment, Industry Employment Projections report 2017

There is the potential for entire new economic sectors and corresponding jobs to be created in Australia. For example, the growth of the autonomous vehicle industry will require new levels of diagnostic skill, control mechanisms and maintenance, pit patrolling, and software engineering.¹⁸ Indeed, software now accounts for ten percent of the value of new cars.¹⁹ These skills, and their emerging jobs, will require different education pathways, and, if given the attention and focus required of developing new industries, could create a world-class intellectual export hub.

The same is true of Australia's potential to leverage our experience and understanding of mining industries to transform mining technology into a global powerhouse with the requisite high wage jobs (as per the German example, transforming from coalmining to coal-machine design, development, production and export). Germany has of course just closed its last 'black' coal mine and plans to phase out all coal by 2038, and is a best practice example of cooperative business-labour relations, environmental sustainability and technological innovation. Learning from Germany and the spin-off value-adding from this example of production shift are immense, if yet to be qualified, but Australia is well-suited to capitalise on these opportunities.

Seizing the AI centuries

People often talk about this century as the Asian century, pointing to the threats and challenges created by the rise of rapidly growing Asian economies, especially China, and a leviathan middle-class on our doorstep. They're right. But it's also the dawn of the AI centuries and we need to adapt quickly if we are to grow our economy, create the jobs of the

¹⁷ Department of Jobs and Small Business, 'Share of projected employment growth, by industry – five years to May 2022', Commonwealth of Australia, <http://lmip.gov.au/default.aspx?LMIP/GainInsights/EmploymentProjections>

¹⁸ Australian Information Industry Association, 'Skills For Today. Jobs For Tomorrow Report', Pre-Budget Submission, February 2019, https://www.aiia.com.au/_data/assets/pdf_file/0003/95268/AIIA-Pre-Budget-Submission-1-Feb-2019.pdf

¹⁹ McKinsey & Company, 'Automotive revolution – perspective towards 2030: How the convergence of disruptive technology-driven trends could transform the auto industry', January 2016, <https://www.mckinsey.com/~media/mckinsey/industries/high%20tech/our%20insights/disruptive%20trends%20that%20will%20transform%20the%20auto%20industry/auto%202030%20report%20jan%202016.ashx>

future and maintain our historically high standard of living. The key as always is education, vocational and university: a system that delivers a pool of globally competitive workers, managers, entrepreneurs and businesses. Education will be Australia's engine-room when it comes to embracing the AI-future.

What more precisely can we do seize the opportunities of AI and ward off its threats?

1. Invest in technology for existing businesses, especially manufacturing

Australia is a high-wage economy, which supports our enviable quality of life, but this status can also make it difficult for some of our industries to compete in global markets. Properly applied, automation (underpinned by AI) can lower the costs of established businesses. For example, Adelaide-based firm Resolution Systems, through its flagship product 'MaxMine' is using predictive algorithms to better optimise the use of mining vehicles. This helps makes mines become more competitive, protecting export markets, and keeps Australian mines open, all leading to more employment opportunities in regional areas. Similar opportunities are emerging in agriculture (e.g. protected cropping) and remain a feature of successful manufacturing. It is also increasingly difficult to separate growth in technology from the creation of new services and jobs.

2. Equality of Opportunity

One of the central features of new technology is its ability (through scale and production outlays) to massively reduce cost of access, and AI will continue this trend. In an increasingly unequal world, access to digital infrastructure is a critical element for a society that seeks to provide opportunity for all. This is critical for equal access to online education, telemedicine, and virtual jobs (that is, jobs that require task completion irrespective of location). This can enable otherwise disenfranchised workers to participate, for example parents taking leave to care for children can maintain a form of connectivity to work while home-based. Cloud computing has made popular subscription services for software, storage and like purchases, which has released investment from acquiring expensive hardware. Ultrafast internet is remaking whole industry models, such as subscription-based content streaming, video messaging (and finally bringing phone and video calls to anyone anywhere to its true cost – virtually zero) and realising the promise of telemedicine.

3. Build new businesses

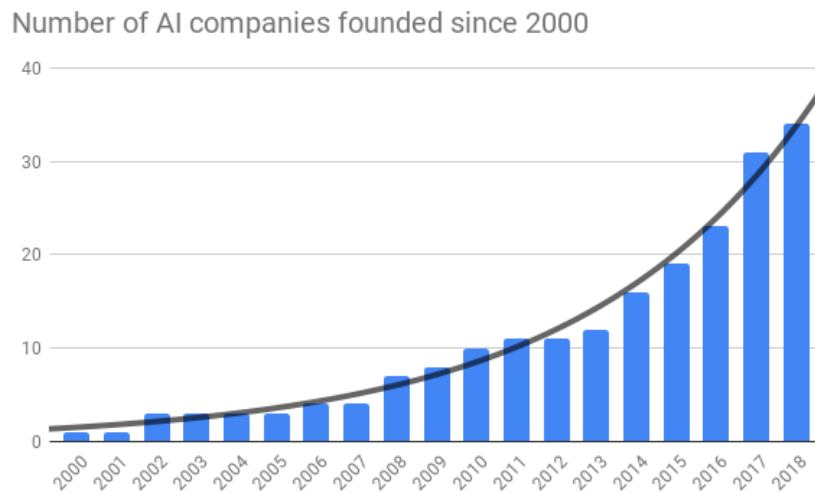
AI is enabling new companies to be built around entirely new products and services. Approximately 50 per cent of the last round of AusIndustry Accelerating Commercialisation grants were given to projects that included AI.²⁰ This trend will only increase, as new businesses race to be first to market with exciting new innovations. Economic development and employment growth will be increasingly linked to the use of AI to solve problems in new ways. SA company Consilium Technology has been engaged by the Viticulture industry to measure vineyard growth from satellite imagery using the latest in AI technology, opening up an entirely new agronomic service that provide farmers with advice that is low cost and accessible.²¹ Data drawn from Brisbane (Figure 7) demonstrates the exponential increase in the number of AI companies since 2000 and in the last decade a 2500% increase in the number of people employed in companies working with artificial intelligence or similar technologies. Similar trends are happening nation-wide. One Google-commissioned study, estimates that correct application of AI and automation could boost the Australian economy by \$2.2 trillion.²²

20 'Accelerating Commercialisation funding offers', <https://www.business.gov.au/Assistance/Entrepreneurs-Programme/Accelerating-Commercialisation/Accelerating-Commercialisation-funding-offers>

21 'Media Release: GAIA's A.I to reveal Mother Earth's vineyard secret', Wine Australia, 9 April 2018, <https://www.wineaustralia.com/news/media-releases/gaias-ai-to-reveal-mother-earths-vineyard-secret>

22 Paul Smith, 'Labor's AI Vision for Melbourne', *Australian Financial Review*, 23 April 2019, <https://www.afr.com/technology/technology-companies/labor-s-ai-vision-for-melbourne-20190422-p51g23>

Figure 7. Number of Brisbane-based AI companies founded since 2000



4. Re-capture old markets

Australia lost whole sectors of its economy during the globalisation of the 1980s and 1990s as lost-cost manufacturing industries and jobs were off-shored into lower wage markets. AI-driven automation will increase productivity and enable Australian manufacturers to use their competitive advantage to compete more effectively with these lower-cost markets and give our companies a chance to re-capture a greater share of the global manufactured goods market.

5. Increase our self-sufficiency in security

Automation has been applied in Defence for at least 1000 years. In 1139, the Catholic Church (unsuccessfully) banned the use of crossbows in war, because crossbows automated what was otherwise a specialist skillset, and allowed relatively untrained peasants to kill knights on the battlefield with a simple squeeze of a trigger. In the nineteenth century, the Gatling gun automated the process of loading and firing a firearm, giving a huge battlefield advantage by replacing many soldiers with one. Today, robots search for IEDs (Improvised Explosive Devices) and drones undertake intelligence-gathering missions. Offensive weapons such as Reaper, Predator and Avenger are able to undertake long-distance offensive missions, but, in reality, contain little AI, and will require a human to make a decision to release deadly force for the foreseeable future. The primary application of AI in Defence in the near term is in data processing to enable better informed decision making.

In the longer-term, the use of artificial intelligence to automate defence systems raises a wide range of ethical, legal and practical issues. Australia is recognised as world leader in its application of law and ethics in battle and has a role to play in providing leadership in identifying where global cooperation is required to minimise unintended negative consequences from the adoption of these technologies, and to promote world peace and stability.

A common concern raised about Autonomous Weapons Systems (AWS) is that they will behave and have the capability of self-aware robots as seen in sci-fi movies such as *The Terminator* and *The Matrix*. In these dystopic scenarios, autonomous machines turn against their human creators and take control of the world. Such self-aware and fully autonomous systems would require a level of capability that is pure fiction and will be decades or even hundreds of years away, even if it does arise. Currently, Defence AI systems have very limited capabilities and tightly prescribed domains of application. This is likely to remain the case for the foreseeable future.

Australia's Armed Forces will demand greater self-sufficiency in the production of military AI for surveillance and monitoring and improving decision-making in battle-field conditions. This is implied by the speed of development of modern AI, which sees new capabilities developing at a rate that outpaces defence procurement systems. The solution is for Defence to maintain its own AI development process that can rapidly deliver new capabilities to existing platforms. The US and China are moving rapidly towards this model, with others following suit. Self-sufficiency will also give rise

to an Australian export industry in defence software, applications, services and products, but also in technologies that spill-over into non-military applications (radar, the Internet, GPS etc. were all originally military technologies).

6. Educate and reskill at all levels of society

We need to mobilise existing knowledge and expertise to adapt our society and economy to the challenges and opportunities that this powerful new technology will create. Education can secure our economy, ensure productivity and wage growth, and underpin our position as informed and influential negotiators on the international stage in the use and regulation of AI technologies. One of the benefits of AI-enabled automation is that it slows the relentless search by businesses for people willing to work for lower wages. The increased complexity of modern goods and services means research, conceptualisation and design are becoming more important, and wages reflect the demand for workers with associated skills. Upskilling Australians is fundamental to ensuring we are ready to capture this expanding economic base. It also creates an export industry based on the application of complex systems, which is now a standard feature of human and industrial organisation. The days of cheaper equals better are over.

7. Better, smarter investment in research & development

Martec's Law postulates that technology changes at an exponential rate, but organisations change at a logarithmical pace. This means that technological development inevitably outpaces existing organisations' ability to adapt. Management must therefore strategically choose which technologies to embrace, given the constraints within the organisation for absorbing change, and at some point, 'reset' their rules, systems and skills. In the authors' personal experiences, organisations often recognise that they could be more productive with a technology update yet also recognise that the human ability to cope with technological change is limited. This theory of the firm begs the question: if the pace of technological change is increasing at a rapid rate, how can whole economies adapt?

The solution is investing in research and development to take advantage of new waves of automation. The technical skills and knowledge acquired through this research gives countries an edge over their international competitors. This edge has many manifestations, including the number of technologically adept graduates generated, and technologically sophisticated start-ups they create. The more technical capabilities a nation's economy can create, the more it is capable of putting together complex ideas and technologies to create higher value, complex goods.²³ It is no coincidence that those countries with the highest investment in Research & Development (R&D) have some of the highest GDP per capita. Examples of focussing R&D investment in particular sectors leading to global competitive advantage for workers include:

- ✓ Silicon Valley technology companies relying on Stanford University to produce high quality students and technological breakthroughs. This creates a self-perpetuating cycle where the best in the world want to work at Stanford and in Silicon Valley.
- ✓ The Netherlands is the second largest food exporter by value in the world. It has been able to achieve this by investing in research into automated, under-cover food production through Wageningen University. This in turn attracts top companies and people to the Netherlands, who create technologies that are exported to the world.
- ✓ Ben Gurion University located in Beersheba, Israel has a research focus on cybersecurity that has attracted companies such as EMC, Deutsche Telekom, PayPal, Oracle, IBM and Lockheed Martin and resulted in new local start-ups in this sector. Israeli firms now dominate 40% of the global market share in cyber security.
- ✓ The Melbourne Biomedical Precinct is made up of 30 hospitals, research, teaching and biotechnology organisations. It attracts most of Australia's biomedical research funds and has secured 53% of ASX listed life science companies. This bio-med precinct is poised to be a global leader in the developing 'Age of Life Sciences'.

²³ Ricardo Hausmann and César A. Hidalgo, 'Country Diversification, Product Ubiquity, and Economic Divergence', HKS Faculty Research Working Paper Series RWP10-045, John F. Kennedy School of Government, Harvard University, 2010, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1724722

As the above examples clearly demonstrate, the jobs created by investing in Research & Development are of enormous economic significance as Australia, and indeed the world, enters what some are predicting will be a more post-industrial, knowledge-based economy.

AI is not a debating topic of the future. It is transforming our economy and society now, and its further impact is inevitable. The question for Australia is whether we actively participate in the AI-enabled future, or passively import the resulting services from smart, tech-savvy nations. Stronger Australian capability is essential if we wish to capture the economic benefits, but also necessary if we wish to participate in international negotiations about regulating the technology.

AI is the core technology that is driving the next industrial revolution – termed Industry 4.0. This technology will change every industry and give rise to new ones. It will impact upon every sector of the Australian economy, not least by enabling productivity growth, here and overseas. Australia can benefit from industry 4.0 but only if we have technological pre-eminence and grow our pool of innovators and competent workers. The alternative is that jobs move overseas. Australia also needs to be self-reliant in the development of AI-enabled defence systems, for its own defence, and to have a stake in the negotiations about such technology. While Australia currently ranks highly in AI expertise, comparable countries are committing hundreds of millions to billions of dollars for core research. Australia is now out of step globally in terms of its investment in AI research and we risk being left behind.

The Commonwealth government has intervened in key periods during Australia's development to ensure that the Australian economy and its workers have the best chance to compete in the globalised economy. The stakes for Australia are much too high to maintain a hands-off approach and allow a market-oriented-only philosophy to dominate. There are proposals being put to government for the best research groups in Australia to be brought together in a cooperative research framework to maintain and develop their world class expertise. Industry partners will need to support the program of research and help to rapidly translate the research into economic growth, and jobs. It is essential, however, that the focus of government investment is in core capability development. Without a strong investment in core capability Australia will not produce the next generation of technically skilled employees and entrepreneurs, and our existing expertise will move to nations that have invested.

The workforce impact of AI will be akin to the impact of computers, and the Internet. Most future jobs will have an AI aspect, some jobs will disappear, and new jobs will be created. Eventually it will be unimaginable to work without AI (like using a smart phone). The challenge here is that the jobs to be created will largely be service oriented, and online. This means that they will be located where the technology is, not the customer. Facebook, for example, employs over 30000 people but had 123 employees in Australia in 2018 despite the volume of local data held by the company, and \$125m in Australian income.²⁴ The uptake of ride-sharing company Uber also showed that local regulations have little effect in the face of pressure from foreign AI-enabled services, and demonstrated the ineffectiveness of a purely defensive approach. It is inevitable that foreign companies will increasingly use Australian data to extract income overseas. The question is whether we actively participate in this new global information-driven market or succumb to it.

24 'Facebook First Quarter 2019 Results', <https://investor.fb.com/investor-news/press-release-details/2019/Facebook-Reports-First-Quarter-2019-Results/>

Policy Recommendations

A technological alarm bell has been rung a number of times in Australia: for example the loss of a pioneering computer hardware business in the 1970/1980's, and the loss of a car manufacturing industry in the 2000's. A number of specific solutions are available for Australian policy makers. They will involve a close partnership with all segments of Australian society and especially the science, education and business communities. The goal should be an increase in jobs that promote equity and broad improvements in well-being across the community. It will demand better planning from government, and better bipartite cooperation between business and labour. Germany's codetermination model for instance sees workers and unions accept technological change in return for re-training and redeployment, a consensual form of corporate governance explored in Nick Dyrenfurth's 2017 policy report.²⁵

1. Education

A key challenge for the education system is to provide workers with access to ongoing retraining and reskilling to meet the needs of a fast-changing, global economy. There are still too many people who fall out of employment as their skills become less valuable, and who find it laborious, difficult or even impossible to find their way back into meaningful, dignified employment. AI is both an opportunity and threat. AI can lower the barriers to entry for some jobs and create new industries and employment opportunities, just as it can displace the skills required for other jobs. The education system must adapt to this situation rapidly, and not just at the point of crisis when jobs are being displaced but ahead of the change. The current School Education system is slowly being re-oriented for a broader STEM knowledge uptake. This is designed to create an increased equality of access to technology and its associated benefits. This needs to be accelerated. The Post-School Education system is a combination of Federal (University) and State-based (TAFE) systems. Both are aimed to stimulate:

- Increased access and gainful employment in technology-oriented jobs
- Increase the possibilities of developing new and value-added technologies

The Commonwealth Government should provide direction and resources to increase skills in the specific technologies that underpin AI at VET and higher education levels as a matter of urgency. A lack of access to these skills has been identified as a key constraint that is holding back the adoption of AI in Australian organisations compared to their Asian peers²⁶.

The Australian Senate Report on the Future of Work (September 2018), recommended that the Australian Government “undertake a major overhaul of our post-school education and training system, the ensure that Australians are being equipped with the knowledge and skills needed for jobs in the future” (Recommendation 18). The Committee further recommended “that the Australian Government encourage better links between industry, education providers and unions, with a focus on tailoring courses to suit future jobs growth” (Recommendation 19).²⁷

We support these moves. In addition, there is a need for greater social and emotional competencies, as mechanical tasks become automated and human relationships become more important. For example, as diagnostic and treatment

²⁵ Dyrenfurth, *Make Australia Fair Again*.

²⁶ Joseph Brookes, 'Australia Falling Behind On AI: Microsoft', Which-50, 2 April 2019, <https://which-50.com/australia-falling-behind-on-ai-microsoft/>

²⁷ Parliament of Australia, 'Report of the Select Committee on the Future of Work and Workers', Commonwealth of Australia, Canberra, 19 September 2018, https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Future_of_Work_and_Workers/FutureofWork/Report

recommendations become more automated, the role of humans in the healthcare sector will focus more on addressing emotional well-being. As booking systems become more automated, skills in story-telling, interpretation and designing more emotionally satisfying experiences will be in greater demand in the tourism industry.²⁸ Our tertiary education must also provide greater access to such training, in addition to the more obvious STEM and AI related courses. It is vital that our education and industrial systems be geared to maximising the jobs of the future. The key enabler of this change is core world-class capability in AI. The genie of Artificial Intelligence is out of the bottle and the quick are seizing the opportunities that will decide what jobs will be created and where they will be located.

2. Regulation

Improve regulation of the digital economy, and where appropriate and through proper consultation, introduce digital taxation to prevent first movers (e.g. giant US-based tech companies) capturing market monopolies. The advantage that data access provides is so great, and the pace of change so fast, that competing against such first-mover monopolies is almost impossible²⁹. Policy that shields new innovators from market dominants is crucial to creating a burgeoning AI ecosystem, and capturing the opportunities that lie ahead. Governments should consider using taxation to access technology rents. Because large technology companies can monopolise data sources which give them more powerful tools (e.g. Google with search engine data), AI companies can extract monopoly rents. Australia must capture a fair share of this income to maintain government services and economic transfers to guarantee a fair society.

3. Research & Development Stimulus

Australia spends just 1.88 per cent of its national GDP on Research & Development, well below the OECD average of 2.38 per cent.³⁰ A substantial investment in AI core research and development capability is one of the key mechanisms that will provide the required technology and skills that Australia urgently requires. Research is the cornerstone of this capability – it means we are more able to attract, train and retain world-class technologists. The demand for technologists is global, given their economic power, and this makes competing on salary challenging. Australia can compete instead in the research opportunities available, but only through an investment comparable to those being made by our competitors. Reliance on technology imports – dominated by a few mega firm monopolies – is a sure path to job displacement without complementarity or value-adding. We need a significant expansion of government investment over the next five to ten years to bring Australia to international parity. In addition, governments can stimulate a surge in digital R&D, specifically AI, through the provision of increased grants, attractive tax incentives, and by attracting skilled migrants who have a history of commercialising our vast higher education and industrial bases.

4. Venture Capital

Australia has an under-developed and difficult VC sector compared to other OECD countries. In the short-term there is a role for Government at every level to address this market failure in Australia by providing greater access to Seed Funding Grants for start-ups and commercialisation in order to capitalise on our national research firepower. To resolve this structural problem in the Australian economy in the medium term, a review of the VC sector and how it could be improved and matured is warranted. Otherwise, the best and brightest trained and developed in Australia will take their ideas overseas, and Australia and Australians will not benefit. The future of AI-enabled jobs growth is bright as much as there are difficulties in the transition. The market alone cannot ensure a successful economic and social transition. Governments have a vital role to play to ensure the benefits of AI are shared broadly across all sectors of our society.

28 Tourism Research Australia, 'State of the Industry 2019', Tourism Research Australia, Canberra, April 2019, <https://www.tra.gov.au/Economic-analysis/state-of-the-industry>

29 Vikram Mahidhar and Thomas H. Davenport 'Why Companies That Wait to Adopt AI May Never Catch Up', *Harvard Business Review*, 6 December 2018, <https://hbr.org/2018/12/why-companies-that-wait-to-adopt-ai-may-never-catch-up>

30 Michael McGowan, 'Australia's spending on research plummets far below OECD average', *Guardian (Australia)*, 11 July 2018, <https://www.theguardian.com/australia-news/2018/jul/10/australias-spending-on-research-plummets-far-below-oecd-average>

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‘The nation looked to Labor,
and it did not look in vain.’