
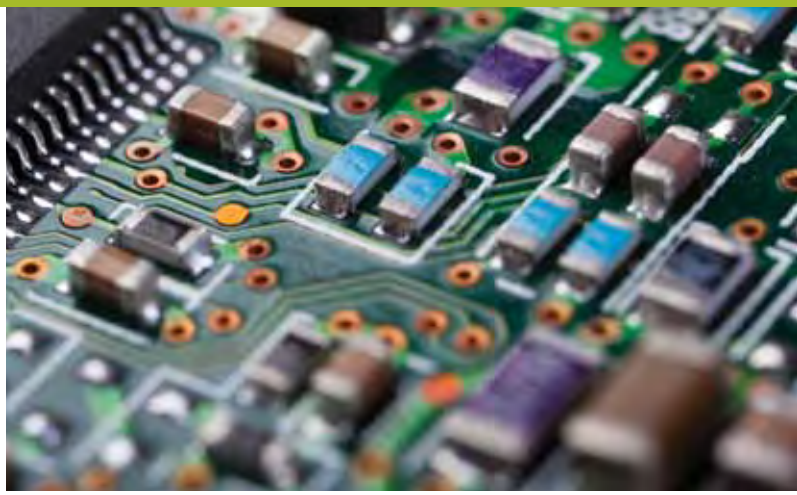

Australia's future workforce?

June 2015

committee for economic development of australia

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About CEDA

CEDA – the Committee for Economic Development of Australia – is a national, independent, member-based organisation providing thought leadership and policy perspectives on the economic and social issues affecting Australia.

We achieve this through a rigorous and evidence-based research agenda, and forums and events that deliver lively debate and critical perspectives.

CEDA's membership includes 700 of Australia's leading businesses and organisations, and leaders from a wide cross-section of industries and academia. It allows us to reach major decision makers across the private and public sectors.

CEDA is an independent not-for-profit organisation, founded in 1960 by leading Australian economist Sir Douglas Copland. Our funding comes from membership fees, events and sponsorship.

CEDA – the Committee for Economic Development of Australia
Level 13, 440 Collins Street
Melbourne 3000 Australia
Telephone: +61 3 9662 3544
Fax: +61 3 9663 7271
Email: info@ceda.com.au
Web: ceda.com.au

committee for economic development of australia

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Foreword

Professor the Hon. Stephen Martin
Chief Executive, CEDA

Australia is on the cusp of a new but very different industrial revolution. Technology is going to dramatically reshape our workforce in coming years and the nation's ability to rapidly adapt to technological change, and even more importantly, innovate, will be paramount for job creation and our future economic success.

That is why CEDA has chosen to examine the issue of Australia's future workforce as its major research project for 2015. This publication reviews the significant technology and related issues our workforce will face and considers what needs to be done to ensure we develop industries, skills and jobs for a future that is still largely unknown.

Technological change over the last two decades has been extremely fast and that is likely to continue. This will mean that a significant portion of Australian jobs that exist today will no longer exist in 20 years' time.

In fact, modelling in this report has found that almost five million Australian jobs – around 40 per cent of the workforce – face the high probability of being replaced by computers in the next 10 to 15 years.

While we have seen automation replace some jobs in areas such as agriculture, mining and manufacturing, other areas where we are likely to see change are, for example, the health sector, which to date has remained largely untouched by technological change.

Our labour market will be fundamentally reshaped by the scope and breadth of technological change, and if we do not embrace economic reform and focus on incentivising innovation, we will simply be left behind in an increasingly competitive global marketplace.

Creating a culture of innovation must be driven by the private sector, educational institutions and government. However, government must lead the way with clear and detailed education, innovation and technology policies that are funded adequately. Currently the commitment needed to link education and innovation policy with funding is significantly lacking compared with other countries.

It is likely some tough decisions about the Australian labour market will need to be made in the next decade; we've already had a taste of this with the decline of the car manufacturing industry. However, if we develop the right policies now, we have the potential to reduce the impact of these challenges and ensure our economy remains robust.

This publication draws together contributions from more than 25 authors and I would like to thank each one for their considered contribution to this project. I would also like to thank the CEDA advisory group, who has overseen this project.

This publication is big, but the workforce challenges we face are big, and if we do not start preparing now for the changes coming, the impact on our economy and our standard of living could be significant.

Executive summary

For most of human history, not much happened from an economic perspective. The level of financial wealth and material wellbeing of society was broadly static, with economic progress so incremental that it was virtually unnoticeable. The wealth that a person was born into was the same as what they would pass on to their descendants. That all changed with the industrial revolution when, for the first time in human history, economic progress began to occur rapidly. Since 1750, it has taken only 50 years for living standards to double. Prior to this, improvement would have taken 6000 years.

Economic progress has not been smooth nor has it been clean. Technological change has frequently created losers, but when job losses have been caused by productivity-enhancing technologies, they have tended to create demand via higher incomes and lower prices, which have generated new jobs economy wide. The next stage of the industrial revolution promises to continue this trend but in new challenging ways. The extension of computerisation into almost all aspects of human activity threatens to radically reshape the workforce of tomorrow. However, in the more globalised economy, it remains to be seen whether it will generate a net increase in employment and wealth within Australia or if the labour market benefits will be dispersed.

While increasing computational power has been reshaping the labour market for over 60 years, the capacity of machines to replicate aspects of human thought is set to most radically reshape the future of work. These advances mean that activities previously considered forever outside the scope of programming are increasingly being undertaken by computers. For instance, driving through traffic was thought to be a task that humans would always have an absolute advantage over computers; now Google has patented a driverless car.

Computers will reshape the labour market in two key ways. They will:

1. Directly substitute for labour, with a high probability that as much as 40 per cent of the jobs in Australia could be replaced by computers within a decade or two; and
2. Disrupt the way work is conducted, expanding competition and reducing the costs to consumers but also reducing the income of workers.

Modelling conducted for this report suggests almost five million jobs face a high probability of being replaced in the next decade or two while a further 18.4 per cent of the workforce has a medium probability of having their roles eliminated. Jobs that involve low levels of social interaction, low levels of creativity, or low levels of mobility and dexterity are more likely to be replaced by automation.

In the face of such modelling, it is vital that Australia rediscovers its ability to implement challenging economic reforms. As the stimulus from the mining boom fades, Australia's prosperity will become increasingly subject to the pressures of the international marketplace. This will occur in an environment of heightened human and financial capital mobility and fast-paced technological advances that can rapidly undermine sources of traditional comparative advantage. Whether recent economic success fades into memory or continues will be substantially determined by the quality of policy implemented by government and business alike.

Australia's future workforce? has brought together leading researchers, thinkers and practitioners to examine what major factors will influence Australia's labour market over the decades to come. The key point is that while it is not possible to predict the future, it is possible to understand the major forces shaping it. Consequently, this report examines the major technological and demographic forces at work in the world today and puts forward the elements of a new social contract that can underpin continued economic prosperity for the nation and help maximise the benefits of the next wave of the industrial revolution for all Australians.

Advisory group

The report was developed with the expert input of a CEDA Advisory Group (CAG). The CAG provided oversight of the project scope and assisted in developing the final reform recommendations.

Participants of the CAG were:

- Professor Roy Green, University of Technology, Sydney;
- Ziggy Switkowski AO, Chair NBN Co.;
- Professor Jane den Hollander, Vice-Chancellor, Deakin University;
- Andrew Stevens, former Managing Director, IBM Australia & New Zealand; and
- Robin Shreeve, Director and CEO, Western Sydney Institute of TAFE.

While these distinguished experts provided guidance in the creation of the report, *Australia's future workforce?* is entirely the responsibility of the individual authors, CEDA Chief Executive, Professor the Hon. Stephen Martin, and CEDA Chief Economist, Nathan Taylor.

Contributions

Global trends

In *Reshaping work for the future*, London Business School Professor Lynda Gratton describes the degree to which technology has already transformed business activity, particularly leading organisations operating in economies that are close to the technological frontier. It also details the implications of technology's ongoing influence over work as people seek to develop skills in areas that cannot be made redundant by computers, and businesses try to engage the best talent both locally and globally. The implication is that careers are becoming a marathon, not a sprint, and that the relationship between the employer and the employee needs to radically alter to reflect the demographic changes being experienced and the increasing power of the individual.

In *The impact of emerging technologies in the workforce of the future*, Telstra Chief Scientist Professor Hugh Bradlow describes how a range of existing technologies, such as cloud services, Big Data, the Internet of Things, artificial intelligence and robotics are rapidly reaching the point where they will have widespread impact on the economy. This contribution expands on machine thinking and unpacks the ways in which a range of technological developments are all acting to transform human activity. On its own, each technology has the capacity to change business activity. Taken together, they have the potential to radically reshape society, the basis of a new wave of the industrial revolution.

In *How next-gen computing is changing the way we work*, IBM Watson Australia/New Zealand leader Belinda Tee and IBM Workforce Science Practice organisational psychologist and management consultant Jessica Xu describe the technological advances underpinning advanced computing and how they are changing businesses. Cognitive computing allows machines to understand human language, making them capable of analysing vast amounts of information and interpreting it in challenging situations. This was demonstrated when the computer Watson was created that could process 200 million pages of data to return confidence-weighted responses to quiz

show questions. This enabled Watson to beat humans in a domain they had previously had an absolute advantage over computers – game shows such as *Jeopardy*. This approach to processing information is being used in more serious applications, such as improving the ability of doctors to diagnose patients correctly, an area where almost 20 per cent of patients are misdiagnosed. This technology changes the way in which customers can engage with business, and the way in which businesses can be organised.

In *The impact of computerisation and automation on future employment*, University of Sydney Professor and ARC Federation Fellow, Hugh Durrant-Whyte, and NICTA researchers Daniel Steinberg, Alistair Reid, Lachlan McCalman and Simon O'Callaghan estimate the potential job losses arising from computerisation. Recent technological breakthroughs mean that computers and robotics can potentially replace labour in routine operations in diverse settings, such as autonomous mining operations. Additionally, machine-learning algorithms will encroach on roles previously perceived as skilled jobs outside the domain of automation, while also increasing the productivity and decreasing employment requirements for many roles that were also previously untouched by information and communication technologies (ICT), such as in the health sector. The consequence of these changes is that almost 40 per cent of the jobs in Australia have a high probability of being substituted with computing in the next few decades. An additional 18 per cent has a medium probability, while the remaining jobs are safe from computing for now. This study does not attempt to predict what types of jobs may be created in the future.

In *Case study: Automation and Australia's future workforce*, Rio Tinto Pilbara Mines Managing Director Michael Gollschewski explains how automation can improve the productivity of activity with the example of their activities in the Pilbara region. Rio Tinto's Pilbara operations comprise 15 mines, four port terminals, and more than 1700 kilometres of rail network supporting a fleet of over 180 locomotives and 11,000 ore cars. The case study describes how automation improves the health and safety of workers, while also creating more interesting jobs, lowering operating costs by eliminating human error, and improving the quality and quantity of output. For instance, the autonomous drill systems, only used in select sites at the moment, have improved productivity by 15 per cent and eliminated injuries. In addition, Rio Tinto is using the process of automation, and the increased level of data being generated in all its activities, to develop Excellence Centres that use this information to generate continuous process improvements. Finally, operating complex activities remotely requires distinct skill sets from workers. The case study describes the characteristics of successful remote operators.

In *Digital disruption – what, why and how*, Reserve Bank of Australia Chief Information Officer Sarv Girn describes how technology is fundamentally changing industry and posits how this change may evolve in the future. Detailing a range of historic digital disruptors, it describes common characteristics of how technological developments have been used to fundamentally change the way in which consumers interact with a business, or in which businesses organise the supply of goods or services. The contribution also describes the recent global shift in innovative capacity to Asia, and discusses the opportunities and challenges of this for Australia. How organisations can best respond to the challenges and opportunities arising from digital disruption is also considered.

In *Megatrends and Australia's future: Older and wiser?*, Australian Futures Project Policy Director Dr Fiona McKenzie describes the megatrends influencing Australia's future. These include the shift in the economic gravity of the world, the geopolitics

of a multipolar world, climate change, resource security, technological developments, the growth of virtual connectivity and demographic changes occurring in Australia and the world more broadly. In particular, the contribution examines the implications of global ageing and the projected growth of Australia's cities. With an ageing and increasingly well educated workforce, Australian businesses will need to deal with very different labour market needs to engage the skill and talent they require to conduct their business.

Australian stocktake

In *Australia's shifting economy*, Department of Industry and Science General Manager Tim Bradley charts the changing shape of Australia's industrial landscape and the consequences for the labour market. This contribution describes how the Australian economy is neither an accident nor a product of design. Rather, it reflects more than a century of economic and demographic pressures and the subsequent response by business, workers, investors and governments. Australia's economy is highly dynamic, with many businesses entering and exiting the marketplace, and large numbers of workers changing jobs, industries and professions. The consequence is a highly productive economy with a large capacity to absorb change. The contribution also examines the potential growth industries of the future.

In *Technological and structural change in the Australian labour market*, University of Canberra Professor Phil Lewis describes labour market responses to structural, technological and skills demand changes. The recent history of the labour market is one of constant change, and it is clear that these changes have largely been successfully absorbed by the Australian labour market. However, there have been distinct losers in recent economic adjustments, particularly unskilled youth and workers unable to develop skills in demand, such as older males made redundant from traditional manufacturing roles. These cohorts make the level of underemployment considerably higher in the Australian labour market than the unemployment rate may suggest. For these workers there is a vicious circle associated with their inability to re-engage with the labour market and specific policy interventions are necessary to enable them to find employment.

In *Information technology and the Australian labour market*, University of Melbourne Professor Jeff Borland and Senior Lecturer Dr Michael Coelli assess the influence that information technology has had on the skill composition of the Australian labour market. Over the last 50 years, there have been large changes in the skill composition of employment, with consistent growth in employment of high-skill workers, a large decline in the share of middle-skill workers and a smaller decline in low-skill workers. The job polarisation experienced in Australia is similar to the trend in Europe. They also find evidence that the change in skill composition is due to the introduction of information and communication technologies that have steadily reduced the demand for labour to complete routine tasks.

In the *Stability of education earnings gaps in Australia*, Dr Michael Coelli examines the winners and losers in the race of education and the machine. Technological change, particularly computerisation, has been a major influence on Australia's labour market over the last 40 years. This contribution examines how technology has changed the lifetime earnings for people with different levels of educational attainment. Australia has unique characteristics that differentiate it from the experience in the United States, which are explained in the contribution.

The future worker

In *Developing the capacity to adapt to industry transformation*, Australian Workforce and Productivity Agency (AWPA) former Head of Secretariat, Sue Beitz, reports on how the major global economic trends will shape the future of skill requirements in Australia. The contribution describes macro trends to inform the skills that workers will increasingly need in the future, and to identify gaps in the way these skills are currently being developed. In particular, there are significant shortages in digital skills, which will become a new basic skillset in the way reading and writing are today. Australia needs to re-examine the regulatory frameworks governing education to help workers develop the required skillsets and to ensure that public resources are being invested appropriately.

In *Closing the gender gap in labour supply*, University of Sydney Professor Patricia Apps examines the implications of the population's ageing and the counterbalancing influence of increasing female participation. In particular, the contribution examines the reforms that would allow the reallocation of resources from the household, looking after young children, to the labour market. It also describes how the current gap in participation between men and women is closer to 40 per cent, rather than the headline 12 per cent, due to high part-time employment of women. Women have almost equal workplace outcomes to men until children are born, when they transition to part-time work. This is a significant social loss since they do not revert to working to the same degree ever again. The contribution makes a series of recommendations to rectify the participation gap.

In *Your future employer – yourself*, Independent Contractors Australia Co-Founder and Executive Director Ken Phillips details the growth in self-employed workers across the world. Despite the stereotype that these workers are relatively low skilled and in vulnerable positions because of the tenuous nature of their work, an increasing percentage of self-employed workers are older, highly skilled professionals. This is a global trend, with the numbers of self-employed people growing most notably by 45 per cent in the past decade in Europe. Technological developments will make it increasingly easy for workers to be self employed, and for agile workers to sell their skills to wider markets. Given the very high reported figures that self employment is an aspirational goal of over half the workforce, it is probable this type of work will become more of a norm in the future. This will potentially create challenges for organisations, particularly for big businesses.

In *Where the jobs are*, IBISWorld Chairman Phil Ruthven AM provides a long-term perspective on human labour. He observes that the quantum of work performed has not changed, but as human life expectancy has increased, the workload has been spread. People now work for much longer but less intensely. The focus of work has shifted from brawn to more durable brains. As wealth has increased, businesses and households have increasingly outsourced activities to others, reflecting increased specialisation. Examining the areas of business and household activities that can be outsourced suggests areas of future growth in employment. Additionally, Australia as a nation will increasingly outsource activities to other nations while being a recipient of other nations' outsourcing.

Policy response

In *The strategic imperative: Australia's place in the global labour market*, Stanford University Professor Steven Callander describes the challenge that the next wave of industrialisation will pose for a small open economy like Australia. The contribution identifies two key economic consequences of the new, highly integrated global economy. The first is that the share of income going to labour, as opposed to physical or intellectual capital, has been in steady decline for decades. The other is that those individuals or nations that do not innovate are condemned to be commoditised. The world is increasingly moving towards 'winner takes all' outcomes where those that create something unique or special command increased returns on their efforts while the rest get lower and lower returns. Australia's relatively small size means it has historically been an early adopter rather than a developer of ideas. Australia needs to build on those areas of the economy operating at the technological frontier to create wealth and jobs in the future.

In *Future skills, industry policy and a new social contract*, UTS Business School Dean Professor Roy Green and University of Technology, Sydney, Professors Christos Pitelis and Ian Marsh provide a review of industry policy and its implications for skills development. The contribution also describes the new industrial revolution's implications for Australia. It discusses the roles of services, particularly manufacturing, in these global value chains, and makes a series of observations as to the importance of the latter in sustained wealth creation for a nation. The contribution makes recommendations as to how Australia can attempt to become a substantial contributor to emerging global value chains

In *A brave new world of higher education*, Deakin University Vice-Chancellor Professor Jane den Hollander, examines how well positioned Australia's university sector is for the disruption arising from technological progress. Operating virtually unchanged for over 500 years, universities around the world are potentially going to experience one of the most radical shakeups of their operations ever. While the result, such as massive open online courses, could threaten the business performance of Australia's higher education sector, it also has the potential to spread knowledge and insight more broadly into the community than in the past. To be successful, universities need to adjust to a world where human knowledge increases dramatically faster than ever before and where people will be educated for jobs that do not yet exist. They need to teach the ability to analyse data and not simply recite facts and figures.

In *Future skills in information technology*, Hugh Durrant-Whyte examines what types of ICT skills Australia needs to develop to successfully adapt to the technological forces reshaping business. The contribution describes how ICT will affect the Australian economy: through the development of new technology companies and products, typically only in a few sectors such as resources and agriculture where there is a critical mass of activity; or through the adoption of technologies developed elsewhere, which will be the dominant influence. As a consequence, Australia needs to embrace the ICT skills that will allow businesses to rapidly adopt technological developments if they are not to fall behind international business best practice. Additionally, a broad appreciation for technology needs to be developed across the population so that it is understood and used in a similar way to how the written word is today. However, this does not mean greater numbers of science, technology, engineering and mathematics (STEM) students. Rather than teaching basic skillsets, the focus needs to be on deeper technical skill development of architecting, designing and analysing. These areas will generate jobs in the future for Australia as the major role of ICT in Australia is to transform existing companies and existing ways of doing business.

In *Northern lights*, Deakin University Associate Professor Dr Andrew Scott examines how countries have successfully retrained workers from industries facing imminent collapse. In particular, the contribution undertakes a detailed examination of the approach adopted by Denmark when facing the collapse of its shipbuilding industry. What is clear is that successfully retraining mature workers requires a specific policy approach, one that Australia is lacking. This has significant ramifications for workers in the automobile sector, let alone any restructuring that might occur as a result of computerisation or contestability.

Reform agenda

Australia is well positioned to respond to the emerging workforce challenges with its highly educated workforce, prosperous and stable society, and geographic proximity to the emerging economic powerhouses of Asia. However, the world economy is increasingly becoming one in which the 'winner takes all' as technological developments allow the widespread dispersion of successful innovations. Australia has historically been a swift adopter of technological developments, but this strategy is going to be less and less useful in the future as more of the gains will accrue to the developer of innovation.

To succeed in this global environment:

- Australia needs a new social contract, one that recognises the role of government in developing the enabling environment for industry to flourish, which maximises the application of the nation's human capital and incentivises innovation;
- The strategy of creating growth centres should be funded to a level commensurate with international best practice and to meet the massive challenges confronting the economy as it transitions from dependence on mining and resources. Australia has currently allocated only $190 million over a four-year period, while the United Kingdom's Catapult Centres, on which the Australian growth centres are modelled, has $3 billion allocated over the same period.

The rapid pace of technological change driving the next stage of the industrial revolution requires new approaches from government, rather than the historic top-down siloed approach. The Federal Government should use the *White Paper on the reform of the Federation* as an opportunity to:

- Bring all parts of the Australian Commonwealth to the table as equals to develop information and learning systems that support accountability and continuous performance improvement.

To enable Australia to optimise its prosperity, it needs to undertake reforms addressing areas of economic rigidity in the economy and incentivising innovation. The nation needs to:

- Establish a National Productivity Policy addressing a comprehensive review of regulation, pricing and licencing arrangements while phasing out industry subsidies, among other important microeconomic reforms, so that Australia can operate on the policy frontier.

Education

A relatively highly educated workforce has been a traditional source of advantage for Australia. However, the rapid rise in global education means this historic strength is being eroded. Further, the increasing ability of computers to substitute human thinking

means Australia needs to ensure that the education system is providing students with valuable skills for their future employability.

To position Australia's workers with the skills to adjust to emerging technologies and to maximise the nation's human capital, the nation needs:

- A unified, overarching policy framework to guide the allocation of investment in education and training from early childhood to further education and training and tertiary education. This is currently lacking in the debate about various forms of education reform;
- To ensure all stages of the education process focus on instilling competencies rather than the retention of specific knowledge. With public funds being invested, it is important that the skills being taught are not firm specific, but instil broad competencies that represent a valuable public investment;
- The Commonwealth Government to examine extending the formal education system to include a public learning-focused childcare and preschool system in an affordable part of the early education package;
- Digital competency to be a basic competency for all workers in the future as Australia does not need larger numbers of computer programmers. Outside a few core areas, Australia lacks the size to become an ICT powerhouse. However, Australia will require ICT students with capabilities in architecting, designing and analysing to adopt international ICT developments if its industries are to stay globally relevant.

Capital cities

An important complement to Australia's innovation policy is to ensure the country has liveable cities. The highly skilled employees who increasingly drive prosperity are able to work globally and are highly mobile. City liveability is a strong predictor of economic activity and wage growth because such areas are able to attract the innovative class of people who drive this activity.

To fully realise the advantages of Australia's favourable environment:

- The nation should create discrete city-wide entities with the responsibility for whole-of-urban planning in its urban centres. These entities should preferably be vested with hypothecated funds from sources that generate it within the jurisdiction, such as the fuel excise and appropriate congestion pricing, to ensure adequate investment so that these cities remain liveable.

Labour force adjustments

Australia's labour market is robust and relatively efficient for the most part. However, historically workers in industries experiencing substantial numbers of redundancies have frequently experienced challenges in re-engaging with the labour market in large numbers. The social and economic cost is substantial. As the new wave of the industrial revolution makes more and more roles redundant, it is important that proactive steps be taken to ensure workers develop the skills needed to remain in the workforce.

- Australia should seek to emulate other countries' success in transitioning workers out of declining industries. This will require a concerted effort to reskill workers prior to retrenchment.

The industrial revolution's next wave

Nathan Taylor
CEDA Chief Economist

Australia is on the cusp of the next wave of the industrial revolution. Like the previous technologically driven transformation, this revolution has the potential to radically upend business practices, change social arrangements and dramatically reshape the workforce. It is also likely to significantly improve the lot of households across the world while having profound implications for average Australian workers. Modelling conducted for this report suggests almost five million jobs face a high probability of being replaced in the next decade or two.

Emerging technologies are threatening to reshape the economy in very different ways to those of the past. While increasing computational power and rapidly falling prices are encouraging greater use of computers, the capacity of machines to replicate aspects of human thought is set to most radically reshape the labour market. These advances mean that activities previously considered forever outside the scope of programming are increasingly being undertaken by computers. For instance, driving through traffic was thought to be a task for which humans would always have an absolute advantage over computers; now Google has patented a driverless car and Rio Tinto has automated its entire Pilbara region operations.

The historic waves of the industrial revolution resulted in ever increasing replacement of human with mechanical brawn. It was little over a century ago that the majority of Australians worked in the agriculture sector, yet today it employs only a tiny fraction of the labour market. After manufacturing took over as a major employer, it too was disrupted by changes to the global marketplace and now employs a far smaller portion of the workforce. In contrast, the information and telecommunication advances detailed in this report are likely to do exactly that to a range of activities associated with traditional white-collar activity. These jobs vary from telemarketers, to insurance underwriters, to radiologists. In other professions, computers will make individuals far more productive than they currently are and significantly reduce the demand for these types of workers. This is not a new trend, but the pace of change is potentially considerably faster than in the past.

In addition to being a direct substitute for labour, computerisation can also radically reshape industries. Digital disruption frequently reduces barriers to entry, both to industries and countries. Business and workers are increasingly competing in a larger marketplace than they have historically; frequently it is a global one. While this process will drive down the costs of goods and services, as globalisation has with manufactured goods, it also means that the income Australian workers earn will be linked to the wages of a globalised marketplace.

Australia's labour market has, for the most part, done well in adjusting to shifting economic conditions. However, key demographics have failed to adjust, and this report explores how to address these deficiencies. In addition, in the past the technological developments that destroyed jobs created higher levels of income, which tended to create more jobs overall. It is an open question as to whether the next round of technological advances will result in concentrating the gains among a fewer number of people, or if it will create more jobs overall for Australian workers. It may be that the benefits of productivity growth may be concentrated to the extremely wealthy and the global middle class.

Australia's future workforce? examines the major technological and demographic forces at work in the world today to best position Australia's future workforce for the challenges of the future.

Global trends

London Business School Professor Lynda Gratton outlines the ways in which leading organisations from countries operating on the technological frontier are changing and the consequences for workers in a globalised economy (refer to Chapter 1.1). Telstra Chief Scientist Professor Hugh Bradlow describes the emerging technologies that are already beginning to change business practices (refer to Chapter 1.2). IBM Watson

Australia/New Zealand leader Belinda Tee and IBM Workforce Science Practice organisational psychologist and management consultant Jessica Xu describe the computing advances that make it possible for computers to increasingly replicate aspects of human thinking and the impact it can have on organisations (refer to Chapter 1.3).

University of Sydney Professor and ARC Federation Fellow, Hugh Durrant-Whyte, and NICTA researchers Daniel Steinberg, Alistair Reid, Lachlan McCalman and Simon O'Callaghan apply modelling to the Australian labour market to find that approximately 40 per cent of jobs have a high probability of being replaced by automation within two decades (refer to Chapter 1.4). Rio Tinto Pilbara Mines Managing Director Michael Gollschewski describes the benefits associated with automating their mining activity in the vast Pilbara region and how it changes the nature of what is required from workers (refer to Chapter 1.5). Reserve Bank of Australia Chief Information Officer Sarv Girn describes how successive waves of digital disruption are transforming industries and business activity (refer to Chapter 1.6). Australian Futures Project Policy Director Dr Fiona McKenzie describes a series of megatrends affecting the world over the coming decades (refer to Chapter 1.7).

Australian stocktake

Radical change is not new for Australia, as outlined by Department of Industry and Science General Manager Tim Bradley (refer to Chapter 2.1). Over the course of 100 years, economic and demographic pressures and the subsequent responses of business, workers, investors and governments have constantly reshaped the economy. University of Canberra Professor Phil Lewis describes how the labour market has been reshaped by changing skills demand, industry restructuring and technological change (refer to Chapter 2.2). For the most part, the labour market has been highly successful at absorbing these changes, however distinct groups have failed to adjust.

University of Melbourne Professor Jeff Borland and Senior Lecturer Dr Michael Coelli detail the influence of 60 years of computerisation on the Australian labour market, particularly the polarisation created in the skill composition of the workforce (refer to Chapter 2.3). Dr Michael Coelli details the return on earnings associated with additional education and how the supply of educated workers has changed in Australia (refer to Chapter 2.4).

The future worker

How the global trends are likely to reshape the skill requirements of workers is described by Australian Workforce and Productivity Agency (AWPA) former Head of Secretariat, Sue Beitz (refer to Chapter 3.1). University of Sydney Professor Patricia Apps describes the policies required to close the gender labour participation gap and how this could significantly eliminate the budgetary implications of an ageing population (refer to Chapter 3.2).

Independent Contractors Australia Co-Founder and Executive Director Ken Phillips describes how, with workers increasingly embodying greater amounts of human capital, they are increasingly moving towards self-employment for either career or aspirational prospects (refer to Chapter 3.3). IBISWorld Chairman Phil Ruthven AM describes long-term trends in jobs growth and speculates how the jobs of tomorrow will be created (refer to Chapter 3.4).

Policy response

Stanford University Professor Steven Callander outlines the strategic imperative of a small open economy like Australia and how it can best position itself to global developments (refer to Chapter 4.1). UTS Business School Dean, Professor Roy Green, and University of Technology, Sydney, Professors Christos Pitelis and Ian Marsh provide a review of industry policy and its implications for skills development (refer to Chapter 4.2). While Deakin University Vice-Chancellor Professor Jane den Hollander examines how digital disruption can potentially transform Australia's universities, and their potential to meet the expanding skill needs of the Australian population (refer to Chapter 4.3).

Hugh Durrant-Whyte describes the information and communications technology (ICT) skills that Australia needs to flourish and take full advantage of the opportunities presented by digital disruption (refer to Chapter 4.4). Finally, Deakin University Associate Professor Dr Andrew Scott examines the policies of countries that have successfully retrained workers from industries facing imminent collapse (refer to Chapter 4.5).

Computing and the workforce

Computers have been reshaping the workplace since the 1960s. There was an accelerating decline in the cost of computations by 37 per cent until the 1980s after which they declined more rapidly by 64 per cent in the 1980s and 1990s.[1] At the same time, the computational power of computers has improved dramatically. This accentuated an existing trend of decreasing the cost of information processing tasks and encouraging the use of educated office workers. It resulted in the decline in employment in routine-intensive occupations, which are those occupations largely consisting of tasks following well-defined procedures that can easily be performed by a computer program.

The process of automating routine tasks resulted in an expansion in high-skill employment. This can be explained by the falling price of carrying out routine tasks by means of computers, which complements more abstract and creative services. The result has been an increasingly polarised labour market, with growing employment in high-income highly skilled jobs and low-income manual ones, accompanied by a hollowing-out of middle-income routine jobs. For instance, it has been shown that computerisation erodes wages for labour performing routine tasks and workers will reallocate their labour to relatively low-skilled service-based occupations.[2]

Australia's experience has been similar to the rest of the world. Over the past four decades, there has been a large shift in the skill composition of employment, with the share of high-skill jobs increasing significantly, middle-skill jobs decreasing by almost as much, and a small decrease in the share of low-skilled jobs. The analysis suggests that the application of ICT has replaced workers who perform routine tasks, typically jobs in the low and middle skill levels. This process, and the associated changes in earnings by occupations, has resulted in an overall increase in earnings inequality in Australia since 1990.

Since the start of the computer revolution, the real cost of computing has created large economic incentives for employers to substitute labour for computer capital. However, these efforts have been blocked because the tasks that computers are able to perform are only those that a programmer can perfectly define. Specific routines have been required for all possible contingencies. As a consequence, the boundaries for

job computerisation have been limited by the degree to which technological advances allow engineers to sufficiently specify problems. For instance, it was once thought that it would be impossible for a computer to come close to a human driver in traffic. The sheer number of potential contingencies of driving through a busy city, with automobiles and pedestrians contesting the use of space, was thought to be such to forever defeat a programmer.

But the computer is now out of the box.

Recent technological breakthroughs are turning non-routine tasks into well-defined problems. This is illustrated in the context of computing interpreting handwriting described by Carl Frey and Michael Osborne:

> "The success of an algorithm for handwriting recognition is difficult to quantify without data to test on – in particular, determining whether an algorithm performs well for different styles of writing requires data containing a variety of such styles. That is, data is required to specify the many contingencies a technology must manage in order to form an adequate substitute for human labour. With data, objective and quantifiable measures of the success of an algorithm can be produced, which aid the continual improvement of its performance relative to humans."[3]

Rather than being impossible, Big Data enabled Google to patent an autonomous car. As described by Professor Hugh Bradlow in Chapter 1.2, the growth of Big Data is an emerging technological development that is in the process of revolutionising computing. The case study from Rio Tinto in Chapter 1.5 describes the benefits that can accrue from strategic use of this data, from more efficient plant and equipment utilisation through to dramatic improvements in system optimisation.

Not only is Big Data allowing non-routine tasks to become programmable, when there is sufficient information available, machine learning can find unexpected similarities between old and new data, aiding the computerisation of more tasks. As a result, computerisation is no longer confined to routine tasks that can be written as rule-based programming but has the potential to spread to every non-routine task where Big Data becomes available.[4]

Another key development has been the improvements in sensory technology, which make its use relatively cheap. This is a major source of information driving Big Data. For instance, Rio Tinto uses the information collected from the numerous sensors on its plant and equipment to more efficiently use them, and to identify and resolve problems more effectively when they occur (refer to Chapter 1.5). Coupled with declining costs and expanding capabilities of robots, sensor technology will make entirely new opportunities to computerise and routinise work.

The attraction and challenge of adopting robots is similar to that of computers in general. While it can be difficult to repurpose a business activity to suit automation, and it requires a significant upfront investment in capital, once that is done it can drive efficiency improvements and avoid human errors. For these reasons, it is not just the rich developed world looking to use robots to replace human labour, with Chinese manufacturers, such as Foxconn, which employs 1.2 million workers, investing in robotic production lines. Robot sales in China are expected to grow by more than 50 per cent.[5] As the cost of robots decreases and their technological capabilities expand, they could be expected to potentially replace human labour in a wide range of occupations in which considerable jobs growth has occurred over the past decade.

Direct substitution for labour

Economists Frey and Osborne modelled the potential consequences of the expansion of automation on the labour market of the United States (US). They examined the barriers to automating roles and ranked all roles in the US labour market according to how much or how little they displayed:

> "While sophisticated algorithms and developments in MR (mobile robotics), building upon big data, now allow many non-routine tasks to be automated, occupations that involve complex perception and manipulation tasks, creative intelligence tasks, and social intelligence tasks are unlikely to be substituted by computer capital over the next decade or two."[6]

So the probability of an occupation being automated is defined as a function of how much of the role involves social intelligence, creativity and detailed perception and physical manipulation. On this basis, a personal trainer is highly unlikely to have their role replaced by a computer due to the high level of social intelligence and the highly varied physical movement associated with the role. In contrast, roles in the postal service display little of the bottlenecks to computerisation and were assessed as being highly probable, at a 95 per cent probability, of being replaced by computers.

The nature of ICT-induced changes to the workforce is not new; they are the continuation of a process as old as the industrial revolution itself. What is new is the pace and magnitude of the change. In this report, machine-thinking expert Hugh Durrant-Whyte describes the coming digital disruption as the fifth horseman of the apocalypse in the breadth and scale of its capacity to reshape economic activity (refer to Chapter 4.4). The modelling by Frey and Osborne suggests that 47 per cent of workers in the US economy have a high probability of being replaced within 10 to 20 years. When this model is applied to the Australian economy, it finds that approximately 39.6 per cent of the labour market faces a high probability of being replaced by computers.

The Australian labour market is highly successful at dealing with a large amount of change. As Tim Bradley points out in Chapter 2.1, a large degree of churning, both of employees and businesses, is a natural consequence of a dynamic and open economy. However, the nature of the ICT changes to the labour market may challenge the capacity of the economy to smoothly absorb displaced workers.

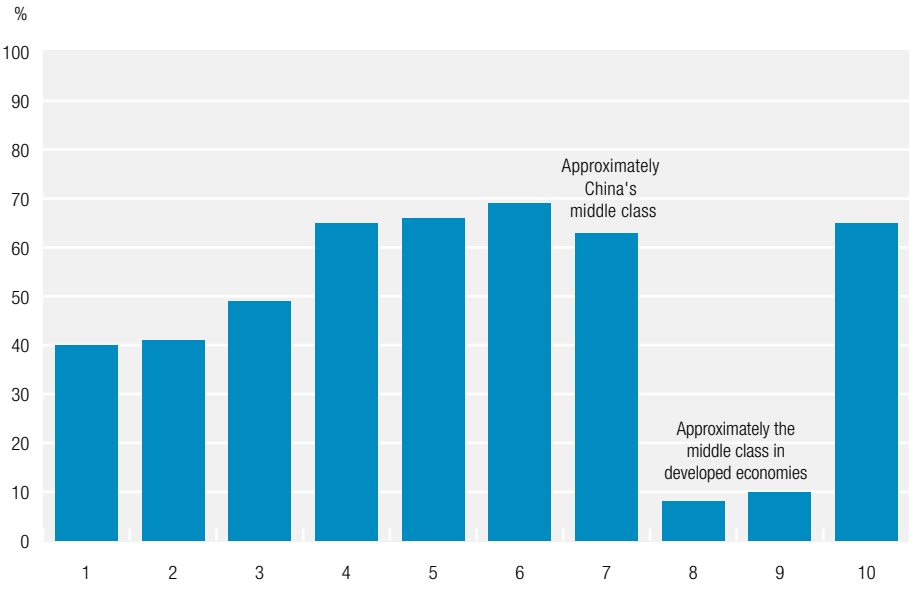
It is much easier to accurately identify the jobs that will be destroyed by technological change than it is to predict those that will be created in the future. However, the jobs to be created are likely to be in areas where machine thinking and robotics are most challenged in replicating human thought and mobility: in creative thinking, in areas requiring high social intelligence, and in jobs that involve considerable mobility and agileness. The dispersion of potential job losses in Australia is also very telling. The roles requiring creativity and social intelligence, which are among the most secure, tend to be clustered in the nation's central business districts.

Increasingly competitive labour market

Technological advances in information and telecommunications in particular are radically reducing the tyranny of distance and making the world more connected. Increasing global contestability allows more and more goods and services to be produced anywhere in the world, which is good for consumers, but it reduces the prosperity of workers and individual nations that are not competitive. Over 1.1 billion

FIGURE 1

REAL INCOME GROWTH AT SELECTED PERCENTILES OF GLOBAL INCOME DISTRIBUTION 1988–2008 (IN 2005 PURCHASING POWER PARITY)



Source: Global income distribution 2013.

non-farm jobs have been created over the past three decades, with 924 million, or 84 per cent, located in developing economies.[7]

In common with other developing economies, the relative competitive advantage Australia has enjoyed from its highly educated workforce is diminishing as the global supply of skilled labour increases. In 2002, the total number of science, technology, engineering and mathematics (STEM) first university degrees awarded in Asia was just over one million, with almost half a million in China alone and a further 176,036 in India. By 2010, the total STEM degrees awarded in China had risen to 2.6 million, with the figure anticipated to rise to 3.5 million in 2015. China alone will produce more STEM degrees in 2015 than all of Asia did as first degrees in 2002. India is experiencing similar growth trajectories in higher education.

The increasing numbers of highly educated people in the world will inevitably increase the international competition for the goods and services they produce. Digital disruption will continue redefining what goods and services need to be produced locally and what can be outsourced to other countries. Consider the case of Elance-oDesk, which allows businesses to engage with over nine million freelancers who bid on specific jobs. In this marketplace, which does over a billion in turnover a year, location is no barrier with workers competing to win bids from all over the world. Businesses like Elance-oDesk eliminate the barriers of distance and significantly expand the supply of workers. This provides great opportunities, for businesses in terms of the quality of the work done and workers by exposing them to a wide variety of potential business opportunities, but it does mean people from all over the world compete on a level playing field. This is just one of numerous forms of digital disruption that is levelling the playing field in which professionals operate. Other examples include taxi drivers, creative directors, doctors and lawyers.

To some degree, it does not matter where work is located if it is potentially relocatable or substitutable. Consider the case of the manufacturing sector, which has a long history of production that was once domestic being outsourced to low-cost destinations, typically developing economies. Recent reductions in the costs of inputs (for example, the US, with a lower exchange rate and cheap gas supplies) have also resulted in some manufacturing plants being established or regaining business in parts of the developed world. However, regardless of where manufacturing takes place, the fact that it can be relocated reduces the bargaining power of labour in the sector.

The consequence of increasing globalisation can be seen when examining income growth since 1988 by percentiles of the world income distribution.[8] It shows a rapid rise in the low to middle income cohorts, for instance the real income of China's middle class increased by 65 per cent over the three decades, as did the income of the very wealthy. This is broadly a positive outcome.

However, the income growth in the middle classes of the developed world was relatively paltry over that same three decades. To a degree, Australia's workers were buttressed by the nation's terms of trade stimulus, which boosted national income. However, this stimulus is rapidly declining and cannot be expected to provide further income growth.

Preparing for the future

It is not possible to resist the tide of technological change, despite the unwelcome disruptions it may bring. The Australian economy successfully transitioned from an agricultural base 100 years ago to one dominated by the manufacturing sector through to an economy where services and management occupations are the largest employers. Throughout it all, concerns over technologically forced unemployment have proven exaggerated. The reason for the success of human labour has been twofold: the capacity of humans to adapt and adopt new skills by means of education and the endless needs and wants of humans creating new jobs. Whether this fortuitous outcome continues will depend on how widely and deeply machine thinking replaces human thinking.

Following the Lancashire riots of 1779, the British Government stated:

> "The sole cause of great riots was the new machines employed in cotton manufacture; the country notwithstanding has greatly benefited from their erection (and) destroying them in this country would only be the means of transferring them to another (. . .) to the detriment of the trade of Britain."[9]

In today's enmeshed globalised economy, with near instantaneous communication, there is no choice to resist technological advances without forfeiting prosperity.

Stylised findings and recommendations

Global trends

For over 60 years, computers have been reshaping the global labour market, favouring skilled workers. This has been an extension of the long-term trend whereby routinisable labour has been replaced by machinery, resulting in polarisation of the labour market and encouraging higher levels of education. Computers have reshaped both work and workers. This trend is set to accelerate.

A series of technologies in the process of widespread adoption are likely to collectively form the basis of a new wave of the industrial revolution. These technologies expand the capacity of computers to directly substitute for human labour and human thinking, as evidenced by the capacity of the supercomputer Watson. This computer was able to win the game show *Jeopardy* by processing 200 million pages of data to provide confidence-weighted responses in the context of a quiz topic.

Just as the technologies underpinning previous waves of the industrial revolution took decades to achieve widespread adoption, these technologies are only starting to reshape business activities. Key emerging technologies are:

- Cloud services;
- The Internet of Things;
- Big Data;
- Artificial intelligence and robots; and
- Immersive communications.

Combined, these technologies are likely to significantly boost efficiency while eliminating many historic jobs. The case study in Chapter 1.5 of how Rio Tinto has used these technologies to automate mining activities in the Pilbara region demonstrates how early adopters are using them to improve efficiency and transform the way in which business is organised.

Modelling conducted for this report suggests it is highly probable that 39.6 per cent of the Australian labour market, approximately five million workers, could be replaced by computers within the next couple of decades while a further 18.4 per cent face a medium probability of having their roles eliminated. Jobs that involve low levels of social interaction, low levels of creativity, or low levels of mobility and dexterity are more likely to be replaced by automation. Work that is resistant to substitution by computers tends to be centred in the central business districts of Australia's major cities.

In addition to directly substituting for human labour, computers are disrupting the delivery models for many goods and services. Digital disruption frequently involves significantly expanding the pool of inputs available for a good or service, which drives down wages in disrupted industries. This is not a new trend but business models, such as those used by Uber for taxi drivers or Elance for graphic artists and other small business contractors, are likely to acerbate this trend for many established businesses. The global centre for innovation is shifting to Asia, which will play an increasing role in driving digital disruption in the future.

Digital disruption is coinciding with a massive expansion of the global labour market, with approximately 1.1 billion new workers added to it in the last three decades. More than 84 per cent of these new workers are located in developing economies. This

has had significant implications for global real income growth rates, which have been strongest for the very rich and the global middle class, both improving by approximately 60 per cent over the past three decades. In contrast, the middle classes of the developed world have experienced relatively low levels of real income growth over the same period, approximately 10 per cent real income growth. Digital disruption and greater educational attainment in developing countries is likely to ensure this trend continues. The 500-year-old business model of the global university sector is one that has the potential to be radically disrupted via online learning.

The business practices of leading organisations operating on the technological frontier are radically shifting to take account of increased globalisation and improved communication technologies. These organisations have been required to chart a new relationship between businesses and employees, drawing on a global pool for the best workers, but also competing on a global pool for much more mobile workers. In addition, the relationship between workers and their own careers is changing as it is no longer a sprint but a long distance marathon that needs to last much longer and results in workers becoming much more specialised.

Australian stocktake

Over the course of 100 years, economic and demographic pressures, and the subsequent responses of business, workers, investors and governments, have constantly reshaped the economy. Australia's labour market has successfully transformed a number of times over the course of the past 100 years. Significant job losses have previously occurred in the agriculture and manufacturing sectors and those works have, for the most part, been absorbed elsewhere in the economy. However, the Australian economy is highly dynamic with more than a million workers changing jobs every year and around 600,000 of those workers changing industry. In addition, more than half a million businesses enter or exit the market while, over the course of the last decade, approximately half of the ASX top 200 companies have changed.

The introduction of computers to the Australian labour market has contributed to significant skill-based job polarisation, with low and medium-skilled jobs experiencing reduced growth relative to high-skilled ones. This polarisation occurred as work that could be routinised was replaced by computing or outsourcing. The labour market response has been a surge in educational attainment. There has been a corresponding high level of demand for skilled workers, resulting in favourable levels of employment and remuneration for educational attainment, and a high level of earnings premia associated with education.

Despite the general success of the Australian labour market at adjusting to changes in industry composition, there have been groups that have lost out. In particular, many middle-age men made redundant by the declining manufacturing sector became structurally unemployed and have not been absorbed by other sectors of the economy. There is evidence that historically, the structurally unemployed have been shifted from unemployment benefits to pensions, a costly approach to dealing with the problem, both in terms of government outlays and indirectly in terms of lost productivity capacity. Given the potential dislocation associated with the next wave of the industrial revolution, Australia must provide better retraining assistance. The other significant cohort not to be engaged by the labour market is younger people who lack suitable skills for employment in the first instance. The problem of youth unemployment is concentrated among the most disadvantaged who have little skills or work experience, with a lack of educational attainment highly correlated with this group.

The future worker

Historically, when job losses have been caused by productivity-enhancing technologies they have tended to create demand via higher incomes and lower prices, which have generated new jobs economy wide. However, in the more globalised economy, it remains to be seen whether the next wave of the industrial revolution will generate a net increase in employment within Australia. Success in this new environment will require incentivising businesses and providing the workers with the right skills and environment to flourish.

So ubiquitous will ICT be in the future that it will be added to reading, writing and arithmetic as basic competencies expected of all Australians. Digital literacy needs to be a basic competency taught to children. It needs to be included as a core component of school education, both in terms of content and delivery, as distinct from the teaching of specialised ICT, technology and computer science subjects. The workers of the future need to have deep computer literacy.

The ageing of the population will potentially act as a drag on the Government's budget. Yet declining fertility rates can provide a demographic dividend if the right policy framework exists. Currently, there is a gap in the headline participation rates between men and women, at 12.1 percentage points. However, the true participation gap is in the order of 40 to 50 per cent during the prime working years due to the high proportion of women in part-time work. This is a response to the cost of child care. To realise the potential demographic dividend from the ageing of the population, and to maximise the human capital of the nation, would involve formally considering early child care as part of the education system while also addressing taxation policy. If these policy changes are introduced, the workforce of the future will be older and more female.

As workers embody more human capital, through skills, experience and knowledge, and as the barriers to establishing a successful business continue to decline due to technological innovations such as cloud computing, it is more likely workers will seek self-employment than in the past. Contrary to popular belief, the average self-employed worker is more likely to be older and professional than in a trades-based business. This is a global trend that will have ramifications for both business and government, particularly as it is an aspirational goal for almost half the labour market.

Successive waves of the industrial revolution have encouraged greater specialisation both by workers and countries. Australia has been a net beneficiary of this trend, growing in wealth and prosperity as the complexity of its goods and services has increased. The jobs of the future are likely to be created as individuals, businesses and even nations continue to specialise further. This specialisation opens up the need for more support services. The 'sharing digital economy' fostered by electronic platforms such as Uber or Airbnb facilitates individuals and businesses outsourcing more of their own needs to others. This trend will benefit individuals who can command higher remuneration for their services, businesses that bring more specialised employees to perform increasingly niche activities in the global value chain that is emerging, and nations that are able to develop value adding specialist goods and services. The alternative is to experience commoditisation of the goods and services offered by the individual, business or nation, resulting in declining prosperity.

Policy response

In many regards, Australia is well positioned to respond to the emerging workforce challenges with its highly educated workforce, prosperous and stable society, and geographic proximity to the emerging economic powerhouses of Asia. The world economy is increasingly becoming one where the winner takes all. Technological developments are allowing the wider and quicker dispersion of successful innovations. Australia has historically been a swift adopter of technological developments, but this strategy is going to be less and less useful in the future as more of the gains will accrue to the developer of innovation and the rest will be commoditised. To maintain and improve living standards in the face of technological change, Australia needs to adopt a broad-based education policy, ensure it can attract the best and the brightest, and enhance its innovation ecosystems to ensure it can operate on the technological frontier. In short, Australia needs a new social contract in education, innovation and attitude to the workforce to underpin its future prosperity.

Innovation policy

In this emerging global environment, Australia needs a new social contract, one that recognises the role of government in developing the enabling environment for industry to flourish, which develops the most from the nation's human capital and incentivises innovation. The current strategy of creating growth centres designed to encourage business and university collaboration is a good start. However, these growth centres have been allocated only $190 million over a four-year period, a sum inadequate to drive Australia's future growth. For comparison, the UK Catapult Centres, on which the Australian growth centres are modelled, has $3 billion over the same period while there are even larger allocations available for the German Fraunhofer network, the Netherlands' Top Sectors strategy and the US National Manufacturing Institutes.

CEDA's recommendation:

- To encourage business and university collaboration, the Australian Government should fund its industry growth centres to a level commensurate with international best practice.

The next stage of the industrial revolution requires faster responses from government. The top-down siloed approach, on which Australia's government is currently structured, is too cumbersome and not responsive enough for the needs of industry and the community. Cooperation is essential for most successful outcomes. *The White Paper on the reform of the Federation* should be used as an opportunity to bring all parts of the Australian Commonwealth to the table as equals to develop information and learning systems, and to support accountability and continuous performance improvement in the delivery of agreed outcomes. This approach, in principle, does not demand that any particular vertical assignment of functions be applied, rather only that there be robust ways of coordinating the shared jurisdictional interests in them. CEDA put forward a case study for just such an approach for dealing with indigenous issues in the report *A Federation for the 21st Century*[10].

CEDA's recommendation:

- Rather than a top-down approach whereby higher spheres of government attempt to mandate activity on the ground, the current review of federalism should examine new frameworks for coordinating federal-state relationships built on collaboration.

CEDA's major report for 2013, *Australia Adjusting: Optimising national prosperity*[11], describes a range of economic reforms necessary to optimise the nation's prosperity. The proposed reforms cover addressing areas of economic rigidity in the economy, incentivising innovation and enhancing the nation's human capital. The report called for the establishment of a National Productivity Policy to replace the National Competition Policy that addresses a comprehensive review of regulation, pricing and licencing arrangements while phasing out industry subsidies among other important microeconomic reforms. These reforms, for the most part, have not been addressed. Politicians have been unable or unwilling to tackle the difficult issues of major economic reform.

CEDA addressed the challenge of policy setting in the reports *Setting Public Policy*[12] and *A Federation for the 21st Century*. The latter report identifies that it is important that the nation operates on the policy frontier as it is on the technological frontier.

CEDA's recommendation:

- The Australian Government should establish a National Productivity Policy addressing a comprehensive review of regulation, pricing and licencing arrangements while phasing out industry subsidies among other important microeconomic reforms so that Australia can operate on the policy frontier.

Education

A relatively highly educated workforce has been a traditional source of advantage for Australia. However, the rapid rise in global education means that this historic strength is being eroded. Further, the increasing ability of computers to substitute for human thinking means Australia needs to ensure the education system is providing students with the skills they need.

CEDA's recommendation:

- In *Australia Adjusting: Optimising national prosperity*, CEDA identified that Australia's education policy lacks a unified, overarching policy framework to guide the allocation of investment in education and training from early childhood to further education, and training and tertiary education. It should build on previous investments, target underperformance – particularly children from disadvantaged groups in the population – and develop initiatives targeted at optimising the capabilities of the brightest children.
- The Commonwealth Government should consider developing a public learning-focused child care and preschool system that is affordable and a formal part of the Australian education system. This means any extension of paid parental leave should be considered in light of the overarching education policy framework. If done correctly, not only can this help improve educational outcomes, it can assist female participation in the workforce, providing an economic dividend as well. There is also the need to ensure all stages of the education process focus on instilling competencies rather than the retention of specific knowledge.

Digital disruption means it is more important than ever that the skills being taught are not firm-specific, but instil broad competencies that represent a valuable public investment. Particularly in the vocational education and training (VET) sector, there is a tension between delivering the skills that students and employers want, while providing learning that is relevant for the longer term. The move towards demand-driven education has made the VET sector more responsive to community and business needs, and has improved its overall efficiency. CEDA explored these benefits in *A Federation for the 21st Century*. However, there is a tendency in some segments of the sector to

teach highly industry-specific, or even business-specific, skills. Considering the investment of public funds, it is important to ensure that skills are being taught that are relevant to the broader economy. The tension between job-ready and broad-based competencies should be guided by the overarching policy framework.

CEDA's recommendation:

- Digital competency will be a basic competency for all workers in the future. It needs to be included as a core component of school education, both in terms of content and delivery, as distinct from the teaching of specialised ICT, technology and computer science subjects. The overarching policy framework should recognise that the next wave of the industrial revolution will require life-long learning.

At the moment, there are barriers preventing individuals undertaking reskilling education due to past attainment. For instance, educational attainment can be a barrier to receiving vocational education and training.[13] These barriers to ongoing education need to be removed so that individuals can maintain industry-relevant skillsets.

When it comes to the ICT industry, it is important that the focus be on the deeper technical skill development of:

- Architecting: the capacity to put together components to build larger systems;
- Designing: conceptualising new solutions, for example, developing optimisation programs; and
- Analysing: making sense of data, for example, applying analytics to make predictions.

Capital cities

An important complement to Australia's innovation policy is to ensure the country has liveable cities. The highly skilled employees who increasingly drive prosperity are able to work globally and are highly mobile. City liveability is a strong predictor of economic activity and wage growth because it indicates an area's ability to attract this innovative class of people who drive economic activity. As a consequence, liveable cities are innovative cities that create jobs at a much higher rate than others do. Australia is well positioned to create globally competitive cities. Yet planning failures diminish the nation's natural advantages.

In *A Federation for the 21st Century*, CEDA recommended creating discrete city-wide entities with the responsibility for whole-of-urban planning, preferably with hypothecated funding arrangements, such as the fuel excise and appropriate congestion pricing. Such entities would be in a better position to appropriately service the capital city economic growth engines that will attract the best and the brightest workers in the future.

CEDA's recommendation:

- Australia should adopt discrete city-wide entities with the responsibility for whole-of-urban planning. These entities should, preferably, be vested with hypothecated funds from sources that generate it within the jurisdiction, such as the fuel excise and appropriate congestion pricing, to ensure adequate investment in the infrastructure that makes these cities liveable.

Labour force adjustments

Australia's labour market is robust and relatively efficient for most people. However, historically workers in industries experiencing large redundancies have frequently experienced challenges in re-engaging with the labour market in large numbers. The social and economic cost is substantial. As the new wave of the industrial revolution makes more and more roles redundant, it is important that proactive steps be taken to ensure workers develop the skills to remain in the workforce.

In particular, Australia should learn from countries that have managed substantial retraining programs focused on mature-aged unemployed workers.

This is not a short-term activity. Taking middle-aged workers, who are frequently lower skilled, out of their familiar environment and putting them in a classroom with the expectation they will immediately learn new skills is unrealistic. Extensive investment in reskilling programs needs to be considered for industries experiencing high levels of retrenchment. The experience from countries such as Denmark is that this retraining should happen as soon as possible, preferably prior to retrenchment being finalised as is the opportunity with automobile workers in Australia.

CEDA's recommendation:

- Australia should seek to emulate other countries' success in transitioning workers out of declining industries. This will require a concerted effort to reskill workers prior to retrenchment.

Endnotes

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10 Committee for Economic Development of Australia 2014, *A Federation for the 21st Century*, October, Melbourne.

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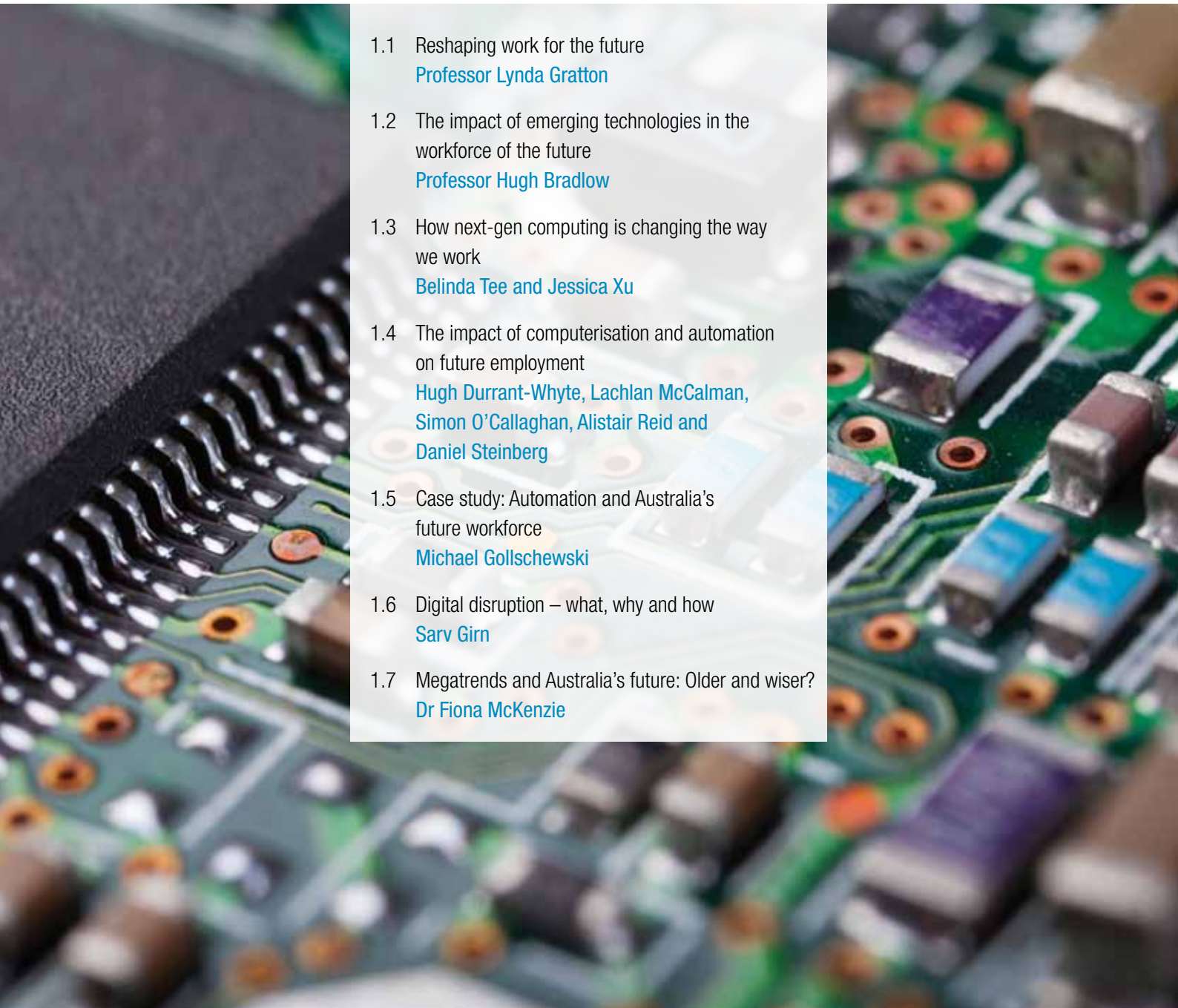
13 An example of a barrier is that individuals with a Certificate IV or above are unable to receive a government subsidy for training in NSW. See page 15 of the *Smart and Skilled fee administration policy*, accessible at *www.training.nsw.gov.au/forms_documents/smartandskilled/contract/fee_administration_policy.pdf*

SECTION

1.0

Global trends



1.1

Reshaping work for the future

Professor Lynda Gratton

Professor Lynda Gratton[1] is a Professor of Management Practice at London Business School where she directs the program Human Resource Strategy in Transforming Companies. Professor Gratton is the founder of Hot Spots Movement and for over six years she has led the Future of Work Research Consortium, which has brought executives from more than 80 companies together both virtually and on a bespoke collaborative platform.

Professor Gratton has written extensively about the interface between people and organisations. Her case on BP won the EECH best case of the year, her article on signature processes won the MIT Sloan Award, and in 2012, her book *The Shift*[2] received the best business book of the year award in Japan. Her latest book, *The Key*[3], looks at the impact of the changing world on corporate practices, processes and leadership.

Introduction

Change is a word which, whether used in political slogans or corporate processes, has come to characterise much of the past decade. We exist in a landscape that is constantly and rapidly changing – and the context in which we work is no exception.

In my book, *The Shift: The Future of Work is Already Here*[4], I discussed in detail the five forces that have a profound effect on our working lives:

1. Technology;
2. Globalisation;
3. Demography and longevity;
4. Society; and
5. Energy scarcity.

Each and every one of us has personal experience of these forces and the shifts that are changing working lives across the world. Yet even the nature of those personal experiences is changing rapidly. Visit any large organisation today and you will find a workforce made up of people whose levels of familiarity with technology are incredibly diverse. Those born in the 1950s will be able to remember using typewriters and correction fluid during their early working lives and can probably pinpoint the exact year when personal computers entered their office. Their colleagues born in the 1970s will have played computer games as teenagers and will have entered a workplace where communicating by email was the norm. Meanwhile, those born in the 1990s will have used computers throughout their childhood as a crucial component of their educational experience. They may never have seen a typewriter outside of a museum.

In just a few short decades, the scale of our interaction with technology has changed completely – and it is still changing. Today, even nine-month-old babies are interacting with their parents' iPads and tablets, beginning to grasp how they function and acquiring a depth of familiarity with technology. In Australia, this trend is becoming institutionalised, with pre-schools beginning to ensure that children become familiar with Smart Boards and iPads and use them as part of the school curriculum. This can only lead to an increasing confidence with technology that will exert great influence over how people approach tasks and, perhaps even more pertinently, how they wish to collaborate with each other.

The dawning age of the specialist

These technological advances are not only changing the way we work, they are exerting influence over the very nature of our work. Perhaps one of the most interesting changes is a phenomenon that labour economists have called 'the hollowing out of work'. This effect sees routine jobs disappear to be outsourced or replaced by technology, leaving only non-routine jobs at the ends of the skill continuum – those that require either low-end skills or high-end skills. The remaining low-skill work cannot be easily outsourced (such as food preparation), or has a non-routine physical element (such as caring work). Because of the relatively low-skill nature of this work, it is always available to recent arrivals to the labour market (for example, through immigration), so wages generally remain low.

The non-routine high-skill work survives because it has not yet been replaced by technology and cannot easily be outsourced – most professionals and some management roles fall into this category. We can expect this type of work to become more complex because the easy parts will be relentlessly replaced by technology, leaving only the components that require more complex human skills, such as collaboration or negotiation, and therefore need more preparation. Of course in most developed economies, it is these highly skilled jobs that are most attractive.

This reshaping of the markets for work puts huge pressure on people to invest more in their skill development and to identify skills that are both valuable and unlikely to be substituted by technology. Workers will be responsible for keeping an eye on the changing working landscape around them to ensure they are developing the complex, specialist competencies they need for a successful future.

These are all issues I addressed in my 2010 book, *The Shift*.[5] Since then, an additional pressure has emerged: the growing recognition that what we think of as a working life will be profoundly influenced by increasing longevity – with working lives going from the age of 20 to 80 increasingly the norm. In these long working lives, becoming a specialist in one area will not be sufficient. People we will have to be prepared to retrain, refocus and relearn at various points in their career.

The global workplace

The forces of technology and globalisation we are seeing right now are not only changing the nature of work, they are profoundly reshaping global labour markets.

Advances in online technology are pushing the globalisation of the market for talent, through a combination of more people engaging in tertiary education and more people having access to world-class online education. A brief look at the figures for tertiary education in China reveals much about how this trend is emerging. According to an Organisation for Economic Co-operation and Development (OECD) study, young people from China represented 17 per cent of the world population of graduates in 2000, and this will rise to 28 per cent by 2030.

The profound effect this globalisation of talent will have on corporations can be glimpsed by taking a look at the evolution of the faculty at London Business School. Photographs of the faculty from 50 years ago show a community that was mostly English and male, and a student group with a rather similar profile. A photograph of the current student body shows that it represents 100 different nationalities and is made up of 35 per cent women. The globalisation of the faculty and the doctoral group has been just as profound. There are now 30 nationalities on the faculty – with very few English men. As the talent pool has become more globalised, the standard of educational excellence has increased. The changes in education illustrated by this example are also taking place in many other labour markets. Globalisation means there are potentially more people available to engage in skilled work – and some of them can work harder, faster, or better, or cheaper than local workers.

This increased globalisation of talent presents a huge opportunity for Australian companies, many of which have struggled to find the right talent over the past decade. Australia's strong economy and low unemployment rate have resulted in a war for talent, with employers often finding it hard to source people when they need them. For example, fewer than five years ago the Australian mining industry found itself with a severe skills shortage during its most recent boom.

With a more globalised talent pool, Australian companies have some distinct advantages, positioned as they are in relative proximity to the large talent pools in Asia. What's more, having already experienced this scarcity of talent, Australian employers have developed a portfolio of tactics for securing the talent they need. The offshoring and partnering arrangements already established have created a 24/7 working environment that is international, networked and diverse. These will be crucial factors in offsetting Australia's relative isolation and ensuring that the country is ready to compete for the best international talent when it comes to hiring its next generation of workers.

Work and society

Naturally, these changes to the landscape of work lives raise serious questions about how workers will be affected as individuals. With the nature of work changing to envelop all of us in an environment of 24-hour connectivity, organisations, academics and individuals are giving serious thought to how people will be able to cope.

My own insight on this comes from a study I conducted with Professor Hans-Joachim Wolfram on how managers across Europe responded to the permeable boundaries that technology creates between work and home. We found, and indeed others have made the same observation, that there is a constant flow of energy between work and home. At times, this energy flow is positive: people gain a great deal from work, they learn new skills that can be transferred to home, and meet people who excite and interest them. At other times, the energy flow from work to home is profoundly negative: people leave work feeling frustrated and angry, they cannot switch off and may feel guilty at home when they are not working. The differences between the two types of energy flows are determined by both the nature of the work and the attitude of the person. Work is more able to create a positive energy flow to home when the design of work allows people to have some autonomy over when and where they work. They are more able to create this positive flow when they are able to actively use this autonomy and build in times for recuperation.

Interestingly, those who study sleep and stress have found that the ability to cope with pressurised work is dependent on having time to recuperate and being able to have a good night's sleep. What this tells us is that it is not work itself, but the relentless nature of work and the poor sleeping patterns accompanying it that have a profoundly detrimental effect on energy flow, and consequently on health and general life satisfaction.

It is perhaps no surprise that in many countries – including Australia – there have been an increasing amount of media coverage on the importance of achieving a healthy work/life balance. Employers are waking up to the fact that supporting wellbeing in the workplace is a vital means of attracting talent – especially younger people, for whom the ability to take regular exercise, have a good night's sleep and eat a balanced diet are all high priorities as they enter a working life that could well stretch into their 80s.

These issues – often characterised by the term wellbeing – touch upon another global change that will exert huge influence on the social values around work: longevity. In Australia, as in most other developed countries, the population is ageing – and pension plans are lagging behind.

Over time, more and more countries will raise the age at which workers become eligible to draw a pension. This has profound implications. Younger employees worry about maintaining their health and wellbeing not out of vanity, but because they will work a great deal longer than their parents and grandparents did. Companies will

have to plan for a workforce demographic they have never previously considered. As careers continue to stretch, people will need flexibility to take time out for reasons other than child care, and employers will need to create job structures that allow them to do so – and to make this possible without resentment.

As I discovered when my team at the Future of Work Research Consortium researched this for our masterclass on The Hundred Year Life, very few companies are already working on structures that will support longer working lives. To make up for this, they will need to be prepared to experiment and to pilot new ways of working to discover what works.

This spirit of experimentation has already been embraced by some pioneering companies. In the 1970s and 1980s, it was work experiments at BT in the United Kingdom that led to its pioneering new ways of working. Now, companies around the world such as Valve and Clearspire are leading the way when it comes to innovative job design and decoupling work from physical office space.

Yet despite these examples, for many other companies new ways of working remain peripheral – reserved for certain groups as part of a diversity agenda or seen as a blocker to career development. This needs to stop. Organisations must experiment to ensure that new ways of working are accessible to all employees and varying life stages.

Revolutionising relationships

At the heart of these necessary shifts in the nature and patterns of work is the need for a wholesale change in the relationship between employers and their employees. As we move from careers that resemble a sprint to working lives that are more like a marathon, with all the potential for deviation a longer journey entails, we need to acknowledge that not everyone's working life will look the same. Employers will need to recognise that securing – and hanging onto – the best talent will mean making allowances for the fact that not all their employees will want to race to the top.

At the heart of this is the process of establishing a relationship between employer and worker that is less 'parent-to-child' and more 'adult-to-adult'. This is a shift that began more than two decades ago, with executives saying 'we cannot give people jobs for life' and workers expressing the need for more autonomy over how they work. At that time, there was a distinct gap between the rhetoric and the reality. In the intervening years, much has changed. Few people now join a company believing they have a job for life, and many realise they need to take more responsibility for themselves.

This shift has not come about because of changes made by employers alone. Adult-to-adult relationships at work are based on trust, and specifically the capacity of workers and managers to trust each other. Home-based working is an example of where trust can be stretched. The technology is there for some people at some time to work from home, but many do not because they implicitly understand that once they are out of sight they are not trusted to be working hard.

At times, peering ahead at the changes that are in view, it may seem as though we in the world of work are at the edge of a precipice about to hurtle into the future without the benefit of the familiar to cling to. But there are some aspects of the world of work that never change. As with previous generations, for most of us, work can be a huge source of excitement, purpose and productivity. It can also be a huge source

of frustration and exhaustion. Crucially, the future of the workplace has the potential to help us develop the inner resilience we need to tip the balance firmly in the direction of the former. Our future working lives will be characterised by empowerment, flexibility, and collaboration – all of which will help us adapt to the subtle combination of technology and globalisation that is shaping the world in which we work.

Endnotes

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The impact of emerging technologies in the workforce of the future

Professor Hugh Bradlow

Hugh Bradlow is Chief Scientist at Telstra Corporation in which capacity he acts as adviser to the CEO, the board and other parts of the business on longer term technology directions and technology disruption.

Prior to becoming Chief Scientist, he was Chief Technology Officer and Head of Innovation, responsible for investigating the future technologies that will affect Telstra's business.

Before joining Telstra in September 1995, Professor Bradlow was Professor of Computer Engineering at the University of Wollongong in Australia and Professor of Electrical Engineering (Digital Systems) at the University of Cape Town.

Professor Bradlow is a graduate in electrical engineering from the University of Cape Town in 1973 and received the D.Phil. degree for research in experimental nuclear physics from the University of Oxford.

Workforce of the future

One certainty about the economy and employment in the years ahead is they will continue to be shaped and affected by new and evolving technology. Over the past 20 years we have successively seen the internet, broadband, mobile and social networks cause disruption to existing business models. For example, consider the impact of Uber on the taxi industry, or the shake-up of the tourism industry caused by online reviews on TripAdvisor or the supply of accommodation through AirBnB, or the steep decline in bricks-and-mortar book and music stores as consumers stream and download content.

While the impact of technology on the workplace to date has been significant, it is likely to be dwarfed by new technologies that are emerging. This will place new demands on employees. In all jobs, across all sectors, the ability to work with technology and understand its impact on the business is now a basic job requirement. However, training in information and communications technology (ICT) alone will not guarantee success in the future workplace. As computing power continues to increase, more and more tasks will be automated. This will require employees to undertake tasks that are less routine and not readily automated, which will involve complex problem-solving, teamwork and interpersonal negotiation skills.

This chapter addresses the key transformational technologies expected to change all our working lives in the years ahead.

Emerging technologies and their impact

Emerging technologies are those technologies currently in early stages of development or adoption that have not yet had a chance to affect the wider society. The technologies discussed in this chapter are predicted to become transformational, which means they will be adopted into mainstream society, with flow-on effects for the economy and the workforce.

Over the past few years, there have been developments in emerging technologies in a number of fields: ICT, clean energy, materials science and genomics. This chapter will focus on the impact of several emerging ICTs that are predicted to have a pervasive impact across all areas of the economy.

Today's ICT environment can be characterised in broad terms by three significant trends:

1. Computing is moving into the cloud and consequently becoming abundant and cheap;
2. Media distribution is shifting from broadcast to broadband, thereby creating the technology environment for immersive solutions that allow realistic telepresence; and
3. Environmental pressures such as climate change, food and water supply, as well as social pressures including security, health and an ageing population, are creating the need to measure the world around us so that we can influence it.

These trends are supported by a range of emerging technologies:

- Cloud services;
- The Internet of Things;
- Big Data;
- Artificial intelligence and robots; and
- Immersive communications.

Cloud services

By taking the infrastructure for computing and putting it in a cloud data centre we create utility computing. The data centre (in reality, a network of multiple data centres) is usually operated by a third party and is shared by many organisations that are customers of the cloud services provider. This provides organisations and individuals with computing capability on demand without the need to invest in their own infrastructure.

This technology is already in the mainstream and has led to abundant cheap computing resources. What makes it emerging is its trajectory to go beyond simply sharing infrastructure. We anticipate that in the future, whole business processes will be purchased out of the cloud from a service provider. This will create utility information technology (IT), putting sophisticated IT solutions within the reach of individuals and small businesses, not just large enterprises.

The benefits of IT purchased out of the cloud as a service are significant, including:

- Users are no longer tied to their PC or laptop for their computing needs. They can operate on the same data and applications on any device that suits their current context. It also saves organisations the significant annual expense of maintaining a PC or laptop on an individual user's desk;
- When the significant effort of securing the work environment is shared, users can receive better security and a much lower cost of operations;
- Users can obtain sophisticated solutions such as Big Data environments on demand without needing the high degree of skills and sophistication it takes to set up such an environment.

The Internet of Things

The Internet of Things (IoT) refers to a new generation of cheap sensors connected to the internet that can report their measurements of the physical world to which they are attached. This will lead to digitisation of the physical world, which makes it more controllable.

The IoT is likely to have an application in, or be used by, every vertical segment in the economy. The impact will vary, but in general it will create the opportunity to optimise the physical world in a way that has never been previously possible.

For example, in the medical field, it can be used to perform constant monitoring of biomarkers of interest for particular patients and allow early medical intervention for those patients. This means a patient with a heart issue could have a small (effectively the size of a large Band-Aid), single-lead ECG monitor attached to their chest to constantly report their heart activity. The sensor is small enough to allow the patient to continue their daily routine without being noticed. The heart signal will be relayed by the user's phone to a cloud database that will constantly monitor it for anomalies.

The impact of the IoT can also be seen in the optimisation of energy use in buildings by reporting and monitoring temperature, and power consumption. Another example would be in the urban environment: surveillance cameras (which are also a form of sensor) could provide public safety and more effective use of police resources.

Such is the pervasive impact of the IoT that Cisco estimates 50 billion 'things' will be connected to the internet by 2020.[1]

Big Data

The previous two trends result in an environment where there are massive amounts of information available as well as the scalable computing environment necessary to store, retrieve and process that data. The data come from many sources: usage patterns of today's consumers and, in the future, all the connected sensors that will be providing information on a continuous basis.

The technical ability to take all this data and store it in a scalable cloud-computing environment has led to the term Big Data. Instead of the need to curate information, data can be stored in a 'data lake' where it can be analysed retrospectively. In many circumstances, there is a need to analyse data in real-time (consider, for example, medical monitoring where timely intervention is critical). New software technologies have emerged to enable the streaming analysis of data for such applications.

One of the significant characteristics of these new software technologies for Big Data is that they tend in the majority to be based on open-source software, which ensures rapid adoption speed.

The remaining pieces of the puzzle are the techniques to analyse this data. All sorts of analytics software solutions are emerging that take the information from data lakes, or streaming platforms, and perform decision support for organisations. The abundance of incoming data enables the prediction and optimisation of outcomes by modelling the implications of business decisions. Visualisation tools may also help business owners understand the trends they are witnessing.

Analysis tools tend to be based on statistical techniques or on machine learning. In the latter case, analysis software learns patterns by ingesting many previous examples of different scenarios that enable it to recognise future scenarios (for example, if you provide it examples of a normal heart signal from a monitor, it will potentially recognise anomalous signals in the future). These machine-learning solutions fall under the loose heading of 'artificial intelligence', which is a significant technology trend in its own right.

Artificial intelligence and robots

While we have seen significant progress over the past 50 years in computing, the ability of today's 'symbolic logic computers' to emulate human thought patterns has been limited. However, the abundance of computing power and the availability of vast amounts of data have led to a surge in machine-learning techniques, which are colloquially referred to as artificial intelligence. These techniques enable computers to perform human tasks such as natural language understanding, speech recognition and pattern recognition.

Significant progress occurred over the last 10 years and we can expect this to accelerate in the next 10 years as new computing architectures emerge that enable these tasks to be performed at larger scale, with lower power and higher speed. As an example, IBM has developed a synaptic computing chip called True North, which emulates the functioning of neurons and synapses of the human brain.[2]

Artificial intelligence enables computers to perform tasks that only humans could do previously and in many cases, because of the ability of a machine to assimilate vast amounts of information, it can perform these tasks better than a person can. For example, IBM has also developed a computer called Watson, which is capable of understanding natural language. The computer was used in the quiz show *Jeopardy* to outperform humans. IBM is now using the same technology to perform functions such as medical diagnosis[3] by using the machine to 'read' the vast amount of medical literature that is published on a daily basis and correlate this data with patient symptoms. Not only can Watson perform a differential diagnosis of the patient's condition, it can explain to the human physician how it reached its conclusion.

Placing this artificial intelligence technology in vehicles and combining it with sensors, communications and cloud computers create robots that can emulate a wider range of human capabilities. A mere 10 years ago, people believed that emulating the cognitive functions of a human driving a car was beyond the capabilities of computers.[4] Yet within eight years, Google has proven it is possible to create a self-driving car by building one and driving it for 1.1 million kilometres around California without an accident (other than being rear ended by a human who made a mistake in the car following it).[5] Research tells us that road accidents are predominantly caused by human error,[6] so autonomous vehicles could significantly reduce the annual road toll, which in Australia is currently 1200 deaths[7] and 50,000 hospitalisation injuries[8] per year.

The use of artificial intelligence or robotics is going to have a profound influence on various tasks that humans perform imperfectly. The autonomous vehicle is just one example from thousands.

Immersive communications

Today's generation of broadband is web-centric, which means it is best suited to downloading web pages that are highly 'bursty' in nature and thus have a low aggregate throughput relative to their peak rate.

As we see media increasingly become broadband-centric (in other words, more TV is being watched on demand over broadband), broadband access technology optimised for the delivery of media becomes more important. This means access technology has to be able to support the bit rates for media streams of the required definition (for example, six to 10 megabits per second [Mbps] for high definition TV), but more importantly, it has to have sufficient aggregate capacity to support multiple users watching simultaneously. To build this new generation of broadband, you need to deploy or upgrade networks to provide the necessary bandwidth. In the fixed environment, this means investment in technologies such as fibre-to-the-node, fibre-to-the-curb, fibre-to-the-premises and hybrid fibre-coaxial (HFC). In the mobile environment, you need to be able to scale the capacity with new technologies, more spectrum and more base stations.

In addition to becoming media-centric, broadband communications need to support cloud computing. Effectively, a user's device is just a remote window into a cloud-computing data centre and without adequate communications, the user's capabilities are severely curtailed. The user experience is determined by how close the experience of working in the cloud is to that of working locally, which is determined by the latency and reliability of the communications link.

Cloud-centric communications require latency that is low enough to ensure that the exchange of computing protocols is not noticed by the user. They also require that the communications coverage and reliability is such that the user can confidently rely

on its availability and throughput wherever they are likely to be. An additional consequence of cloud-centric communications is that the ratio of upstream to downstream bandwidth begins to decrease because of the higher upstream requirements of cloud services. That is not to imply that symmetric bandwidth is required but the high upstream to downstream ratio of web-centric broadband will be a limitation to cloud-centric broadband.

This new generation of broadband networks, combined with rapidly developing screen technology, creates the technology platform for ubiquitous, rich video communications. This means the technology is able to deliver high definition and realistic representation of distance scenes both from a video and audio perspective (which we refer to as immersive communications), thereby allowing effective telepresence.

The impact of technology on the workforce

In this rapidly changing environment, no prediction of the future can be anything other than a postulated scenario. What we do know is that the future can't look like the past because the emerging technologies will inevitably affect the future of employment.

One thing is clear: Technology can take over routine tasks – even intellectual ones – but problem-solving is likely to remain a human skill for many decades to come. Prospects for employment success in the future will be greatly enhanced by the ability to understand business problems and craft solutions that address the issues.

Access to work

Traditionally, proximity of workers to customers was required to deliver service, particularly for high touch, complex or persuasive interactions that usually require face-to-face interaction (consider for example, a customer discussing a complex investment strategy with a banker). However, the widespread access to the new immersive communications, which facilitates telepresence discussions with the same range of visual and non-audio cues as in a face-to-face conversation, may break the nexus between the location of the customer and service personnel. Workers will be able to choose their location for work-life balance reasons and compete for even highly skilled jobs with people in other geographies (notwithstanding the limitations of time zone, culture and language). It may also assist workers faced with physical or ambulatory disabilities to participate in the workforce more equally.

The ability to understand and empathise with customer issues and design suitable solutions to their problems will be a key determinant of employment success. Providing our education system delivers the skills to enable employees to craft solutions to business problems from complex technologies, this bodes well for the Australian workforce as our workers are exposed to leading-edge problems due to the sophistication of the Australian economy.

Job categories amenable to computerisation

Frey and Osborne[9] examined the job categories in the United States (US) market (which had the best data for their purpose) and used a panel of technology experts to identify those job categories they believe amenable to computerisation as a result of the emerging technologies. They estimated that 47 per cent of people are employed in the job categories that are amenable to computerisation.

To understand why jobs are amenable to computerisation, we need to focus on the combined impact of the technologies, but also be aware that the most dramatic changes will be due to progress in artificial intelligence. There is no generic way to identify how jobs will be computerised but we need to look at the economy vertical by vertical. It is also important to note that while some job categories will be affected more than others, in many cases computerisation will yield efficiency and thereby lead to a reduced or different demand for workers in that category rather than a total elimination of the job category.

As an example of the type of logic that would apply to a job category being computerised, consider jobs that involve driving. Table 1 is a rough estimate of the number of jobs in Australia that involve driving today. By these figures, approximately a quarter of jobs involve driving a vehicle. If we assume that over the next 20 years all vehicles become autonomous, these job categories will need to change into something completely different as the human skill of driving a vehicle is no longer the essential part of the job. The customer service aspects of the job will become far more important.

TABLE 1
NUMBER OF JOBS THAT INVOLVE DRIVING

People employed nationally (December 2012)[10]	11,541,500
Commercial vehicles (excluding motorcycles) nationally (2012)[11]	3,266,521
Commercial motorcycles* (2012)[12]	10,000
Train drivers nationally (2011)[13]	11,900
Total**	3,288,421 (or approximately 28 per cent of all jobs)

* Estimate based on 6600 Australia Post motorcycles.
**Assumes each vehicle creates at least one job.

Is it reasonable to assume that all vehicles will become autonomous? Based on the progression of Moore's Law, we shall see computing technology improve approximately 10,000 fold over the next 20 years. The affordability of autonomous driving systems will improve dramatically. Furthermore, if the statistic that 90 per cent of road accidents are caused by human error is correct, governments will inevitably regulate that such systems are mandatory because of the savings to life and health costs.

To highlight another example, consider the job of cytologists who screen cells from patients for signs of cancer. Their work involves obtaining samples from patients, preparing slides for examination and then reviewing those slides under a microscope. It is a complex and painstaking task with high stakes. Yet we are already seeking ways to automate the task[14], and it is highly likely that a combination of machine vision and machine learning will enable the labour-intensive microscope examination part of the role to be automated with more reliable results than can be achieved by a human. Machine vision will identify the morphology of the sample that a human cytologist would review through the microscope, and machine learning will enable the computer to be trained to recognise abnormalities that need to be further investigated.

In a similar vein, examination of any job category that requires routine measurement, operation, pattern recognition or manipulation will lead to a similar conclusion that the declining cost and increasing reliability of technology will cause the scope and demands on human labour to change due to computers at some point in the future.

Job categories that are not amenable to computerisation

Even those job categories not amenable to computerisation (as defined by Frey and Osborne) will inevitably be affected. Frey and Osborne define the job categories that are not susceptible to computerisation as involving:

- Perception and manipulation;
- Creative intelligence; and
- Social intelligence.

While it is arguably difficult to remove humans from such job categories entirely, the more important question is whether people will continue to be employed in such categories at the same rate as today.

As an example, consider the medical profession. A proportion of each doctor's time is spent examining patients, ordering tests and performing diagnoses. Consider a world where patients are constantly being monitored by biosensors on their bodies and the data from those sensors is being assessed in real-time by machine-learning algorithms looking for anomalies, and diagnosis is performed by a Watson-like computer. Under these circumstances, the number of patients each physician can deal with will rise and thus there will be a need for fewer physicians per head of population than today. Furthermore, the major demand on a physician's time will not be technical skill but social intelligence, leading to the need for different selection processes and different skillsets to be taught to medical students.

The substitutional impact of digital infrastructure

Another possible impact on the workforce of the future will be the substitution of digital infrastructure for physical infrastructure.

Today, digital infrastructure is seen as additive to physical infrastructure. For example, smartphone apps make the use of public transport more convenient, but they do not lead to a reduction in the number of roads. However, based on the emerging technologies, it is possible to postulate a world in which there is a reduction in actual people movement due to immersive technologies, optimisation of road use due to the advent of driverless cars (which enable vehicles to be packed more tightly into any given road space), optimisation of the overall road network due to Big Data, and a reduction in the number of cars per person due to car-sharing schemes such as Zipcar. Under such circumstances we could witness a decline in road use and therefore less need to construct new roads in the future.

Conclusion: Challenges to address

The nature of employment – the type of work humans do – is going to change dramatically in the coming decades. For many, this change will lead to disruption of their current work and a drop in demand for traditional skills. For others it may mean new opportunities in new fields and industries but we do not yet have an understanding of what new jobs, and in what number, will be created to facilitate or nurture this change. Given the rate of change of technology, preparation for dealing with this disruption must begin now.

However, assuming we are able to set aside the self-empowerment and belief that employment can provide people (as it may be generationally dependent), we can also conclude on a more optimistic note. If we assume that the purpose of employment is

purely to meet our needs as defined by the bottom two layers of Maslow's hierarchy of needs (physiological and safety)[15], then it is anticipated the machines will take care of those needs, leaving humans free to pursue the upper layers of Maslow's hierarchy. The change could result in a new generation free of poverty and the burden of labour, thereby unleashing the next wave of human innovation and creativity in directions we can never imagine.

How might such a utopian scenario arise? Consider for example the care of people with special needs such as the mentally and physically handicapped, the chronically ill and particularly the aged (the latter being particularly important in the ageing societies of the developed world). Today the elderly often need human assistance with basic functions such as making meals, washing, using the toilet and catching transport. This is a labour-intensive and expensive undertaking. There are strong indications that the future workforce will struggle to provide the tax base to adequately support the large elderly population we can anticipate.

In the future, the promise of technology is such that it is conceivable that special 'aged care robots' will be created to perform these functions for the elderly. Ambulatory robots are being designed to assist with movement and chores such as washing and cleaning. 'Aged care' robots could draw on the internet to create recipes tailored to the recipient, order the ingredients, have them delivered (by other robots such as autonomous vehicles), and then cook and serve a meal, customised to the health needs and preferences of the elderly recipient.

Robots can potentially even offer emotional support for lonely people. For example, consider Pepper, the robot developed to offer customer service for Softbank in Japan,[16] or the robot pets offered by Innvo Labs.[17] The use of robot workforces could overcome many of the doomsday scenarios that people speculate for the future.

The changes caused by emerging and disruptive technology will have broad implications for society and challenge us to develop responses. The caveat on this utopian view of the future is that for society to benefit from the automation of work, we must have a means of distributing the wealth created by machines. The political and social implications of this change will occur at different speeds in different industries and markets. What is clear is that as a society these are questions we need to consider. We need to better understand these changes and plan how to deal with these changes well in advance of their actual occurrence.

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1.3

How next-gen computing is changing the way we work

Belinda Tee and Jessica Xu

Belinda Tee is leading IBM Watson Business Development for Australia and New Zealand. She has been working in the IT industry for over 20 years, starting off as a software engineering specialist. She has had stints in consulting, been the technical manager for Australia and New Zealand, and worked in business development for IBM's industry accounts.

Belinda has a Bachelor of Science (Computing) degree from the University of Technology, Sydney and also a Graduate Certificate in Change Management from the AGSM. Belinda has also been a part of many IBM leadership development programs.

Jessica Xu is an organisational psychologist and a management consultant in IBM's Workforce Science Practice. Jessica has a strong passion for maximising organisational performance through people. She has worked with a wide range of organisations in the education, ICT and government sectors, and her skills and expertise span across organisational research, workplace culture and leadership assessment.

Jessica is a published author, and works closely with universities for joint research projects in the field of organisational wellbeing and performance.

Introduction

Humans have long relied on tools to expand their cognitive abilities. For the better part of 60 years, these tools have been programmable computers. But computers have limitations. They are limited to carrying out specific functions and rules. They use a rigid decision-tree approach that provides single responses in a world where there is seldom a single answer.

We may be using new devices such as smartphones and tablets, but the underlying technology hasn't changed all that much. Until now. In the new era of cognitive computing, systems think and act differently. They can process the complexity of human language, and get progressively smarter with every interaction. They can learn.

This chapter will explain how cognitive computing works and how this technology is used in a number of industries right now, such as healthcare and financial services. It will then examine what the future workplace might look like for both employers and employees.

Why organisations need cognitive computing

Did you know that more information was created in the past two years than in the history of humankind? According to IBM research, 4.7 quintillion bytes of data are created every day. That's equivalent to 340 newspapers being delivered to every man, woman and child on the planet. If someone asked you a question and said the answer was in one of those newspapers, what's the probability you would be able to answer that question?

Even our top experts can't keep up. How can our doctors possibly keep track of the 185,000 clinical trials which, according to the US National Institutes of Health, occur every year?

The next time you ask your investment adviser what you should buy, think about this: There are typically more than 1.2 million trades on the Australian Stock Exchange every day. Reuters publishes 9000 pages of research every day.

Cognitive computing can help our doctors and investment advisers by processing all that data and providing the analysis they need to make an informed decision. It's a natural extension of what we do, creating a new partnership: human *and* machine, not human *versus* machine.

It will fundamentally redefine the way we work. Organisations are already using Watson[1] to better engage their customers, enable their business leaders to make better decisions, and help their experts make new discoveries.

How cognitive computing works

The human brain is an amazing thing. Our brains process incredible amounts of information very quickly. We're able to absorb it, put it into context, interpret it, evaluate it, make a decision and then act on it.

Doing this well begins with education and learning. As we progress, many of us become experts in a given field or area of focus. As any doctor, lawyer, scientist or

financial adviser can tell you, becoming an expert is a long journey, and it requires an enormous amount of practise and iteration.

Think about what it takes for a doctor to perform a task. They observe. Is their patient perspiring? Do they have a fever? What is their family history? Then they hypothesize, draw conclusions, make a diagnosis and recommend a treatment. This happens in a relatively short period of time, and the stakes are usually high.

Until now, the cognitive capability of computers has not come close to that of the human brain. The biggest challenge is natural language and the ability to understand the contextual nuances and idioms inherent to English, Japanese and other languages. For example, traditional systems struggle with phrases like "let's wrap it up" which, depending on context, could apply to a Christmas gift or business meeting.

However, a cognitive computing system such as IBM's Watson can understand natural language in the way humans do. As demonstrated four years ago by its victory on the United States (US) TV quiz show, *Jeopardy*, it can differentiate meaning based on the context in which words and phrases are used due to its powerful linguistic algorithms. This allows it to quickly analyse high volumes of unstructured data such as blogs, tweets, newspapers and videos to understand the meaning, context and even emotion of human interaction. During its *Jeopardy* appearance, Watson processed 200 million pages of data and returned confidence-weighted responses in the context of the quiz topic. One great example of this capability is the Watson Personality Insights service.[2]

The opportunities to apply Watson's cognitive computing capabilities to transform entire industries and professions are nearly endless. Watson is able to learn specific domains from healthcare to financial services, not just technical terminologies used in research documents or studies, but the standard vernacular used by human experts in a given field. Those experts play an important role in training Watson to disregard irrelevant information and improve its interpretation of the underlying data. This training enables Watson to understand the subtle linguistic patterns of that discipline.

After the learning process, Watson is able to rapidly respond to highly complex questions or enquiries. Using our earlier example, it is able to assist doctors and physicians in their efforts to identify symptoms and hypothesize about potential causes and treatment plans, all backed by evidence-based, confidence-weighted responses. Throughout this process, Watson learns with each user interaction to continuously sharpen its knowledge of a given topic, while at the same time adapting to new data that is presented.

Transforming evidence-based medicine

Today, less than half of medical practice is evidence-based, which may be one reason up to 20 per cent of patients are misdiagnosed, according to the *Journal of the American Medical Association*.

The medical community has been one of the first to partner with IBM to identify and create Watson technologies. IBM has been collaborating with leading hospitals and research organisations including Memorial Sloan Kettering Cancer Center, University of Texas MD Anderson Cancer Center, Cleveland Clinic, Mayo Clinic and New York Genome Center to advance Watson's healthcare capabilities and transform how medicine is taught and practiced.

To speed the adoption of Watson technologies in healthcare, IBM is also making a number of direct investments in innovative start-up organisations like Modernizing

Medicine, Pathway Genomics and Welltok that are building new cognitive apps and services powered by Watson.

Driving deeper customer engagement

Few of us enjoy dealing with automated systems when calling contact centres for service or help. Instead, we try to navigate through the system to get to a real person.

Why? Because we know the system is probably not going to be able to help, and our best chance of getting a meaningful answer or resolving the problem is to talk to a person.

Cognitive systems can change that. For example, American military insurance company USAA uses the Watson Engagement Advisor to address one of its hardest challenges: helping 150,000 US service members returning to civilian life from military service. To further enhance their best-in-class customer service processes, USAA is using Watson to analyse thousands of documents to intelligently and personally answer questions on topics ranging from Veterans Affairs' benefits to vocational training.

Accelerating research discovery

The huge and growing volumes of information are a big challenge to scientists and researchers. Baylor College of Medicine in the US is using Watson to accelerate research that normally takes years. It's helping biologists and data scientists identify proteins that modify p53, a key protein related to many cancers.

"There are more than 70,000 papers published on this protein. Even if I'm reading five papers a day, it could take me nearly 38 years to completely understand all of the research available," said Dr Olivier Lichtarge, Baylor's Principal Investigator and Professor of Molecular and Human Genetics, Biochemistry and Molecular Biology.

Watson evaluated and analysed all 70,000 scientific articles to predict proteins that turn p53's activity on or off. As a result, cancer researchers found six potential proteins to target for new research – a dramatic increase from the average of one protein discovery per year.

Cognitive computing is the new competitive advantage

This is just the beginning. Every day IBM is identifying new potential applications for Watson in finance, education, healthcare, legal and other domains. Cognitive computing is the new competitive advantage. Pioneering organisations are working with IBM to use Watson to make more informed decisions and better engage with customers. This includes a diverse and growing ecosystem of thousands of partners, developers, students, entrepreneurs and others that are building entirely new cognitive computing apps and services powered by Watson. They're unlocking patterns in all types of data to make new discoveries. And because Watson builds on its knowledge and learns, organisations that start using cognitive computing now will have a big advantage in solving tomorrow's challenges.

Australian organisations are among those pioneers. Victoria's Deakin University is using Watson to reinvent how students experience their education, including giving them a better understanding of what university services are available to them.

"Watson will revolutionise and simplify student problem-solving. The more questions it is asked, the more informative its answers will become," said Deakin's Vice-Chancellor, Professor Jane den Hollander.

Creating the skills for the future workforce

In a world where computers are getting smarter, what will the future workplace look like? What skills will employers want and workers need? How do organisations – and people – need to adapt?

IBM's recent Global C-suite Study[3] provides some insights. IBM interviewed more than 4000 chief executive officers (CEOs) and other executives across 70 countries and 20 industries. The study identified two game changers:

1. New systems of engagement that break down barriers internally and externally, offering better ways for employees to interact with each other and with customers.
2. Real-time advanced analytics that provide deeper insights and enable us to make better-informed business decisions.

Organisations are becoming more inclusive and collaborative. Business leaders are listening to their customers for more than just feedback on products and services – customers are influencing their business strategies, pricing structures and policy development.

Similarly, businesses are beginning to recognise the need for more frequent contact with their frontline workers – to gather their feedback on the work environment, policies and processes.

Leading organisations are using both mobile and social technologies to engage with customers, attract potential talent, gather feedback and share knowledge more quickly and frequently.

However, the really disruptive enterprises are combining predictive analytics with systems of engagement to gather insights through every customer and employee interaction, to predict behaviours and anticipate trends and needs. This takes decision-making to a new level and allows businesses to create highly personalised experiences for both their customers and employees.

To adopt these two game-changing technologies, an organisation needs to ready its practices, culture and skills, as well as its systems and infrastructure. Its workforce needs to be constantly learning and adapting. Organisations need to make three key transformations:

1. Start at the top

Collaboration is the key to success in today's connected world. According to the C-suite study, more than 50 per cent of CEOs believe collaboration and teamwork in the executive team is the most important trait for success; followed by openness, transparency and trust (27 per cent); and having a shared purpose, a clear vision and goals (25 per cent). However, more than 30 per cent of CEOs believe their executive

team is not up to speed with the way the market is evolving or where their customers are heading.

Traditionally, chief financial officers (CFOs) and chief marketing officers (CMOs) are more actively involved in formulating business strategies than chief information officers (CIOs) or chief human resources officers (CHROs), who are often more focused on operations. However, the study found that the most effective executive teams were far more aligned in their approaches to strategy, customers and performance.

When the CEO, CFO and CMO are aligned, it's more likely customers will shape the organisation's market initiatives. The CHRO's involvement helps create a collaborative workforce that is more likely to innovate. CHROs can ensure the strategies for recruitment, learning and development, talent management and succession planning are aligned with business strategies.

Input from CIOs can ensure the organisation's digital strategy is well integrated and aligned with the organisation's commercial, customer and people strategies. They can deliver digital initiatives that offer real-time insights to allow more informed decisions, and drive innovations that improve the customer and employee experience.

The most effective executive teams are readying themselves for the future in a number of different ways:

- Engaging in collaboration for a purpose: Leading executive teams are actively forging relationships with customers, partners, suppliers and employees. They are not only anticipating, but embracing disruption. They are building networks with people from different industries and backgrounds, but all with a clear purpose to foster innovation and create value for the business.
- Building a collective skillset: Counter to common belief, a C-suite with a diverse skillset is generally more effective than having individuals with a broad set of generalist skills. In high-performing organisations, each executive brings unique expertise and experience in their own field, but has a shared vision and strong grasp of how different parts of the organisation function and work together.
- Actively sharing data and plans: The C-suite study identified lack of time and physical proximity as barriers for collaboration, but high-performing organisations make regular communication and interaction a high priority. They use technology to maintain regular contact, build and share digital dashboards and scorecards dynamically, discuss progress with plans, re-evaluate priorities and readjust strategies.
- Engaging socially: Some executives from the analogue era are struggling to keep up with digital transformation. Those who are ahead of the curve understand the shift to the sharing 'everyone-to-everyone' economy. They are exploring their customers' and employees' social and business networks, and piloting social tools for interacting with customers. Reverse mentoring is increasingly used, not only to learn from digital natives but also to build a pipeline of future leaders.
- Building a strong culture: Executives in high-performing enterprises understand the importance of culture. They are personally involved in building a culture with three core values – collaboration, innovation and a customer-focused approach – and ensuring that their people-related strategies (recruitment, induction, KPIs, learning and reward) are closely aligned with these core values.

2. Transform management practices

Management practices are transforming due to the shift to the 'everyone-to-everyone' economy, the increasing importance of customers and an increasing use of analytics and social interactions.

Many industries are feeling the impact of an increasingly distributed workforce. While most see the benefits of teleworking and flexible working hours, many managers are struggling to respond to managing remote or mobile employees.

Australia Adjusting: Optimising national prosperity[4] – a report by the Committee for Economic Development of Australia – pinpointed a lack of a 'talent-focused' mindset among Australia's management population. And although managers were strong in technical expertise and operational management, they lacked the capability to support, develop and drive innovation in a sustainable way.

IBM Kenexa's Global Work Trends Study found that customer orientation, collaboration, instilling staff autonomy, removing barriers for innovation and inclusive managerial practices were keys to building a high-performing organisation.

Similarly, a study by the Society for Knowledge Economics, Sydney highlighted a number of managerial practices that differentiated high-performing Australian workplaces from the rest, including:

- Clearly articulating vision and goals;
- Investing time and resources to listen to and respond to customers' and employees' needs;
- Involving staff in making decisions;
- Fostering collaboration;
- Encouraging innovative thinking; and
- Enabling individual learning and growth.

In other words, organisations need to transform their management practices to be much more focused on adding value to customers, investing in employees and driving results across the organisation, not just their departments.

Leading organisations are recognising the shift and creating a leadership framework that is:

- Aligned: A well-aligned management team ensures that business strategies and goals are translated into improved key performance metrics and outcomes, and consistent managerial practices, at every level of the organisation.
- Data informed: By using analytics, organisations can profile their top-performing managers and pinpoint the exact skills, personal attributes and behaviours that contribute to success indicators such as positive employee and customer outcomes, financial performance and sustainable innovation. They can ensure these qualities are included in the leadership framework.
- Integrated: The leadership framework needs to complement other practices, such as leadership pipeline development, applicant assessment and selection, and employee recognition, coaching and development.

3. Create a learning organisation

Skillsets are rapidly changing. Organisations now need flexible and transferable skills, shared knowledge, analytical capabilities and a workforce willing to learn. At the same time, the workforce is becoming more mobile and people are increasingly seeking highly personalised and rewarding learning experiences from their employer.

CHROs taking part in the IBM C-suite study revealed that talent development was the biggest current workforce challenge. They anticipated knowledge sharing would become more vital, with 55 per cent seeing this as important now, rising to 92 per cent in three to five years. The development of workforce skills and capabilities would also

become far more important (rising from 57 per cent to 89 per cent). However, CHROs said that both knowledge sharing and skills development were the least effectively addressed workforce challenges.

The CHROs identified two major barriers to workforce development: a lack of insight into the critical skills required for the current and future workforce; and a lack of ability to match ongoing individual learning demands with available, effective and relevant learning methods and content. The C-suite study found that only 20 per cent of organisations used analytics to track the quantity and quality of specific skills.

The top performers are creating a learning organisation in a number of different ways:

- Locating knowledge and experts: Leading organisations use systems of engagement to enable individuals to connect with others who have the knowledge, skills and experience they need. They do this either directly (using social networks to interact with customers) or indirectly (using collaborative tools to access knowledge and locate in-house experts).
- Facilitating talent development: Armed with talent analytics, leading organisations are moving beyond a single source of information (performance rating) to multiple sources (such as assessment scores, performance and customer rating, motivation and career orientation) to identify talent, and to gain insights to improve coaching and career advice.
- Building a learning portfolio: Some organisations are integrating talent databases (including assessment scores, competency data, performance ratings and customer ratings) to identify skills gaps and match learning content to individual needs. The top performers are piloting advanced analytics and cognitive computing to extract real-time insights from diverse sources (such as call centre conversations, accident and injury measures, and stakeholder blog posts) to track learning needs more efficiently.
- Crafting an engaging learning experience: By combining systems of engagement and advanced analytics, leading organisations are tailoring training content. They are also creating an interactive, personal and collaborative experience by using tools such as self-directed learning, video and online charts, virtual learning groups, simulations and game-like learning applications known as gamification.

Leading organisations understand their evolving learning needs. They are constantly adjusting their learning and development strategies to reflect changing customer demands, market trends and workforce dynamics. This flexibility, together with well-aligned management practices that focus on the value of people, customers and technology to drive innovation, will prepare your organisation to thrive in the next era. Because just as cognitive systems are always learning, so too will the future workforce.

Endnotes

1 Learn more about Watson: *www.ibm.com/smarterplanet/us/en/ibmwatson*

2 A demo is available for anyone to test at *watson-pi-demo.mybluemix.net*.

3 Learn more about the study: *www-935.ibm.com/services/au/en/c-suite/csuitestudy2013*

4 Committee for Economic Development 2013, *Australia Adjusting: Optimising national prosperity*, November, Melbourne. View the report online at *adminpanel.ceda.com.au/FOLDERS/Service/Files/Documents/15384~cedaaustadjusting_web.pdf*

1.4

The impact of computerisation and automation on future employment

Hugh Durrant-Whyte

Lachlan McCalman

Simon O'Callaghan

Alistair Reid

Daniel Steinberg

Hugh Durrant-Whyte is a Professor and ARC Federation Fellow at the University of Sydney. He was CEO of National ICT Australia (NICTA) from 2010 to 2014, Director of the Australian Research Council (ARC) Centre of Excellence for Autonomous Systems and of the Australian Centre for Field Robotics (ACFR) at the University of Sydney from 1995 to 2010, and University Lecturer in Engineering Science at the University of Oxford from 1986 to 1995. Hugh Durrant-Whyte was named the 2008 Professional Engineer of the Year by the Institute of Engineers Australia, Sydney, and the 2010 NSW State Scientist of the Year. He is a Fellow of the Australian Academy of Science (FAA) and a Fellow of the Royal Society (FRS).

Lachlan McCalman is a senior research engineer at NICTA. He obtained his PhD in 2014 at the Australian Centre for Field Robotics, University of Sydney. He graduated with a BSc in theoretical physics from the Australian National University in 2008. His current areas of research include multimodal and scalable non-parametric inference techniques, and the development of algorithms and software systems for applying probabilistic inference to diverse problem domains.

Simon O'Callaghan is a researcher in the machine learning group at NICTA. He obtained his PhD in 2012 at the Australian Centre for Field Robotics, University of Sydney. He graduated with a BE in electrical engineering at University College Cork in 2008. His current research interests include non-parametric methods for active learning and adaptive sampling techniques.

Alistair Reid is a researcher in the machine learning group at NICTA. He obtained his PhD in 2011 from the Australian Centre for Field Robotics, University of Sydney. He graduated with a BE/BSc from the University of Sydney in 2007 with the university medal in aeronautical engineering (space). His research is focused on the development of probabilistic models for spatial inference, multitask learning and active sampling for applications such as mapping, demography, natural sciences and resource exploration.

Daniel Steinberg is a researcher in the machine learning group at NICTA. He obtained his PhD in 2013 at the Australian Centre for Field Robotics, University of Sydney. He graduated with a Bachelor of Engineering (Mechatronics) and Bachelor of Commerce (Finance) also from the University of Sydney. His research interests are in applying and deriving new machine learning algorithms for spatial prediction problems, and in making algorithms for the automatic, unsupervised interpretation of data.

Background

This report provides an estimate of the susceptibility of jobs in Australia to computerisation and automation over the next 10 to 15 years. The methodology and initial data used is based on the much-cited paper by Frey and Osborne[1], which studied this same problem for the United States (US) and, more recently, for the United Kingdom (UK).[2] The key to this work is trying to understand and quantify the impact of emerging technology on jobs and employment in areas such as artificial intelligence, robotics and machine learning.

While prediction of the future is never easy and while there will be many other impacts, both positive and negative, on jobs and future employment, Frey and Osborne's study has opened up an interesting line of enquiry. Of most importance is insight into the qualities of future jobs and what makes these uniquely human and not automatable. In turn, this focuses on the question of what we should currently be doing to educate and train the next generation: We need to look into the future to understand where we now stand.

The results show that 40 per cent of jobs in Australia have a high probability of being susceptible to computerisation and automation in the next 10 to 15 years. Jobs in administration and some services are particularly susceptible, as are regions that have historically associated with the mining industry. Jobs in the professions, in technical and creative industries, and in personal service areas (health for example) are least susceptible to automation. Much more analysis could be done with this data.

The methodology employed to reach these results was broadly as follows: The same estimates for the susceptibility of *job types* to computerisation and automation were migrated (cross-walked) from US estimates based on US job codes, to job codes based on the Australian and New Zealand Standard Classification of Occupations (ANZSCO) system. The probability of automation per ANZSCO code was then weighted by the fraction of workers in each job type to produce an overall estimate for susceptibility of job computerisation in Australia. In addition, this information was mapped across local government jurisdictions in Australia.

Results

The results presented here are broad estimates of what the future might hold based on the best understanding of current technology, and on the qualities and skills required of different job types.

The starting point for the analysis is a probabilistic labelling of job categories as 'automatable' based on a subjective view as to where future technology is leading. These labels are taken directly from Frey and Osborne – although further work might re-examine these in a specifically Australian context. In turn, these job categories are associated with different qualities or skills, for example, creativity, analysis, manual dexterity and negotiation skills. Job characteristics such as these give some broader sense of the types of skills more or less likely to result in automation, and thus where future education and training might be focused.

In new work, the geographical spread of jobs most susceptible to automation is also presented. The availability of job category data at the local government level allows disaggregation of national estimates to local estimates and thus regional estimates of job susceptibility to automation. While this information shows general geographic trends, much more analysis could be undertaken to look at future regional developments.

March of the machines

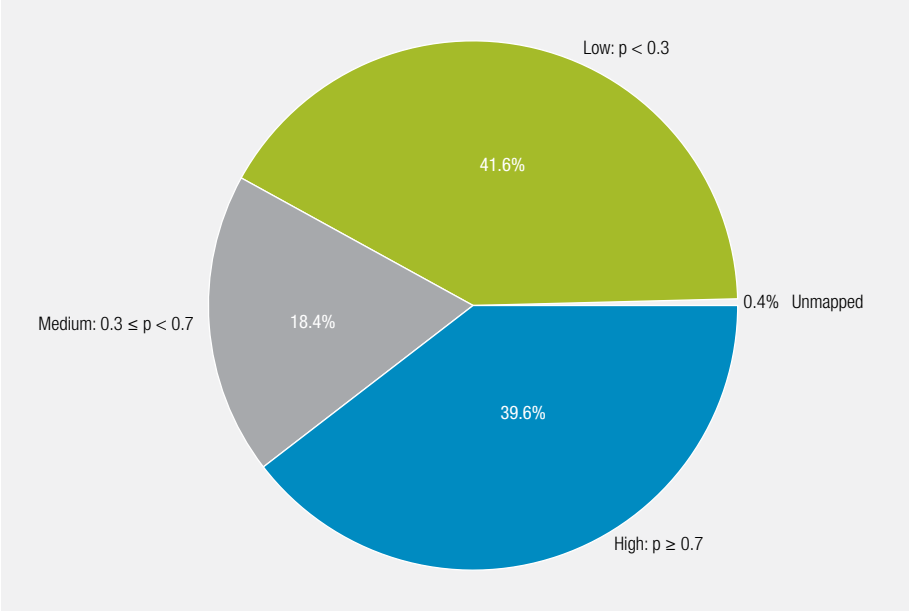
There has been much written about the replacement of humans by robots and computers across all areas of work. Practically, in the next decade or two, the largest impacts will come from the automation of intellectually and physically routine jobs for which machine intelligence and robotics already play a large role. Also important will be the use of automation to substantially increase productivity, and thus reduce employment, in many non-routine occupations. An important trend is the automation of *analysis* roles for which machine learning is especially effective and the increasing use of data is key, rather than *creative* roles for which computer algorithms have yet to make a mark. Brief examples of job automation or computerisation are given here.

There has been notable work in automation in Australia, especially in the mining industry, replacing human operators on trucks, loaders, drills and trains with autonomous vehicles operated by computer from a remote location. Increasingly, this extends to other occupations in mining including geologists, surveyors and other routine operations. Much of this is driven by productivity and utilisation as well as a reduction in the on-site workforce. In the next decade, most mines will operate with less than a third of current workforces, with a significant number of these engaging remotely. The same levels of automation are likely to occur in related industries where routine operation is the norm, such as in agriculture and materials or cargo-handling. The impact of automation in these industries is clear in geographic results (refer to *Geographic impact of computerisation on jobs*).

A second important area will be the increasing automation of routine office jobs by computers and machine-learning algorithms. This has already come a long way in the past 30 years: from word processing to automated stock trading. However, current machine-learning algorithms are taking a larger share of what were once perceived skilled jobs or roles around customer engagement. These include occupations such as legal clerks (with automated search and analysis of legal documents), market research and sales (ranking and recommendation engines, credit risk and management), predictive analytics and many others. These examples show that the scope of computerisation is growing, especially in analyst-type roles. These are probably the largest impact on the data presented in Figures 1 and 2, particularly in a service-centred economy like Australia.

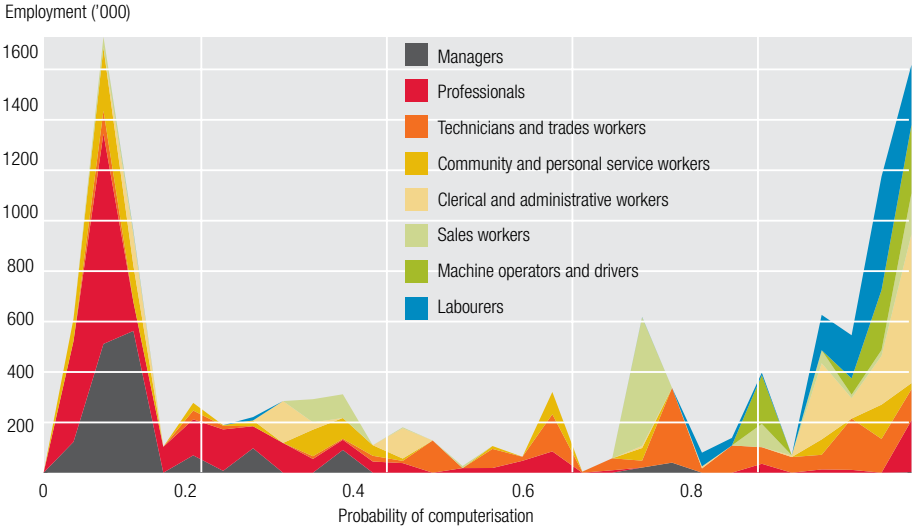
Third are jobs which, while not always routine, will see increased productivity (and therefore relatively less employment for the same output) through application of robotics and machine-learning algorithms. Health is an especially significant area likely to be impacted – through automation in clinical data and predictive diagnostics (analysis roles), to robotics assisting in areas from surgery to nursing and from hospital logistics to pharmaceutical dispensary. Other examples include banking and legal advice – typically activities that involve a qualified professional, but where data and analysis play a large role, and where most, but not all, work is routine. An important trend is also to redesign roles to enable them to be more automatable (a lesson from the manufacturing industry) – this includes examples ranging from growing fruit trees in particular shapes to allow robot picking, to allocating special lanes on a road system for automated freight or car movements.

FIGURE 1
OVERALL PROBABILITIES OF JOB COMPUTERISATION IN AUSTRALIA



Note: p = probability

FIGURE 2
DISTRIBUTION OF JOB CATEGORIES AGAINST PROBABILITY OF COMPUTERISATION



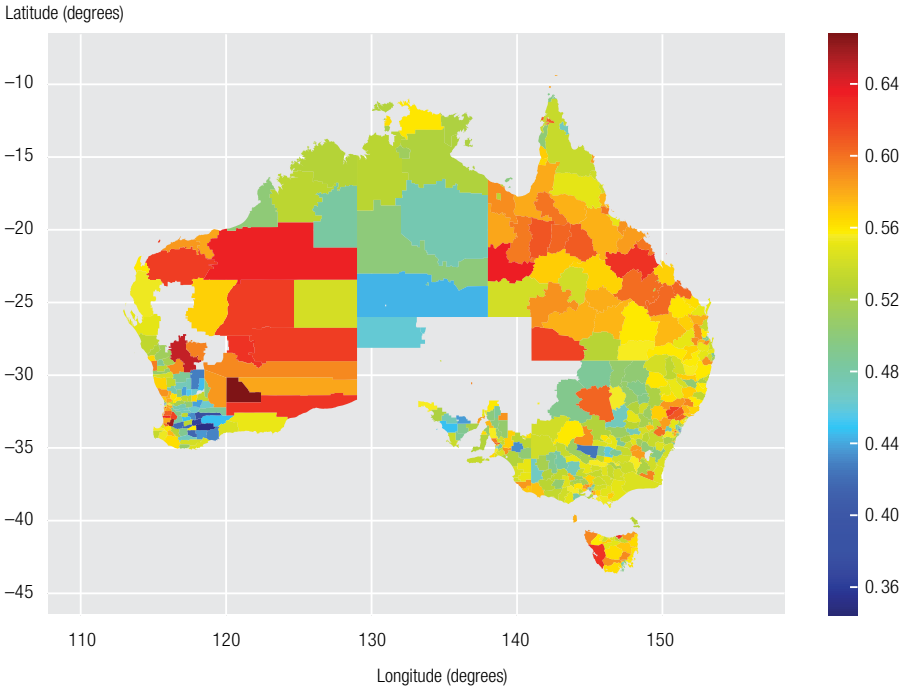
Note: This is the Australian equivalent of Figure 3 on page 37 in Frey and Osborne.

Overall impact of computerisation on jobs

Figure 1 shows the estimated probabilities of the susceptibility of jobs to computerisation and automation in Australia, segmented into notionally high, medium and low probability sectors. Notably, 40 per cent of current jobs have a high probability (greater than 0.7) of being computerised or automated in the next 10 to 15 years. This is a lower figure than that for the US (50 per cent) – we believe due to smaller numbers of workers in the service sector – and is comparable to the UK.

FIGURE 3

PROBABILITY OF JOB LOSS THROUGH COMPUTERISATION AND AUTOMATION IN LOCAL GOVERNMENT AREAS OF AUSTRALIA



Note: Map shows local government areas with more than 100 workers, so some areas of the country are blank.

The rate of job impact from automation is substantial and will likely cause significant social adjustment as new jobs and new ways of working emerge. However, it is important not to be too pessimistic; this data clearly takes no account of the creation of new jobs and new opportunities in fields that will be opened up by this digital disruption.

Figure 2 shows the distribution of jobs in different job categories against the probability that those jobs will be computerised. There are a number of clear messages in this plot. First, potential job losses are polarised: Jobs in administration and sales (and many service areas) will disappear, while jobs in the technical professions and personal services will remain. Second, many of those jobs remaining are characterised by non-routine thinking and especially high levels of originality and creativity. Consideration of future job characteristics helps in understanding future skills education in schools and universities around the creative application of technology to solving problems.

Geographic impact of computerisation on jobs

Beyond the original work in Frey and Osborne, this chapter provides a regional picture of the susceptibility of jobs to automation and computerisation. This picture is obtained by disaggregating national estimates against job code data at the granularity of local government areas.

Figure 3 shows the overall plot of probability of job loss due to computerisation and automation in local government areas for all of Australia. While this information is very preliminary and should not be over-analysed, one trend is clear: regions with high dependence on mining (Western Australia and Queensland in particular) will suffer a bigger impact from automation and computerisation. At a national scale, another caution is simply the low level of population in many regions.

FIGURE 4

WEIGHTED PROBABILITY OF JOB LOSS THROUGH COMPUTERISATION AND AUTOMATION IN LOCAL GOVERNMENT AREAS OF SYDNEY

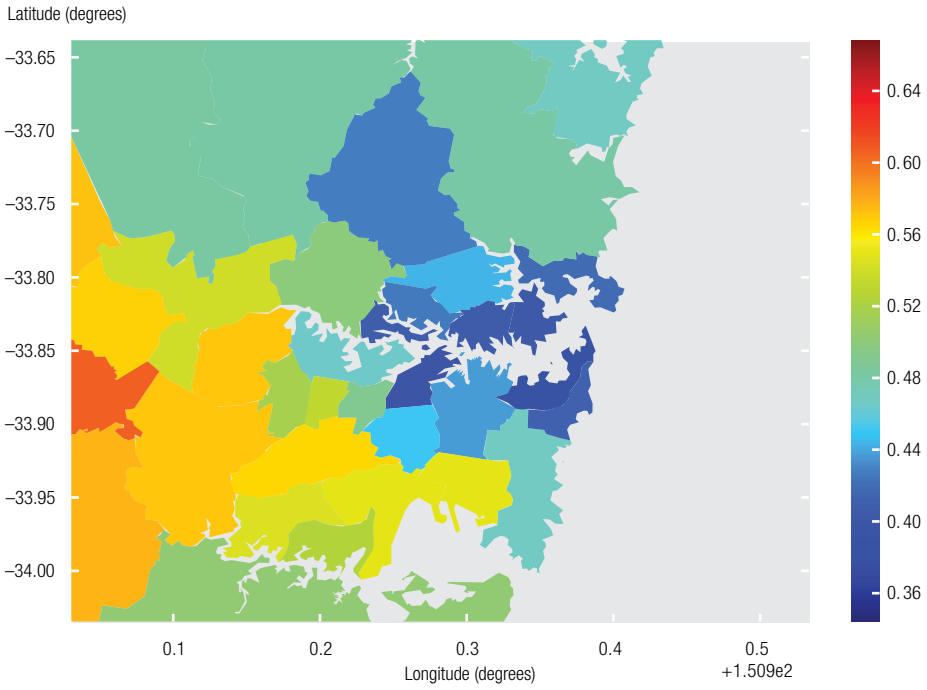


FIGURE 5

WEIGHTED PROBABILITY OF JOB LOSS THROUGH COMPUTERISATION AND AUTOMATION IN LOCAL GOVERNMENT AREAS OF MELBOURNE

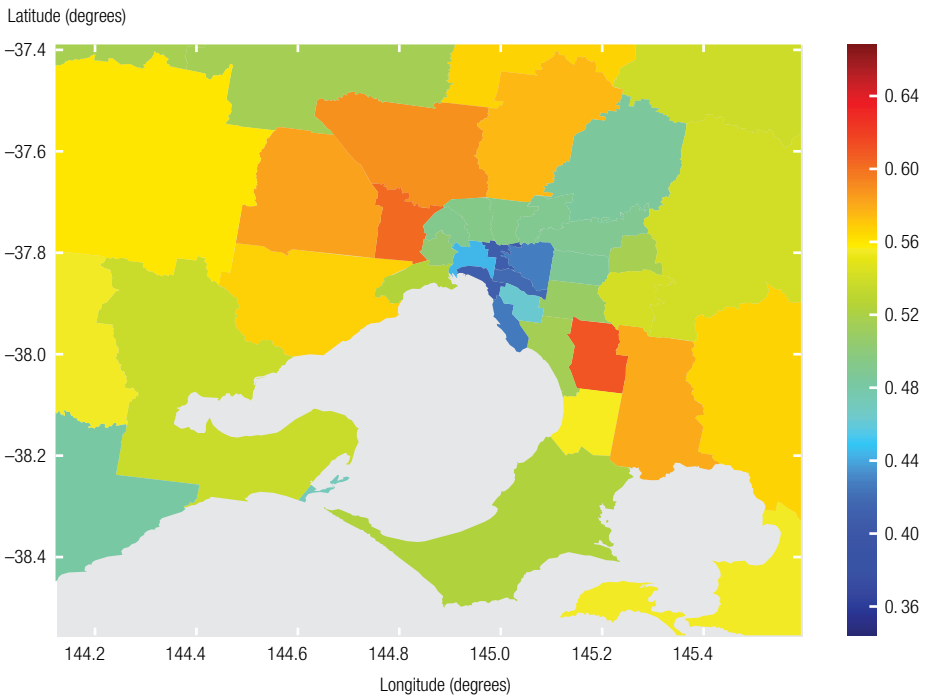


Figure 4 and Figure 5 show the estimated probability of job loss through computerisation and automation in local government areas for Sydney and Melbourne respectively. These plots simply underline many of the messages in the national data: The jobs that will remain will most likely be those in professional, technical and creative areas. Again, much further analysis could be undertaken of these geographical trends for planning, education and other purposes.

Employment automation – analytics

This section provides a brief description of the method used to replicate and extend the Frey and Osborne US employment automation study for Australia. Familiarity with the original work is assumed. We would like to acknowledge Michael Osborne's assistance and for his provision of machine readable data from the US study.

Mapping the US Standard Occupational Classification (SOC) features to the ANZSCO system

Both the SOC and ANZSCO[4] job code systems are hierarchical. ANZSCO has the following aggregation levels:

- Major;
- Sub-major;
- Minor;
- Unit; and
- Occupation.

Following is a summary of the process undergone to map the US study to Australian job codes.

Step 1

Transferring the features from the US study to Australian job codes:

1. A 'crosswalk' was used to map the 702 SOC job codes used in the original US study to International Standard Classification of Occupations (ISCO) job codes. This is a potentially a *many-to-one* mapping (a similar process was used for the UK study).
2. The nine job features used for job characterisation in the US data were mapped to the ISCO system. Where there is a many-to-one correspondence, averages over features were employed.
3. A second 'crosswalk' was used to map from the ISCO codes to the ANZSCO job codes. This is potentially a *one-to-many* mapping.
4. The features from Step 1.2 were transferred from ISCO to ANZSCO. This involves potentially replicating them from the ISCO jobs to the corresponding ANZSCO jobs.
5. Whichever SOC jobs were not transferred to the ANZSCO system in the above process were *manually* mapped (to sub-major to occupation level ANZSCO). Though a couple of SOC jobs were not mappable (no equivalent job existed).

Step 2

Mapped features were matched with Australian employment counts. The monthly employment counts (November 2014 was used) are only given at the ANZSCO unit level at best (no occupation level). Thus, occupation level features need to be combined into the aggregations used by the employment data. Again, aggregation is done by taking the average features. Only 47,000 out of 11,642,600 Australian jobs were not used because they failed to map to the SOC system (from Step 1).

Step 3

With features corresponding to employment count data, a classifier can be (re-)run as follows:

1. Train a probabilistic support vector machine[5] (using the python scikit-learn SVC class) on the original US data (it gets an AUC of 0.9233 using the same testing procedure as the original paper, their GP classifier gets 0.89); and
2. Run the classifier on the Australian features to get probability of automation with matching employment counts.

Mapping national estimates to local estimates

This report provides a geographical view of the probability of job susceptibility to automation. These Local Government Area (LGA) estimates are obtained as follows:

1. The probability of automation per ANZSCO code is weighted by the fraction of workers in each job type in each LGA to compute to the expected probability of automation across all jobs per LGA:
   a. The Australian Bureau of Statistics (ABS) table builder tool was used to obtain ANZSCO counts in each LGA region up to four digits of the job code;
   b. Each count was normalised by the total working population of the LGA to obtain proportions in each occupation;
   c. The ABS has applied artificial noise on LGAs with small population – so LGAs with fewer than 100 workers were excluded (there are also large regions of South Australia that do not belong to an LGA because of their low population); and
   d. The proportional counts (an nLGA x nANZSCO matrix) are multiplied by the probability of automation vector (nANZSCOx1) to obtain a weighted probability of automation for each LGA. These were plotted using the LGA boundary shapefiles, along with the occupations grouped by major category (first digit of job code).

Endnotes

1 Frey CB & Osborne MA 2013, *The future of employment: How susceptible are jobs to computerisation*, Oxford Martin School, University of Oxford, *www.oxfordmartin.ox.ac.uk/publications/view/1314*

2 Deloitte 2014, *London futures – Agiletown: the relentless march of technology and London's response*, *www2.deloitte.com/uk/en/pages/growth/articles/agiletown-the-relentless-march-of-technology-and-londons-response.html*

3 The methodology for doing this from ABS data is described in the section *Mapping national estimates to local estimates*.

4 *www.abs.gov.au*

5 Platt, J, et al. 1999, 'Probabilistic outputs for support vector machines and comparisons to regularized likelihood methods', *Advances in large margin classifiers*, Vol 10, No 3, pp 61–74.

1.5

Case study: Automation and Australia's future workforce

Michael Gollschewski

Michael Gollschewski was appointed Managing Director Pilbara Mines for the Iron Ore business in May 2013. In this role, Michael has accountability for operational mine sites across the Pilbara, as well as the Fleet Strategy and Delivery, Mine of the Future and Technical Services functions.

Michael is also a member of the Iron Ore executive committee.

Michael has been with Rio Tinto for eight years, with general manager roles in Pilbara Mining and Infrastructure Projects and at Greater Brockman operations.

Most recently he has been Chief Operating Officer Pilbara Projects, playing a lead role in the development of the contracting and procurement strategy for Pilbara expansion, and initiating a key safety program that has now been widely deployed.

Prior to joining Rio Tinto, Michael held a wide range of engineering, supervisory and management and project roles with CSR and Alcoa.

Michael graduated from the Queensland Institute of Technology with honours in Mechanical Engineering and holds a Masters of Business Administration from Curtin University, Perth.

Introduction

The foundation to Rio Tinto's success as one of the biggest mining companies in the world is our people. We only invest in technology and innovation if it results in improving business safety, reliability and efficiency and this is dependent on the input, commitment and interaction with our employees – our people are part of every step of this journey.

Change is inevitable. But we can harness the change to stay ahead of the curve. This way, we realise the opportunities that innovative technologies deliver, and in doing so, maintain and enhance our world-class position.

The one sure thing is: we can't stand still. Smarter use of technology and reskilling will maintain and increase our competitive edge. While some roles will become less common, often more interesting, better paid new jobs will be created to replace them.

The creation of roles that currently don't exist in the industry – in disciplines such as specialists in communications, systems, electronics, software and niche technical fields – will give many of our people the opportunity to acquire new advanced skills that will drive the future of mining.

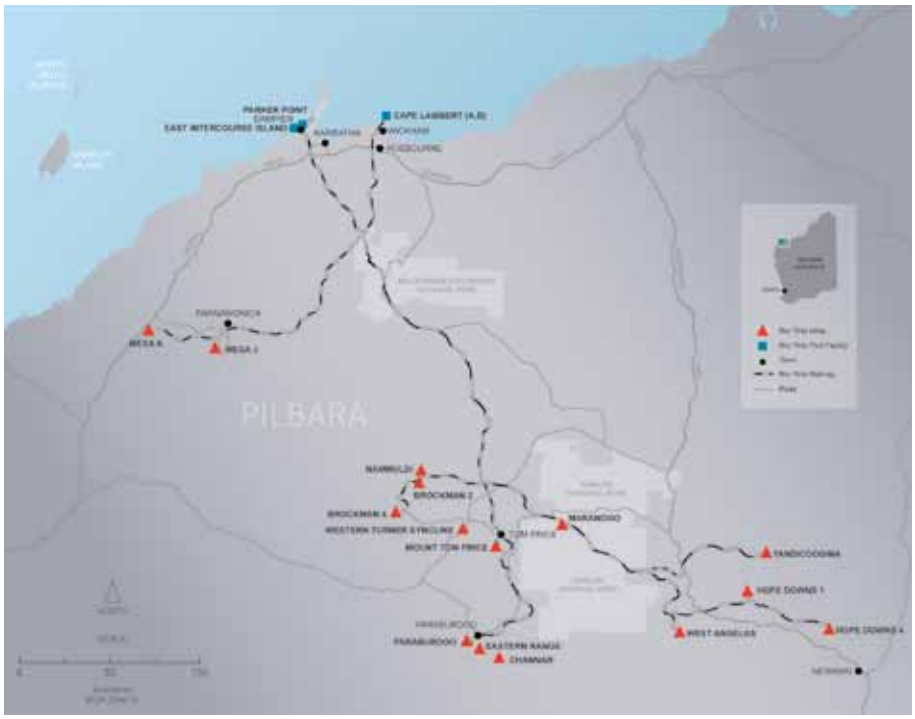
It is important to recognise that the purpose of automating various processes of a mine is to add incremental improvements. If you don't have that strong management team behind it, and the talented and skilled workers to implement it correctly, it won't add additional value to an operation.

As we move rapidly with the rest of the world towards increasingly sophisticated technologies, exactly what this means to Australia's future workforce is outlined in this chapter:

- Rio Tinto's current operations, how we use this technology today and our journey to becoming a world leader in the use of mining technology and automation;
- Our approach to identifying, harnessing, developing and retaining employee core skills required to efficiently and effectively run mining operations – both now and for future generations; and
- Case studies about the introduction of autonomous haulage trucks and autonomous drills to Pilbara mining operations.

Rio Tinto is committed to a long-term investment in technology, and in the talented and well-trained workforce needed to develop, operate, maintain and manage it.

FIGURE 1
PILBARA OPERATIONS



Rio Tinto Pilbara operations: 50 years on and leading the world

Rio Tinto's Iron Ore operations in the Pilbara involve large and remote areas encompassing huge scales of capital, equipment and workforce that function in an integrated model. Our Pilbara operations achieved production of 290 million tonnes in 2014. This is expected to increase to 330 million tonnes in 2015.

The Pilbara operations (refer to Figure 1) comprise 15 mines; four port terminals; more than 1700 kilometres of rail network supporting a fleet of over 180 locomotives and 11,000 ore cars; and 361 trucks, excavators, dozers, drill rigs, and other mobile equipment. The workforce number varies with the evolution phases of the business and currently is approximately 12,500.

Our operations are vastly different to when our business commenced nearly 50 years ago in the Pilbara town of Tom Price and the Port of Dampier. Throughout this long history, various new and emerging technologies have been trialled and subsequently introduced to mines, rail and ports.

Examples of the early technology that started the pathway to more autonomous operations include automating the train ore car dumpers, stackers, reclaimers and product sample analysis (laboratory robots in 1994) as well as autonomous haulage and drilling systems. These automation initiatives were initially managed by individual control centres based on each site. As evolving technology enabled data transfer (including video and voice) to become faster and more reliable, Iron Ore's Operations Centre in Perth was officially opened in June 2010 to provide a single location source to more effectively manage all of these individual components.

The Operations Centre produces better, smarter, faster decisions at every level monitoring and controlling the mining, rail and port activities remotely from a single location. We believe it embodies a cutting-edge approach to bringing people of many disciplines, design, technology and planning processes together.

The Operations Centre also provides the platform from which we can further trial and implement new autonomous technologies.

Part of our evolution to using technology also involved the development of a program in 2008 called Mine of the Future™. The program investigates and manages the creation and implementation of next-generation systems and technologies with the aim to significantly improve employee safety, increase productivity and reduce environmental impact through new technologies, such as automation.

Automation will be a key enabler in continuing to transition our iron ore business from its early beginnings as a collection of independently managed operations to a highly automated, sophisticated and synchronised value chain.

Why invest in new technology

When making the decision to invest in any new technologies, leaders are looking for it to deliver real improvements in safety, reliability and efficiency. This assessment is based on a combination of internal and external research. We are already working smarter than ever, using innovative technology to deliver the greater efficiencies and productivity essential to our growth and success.

Our vision for automation is to enable the operation of the Pilbara as a highly reliable continuous process, having low variability and high predictability similar to other highly automated sectors such as chemical processing or oil refining.

Our Pilbara operations are managed and synchronised through a consistent set of key performance indicators (KPIs) that are effective in driving value maximising behaviour. The production and maintenance plans/schedules across operations and time horizons are integrated to maximise overall system performance. Real-time data and performance measurement provide frequent updating of predictive models used to optimise tactical and strategic mine to market decision-making and further optimisation of overall production system control.

This integration of technology, processes and people has the objectives of:

- Reducing injury frequency rate to a level that is comparable with the best process/chemical industry metrics (which are typically significantly lower than mining);
- Providing a greater knowledge of the ore bodies and the precise state of our mines, plants, rail network and ports; and
- Reducing variability in processes caused by sub-optimal decisions, enabling people to focus on decision-making rather than regulatory control through the use of purpose-developed algorithms.

In summary, by developing and delivering next-generation systems and technologies, we are improving the safety and wellbeing of our people, creating new roles and opportunities in less remote environments – as well as increasing the productivity of our operations in a way that minimises impact on our operating footprint.

Safety

An important and valuable benefit of mine site automation is that employees are removed from potential operational hazards. Technologies such as autonomous trucks, drills, train ore car dumpers, stackers and reclaimers significantly reduce employee exposure to hazards and risks associated with operating heavy equipment, such as fatigue-related incidents (particularly on night shift) and also sprains, strains and other soft tissue injuries.

The introduction of higher level engineering controls such as automated collision detection also significantly reduces critical safety risks. For example, if an autonomous haul truck or other piece of ancillary equipment breaches the system safety parameters, it automatically stops, preventing collisions that could cause fatalities or injuries. Detailed information on incidents in an autonomous mine are also recorded automatically, enabling prompt and immediate investigation followed by evidence-based corrective actions.

We have already seen improvements in the reduction of injuries as a consequence of automation. For example, there have been zero sprain and strain injuries as a result of the autonomous haulage operations in 2014 and zero injuries caused by autonomous drilling operations due to the reduced exposure of hazards to the drill operator.

Reliability, efficiency and productivity

Automation not only improves operating costs, it also has the ability to improve the productivity of the mine. Autonomous trucks and drills are able to operate for longer periods within each shift resulting in a higher effective utilisation. Human needs for breaks, sleep, shift changes and so on can occur without disrupting the operation of machines that continue to do the physical work needed to maintain production. This more than offsets the inherent requirements of automation, such as, longer daily inspections on technology hardware.

This higher effective utilisation can result in a reduction in capital equipment required to sustain a particular production level. For example, automation in mining through the aforementioned reduction in operating costs has seen a 13 per cent decrease in load and haul costs and an eight per cent reduction in drilling cost, and we have seen mining fleet purchases reduced by more than 15 per cent in some instances.

Further detail on the benefits of automation is discussed later in the case study on Hope Downs 4.

Summary

Automation should not be seen as an added layer of complexity from the standpoint of the operator. The initial set up and ramp up will be more complex than a manned operation; however post-implementation, the operation should see a more efficient and streamlined mining operation.

Benefits of automation for Australia's future workforce

As we introduce new automation technologies, we are identifying, harnessing, developing and retaining employee core skills required to efficiently and effectively run mining operations – both now and for generations into the future. We are redefining the relationship between person and machine, with highly skilled people at the centre.

The skillset necessary for the automation environment has a different balance from that of traditional mining operations. Both internal and external role requirements have changed and will continue to change.

Keeping employees engaged and motivated generally comes from providing challenging, fulfilling and diverse roles. For example, driving a haul truck is a very routine task with sometimes little variability in task assignment and so generally results in the highest staff turnover.

Every day we hear illuminating stories from our people about how the new technology is transforming the way they work.

Example

Rachael Eppen, Autonomous Haulage System (AHS) coordinator, manages a team of nine people in our Operations Centre in Perth, coordinating the efficient deployment of autonomous trucks. Since the project began in 2008, the AHS fleet has moved 325 million tonnes of material (as of end of March 2015).

> "I wish everyone in the company could see the innovative technology we're working with here. The stuff we can make happen 1500 kilometres away is pretty spectacular.
>
> "So much is evolving here that I get a real insight into where the industry is going. Even after 10 years in the business, it gives me a real buzz to think I'm part of that future."

It's also about better using and freeing up human capital for work tasks that are more complex, and require a high level of problem-solving skills that automation cannot replicate. For example, a truck operator either physically driving or remotely controlling the machinery over time applies 'tricks of the trade', which is an in-depth knowledge and understanding of the task at hand. This means that person will instinctively learn to find more efficient ways to do the job within the system in a way that computer programs cannot.

Another advantage is the ability to operate haul trucks and drills from a remote location resulting in more roles relocated from fly-in, fly-out mining camps to the city. This not only removes people from the potential physical risk of injury, the central location of these roles in one room rather than in individual truck and drill cabins also lends itself to the ability to job share across different sites and to work collaboratively as a community of operators and controllers in a common location.

Employees of the future

As we move forwards with automation systems, we will need specialists in computing, systems and diagnosis, and the upskilling of maintenance people to service and maintain the technology.

These 'employees of the future' will have good operational knowledge and detailed systems knowledge of the automated system. This will enable them to trouble shoot, conduct investigations, generate meaningful corrective actions, manage continuous improvement, and contribute to operational procedures and training materials.

To match the programming and analytical skills, we will need industry experienced and/or ready employees who can validate and interpret data to challenge both operational and system behaviours.

What will need to be done to obtain these skills now?

Consideration needs to be given to training and development of new operators, maintainers and professionals into the automation arena. There are risks associated with them learning by exposure and it also implies an extended learning period. The early system users were taught in this manner but in a very controlled/safe environment. Since we are now operating in a mainstream production environment, this is no longer practical. To speed up the process, packages of knowledge gained and lessons learned have been developed (for example, standard work procedures and training materials). However, it is also important to adopt new training philosophies such as the use of media and simulation systems to reduce the impact on production while training new operators.

We need to modify the recruitment process for automated operations to continue to perform well. Technology aptitude testing is required at all levels to ensure that the correct skills are selected for these new technology-focused roles. Controllers have a significant influence on system performance. They must have a wide and deep knowledge of the end-to-end operation as well as the business impacts of their decisions. We must be aware of the stresses and requirements of the new roles and be prepared to rotate people where needed. We must be mindful that mental fitness will be an increasingly important factor for our people to maintain the levels of working memory capacity necessary to be resilient and effective in their roles.

Moving forward we must encourage more and diverse people to study the science, technology, engineering and mathematics (STEM) streams.

Rio Tinto actively supports various initiatives around the world to encourage young people to study STEM subjects, for example, we are involved in a program run by the Australian Academy of Technological Sciences and Engineering (ATSE) that aims to increase the number of Australian students studying science and mathematics in upper secondary school.

Rio Tinto has also partnered with the University of Western Australia in Girls in Engineering, a program designed to engage secondary school girls in science and engineering and inspire them to consider engineering careers.

Furthermore, Rio Tinto is the founding member of a Women in Engineering partnership with the University of Queensland (UQ) that aims to inspire the next generation of female engineers and includes sponsorship of UQ's InspireU engineering camp for Indigenous students.

The upcoming younger generations are also a key focus. An example of this is Rio Tinto's Innovation Central exhibition developed in partnership with Scitech in Perth's City West centre. Inspiring and developing tomorrow's creative thinkers is the core aspiration of the exhibition. The initiative will encourage visitors to experience the building blocks of innovation for themselves through a range of hands-on exhibits that follow the innovation process: identifying a problem or need, thinking of possible solutions, making and trying prototypes, and refining designs.

Automation and technology do and should continue to create a more inclusive work environment by making industries such as mining more accessible and more appealing to a greater diversity of potential employees.

Skillsets necessary for the new working environment – Excellence Centres

Excellences Centres are part of Mine of the Future™ program and analyse real-time data from operations around the world, and leverage deep technical and operational expertise. These centres allow us to maximise value by significantly improving and sustaining the performance of our operations.

Rio Tinto's Excellence Centre program commenced with the development of the Processing Excellence Centre (PEC) in Brisbane, which was officially opened by our Chief Executive, Sam Walsh, in March 2014.

This world-first, state-of-the-art facility uses a large interactive screen where a team of experts can jointly analyse technical data and identify operational improvements. The system also allows particular improvements to be monitored to ensure they are sustained. PEC is currently supporting the Rio Tinto product groups Copper, Energy and Iron Ore at eight mine sites in Mongolia, Canada, the United States and Australia.

The following employee skillsets are specifically required for Excellence Centres:

- Strong technical skills in mining and processing domains relevant to the operations. People with these skills typically have more than 15 years of experience in their domain and extensive site experience. These people provide the context and understanding of the problems at sites and lead the programs of work with the operations. People with multi-commodity experience are particularly valued given that Excellence Centres are not restricted in application by commodity type.
- Complementing the domain experts are engineers and scientists who have deep technical expertise in a range of areas that are fundamental to improving the performance of our operations, such as:
  - Process control;
  - Advanced mathematics and modelling;
  - Engineering, instrumentation and sensing; and
  - Maintenance and operating tactics.
- Strong capability is also required in the following areas:
  - Collaboration and interpersonal skills; and
  - Human systems integration and ergonomics.

Case study 1

Application of automation at Hope Downs 4 iron ore mine located in the Pilbara of Western Australia

Hope Downs mining operation is located approximately 35 kilometres from Newman in the Pilbara region, Western Australia. The mine is 50 per cent owned and operated by Rio Tinto with Hancock Prospecting owning the other 50 per cent.

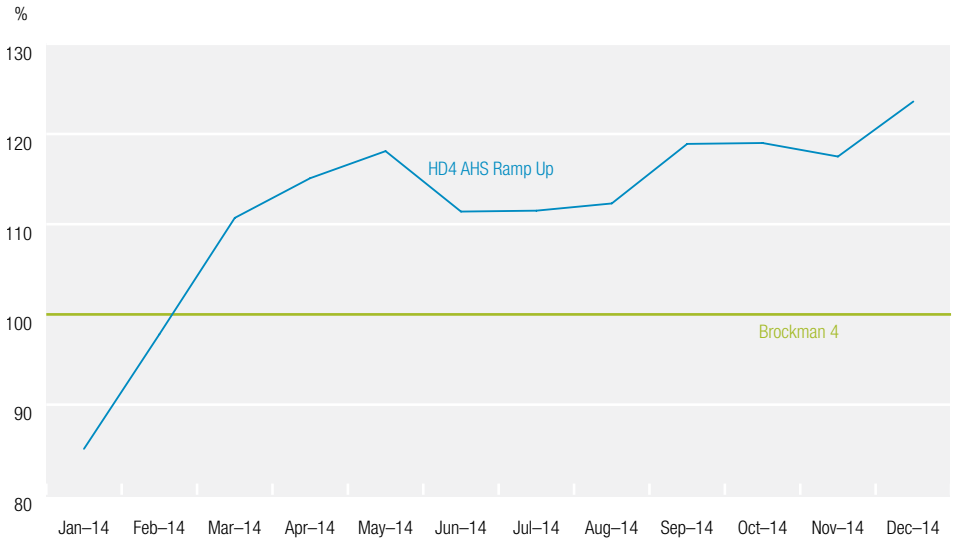
The AHS driverless trucks are a key part of the Hope Downs operations and were deployed to the mine in January 2014, with the ramp up to a fleet of 19 trucks completed in April 2014. (This number varies from time to time due to operational requirements.)

The AHS consists of driverless haul trucks supervised by a central system and central controller. AHS uses a pre-defined GPS course to navigate haul trucks. The AHS technology includes software, hardware and operating processes. Each truck is equipped with hundreds of sensors feeding back live data on its status and performance for analysis – this is cutting-edge technology. Many of the sensors and sources of data come from 'plugging' into various processors and instruments that are already part of modern machines, but the data was only being used internally by the machine itself to function.

Due to the AHS, there was a reduction in labour to drive the trucks; however, more challenging and interesting roles were created to both support and further drive productivity for AHS. These roles range from central controllers, who control and monitor the autonomous trucks; pit patrollers, who manage how the trucks operate in the pit; to roles such as communication and system engineering experts, who provide detailed fault diagnostics. In most cases, these new roles provide existing employees new challenges, and a much more rewarding job. Other than a small selection of highly skilled engineers, the new roles were filled by existing employees.

FIGURE 2

HOPE DOWNS 4 TRUCK EFFECTIVE UTILISATION



Note: Average EU per cent is calculated using Total Operating Hour / Total Calender Hour. Each month must be weighted by the number of trucks to calculate the total average.

In addition, existing mine roles, such as drivers of graders and excavators, were up-skilled. They were trained to be able to operate safely alongside the autonomous trucks and how to significantly influence the AHS as a whole to achieve its required performance level.

Since the implementation of an autonomous haulage system at Hope Downs 4, there has been a significant improvement in haul truck safety incidents. Sprains, strains and muscle injuries normally related to manned haul truck operations have been reduced to zero for autonomous haulage. Also, incidents resulting in an actual consequence of property damage to machinery or injury to personnel have also reduced significantly.

Haul truck effective utilisation at Hope Downs 4 is also the highest of all operating mine sites in Rio Tinto globally.

Figure 2 compares the effective utilisation of the autonomous trucks at Hope Downs 4 (blue) to manned trucks at another Rio Tinto Pilbara mine (green).

The ability to operate haul trucks at a 14 per cent higher effective utilisation to manned trucks resulted in three fewer trucks needing to be purchased for the Hope Downs 4 mine site, realising a significant cost saving to the business. Hope Downs 4 has been able to deliver significant value to the joint venture between Hancock Prospecting and Rio Tinto by delivering on improvements in safety, productivity and costs.

Case study 2

Autonomous Drilling System at West Angelas iron ore mine located in the Pilbara of Western Australia

Rio Tinto's Technology and Innovation group commenced the Autonomous Drilling System (ADS) project in 2006 with the development of a concept for autonomous drilling. This idea progressed through development stages from early remotely operated prototypes to the final stage of the development program, which saw three current generation SKSS drills operating autonomously with supervision and control provided from a mobile Autonomous Control Vehicle (ACV) located at the West Angelas mine.

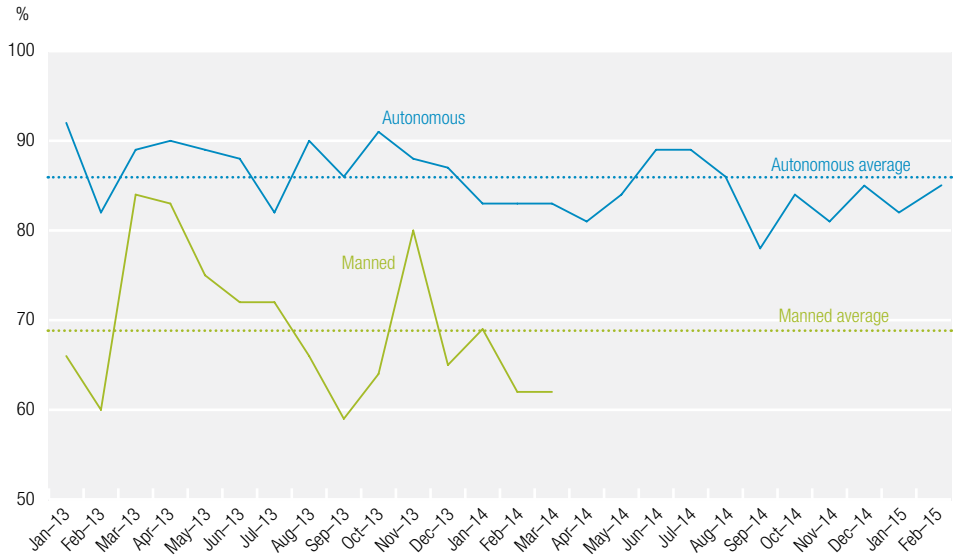
In 2008, Technology and Innovation collaborated with the West Angelas mine operations, and in 2012, Rio Tinto Iron Ore's Mine of the Future™ team was engaged to assist in the deployment of autonomous technologies, including ADS.

Currently our West Angelas mine is the only mine in the world with all its large production drills working autonomously.

The business has realised many benefits from ADS in terms of safety, productivity and cost. Safety has improved by operating remotely, and reduced the risk of injury to drill operators by removing them from a hazardous operating area. There is also a reduction of personnel exposure to health risks such as dust, noise and vibration. Since being in operation, ADS has had zero injuries. Plans are in place for other mines to obtain these benefits from ADS.

Due to the impact of ADS, there was a reduction in labour to operate the drills, but not to the same level as AHS. This is due to only a small number of drills that are on each site. In many of the cases, the drill operator role changed from being on-board a single drill to operating multiple drills remotely. For this, additional up-skilling was required to cover areas including the new remote operations, ADS computer system and technical problem-solving skills. Also, similar to AHS, new roles were created, such as communications, system engineering and data analysis experts.

FIGURE 3
USE OF AVAILABILITY: COMPARISON OF AUTONOMOUS AND MANNED DRILLS



Due to the success of ADS and AHS, new roles were also created in the investigation and planning of newer/emerging technologies to further progress the Mine of the Future™ program to generate benefits from automation and technology.

A key component of the productivity benefits is the increase of use of availability. Figure 3 shows that ADS has an improvement over manned drills of approximately 15 per cent in the use of availability.

The benefits of consistent and precise drilling means that each hole is drilled accurately leading to improved fragmentation during blasting and a significant reduction in the need for re-drilling. Not only does operational efficiency improve, it results in less consumables (such as drill bits and explosives) and a more than eight per cent reduction in costs compared with a manned drilling fleet.

When used in conjunction with our 'Smart' explosives charge trucks, it starts to come together as a system with the potential for further automation that will allow us to fully optimise drill and blast as well as increase throughput and reliability of our processing plants. We see reduction of variability as an opportunity to add further value and increase productivity of people and assets.

Conclusion and moving forward…

We are committed and optimistic about the future of automated technology and its role in our mining operations. As a business we have already seen the benefits of successfully deployed automated technologies and are encouraged by the enthusiasm of our operators to see it as an opportunity rather than a threat.

It is exciting to know that as we implement more technology we are gaining more data about our production system, its asset health, efficiencies and opportunities for continuous improvement.

This is demonstrated by the recent official opening of Rio Tinto's world-first Analytics Excellence Centre, which significantly enhances equipment productivity through data analysis.

The centre will assess massive volumes of data captured by the array of sensors attached to Rio Tinto's fixed and mobile equipment, and enable experts to predict and prevent engine breakdowns and other downtime events, significantly boosting the safety and productivity metrics.

Using predictive mathematics, machine learning and advanced modelling, data scientists in the Analytics Excellence Centre in Pune, India, will be working to identify a range of problems before they occur. This analysis will reduce maintenance costs and production losses from unplanned breakdowns. We believe it will also assist even better predictive modelling to continuously improve automation control.

Change is inevitable. But it's how we proactively harness the change to make our operations more predictable, efficient and safer.

Having started on this path, we cannot become complacent. Only our collective skills, talent and engineering innovation will ensure we retain our competitive edge and deliver even greater value to our shareholders. We have an opportunity not an entitlement to be the best miners on the planet, we are very conscious of this, hence our passion and relentless commitment to always improving.

1.6

Digital disruption – what, why and how

Sarv Girn

Sarv Girn is the Chief Information Officer at the Reserve Bank of Australia (RBA), a position he has held since September 2012. In this role, he provides strategic leadership in transforming and developing the core IT functions that support the RBA's policy, operational and corporate objectives.

Mr Girn has also previously held strategic and transformational executive IT positions at both Westpac and the Commonwealth Bank. He holds a Bachelor of Computer Science (Hons) from the University of London, and his career in the financial services industry in Australia, the United Kingdom and Asia spans more than 25 years. Mr Girn is a Fellow of the Australian Institute of Company Directors.

Context (what)

'Digital disruption' has a different meaning to different people, and it is often confused with the use of technology to solve a problem or the adoption of the technology of the day. However, digital disruption is far from that. It is about innovating to break the ranks of the status quo. It is change that is radical in the way it transforms businesses and societies through the application of technology. Still, it is not evolutionary in nature; it redefines the norm, and it changes the markets and competitors around us. It comes about from a relentless focus on the customer or consumer through an innovative and entrepreneurial lens, and it offers new business models and new ways of applying technology.

We only have to look around us to see the effects of digital disruption on traditional markets. The music industry was redefined by Apple (iTunes), advertising and market research changed by Google, and retail now spans geographies through eBay and bookstores via Amazon. The list goes on. Interestingly, other technologies are now in many instances disrupting these original disrupters.

But this is not just about technology companies disrupting traditional business models. It extends far beyond that. Think about the stockbroker business being disrupted by the likes of CommSec in Australia in the late 1990s. Look at Domino's Pizza and how it redefined the basic value proposition by giving customers direct control of how they order, customise, track and receive their pizza. We now see Uber bringing competition to regulated transport industries to meet new customer behaviours and needs. More recently, massive open online courses (MOOCs) are challenging traditional education by offering an online platform for students and professors to collaborate, and learning environments outside of traditional universities.

Some of this disruption is clearly very positive for society, business and economies. But if you are the firm being disrupted by others, it's not that positive at all – you only have to look at the likes of Kodak, Borders, Nokia, Blockbuster and Blackberry.

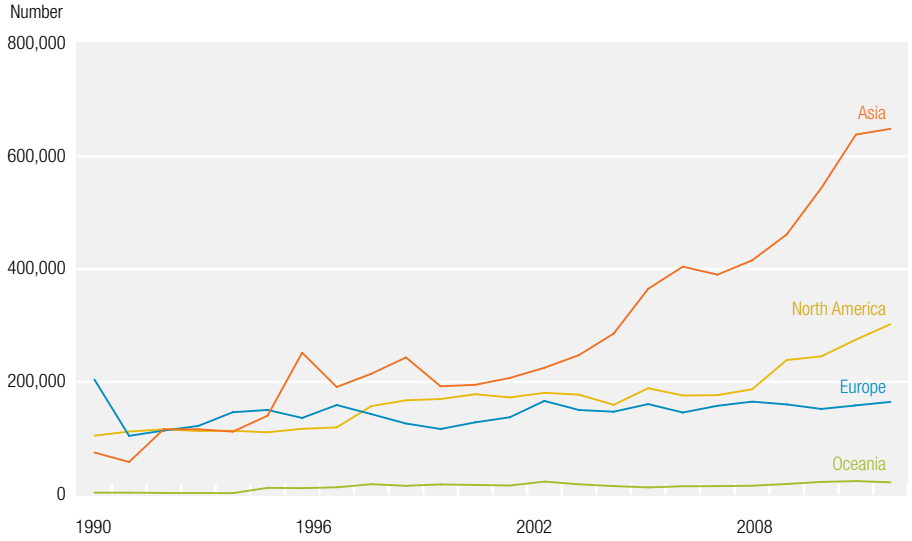
Opportunity (why)

Digital disruption is not constrained to geographic boundaries and as such brings both more opportunities and greater threats. Ideas and models that succeed are mostly global, or can be replicated quickly in multiple geographies.

The velocity of change we now experience as a consequence of digital disruption is unprecedented and, in most cases, unpredictable. The use of the internet is expected to double over the next five years in terms of the number of people online using internet-enabled personal electronics, otherwise known as the 'Internet of People'. Overlaying this with the 'Internet of Things' – machines/devices talking to each other across the internet – brings exponential growth in interactions and ideas, and creates winners and losers from the many opportunities and risks brought about by such change.

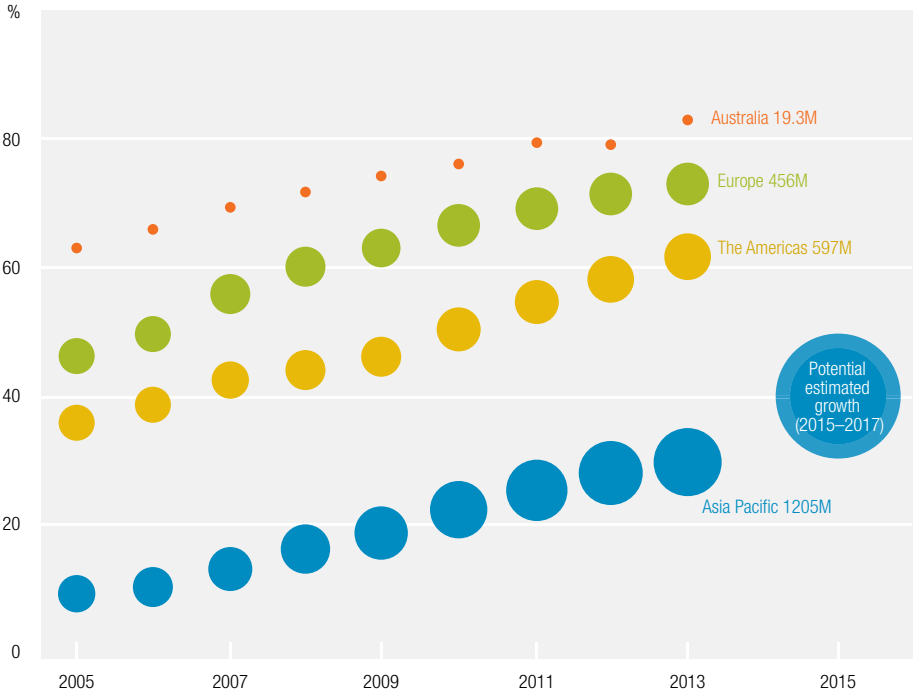
Australia is uniquely placed to benefit from this wave of innovation.

FIGURE 1
GLOBAL PATENT GRANTS BY REGION (TOP FOUR)



Source: World Intellectual Property Organisation.

FIGURE 2
INTERNET PENETRATION RATE



Note: Size of bubble = number of internet users.
Source: ITU World Telecommunication/ICT Indicators database.

Figure 1 shows the growth in global patents by region, a lead indicator that can often point to innovation and know-how that may result in future economic benefit.

In the last 10 years, growth has been predominately from Asia, with rates far exceeding North America and in particular Europe, which was a world leader in this area up until the mid-1990s. This growth in the number of patents points to a concentration of skills and capabilities in the Asia region, which itself flags an environment and culture that fosters change and innovation. This is akin to much of the innovation led

from Silicon Valley in the 1980s. The number of patents isn't the only factor at play here. The quality and ability to commercialise these to deliver 'disruptive' products and services is also relevant. So it's important to note that this growth doesn't necessarily imply this is where subsequent disruption will be.

Figure 2 shows the internet penetration rate, or the proportion of people in a region that use the internet. The first thing to note here is that Australia, at just over 80 per cent, has one of the leading internet penetration rates globally, even though the absolute numbers are clearly much smaller than other geographies.

Taking a look at Asia Pacific, we see a very low penetration rate of 30 per cent, but one that is growing more rapidly than the rest of the world. The projected growth suggests there is a disruptive change coming. If this increase continues over the next five years, even a modest increase from 30 per cent to 40 per cent penetration (which is still well below Europe and the Americas) could see the projected number of people on the internet worldwide roughly double.

This may seem like a massive sales opportunity given the consumption of the region. But be warned; those additional people on the internet will not just be buying; they will also be selling and disrupting markets globally. This has been seen recently through Alibaba, a company that handles 80 per cent of China's e-commerce, and whose sales now far exceed the likes of eBay and Amazon.

Digital disruption has affected many sectors already, but it has been concentrated primarily in service-based industries that directly support the needs of consumers and societies. These include:

- Tourism and travel – through businesses such as Airbnb, Couchsurfing and Homestay, which allow people to rent out their house, room or couch to global travellers at a fraction of the cost of a hotel.
- Courier and postage – through online shopping and partnerships between eBay and a range of other retailers including Woolworths and Big W. The introduction of 'Click & Collect' allows shoppers to pick up their eBay parcels purchased from established online retailers at a preferred physical store, cutting out courier and post office services.
- Retail – through the implementation of self-service checkouts, 24/7 online ordering, virtual stores on public websites, eBay and Amazon, and the concept of virtual walls in stations and subways across Korea and Japan, all of which have redefined the traditional supermarket by offering convenience to shoppers and at the same time dramatically reducing the cost of servicing customers.

In recent years, manufacturing and utilities have also been affected by disruptive innovations such as 3D printing and fast 4G wireless communications on mobile devices and within homes. These disruptions often question fundamental operating models, the necessity of intermediaries in the value chain and the need for wired communications.

When we look at the Australian economy, where 70 per cent is made up of service-based industries, we can see this as either a great opportunity or a threat. The expertise seen in service-based industries and the right operating environment offers great opportunity for this sector to innovate and disrupt its services, and, in many cases, take them global given that digital traverses geographical boundaries. On the other hand, disruption led from overseas sources could affect the very viability of those industries.

Australia's proximity to Asia brings a clear advantage we cannot afford to ignore. The traditional leaders of the global landscape will clearly be challenged with innovation and disruption arising from this part of the world.

Against the backdrop of this opportunity, how do you deal with disruption and what kind of environment is necessary in Australia to harness the economic benefits from this change?

Environment (how)

The recipe for dealing with digital disruption lies in having the right operating environment where private and public sector organisations can flourish among communities that are able to feed the education and talent needs necessary for digital change to be harnessed. The operating environment is far more important than the technical capability itself. The way private and public sectors deal with digital disruption is more critical now than ever before, and surviving with a status quo mindset may not be enough when challenger business models are thriving in this digital age.

There is no silver bullet to deal with this need. We see many technology parks and hubs appearing, debates on entrepreneurship and start-ups, and growing discussion on what educational environment Australia requires for the next generation. A balanced view across multiple dimensions is necessary. A simple way of considering the operating environment is outlined in Figure 3, which shows a holistic approach to examining best practice environments from around the world.

FIGURE 3
CONSIDERATIONS FOR A BALANCED DIGITAL ENVIRONMENT

Source: RBA

Across one dimension is 'hardwiring', which includes the policies, regulation and rules that govern a society or organisation and enable innovation to flourish. At the other end of this dimension is 'softwiring', which refers to the culture, behaviours and skills necessary for dealing with the digital era in a society or organisational sense. Both dimensions, in a coordinated and complementary way, are vital in creating the right operating environment for established and emerging businesses to prosper.

In the context of this framework, when we look at some of the lessons of the past, digital leaders around us and those that are succeeding, a number of environmental considerations in each quadrant stand out.

Society

In the digital age, where new knowledge and service industries are growing at faster rates than traditional ones, Australia is in a unique position to benefit. It has all the right ingredients: one of the highest internet penetration rates in the world, neighbours in Asia growing their online presence at exponential rates, and a large service industry that is ripe to drive and adopt disruptive innovations itself from the start-up world around it.

While the digital debate is gaining a lot of attention nowadays through a range of publications, finding ways to have cross-industry and cross-society discussions that draw together the needs and actions for the economy become even more critical.

Through this, ensuring laws and rules encourage new start-ups to flourish without inhibitors is critical, but what is even more vital is finding ways to retain their home presence in Australia as they become successful in a global sense, instead of forcing them offshore to continue their growth. At a grassroots level, a focus on education curriculums that encourage and develop an entrepreneurship skillset in schools, TAFEs and universities is vital. This has been done successfully in many other countries, resulting in more young people launching start-ups in an informed way. Without this focus, the technology parks, hubs and accelerators will be starved of a pipeline of talent and capability.

While this hardwiring of society is critical, the culture of the communities that embrace this becomes equally important. The acceptance that start-ups may fail as well as an attitude that it's okay to start again need to be nurtured. For many of the disruptors in Silicon Valley communities, the number of start-ups an individual has been part of is seen as a valuable and saleable credential, not a black mark on their ability. This clearly is a mind shift from a society that may see this as a failure.

Fostering a culture that supports budding entrepreneurs to pitch ideas, gain feedback and then grow requires a supportive community – one where the thought of such opportunity is seeded early in the education system and the broader business community.

Organisation

For organisations, getting the strategy for digital innovation agreed up-front is as important as the risk appetite statement you may traditionally see in the boardroom. An organisation needs to formulate a conscious and clear strategy on whether it will be a leader of change and disrupt its own and other business models, a fast follower of another firm's innovation or simply focus on incremental continuous improvement itself through the adoption of technology for efficiency and effectiveness.

This strategy will require leadership that is more nimble and adaptive, and that has the courage to trial new ways to adapt to disruptive digital change. Fundamental approaches to experimentation, funding models that allow a test-and-learn approach, and ways to 'fast fail' projects that do not show signs of success are vital in this new business environment.

Coupled with these hardwired controls, ensuring the culture embraces relationships with industry partners and suppliers to tap into research and development, and detect early signs of change arising from technology becomes even more critical. This is where leaders such as Apple and Amazon have performed exceptionally well through upstream and downstream partnerships that enable their ideas.

Some of the disrupted ignored these considerations and became locked away in their innovation for fear of losing their traditional products, or did not want to collaborate with others for joint success. Unfortunately, others catch up and then overtake. All of these considerations are ones that many digital leaders have addressed explicitly in the past to succeed.

Conclusion (what, why and how)

What is clear when dealing with disruption is that the approach has to be built into the goals and embedded into the DNA of society and the organisation, especially within the culture, which can lead to the adoption or shelving of new ideas.

Disruption is happening all around us. There are many opportunities for us and it is possible to deal with disruption. If you want to harness the growth potential, observing and learning from the patterns of digital leaders is vital.

In this new world, Australia is uniquely placed to benefit from digital disruption. The strength in a service industry, the proximity to a growing digital presence in Asia and the foundations of an education system focused on a knowledge society are all ingredients for a successful recipe in this new digital era.

Views expressed in this paper are those of the author and not necessarily those of the Reserve Bank of Australia.

1.7

Megatrends and Australia's future: Older and wiser?

Dr Fiona McKenzie

Dr Fiona McKenzie is the Policy Director for the Australian Futures Project, the objective of which is to build Australia's capacity to make decisions for a flourishing shared future. The Project is hosted by La Trobe University where Fiona is also an Honorary Associate in the School of Humanities and Social Sciences. Fiona's main focus area is on the decision-making and innovation processes of individuals and groups across complex systems and networks, and their potential to unleash creative solutions from local to global scales.

Fiona has policy experience within Australia and internationally, having worked with government, non-government and intergovernmental organisations. This includes the NSW Government, the Australian Centre for International Agricultural Research, the Terrestrial Carbon Group, EcoAgriculture Partners, the United Nations Environment Programme and the Wentworth Group of Concerned Scientists. Fiona's academic background is in human geography. She is a Council member of The Geographical Society of New South Wales. In 2011, Fiona completed a PhD on farmer-driven innovation in Australian agriculture at the University of Sydney where she was also a lecturer.

Introduction

The world is more interconnected than ever before.[1] Complex and often non-linear linkages are driving rapid changes across sectors and systems globally. Events happening in one part of the world can have fast and far-reaching consequences a long way from ground zero. Figuring out what factors are driving these changes is not easy, nor is predicting where the next change will occur.

One way to make some sense of it all is through the identification of megatrends. Megatrends are major shifts in environmental, social and economic conditions occurring at the intersection of many trends. Megatrends have the potential to irreversibly change the way we live and challenge the models we use to organise our societies.

A range of authors and organisations around the world have undertaken studies to identify megatrends. While the names and classifications of megatrends can differ, common themes have emerged. Based on a review of available literature, this chapter synthesises some of the major shifts occurring. Five categories are outlined, each with the potential to significantly influence Australia's future:

1. Economics: a shift towards emerging-market economies.
2. Climate change – both mitigation and adaptation.
3. Resource security: reconciling resource consumption and ecosystem health.
4. Virtual connectivity: the acceleration of global networking.
5. Demographics: population growth, ageing and urbanisation.

The implications of these megatrends are then explored in the context of Australia's future workforce, with a particular focus on demographic changes (population growth, ageing and urbanisation).

Economics: a shift towards emerging-market economies

One of the most common megatrends is the major transformation currently taking place in the global economy as the centre of gravity shifts towards emerging-market economies. It is anticipated that, in the next decade, these economies will become powerful economic actors in their own right, with Asia the centre of global economic activity.[2] Whether China will replace the United States (US) as the strongest economy by 2050 is subject to conjecture. Some authors[3] suggest that China will replace the US as the US experiences stagnation. Other authors, like Friedman[4], suggest this won't be the case, instead foreseeing stagnation in China and a US resurgence.

In terms of developed versus developing country economies, the US National Intelligence Council[5] foresees that the US, European and Japanese share of global income will fall from 56 per cent today to 'well under half' by 2030. While the West won't necessarily get poorer, economic growth will be affected by demographic change and high per capita income.[6] Middle classes in the developing world are poised to expand substantially in both absolute numbers and the percentage of the population that can claim middle-class status during the next 15 to 20 years. This is related to the acceleration of individual empowerment, and linked to poverty reduction, greater educational attainment, widespread use of new communications and manufacturing technologies, and healthcare advances.[7]

Climate change – both mitigation and adaptation

The Intergovernmental Panel on Climate Change projects an increase of global mean surface temperature of 1.1°C to 3.1°C by the end of the 21st century (relative to 1986–2005). This is the result of their intermediate scenarios (versus their 'stringent mitigation' or 'very high greenhouse gas emissions' scenarios). In many regions, this means heat waves will occur more often and last longer, and extreme precipitation events will become more intense and frequent. Occasional cold winter extremes will continue to occur.[8]

From a geopolitical point of view, shifts in monsoonal rainfall in India and the rest of Asia, or the increased frequency and severity of natural disasters, would be likely to result in greater geopolitical instability and tension around the globe, especially in fragile states.[9] In Australia, future winter rainfall is likely to be lower across the entire South East of the country while the incidence of catastrophic fire weather days will significantly increase, with future mean annual runoff also decreasing by an average of eight per cent.[10] The number and value of built assets exposed to sea level rise is also expected to increase exponentially.[11]

Resource security: reconciling resource consumption and ecosystem health

The challenge of meeting growing demand for natural resources (for example, food, water, energy) while maintaining ecosystem health and services in a finite world is not a new one. However, it is likely to become increasingly difficult as resource insecurity grows. Given current conditions, the world could face:

- A 40 per cent shortfall between global freshwater demand and supply by 2030[12];
- An energy production shortfall of around 400 EJ/a in 2050 – equivalent to the size of the whole industry in 2000[13];
- Rapid expansion in global cropland area triggered by higher population and higher demand for food[14];
- A further 10 per cent loss of all global terrestrial biodiversity by 2050[15]; and
- Unrest within fragile states in Africa and the Middle East (and possibly China and India) due to resource shortages manifesting as higher prices for basic necessities.[16]

Consistent with economic growth forecasts, the fastest growth in agricultural exports are expected to come from emerging exporters in Eastern Europe, Central Asia and Latin American countries.[17] The real value of Australian agricultural exports is expected to be 140 per cent higher in 2050 than in 2007, with the largest increases in real value expected for beef, wheat, milk and sheep meat.[18] However, these figures are based on the assumption that agro-environmental conditions are maintained and climate change will not cause large-scale disruption. In reality, longer term food security for Australia and its trade partners is likely to be threatened by climate impacts, lack of planning controls over urban development and mining on productive land, shortages of skilled labour and underinvestment in agricultural research and development.[19]

Despite potential resource scarcity, some authors suggest that modern lifestyles could be maintained at affordable prices because of our technological base.[20] Hajkowicz et al. foresee a shift in consumption patterns and behaviour driven by rising consumer, societal, demographic and cultural demand for experiences over products and the

rising importance of social relationships.[21] Such 'experience-based consumption' could become a means of maintaining economic growth and delivering quality of life while conserving the natural world's limited resources. On another front, the Organisation for Economic Co-operation and Development (OECD) foresees a bio-economy emerging by 2030 from the invention, development, production and use of biological products and processes. They estimate this could contribute up to 2.7 per cent of GDP in OECD countries.[22]

Virtual connectivity: the acceleration of global networking

The last 20 years has seen the rise of virtual networks of unimaginable scale and complexity. Money, goods, data, and people now cross borders in huge volumes.[23] This online connectivity and networking is only going to accelerate. In 2012, there were five billion devices connected to the internet, including computers, phones, music devices, vehicles and appliances. This will grow to 22 billion by 2020.[24] All surfaces have the potential to become an interface point with this networked technology. Some even predict that devices and information and communications technology (ICT) systems could be controlled directly from the brain.[25] In this networked world, learning could be democratised by near-universal access to virtual universities, while collective intelligence could supplement individual intelligence.[26]

Increased online engagement creates economic opportunity and opportunities for greater social interaction. It also facilitates increased levels of malicious activity, from organised crime to state-sponsored espionage.[27] As traditional legal systems are updated to reflect the new virtual reality, the future may see cyber police forces in place to detect, apprehend and penalise online criminals, with a 'cyber judicial system' in place to convict criminals online.[28]

Demographics: population growth, ageing and urbanisation

Population growth

World population is expected to increase from the current 7.2 billion people to 9.6 billion in 2050 and 10.9 billion in 2100.[29] Nearly all future population growth will occur in developing countries, while developed countries as a whole will experience little or no population growth in this century, and any growth that does occur will largely be driven by immigration from less developed countries.[30] This means that the relative size of different countries will shift. In 2050, there will be almost as many people in Nigeria as in the US, and Ethiopia will have twice as many people as projected in the United Kingdom or Germany.[31]

In Australia, population growth is projected to slow, but total population is still projected to reach 31 million people by 2033 and 42 million people by 2060.[32] This is compared with Australia's resident population in December 2013 of 23.3 million. This growth is a function of a combination of natural increase (total births minus total deaths) and net overseas migration. The total fertility rate in Australia is currently 1.9 babies per woman (around half what it was in the early 1960s) and life expectancy is steadily increasing (refer to Table 1).

Ageing

In Australia, like many countries in the world, our population is ageing. If fertility, net overseas migration and life expectancy rates were to continue in line with recent trends, the proportion of the population aged 65 years and over can be expected to increase from 14 per cent in 2013 to 23 per cent in 2061.[33] With population ageing, the working age population (aged 15 to 64) will decline from 67 per cent in 2013 to 63 per cent in 2033 and 61 per cent in 2061. This translates to less working aged people per aged person. To date, people aged over 65 years have had relatively low labour force participation rates.

The number and proportion of Australians aged 85 and over will also grow rapidly. It is projected that 4.9 per cent of the population, or nearly two million Australians, will be aged 85 and over, compared with less than one per cent or 80,000 people in 1974–75.[34] This means a potential increase in the number of users of government services such as healthcare, aged care, and public housing.[35] On the flip side, ageing is creating new economic opportunities and consumer markets across the world. Over 60s spent $8 trillion in 2010, and by 2020, they will spend $15 trillion. In Australia, 50 to 69-year olds alone hold more than 40 per cent of the nation's wealth.[36]

Table 1 shows what Australia's population (age and structure) would look like in 2033 and 2061 compared with today. Note that the Australian Bureau of Statistics (ABS) estimates of current and future life expectancy are significantly lower than estimates in the 2015 Intergenerational Report (IGR) because they use a different method. The IGR uses a 'cohort method' that gives a male life expectancy in 2015 as 91.5 years, growing to 95.1 years in 2055.[37]

TABLE 1
AUSTRALIAN DEMOGRAPHIC STATISTICS AND POPULATION PROJECTIONS[38]

	2013	2033	2061
Total population	23.3 million	31 million	42 million
Population aged over 65	14 per cent	19 per cent	23 per cent
Working age population (aged 15 to 64)	67 per cent	63 per cent	61 per cent
Population aged less than 15	19 per cent	18 per cent	17 per cent
Dependency ratio (dependents for every 100 workers)	50 per cent	59 per cent	65 per cent
Fertility rate (births per woman)	1.9	1.8	1.8
Net overseas migration (migrants per year)	240,000	240,000	240,000
Life expectancy	79.9 years for men 84.3 years for women		85.2 years for men 88.3 years for women

The forces that have led to ageing in Australia – higher life expectancy and lower fertility rates – are common among many countries. All of Australia's major trading partners will go through a major demographic transformation to older societies, including the European Union, Japan and China.[39] Working populations are projected to contract dramatically in developed countries, including Japan (–37 per cent) and Russia (–31 per cent), and also in the Eurozone (–29 per cent).[40] In 2012, only Japan and Germany had matured beyond a median age of 45 years. By 2030, most European countries,

South Korea and Taiwan will have entered the post-mature age category.[41] In 2060, China's share of people aged 65 or more years is projected to be over 28 per cent, or around five percentage points greater than Australia in that year.[42]

Urbanisation

In 1800, only two per cent of the world's population lived in cities – now it is 50 per cent. One-and-a-half million people are added to this total every week.[43] It is predicted that by 2050, three-quarters of the world's nine billion people will live in cities.[44] Most of the increase in urban populations will be in middle- and lower-income countries.[45] Larger, urban populations will require expanded security and law enforcement due to the increased potential for communal violence, public disorder or social unrest. Urban areas can also be vulnerable due to their high reliance on critical infrastructure. Communicable diseases can spread more quickly in densely populated areas, increasing the risk of global pandemics. More generally, cities are connected systemically through physical and informational networks where events in one location can be rapidly transmitted globally in unexpected trajectories.[47] Populations are agglomerating along coastal areas at risk of rising sea levels, extreme weather events, earthquakes and tsunamis. Urban flooding has already become the leading form of disaster in the world, and the United Nations (UN) forecasts that the number of people in large cities exposed to cyclonic winds, earthquakes and flooding will more than double in the first half of this century.[48]

Australia has long been a strongly urbanised country with population highly concentrated around a narrow coastal belt. More than 70 per cent of the population live in major cities while the majority of the rest reside in inner regional areas. This urbanisation is continuing. Within Australia, areas of population growth and decline in the past are likely to be reflected in future trends. From 2001 to 2011, major cities experienced the greatest proportional increase in population relative to other areas. This included older built-up areas, encouraged by both planning policy and changing preferences. Strong net migration and moderate natural increases will continue to drive population growth in major cities.

Implications and policy considerations

Spatial and skill mismatches

Employment opportunities shifting to other sectors and locations can have negative outcomes for individuals and regions, especially if there are no jobs available that match existing skills and experience. This is an urban as well as a rural issue. In our major cities, there is a growing spatial divide between where jobs are (inner city) and the outer suburbs where people can afford to live.[49]

To see how much the working world can change in a few decades, we only have to look to the recent past. In 1966, 46 per cent of all employed people in Australia worked in production industries such as manufacturing.[50] In 2011, the most common industry was the healthcare and social assistance industry, and the most common occupations were professionals, clerical and administrative workers. The proportion of people working in production industries has now halved. Almost all employment growth has been in the service sector, the workforce of which has more than tripled from 2.6 million to 8.7 million from 1966 to 2011.[51] However, the actual number of people working in production industries has not declined. It has remained steady at

between 2.2 million and 2.7 million positions. And job losses over the last decade in manufacturing; agriculture, forestry and fishing; and information, media and telecommunications have been offset by more than a million job gains in higher paying industries. The challenge is that the jobs available don't always match the skills or location of workers, meaning painful impacts for many individuals and regions.

In 2025, Australia is expected to have almost two million new jobs compared with today, while 65 to 75 per cent of people employed will hold a post-school qualification.[52] The Department of Employment forecasted that over the five years to the end of 2018, one in three new jobs will be for professionals.[53] However, there is the question of matching skills with demand. Having a qualification doesn't guarantee a job. This is evidenced today where there is an oversupply of graduates in some disciplines and a deficit in others.

There is a risk of mismatch not only for employment, but also for the provision of services. Looking ahead, the geographical distribution of Australians aged 65 and over and 80 and over in 2021 and 2031 will be quite different to that of today. Currently, major cities, remote and very remote areas have a greater proportion of young adults while inner and outer regional areas possess above average proportions in the middle adult and elderly ages.[54] Remote and regional areas are both likely to experience population ageing in the future as low natural increases and low migration reduce their proportion of young people. This means that the location of aged care infrastructure may end up being mismatched with where older Australians live.[55]

The IGR projects that the proportion of Australians aged over 65 participating in the workforce will increase from 12.9 per cent in 2014–15 to 17.3 per cent in 2054–55.[56] This assumes that they can find jobs. As regional and remote Australia ages, many older Australians will be living in areas with potentially fewer jobs and higher unemployment rates. Today, unemployed older workers can find it more difficult to find work because their skills do not match contemporary employer needs or due to disability or discrimination.[57] They face higher rates of long-term unemployment. On average, unemployed people aged 55 and over last worked in a full-time job 67 weeks ago, compared with 38 weeks for people aged 15–54.[58] While financial disincentives related to tax and superannuation can be addressed through policy measures, shifts in the attitudes and expectations of employers and the labour force will be as important.

This is not to forget that, in Australia, there is a higher proportion of young people (15–24 years) who are unemployed than those aged 55 years or over. While the current national unemployment rate is 6.3 per cent, for 15 to 24-year olds, the unemployment rate was at 14 per cent in January 2015. For 15-to-19-year olds, the unemployment rate is over 20 per cent – a return to levels not seen since the 1990s after a period of recession. Youth unemployment is even higher than the national average in many regional and remote areas.[59] Again, job demand doesn't match supply. And today's young will be tomorrow's old.

Crowded cities

By 2020, the cost of urban congestion in Australia is expected to more than double to $20.4 billion. By 2030, Australian cities will need to cope with the added pressure of 30 per cent more people, with increasing city density placing more pressure on infrastructure, the environment and the social fabric of the city. City leaders will be presented with difficult choices if growing cities are to remain liveable cities.[60] As urban populations grow, substantial improvements in urban governance capacities will be needed to make cities resilient against complex and interconnected risks.[61]

As populations decline in regional areas, and traffic congestion and unaffordable housing increase in urban areas, governments will no doubt be pressured to do more to promote population and economic growth in regional areas. However, policy measures attempting to increase population growth in regional areas will struggle against demographic forces of decline.[62] For those wanting to live and work in major cities, public transport and new transport infrastructure is important, but housing affordability will also need to be addressed. At its most basic, this will require more streamlined planning and zoning rules to enable the building of new homes in inner-city suburbs.[63]

As urban populations age, new approaches will be needed to ensure housing and urban developments enable rather than restrict workforce participation of our ageing population.[64] Urban planning will need to create accessible local environments in which older people can get out and about. Improving accessibility can include relatively simple measures like reliable transport options for those with mobility problems, well-maintained footpaths without trip hazards, low kerbs with wheel chair ramps, places to sit and rest, and safe and well-lit streets with a good police presence.[65]

Global competition for job opportunities

> "More than ever, governments need to distinguish between jobs lost to other countries and jobs lost to the past."[66]

As population growth slows and people age, workforce shortages can occur. Yet while some developed countries are facing shortages, others are facing a surplus. While Australia may be seeking to lift workforce participation in the face of worker shortages, globally, employment is not expanding fast enough to keep up with the growing labour force.[67] Almost 202 million people were unemployed in 2013 around the world, an increase of almost five million from the year before. The bulk of the increase in global unemployment is in the East Asia and South Asia regions, which together represent more than 45 per cent of additional jobseekers, followed by Sub-Saharan Africa and Europe. If current trends continue, global unemployment is set to gradually worsen, reaching more than 215 million jobseekers by 2018. During this period, it is estimated that around 40 million net new jobs will be created every year, which is short of the 42.6 million people who will enter the labour market each year looking for work. Meanwhile, the global youth unemployment rate is almost three times as high as the adult unemployment rate. In certain countries, almost one-quarter of young people aged 15 to 29 are now neither in employment, nor in education or training.[68]

Virtualisation of the workforce

> "No one knows for certain which industries will generate the jobs of the future. But we do know we want them here in America."[69]

Jobs and organisations are likely to become increasingly globalised and fluid as people move from project to project, from areas of workforce surplus to workforce shortage. This global diffusion of job opportunities will be aided by the rise of virtual networks. In 2030, technology will be pervasive and the global labour market highly competitive.[70] This proliferation of technology and our increased global interconnectedness will also make societies and business processes more vulnerable. Within this context, companies will be forced to remodel their businesses to enable further flexibility and virtualisation of the workforce. This new business environment could see companies play a role as 'network orchestrators' rather than traditional employers.[71]

A new world of work

Everyone, not just employers, needs to be thinking now about where and how the way people work in the future will shift. If employees are scattered across networks and couches, working at all hours and in many locations, what are the implications for occupational health and safety, cybersecurity and data confidentiality? Having virtualised teams and networks would require new capacities in leadership and team management, as well as new ways of managing performance and motivating staff.[72] Are we prepared for this?

And what are the industrial relations implications if the traditional working week – or even a traditional job – becomes a thing of the past? As businesses shrink their workforces to a minimum using flexibly employed external service providers, this may mean a much smaller group of employees will be able to enjoy long-term contracts. The Oxford Martin Commission for Future Generations suggests that "economic models and political systems built upon a desire for full employment may require revision".[73] They cite evidence of movement "towards a more fluid employment relationship", whereby "people are holding portfolios of activities, including paid employment, unpaid employment such as internships or volunteering, self-employment, and caring for children or the elderly".

Increased employment flexibility can translate into the reduced security of workers. While the highly skilled will push for a better work-life balance, many others will experience increasing insecurity of employment and income.[74] For some, this is already the case. Globally, 'vulnerable employment' (including self-employment) accounts for almost 48 per cent of total employment. Persons in vulnerable employment are more likely than wage and salaried workers to have limited or no access to social security or secure income. The number of people in vulnerable employment expanded by around one per cent in 2013, a rate of growth five times higher than it was during the years prior to the Global Financial Crisis.[75]

At the time of writing, the Productivity Commission was undertaking an inquiry into Australia's 'workplace relations framework'. Its scope of reference includes patterns of engagement in the labour market and the ability for employers to flexibly manage and engage with their employees. In *Issues Paper 1*, it recognises that:[76]

- Long-run shifts in labour markets, institutions, the nature of the economy and social security systems may provide an impetus for further change;
- There are risks to less skilled labour posed by technological change and the increasingly tradable outputs of the service sector;
- Traditional notions of the workplace may change for some types of occupation because of technological advances that allow people to work remotely; and
- Concerns exist about the lack of a safety net for workers not classified as employees, such as outworkers and contractors.

This is a start. But we need to take this thinking further. For example, much of the current thinking about innovation clusters and professional networking emphasises the importance of physical proximity, often in inner-city locations. But what if we all work remotely? Can innovation occur across geographical boundaries – beyond business precincts or hubs? What might the new patterns of business and collaboration be?

In examining creative industries in the outer-suburbs of Melbourne and Brisbane, Felton et al.[77] found that networks could thrive outside the dense 'proximity clusters' of the inner city, and were often less spatially dense than accepted wisdom would recognise. Might this be the case in other industries as well?

Conclusions

Australia is facing a range of megatrends that will change the way we live and work in coming years. We need to start thinking creatively about the opportunities and challenges on the horizon. This goes beyond debating minor reforms or making a few policy tweaks. The world is changing and with it our society, our economy, our democracy and the environment around us. How do we thrive in this brave new world? In a time of increasingly complex and interconnected systems, what skills do we need to navigate our way?

For those that learn how to thrive in an unpredictable and uncertain world, rapid change and complexity need not be a liability. They can be an advantage. We need to be proactive in building our capacity to make decisions for the long-term while having the ability to successful react and adapt in real time to curve balls thrown our way. We need organisations that can cope with complexity by being able to learn and adapt to changing circumstances. We need leaders with humility, willing to draw upon the emergent and self-organising nature of complex adaptive systems through empowering others and continuous re-calibration. This requires taking risks, experimentation, and accepting failures. We need governments that are willing to do all these things. And we need citizens that will encourage them doing so. We might be getting older, we can also get wiser. The 21st century is still young.

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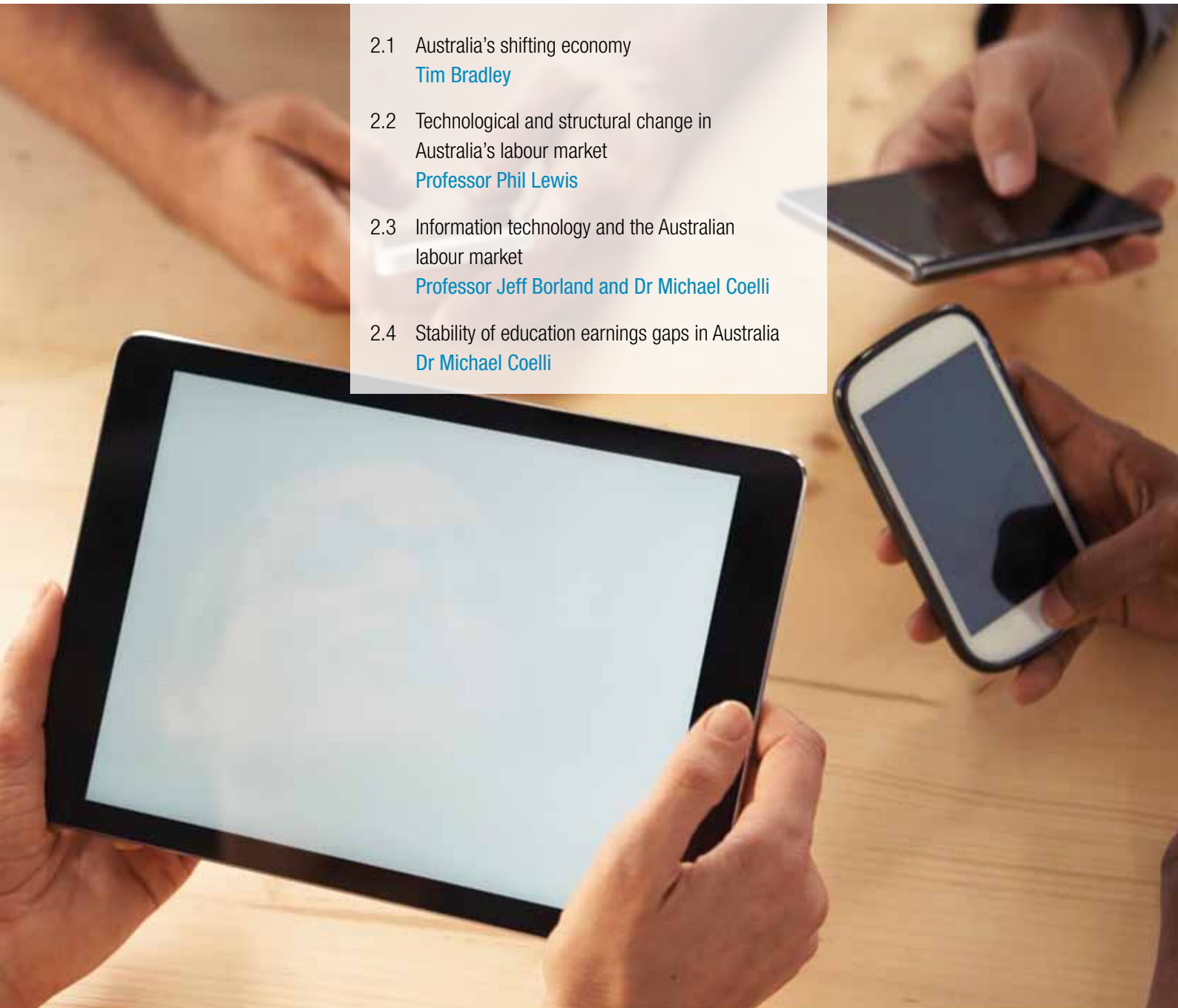
SECTION

2.0

Australian stocktake



2.1
Australia's shifting economy

Tim Bradley

Tim Bradley is General Manger of the Industry Economics Branch at the Department of Industry and Science. He works closely with the Department's Chief Economist on issues relating to industry policy, sectoral analysis and firm behaviour. He was part of the team that compiled the inaugural *Australian Industry Report 2014*. Prior to joining the Department, Tim spent nearly a decade as a consultant where he worked on issues relating to regulation, the resources sector, higher education, industry performance and economic policy.

Introduction

In the 1970s, Australia produced nearly half a million vehicles each year. Australia was one of few countries with the capabilities to design and manufacture automobiles on such a large scale. The sector employed near 90,000 workers directly and thousands more indirectly.[1]

Since then, the story of Australian automotive manufacturing has been one of slow decline. Renault announced in 1981 that it would no longer manufacture cars in Australia. In 1992, Nissan withdrew; and in 2008, Mitsubishi. By early 2014, the remaining three producers – Ford, Holden and Toyota – had each announced that they too would be pulling out of the market. By the end of 2017, cars will no longer be manufactured in Australia.[2]

Australia's experience in automotive manufacturing is an illustration of the pressures applied by different economic and demographic forces:

- Advances in technology have reduced the cost of manufacturing and highlighted the importance of scale production;
- Shifts in consumer preferences have changed the types of cars that consumers want to buy; and
- Government policies have opened our borders to trade and facilitated intense international competition.

The forces behind the decline of automotive manufacturing are the same forces that the Australian economy has had to grapple with over the past century. They will be the same forces that the economy will have to grapple with over the next century.

This story is not unique to automotive manufacturing. There are many other examples of industries that have either disappeared or significantly contracted over this same period.

The economy is constantly challenged by competitive forces. They force firms to innovate and invest, to seek improvements in the products they offer and to reduce their costs of production. Those firms that cannot compete on value and price ultimately fail. Those that can, succeed. Employment, investment and production follow accordingly.

At a national level, the effects of these competitive forces translate into productivity improvements and economic growth.

While it is easy to focus on the industries and jobs lost, there is a bigger story at play. In the decade to 2013–14, Australian manufacturing employment decreased by around 92,000 jobs. In that same decade however, employment in healthcare and social services increased by 462,000 jobs, by 314,000 jobs in professional services and by 222,000 jobs in construction.[3]

This chapter provides an overview of the structure and composition of the Australian economy and how it came into being. It draws on the findings of a recent report produced by the Department of Industry and Science's Office of the Chief Economist, *The Australian Industry Report 2014*.[4]

The Australian economy in 2015

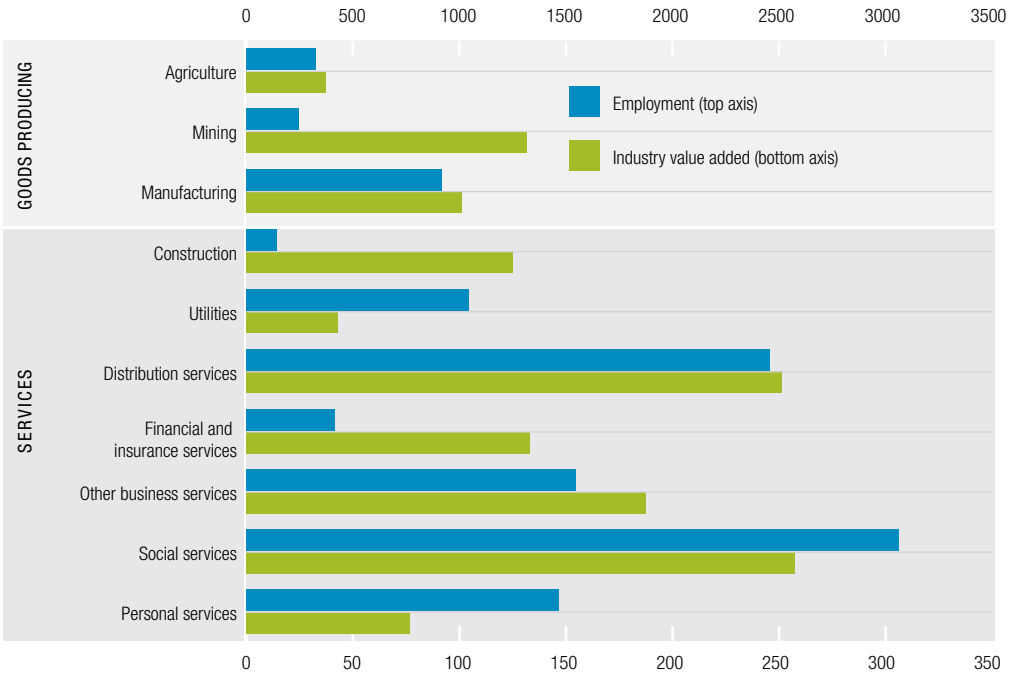
To understand what will be required of the Australian economy in the decades to come, we first need to understand where we have come from and what we look like today.[1]

Australia's $1.6 trillion economy comprises more than two million businesses and 11.5 million employees. Like most developed economies, the majority of our output and employment is produced by the services sector (79.9 and 86.7 per cent respectively).[5] The largest industry within the services sector is social services. This industry – which includes healthcare and social assistance, education and training, and public administration and safety – makes up around 19.1 per cent of industry value added (IVA). It is followed by distribution services (18.7 per cent), other business services (13.9 per cent), and financial and insurance services (9.9 per cent of IVA). Combined, the services sectors produce $1.1 trillion of output a year and employ over 10 million people.

Mining is Australia's largest goods producing industry, at 9.8 per cent of IVA. Manufacturing and agriculture follow with 7.5 and 2.8 per cent of IVA respectively. Figure 1 reports Australian production and employment by industry for 2013–14.[6]

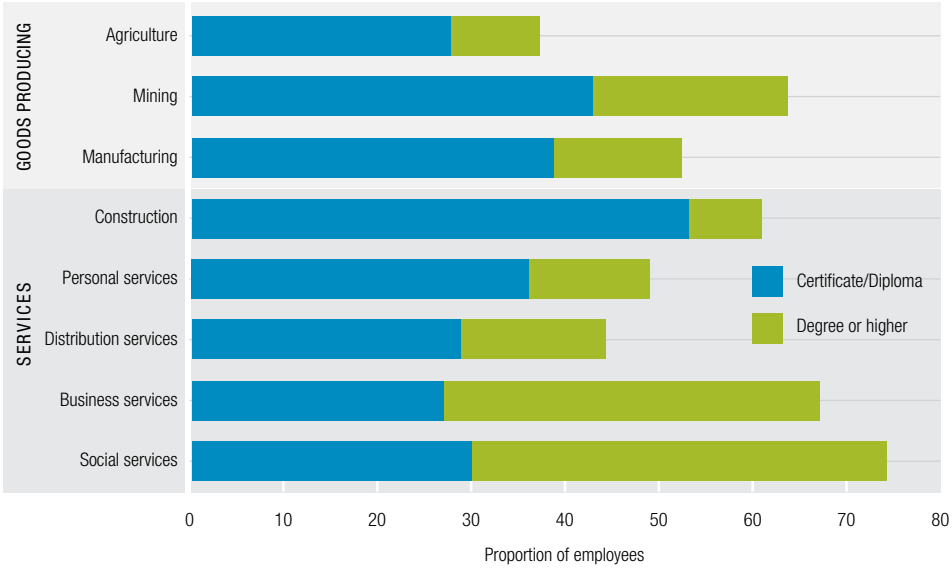
The services industries are generally very labour intensive. Producing $1 million of services requires a year's labour from about 9.4 workers, compared with the 5.5 workers required to produce $1 million of goods. The social services industry is Australia's largest employer with a workforce of more than three million workers. This is more than the combined employment of all three goods producing industries. Manufacturing is the largest employer of the goods producing industries, employing around one million workers.

FIGURE 1
INDUSTRY VALUE ADDED AND EMPLOYMENT BY SECTOR 2013–14



Source: Australian Bureau of Statistics (ABS) 2014, *Australian System of National Accounts*, Cat No 5204.0; ABS 2015, *Labour Force, Australia*, Cat No 6291.0.55.003; Thomson Reuters DataStream.
Note: Data for employment is in trend terms as at May 2014; industry value added is in current prices.

FIGURE 2
EMPLOYEE EDUCATION LEVELS BY INDUSTRY AND QUALIFICATION TYPE 2011



Source: ABS 2011, Census of Population and Housing.

A key strength of the Australian economy is its highly educated workforce. Over half the working age population has a qualification of some kind.[7] More than two-fifths of workers in the business services and social services industries have a bachelor degree or above (refer to Figure 2). Goods producing industries employ fewer graduates in proportional terms, but its workforce is still very highly qualified.

Compared with the Organisation for Economic Co-operation and Development (OECD), only five countries have greater rates of higher educational attainment.[8] Outside of the OECD, Australia's rate of tertiary attainment is three times that of Argentina, seven times greater than South Africa and 14 times that of China.[9]

Our economic history has been shaped by structural change

The composition of the Australian economy is neither an accident nor a product of design. Rather, it reflects over a century of economic and demographic pressures and the responses to those pressures by businesses, workers, investors and governments.

Like other OECD economies, the Australian economy has seen a progressive shift in its economic base, first away from agriculture and towards manufacturing, and second away from manufacturing and towards services. A hundred years ago, approximately one in three workers were employed in primary industries. Back then, farming techniques were far less efficient than they are today and a workforce of this size was required to simply feed the population.

Today, this figure has fallen to less than one in 30. Advances in technology freed up labour and allowed the economy to industrialise. By the 1950s, manufacturing's share of the economy had doubled, while agriculture's had halved.

Australian manufacturing has since followed a similar path to agriculture. Manufacturing accounted for one in four jobs between the 1950s and 1970s. Today the sector accounts for less than one in 12.

Services dominate the modern economic landscape and have done so for some time. Services have accounted for more than 70 per cent of production since 1975.

Sustained shifts in the composition of the economy are the result of structural change – a continual process that sees resources flow into and out of industries in response to movements in relative prices. Changes in relative prices of goods and services will mean that the production of some *products* will be more profitable than others. Changes in relative factor prices will mean that some *production processes* will be more profitable than others. These movements provide opportunities for some businesses to grow, and force the less competitive firms to exit the market.

Prices are constantly changing and consequently the economy is in a constant state of flux.[10] Each year, more than a million workers – nearly a tenth of the workforce – change jobs. Of these, around 600,000 change industry and around 450,000 change occupation.[11] Similarly, more than half a million businesses will either enter or exit the market. Over the course of the last decade, the rate of turnover in the constituency in the ASX 50 has been about 50 per cent. The same is true for the ASX 200.

This flux is critical to productivity and long-term economic growth. It is a sign of a highly dynamic and resilient economy, and that 2014 marked the 23rd year of consecutive economic growth – a feat that has only been matched by one other OECD economy since World War II – is a testament to this feat.

To thrive, economies must be free to respond and adapt to new conditions. The benefits of the mining boom for example, would not have been possible without a rapid reallocation of resources towards this industry. Mining exports tripled during the boom and the sector's share of gross domestic product (GDP) increased fourfold. The mining boom provided direct benefits to mining companies and their employees, as well as to those in supporting industries.

However, the benefits of the boom flowed beyond this and were felt much wider across the community. One study estimated that the mining boom caused real per capita household disposable incomes to increase by 13 per cent, raised real wages by six per cent and lowered the unemployment rate by over a percentage point.[12] In addition, the mining boom increased tax revenues and saw the real consumer wage grow (as a result of lower import prices) at a rate more than twice that of its historical average.[13]

Timely adjustment is therefore crucial for economic prosperity, growth and development, and the flux we observe is evidence that our economy is responsive and dynamic.

Drivers of structural change

A number of factors are driving structural change. Perhaps the most obvious examples relate to technology. Technology has had a significant and transformative effect at every point along the supply chain. Consider for example, the impact of:

- Advances in communications and data transfer technologies on global commerce;
- Robotics and automation on the production process;
- Computerised stock-management systems, and storage and delivery costs; and
- Online retailing and the consumer interface.

Technology has promoted greater globalisation. It has reduced transport costs, improved communication and information flows. Combined with policy changes that have reduced barriers to trade, capital flows and labour mobility, markets have become increasingly interconnected. This has provided the economy with a raft of opportunities but also challenges evident by the rise of East Asia as a centre of low-cost manufacturing.

Another driver relates to changes in consumer preferences. The Australian population is becoming larger, older and richer. Over the past four decades, the population has grown by nearly nine million people; the median age has increased by close to 10 years; and per capita incomes have doubled. These changes have had significant impacts on what Australian consumers demand, and consequently the market opportunities that exist for business. In particular, this explains the increased demand for healthcare services, luxury goods and leisure activities.

Finally, government policies have been instrumental in facilitating structural change. The competition reforms in the 1990s, reforms aimed at increasing the participation rate, trade liberalisation, changes to education policies and support for science and innovation, have each left a permanent mark on the Australian economic landscape.[14] The implementation of efficient regulatory regimes and the erosion of protectionist policies over time have freed the economy to react to competitive forces and reallocate resources to their most productive uses. This has resulted in higher incomes, lower prices, greater choice and opportunities across the economy.

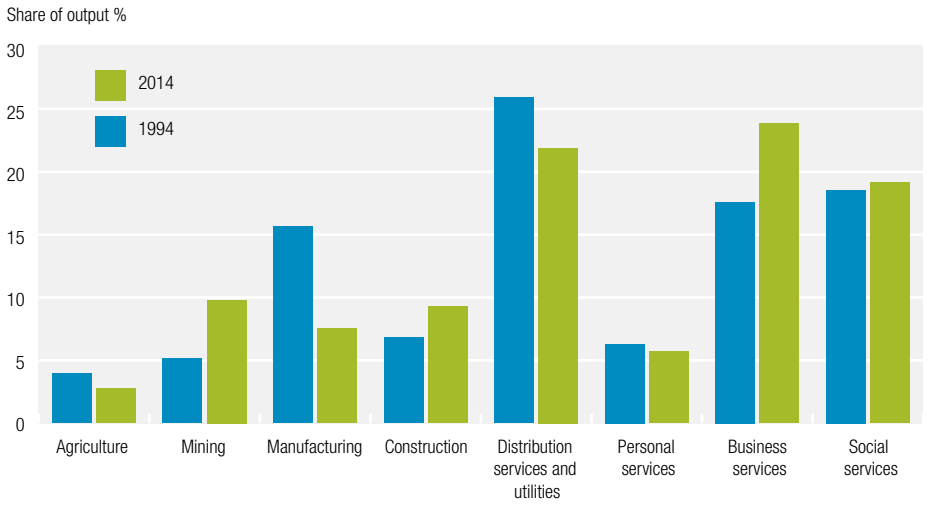
Combined, these drivers have defined the economic opportunities made available to Australian workers, firms and investors over the decades. They are the reasons why industries have failed and flourished in the past, and they are the reasons they will continue to do so in the future.

A smarter economy

The effects that these forces have had on the economy over the past 20 years can be seen in Figure 3. The figure shows marked increases in the *share* of the economy devoted to business services, mining and construction, and marked decreases in the *share* of the economy devoted to manufacturing, distribution services and utilities, and agriculture. (It is important to note that although an industry's relative *share* may have decreased, this may not mean that production has decreased in absolute terms.)

The shifts in production have resulted in corresponding shifts in employment. Over this period, employment by declining industries has seen a net decrease of 220,000 jobs, most of these being in manufacturing (150,000 jobs).

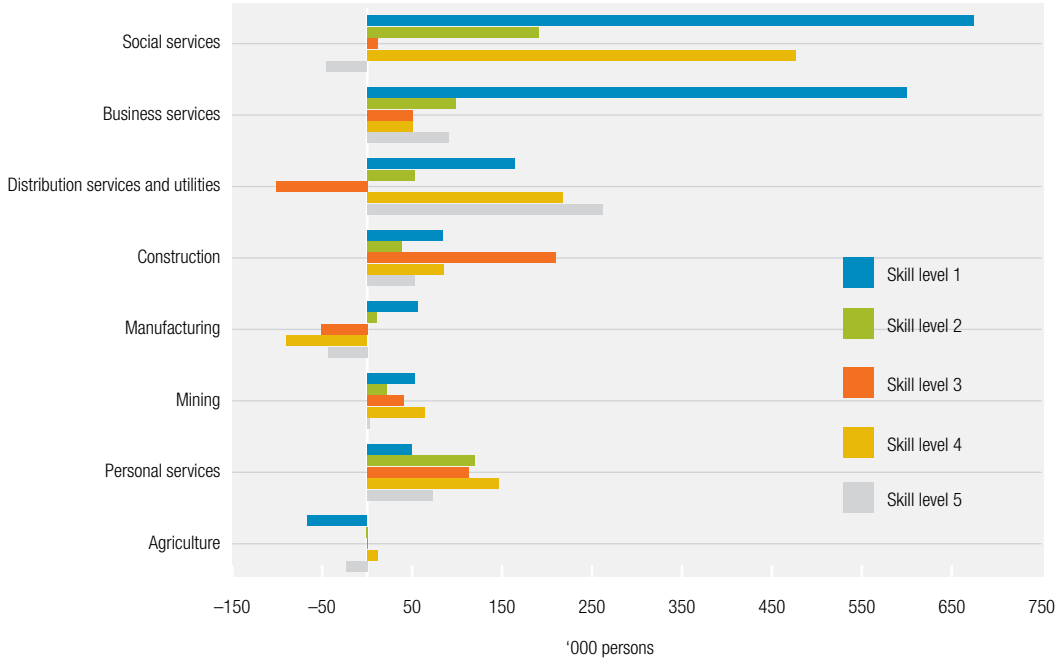
FIGURE 3
OUTPUT SHARE BY SECTOR 1993–94, 2013–14



Source: ABS 2014, *Australian System of National Accounts*, Cat No 5204.0
Note: Output is total industry gross value added at current prices.

Offsetting this has been the creation of more than 3.9 million jobs in other sectors. Employment growth in healthcare and social assistance compensated more than twice for the total job losses in the decreasing industries. In fact, employment growth across the bottom five increasing sub-industries (wholesale trade; rental, hiring and real estate services; administrative and support services; arts and recreation services; and electricity, gas, water and waste services) outweighed employment losses experienced elsewhere.

FIGURE 4
GROWTH IN THE NUMBER OF EMPLOYED PERSONS BY ANZSCO SKILL LEVEL 1993–94 TO 2013–14



Source: ABS unpublished *Labour Force Survey* data.
Note: Skill levels range from one to five, where one represents Bachelor degree or above and five represents Australian Qualifications Framework Certificate I.

Perhaps more important than the shifts observed in production and employment however, are the shifts in skills. The increasing importance of the services sector and the overall move towards a knowledge economy has required workers to invest in their human capital.

Figure 4 shows the distribution of employment by skill level since 1993–94. Over the last 20 years, the majority of the jobs created have been filled by people with a bachelor degree or above. This includes 674,000 jobs in social services (mostly in health care and social assistance) and 600,000 jobs in business services (mostly in professional, scientific and technical services). The only job growth in manufacturing was either at this skill level (57,000) or at skill level two (11,000). With the exception of agriculture – which saw the loss of 66,000 highly skilled jobs – net job losses were almost exclusively from lower skilled occupations.

Structural change will shape our economic future

Precisely how the Australian economy will develop in the future is uncertain. It will depend on what technologies develop, where and how new markets emerge, and what unknown variables are put into the mix.

What is assured, however, is that structural change will remain a permanent feature of our economic environment.

Some changes we can predict…

It is reasonable to expect the long-run drivers of change will continue. Population ageing, globalisation and technology advances are, for example, unlikely to cease or reverse any time soon. Rapid economic growth across Asia and the rise of its middle class will continue to provide investment and export opportunities for Australian businesses.

Australia's strengths today and the trends in global demand and supply provide an insight into future sources of Australia's economic growth. The Australian Government's *Industry Innovation and Competitiveness Agenda* notes that Australia's clearest industry prospects are linked to our natural resources, our environment, our strengths in innovation and research and development (R&D), and our highly skilled workforce.[15]

In particular, five sectors have been identified as having major growth potential[16]:

1. Food and agribusiness;
2. Mining equipment, technology and services;
3. Medical technologies and pharmaceuticals;
4. Oil, gas and energy resources; and
5. Advanced manufacturing.[17]

Combined, these sectors account for around 15 per cent of the total business population and 12 per cent of employment. However, they are responsible for 16 per cent of production and 27 per cent of exports. They undertake more than a third of Australia's total business expenditure on R&D.

The growth potential of each of the sectors is explored in detail in the *Australian Industry Report, 2014* and summarised in Table 1. Looking ahead, the continued rise of Asia, population ageing and higher global income levels are common sources of demand for each sector.

TABLE 1
DRIVERS OF GROWTH IN THE GROWTH SECTORS

Growth sector	Source of growth
Food and agribusiness	Australia has a reputation for safe, reliable, clean food supply and high levels of food security, with quality standards and safety regulations imposed along the food supply chain. Asia's rapid growth in incomes and population, along with urban migration, is driving increased demand for food in terms of quantity, quality and product integrity. Asia's increasingly affluent consumers will demand more premium food products, animal proteins and dairy products, as well as a greater variety of fruit and vegetables and foods processed for convenience, functionality and other value add.
Mining equipment, technology and services	Domestically, market opportunities are likely to increasingly stem from a greater emphasis on operations, lifting productivity, cost competitiveness and consolidation in parts of the mining sector. Significant opportunities also exist in the energy supply sector, particularly in the production and export of natural gas and LNG. Internationally, the sector is uniquely positioned to emerge as the legacy of Australia's world-leading mining industry in terms of international competitiveness.
Oil, gas and energy resources	Emerging economies fuelling their economic development will provide prospects for the sector in the long term. There are significant opportunities within the sector to meet the rising energy demand from growing Asian economies providing the sector remains competitive. While the sector has and is projected to experience strong export growth as current projects under construction enter production, strong competition from oil and gas suppliers in other countries may limit these opportunities. The ability of Australian firms to prosper will depend on them being able to respond efficiently to market signals when making their investment and production decisions.
Advanced manufacturing	Australia, like other advanced economies, is well placed to compete in advanced manufacturing due to its highly skilled workforce. Australia's competitive advantages are likely to be in niche areas of advanced manufacturing characterised by unique technologies, skills and supply chains that cannot easily be replicated by lower cost countries.
Medical technologies and pharmaceuticals	Growth in this sector will be driven by a number of factors including: population ageing; lifestyle choices, healthcare expectations; new and chronic diseases; new products such as biologic medicines; and more specialty drugs with higher prices. Australia has world-class researchers developing medical technologies, devices and pharmaceutical goods. As the population continues to age, this sector is expected to show significant growth over the coming decades.

Source: *Australian Industry Report 2014.*

Importantly, the economy is an incredibly complex web in which no industry is an island. As the growth sectors develop, they will draw heavily on intermediary and enabling sectors from across the economy. The transport, trade and logistics, information and communications technology and professional and support services sectors are all very well placed to benefit from their close alignment with the growth sectors.

Government has a role in facilitating structural change in a way that allows business to capitalise on the opportunities presented. Governments facilitate structural change by providing the framework conditions necessary for markets to operate efficiently and for resources to flow to their most productive uses. They also can assist the transition by providing support to individuals and regions to adjust to the changes.

Government also has a role in shaping, coordinating and providing direction to the economy. To the extent that the future can be foreseen, governments can promote structural change towards sectors with the most potential. The Department of Industry and Science's *Industry Growth Centres Initiative* is an example of a policy that has been designed to do exactly this. Under an industry-led framework, the initiative will seek to capitalise on the potential of the growth sectors and identify opportunities to increase collaboration and commercialisation. It will help improve capabilities to engage with international markets and global supply chains, and to enhance management and workforce skills. In doing so, the initiative is designed to assist the Australian economy to transition into a more productive, competitive, knowledge-based economy that will maintain our high standard of living into the future.

…other changes we cannot

We must be conscious that history is filled with failed predictions, particularly in regards to the growth, direction and capabilities of technological change. At the turn of the century, cars were dismissed as a fad.[18] In the 1960s, satellite communications were considered an impossibility.[19] And in the 1980s, it was claimed that the cassette would destroy the music industry.[20]

History is equally filled with *missed* predictions. Some of the major features of the economy today were almost totally unforeseen two decades ago. Almost no one, for example, predicted the dramatic growth in the online business sector. It is now nearly impossible to imagine a world without it. The same is true about the extent of Chinese growth and its importance to the Australian economy.

A decade from now, the economy will look very different to how it does today. But precisely how different is anyone's guess. Technological changes, globalisation and changing consumer preferences will pull the economy in a range of directions. More occupations may become automated. Driverless cars may become the norm. Big Data and 3D printing may each impose a step change of their own in regards to commerce and production. New markets may emerge following developments in nano- and bio-technologies. Consumer preferences may change in an unexpected way.

Because the answers to these questions are unknown, it does not mean that businesses and workers should not take steps to prepare for those changes and ready themselves to take advantage of the opportunities as they arise. The businesses that will profit from the next wave of structural change will be those that are nimble and innovative, and that have made smart decisions about the future. Similarly, it will be those workers that are most flexible, who are able to leverage their high skill bases, who will find adapting to changes in the labour market the easiest.

Conclusion

The global location of motor vehicle production plants has changed dramatically over the decades, as has the geographic distribution of demand for motor vehicles.[21] The sector has been the subject of immense and relentless pressure to lower manufacturing costs throughout the supply chain. At the end of the day, an Australian automotive manufacturing sector is unable to compete with large-scale plants in low-cost locations based in regions of growing demand such as Brazil, China, India and Thailand.

We cannot afford to become complacent. The openness of the economy has exposed us to external shocks and pressures, our terms of trade have fallen from record highs, our population is ageing, and businesses face intense global competition and disruptive technological change.

While all of this is true, this chapter has argued that we should not lament the loss of an industry, because that loses sight of the bigger story. The same drivers that lead to an industry's demise, present opportunities for firms and workers to become more competitive, access new markets and discover new ways of conducting their business.

Endnotes

1 Industry Commission 1995, *Australian Manufacturing Industry and International Trade Data 1968–69 to 1992–93*, Information Paper, February, p B4 ASIC 32.3.

2 Productivity Commission 2014, *Australia's Automotive Manufacturing Industry*, Inquiry Report No. 70, Canberra.

3 Department of Industry 2014, *Australian Industry Report 2014*, Australian Government, Canberra, accessed at *www.industry.gov.au/industry/Office-of-the-Chief-Economist/Publications/Documents/Australian-Industry-Report.pdf*

4 Ibid.

5 Ibid.

6 Australian Bureau of Statistics (ABS) 2014, *Australian System of national Accounts*, 2013–14, cat no. 5204.0.

7 ABS 2011, *Census of Population and Housing*.

8 Forty-one per cent of Australians aged between 25 and 64 have achieved tertiary education. Countries with higher levels of attainment include Canada (53 per cent), Japan (47 per cent), Israel (46 per cent), the United States (43 per cent) and Korea (42 per cent). OECD 2014, *Education at a Glance: OECD Indicators*, OECD Publishing, p 44.

9 Ibid.

10 There is a misconception that the current period of structural change is different to past experiences, occurring at a rate much faster than we have previously encountered. But by most measures this is not the case. The rate of structural change (as measured by real output and employment) has stayed relatively constant since the 1960s. Productivity Commission 2013, *Looking Back on Structural Change in Australia: 2002–2012*.

11 Department of Industry and Science, op cit, p 72.

12 Downs, P, Hanslow, K & Tulip, P 2014, *The Effect of the Mining Boom on the Australian Economy*, Research Discussion Paper 2014–08, Reserve Bank of Australia, p 1.

13 Corden, M 2012, 'Dutch Disease in Australia: Policy Options for a Three Speed Economy', *The Australian Economic Review*, Vol 45, No 3, p 298.

14 Productivity Commission 2013, op cit, p 41.

15 Australian Government 2014, *Industry Innovation and Competitiveness Agenda*, p 8.

16 Table 1 of the Government's Industry *Innovation and Competitiveness Agenda* on page 9 for example lists of some future growth sectors that have been identified by Deloitte, PwC, IBISWorld, Outlook Economics and McKinsey.

17 Appendix E of the *Australian Industry Report* provides more detail on how these sectors have been defined.

18 "The horse is here to stay but the automobile is only a novelty – a fad." – The president of the Michigan Savings Bank advising Henry Ford's lawyer, Horace Rackham, not to invest in the Ford Motor Co., 1903.

19 In 1961, Federal Communications Commissioner Thomas Craven remarked: "There is practically no chance communications space satellites will be used to provide better telephone, telegraph, television, or radio service inside the United States."

20 "Home Taping Is Killing Music" – A 1980s campaign by the British Phonographic Society, claiming that people recording music off the radio onto cassette would destroy the music industry.

21 Productivity Commission 2014, op cit. p 14.

2.2

Technological and structural change in Australia's labour market

Professor Phil Lewis

Phil Lewis is Emeritus Professor of Economics and Director of the Centre for Labour Market Research (CLMR) at the University of Canberra. Phil is among the best-known economists in the area of the economics of employment, education and training in Australia and is the author of over 100 publications including journal articles, book chapters and books including the best-selling *Essentials of Economics* published by Pearson. Apart from a distinguished academic career he has worked in government and has produced a number of major reports for the private and public sectors. Phil is the editor of the *Australian Journal of Labour Economics*. He is past National President of the Economic Society of Australia and past President of the Western Australia and Canberra branches of the Society. In 2008, he was awarded the Honorary Fellow Award by the Economic Society for his exceptional contribution to the economics profession.

Introduction

The Australian economy's structure has changed significantly over the past four decades. The pace of this change accelerated in the late 1980s and 1990s following the implementation of broad-ranging microeconomic reform policies. These changes have continued in the 2000s.

While policy has changed, industries have also embraced new technologies and have become increasingly involved in the global economy. Overall, Australia now has a more highly skilled workforce and a more efficient economy; the changes have also been associated with persistent structural unemployment. This continues to be a major policy challenge.

Over the last two decades, Australia's economy shifted away from agriculture and manufacturing. The growth industries have been in services, consistent with long-term trends in advanced and many developing economies. These trends have had a profound effect on the skills that are in demand in the economy. This has also altered the structure of skills and average skill levels within industries.

Other important trends include:

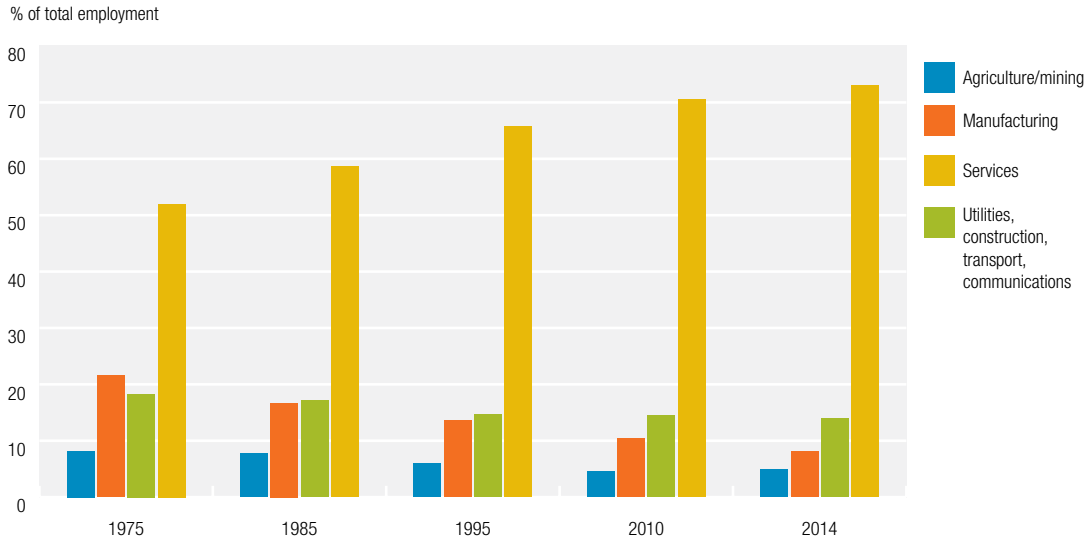
- Significant institutional changes;
- Growth in part-time and casual work;
- Increased participation in post-compulsory education; and
- Greater participation of women in the paid workforce.

There has been a pronounced shedding of low-skill workers and increased demand for skilled workers observed in many countries. This has been attributed to many different causes, with the most commonly cited being skill-biased technological change. There have been many studies on the influence of new technologies, in particular, information and communication technologies (ICTs), on skill demand. The overwhelming majority find a positive link suggesting a high degree of complementarity between skill and technology. It has been argued that ICTs change the composition of skills in the economy in two ways: the direct substitution of easily automated labour-intensive jobs by computer-based technologies; and the organisational complementarity that exists between computer-based technologies and managerial and professional occupations.

Business cycles have also had permanent effects on the structure of the labour market. It is well known that the business cycle does not affect all labour skills equally. For instance, recessions disproportionately affect the lower skilled and increase the likelihood of lower skilled workers becoming unemployed. Also, the long-term unemployed tend to have lower levels of skills, education and experience; and long-term unemployment tends to exacerbate the underlying problem leading to hysteresis. Finally, 'structural mismatch' worsens during long periods of high unemployment.

A combination of external shocks, globalisation and technical change has significantly changed the nature of demand for labour while certain inflexibilities in the labour market have prevented adjustment to these demand changes. This has been most manifest in the relative growth in service sector employment, the growth of part-time and casual work, the relative decline in demand for manual skills, the growth in demand for knowledge-based and people skills and the decline in trade unionism.

FIGURE 1
EMPLOYMENT BY INDUSTRY



Source: Australian Bureau of Statistics (ABS), *Labour Force, Australia*, Cat. No. 6203.0, 6202.0

Labour demand

The Australian labour market looks quite different from what it was prior to the succession of oil shocks that hit the world in the 1970s. Even after the 1990s recession, the long period of recovery left a large number of the low-skilled workforce stranded in long-term unemployment and marginalised employment.[1] Since the 1991–92 recession, there was a remarkable period of growth, until the Global Financial Crisis (GFC) in 2008, which affected total employment in Australia.[2] This has followed very different trajectories across different sectors in the Australian economy (refer to Figure 1). Much of the changing composition of employment can be attributed to the changing industry mix, which is generally thought of as structural change.

In 1975, soft services, such as health, finance, retail and education, accounted for just over 50 per cent of all jobs. By 2014, the sector accounted for over 70 per cent of all jobs.[3] By contrast, manufacturing's share of total employment more than halved over the same period to about eight per cent in 2014. There were similar reductions in the relative shares of jobs in industrial services, such as construction, communications, electricity, gas and water. Primary sector (agriculture and mining) employment has for many years made up a relatively small percentage of total employment, even given the recent minerals and energy boom.

The observed growth and contraction of each sector have also had different drivers. The primary sectors of the economy are the most capital-intensive industries in Australia and this intensity has increased over time. The utilities sector experienced substantial restructuring and labour shedding throughout the 1990s and 2000s because of partial deregulation and privatisation.

The manufacturing sector has steadily declined over the entire period, for the most part due to reduced protection and increasing productivity and sophistication of manufacturing in Asia, particularly China. This enabled a wider range of consumer goods to be cost-effectively sourced from overseas. Growth in employment in each of the manufacturing sub-sectors has been mixed. The standout is a 73 per cent decline in the number of people employed in textile, clothing, footwear and leather (TCFL) manufacturing. TCFL employment fell from 10 per cent of total employment

in manufacturing in 1984 to three per cent in 2014.[4] Growth in share of employment in services is a common trend in advanced developed economies like Australia, as consumers become richer (demand is income elastic).

Skill-biased technological change

Many studies have been undertaken on the influence of new technologies (particularly ICT) on skill demand. The overwhelming majority find a positive link suggesting a high degree of complementarity between skill and technology. It has been argued that ICTs change the composition of skills in the economy in two ways:

1. Through the direct substitution of easily automated labour-intensive type jobs by computer-based technologies; and
2. From the organisational complementarity that exists between computer-based technologies and managerial and professional jobs.

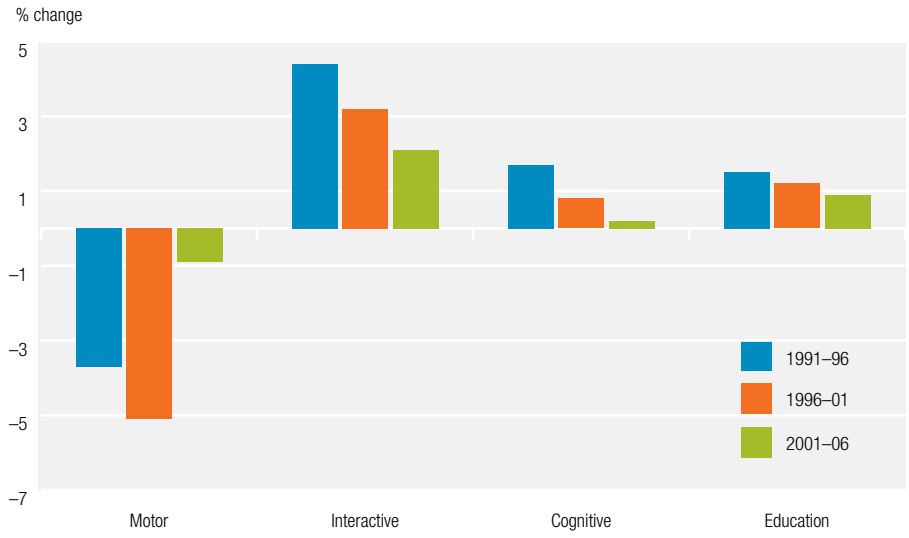
Changes in industry composition have combined with technological change to systematically change the demand for skills. Technological change has allowed for, or even driven, a restructuring of occupations within industries.

Kelly and Lewis[6] examined the changes in demand for four types of skills:

1. Motor (manual);
2. Education;
3. Cognitive (knowledge-based); and
4. Interactive (people) skills.

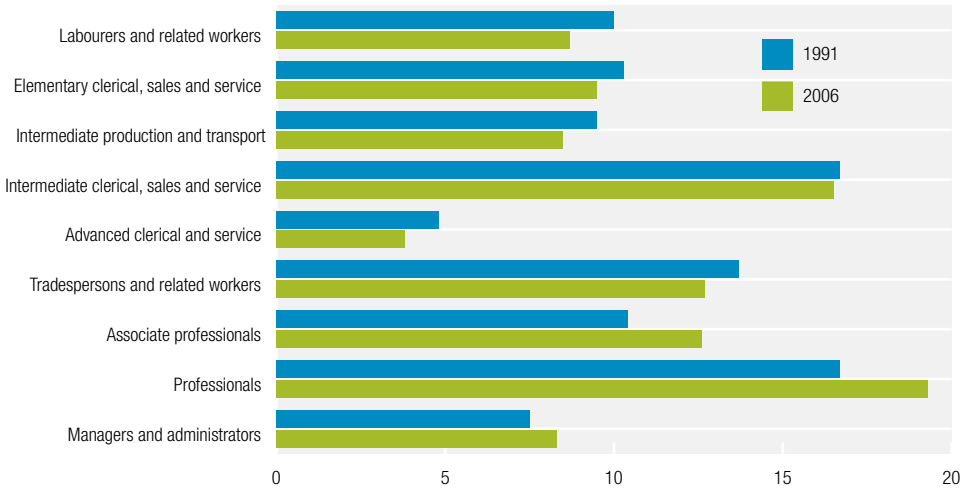
The economy-wide trends in mean skills observed during the 1991-to-2001 period continued during the boom of 2001 to 2006 (refer to Figure 2). The mean level of motor skills declined over one and half decades – even in the most recent boom – with associated shortages of almost all forms of labour.[7] The other skill dimensions increased, particularly for interactive skills. This last result is interesting given much of the media emphasis during the recent boom on industrial jobs such as the trades. The biggest increase was for interactive skills. Perhaps surprisingly, given the huge growth in educational participation over the period, the estimated mean demand for education increased only modestly.

FIGURE 2
ECONOMY-WIDE MEAN SKILL LEVELS



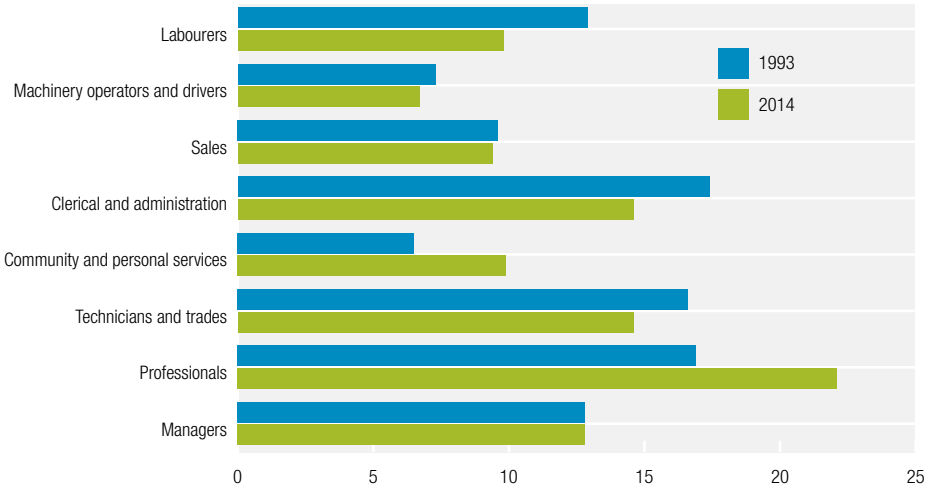
Source: Derived from Kelly and Lewis.[5]

FIGURE 3A
OCCUPATION OF EMPLOYMENT – ASCO DEFINITION – 1991 AND 2006 (%)



Source: ABS 2009, *Labour Force, Australia*, Detailed, Quarterly, Nov 2014, Cat. No. 6291.0.55.003

FIGURE 3B
OCCUPATION OF EMPLOYMENT – ANZCO DEFINITION – 1993 AND 2014 (%)



Source: ABS 2009, *Labour Force, Australia*, Detailed, Quarterly, Nov 2014, Cat. No. 6291.0.55.003

Kelly and Lewis[8] also found that while the post-recession period of 1991 to 1996 was characterised by skill changes resulting from structural change, in the recovery and boom periods, technological change was the dominant influence on skills change.

A combination of structural and technological change has significantly changed the demand for labour with respect to part-time employment, gender and skills. More generic and general skills rather than firm-specific skills are required. Less skilled workers are more vulnerable, as are younger and older workers.[9] The overall outcome is a more highly skilled workforce and a more efficient economy.[10]

The changes in occupational mix are shown in Figures 3a and 3b. There is no continuous series for employment by occupation since the ABS changed from Australian Standard Classification of Occupations (ASCO) to Australia and New Zealand Classification of Occupations (ANZCO) in 2006. However, examination of the series using both classifications allows significant trends to be identified.

The relative decline in employment of those with manual skills, such as tradespersons and labourers, is clearly seen in Figures 3a and 3b. Also clear is the relative growth of occupations requiring high levels of education and interactive skills, such as professionals, associate professionals, and community and personal service workers. While part of this growth is no doubt due to the aforementioned industry changes, particularly the growth in demand for services, part of this is also due to technological change. Less obvious is the relative decline in employment in clerical occupations. Kelly and Lewis[11] argue this is due to technological change, particularly developments in ICTs, which have replaced routine clerical tasks in much the same way as previous innovation in technology allowed for the replacement of routine manual tasks.

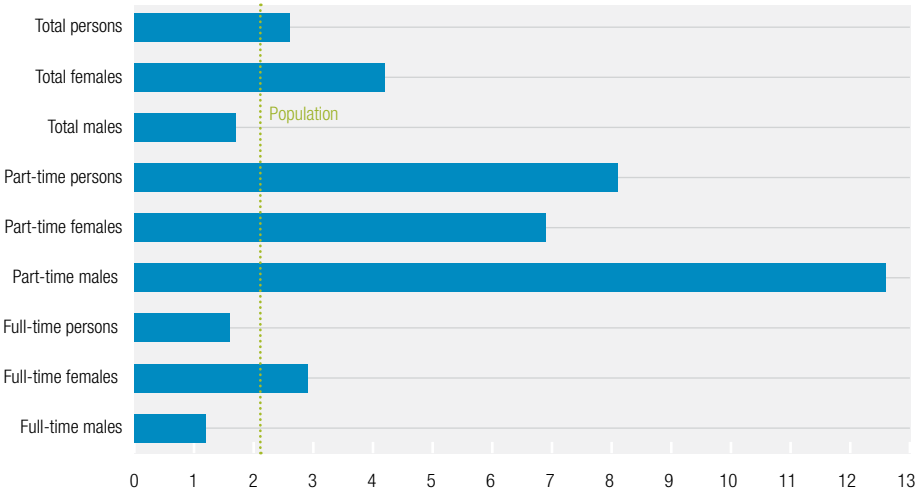
Kelly and Lewis[12] found that the timing of employment growth by occupation has also varied, with some lower skilled occupations only increasing in the mid-2000s mainly in response to the massive investment boom in the resources sector that occurred from around 2002. Managers and administrators really only began to increase in any volume after 2004, as was the case for tradespersons, and intermediate production and transport workers. Employment of professionals, associate professionals, and intermediate sales and clerical workers grew at a steady rate throughout 1996 to 2006, with the higher skilled occupational groupings growing significantly faster than the traditional blue-collar unskilled and trade-qualified occupations. However, total employment for the advanced clerical and service workers occupation grouping actually fell. This is clearly an anomaly given the scale and duration of the economic expansion in Australia.

The picture that emerges, when combined with the industry distribution, is that a typical Australian worker today is a white-collar employee in the service sector.

Perhaps the most significant impact of changes in the Australian economy has been on employment of males. Figure 4 shows the annualised growth rate in employment over the relatively long term: 36 years. By comparison, the corresponding rate of growth in the adult population, which is approximately the growth in labour supply, was about 2.1 per cent.

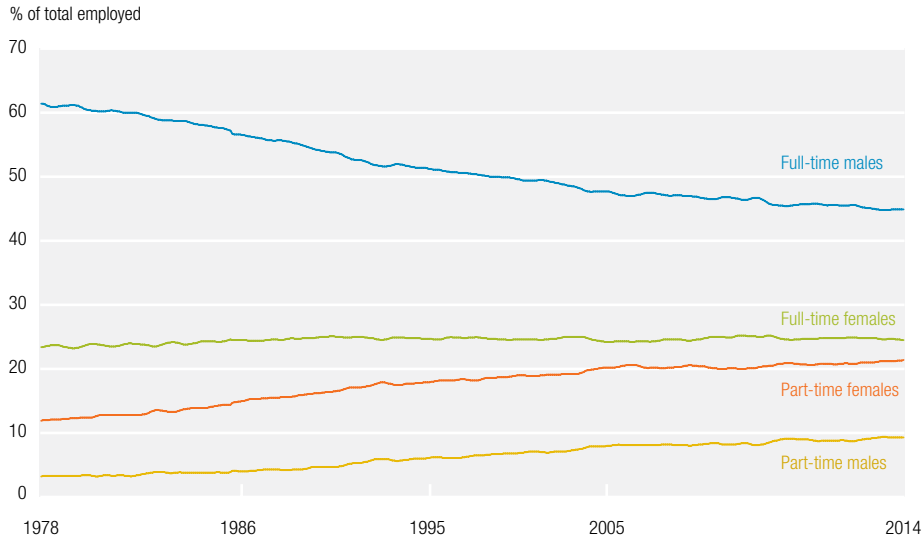
The major trend in the Australian labour market is that the demand for full-time workers, particularly males, has not kept pace with supply. There has been a substitution of females, particularly part-time workers, for full-time male workers. For particular groups, the changes in demand have been particularly noticeable. For instance, a

FIGURE 4
EMPLOYMENT GROWTH 1978–2014 (ANNUALISED % CHANGE)



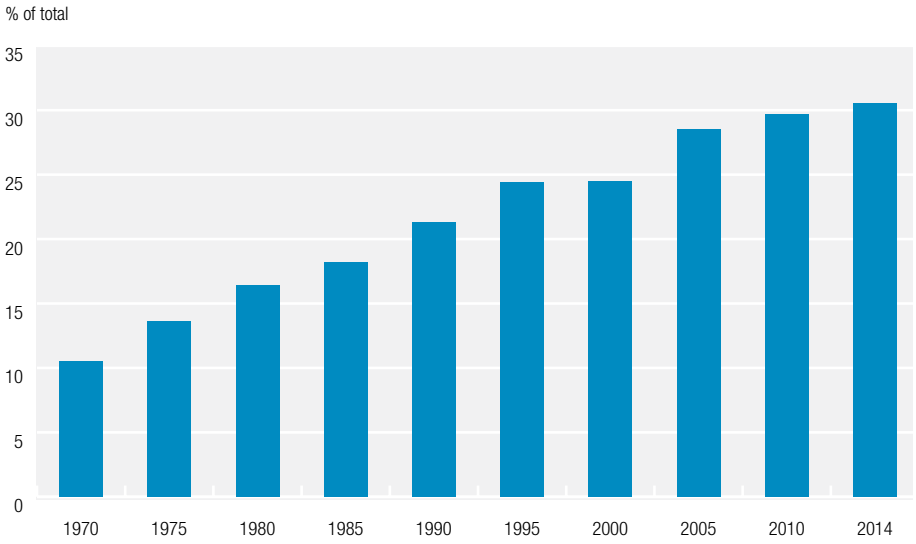
Source: ABS, *Labour Force, Australia*, Cat. No. 6203.0, 6202.0

FIGURE 5
COMPOSITION OF EMPLOYMENT 1978–2014



Source: ABS 2009, Labour Force, Australia, Detailed, Quarterly, Nov 2014, Cat. No. 6291.0.55.003

FIGURE 6
PART-TIME EMPLOYMENT 1970–2014



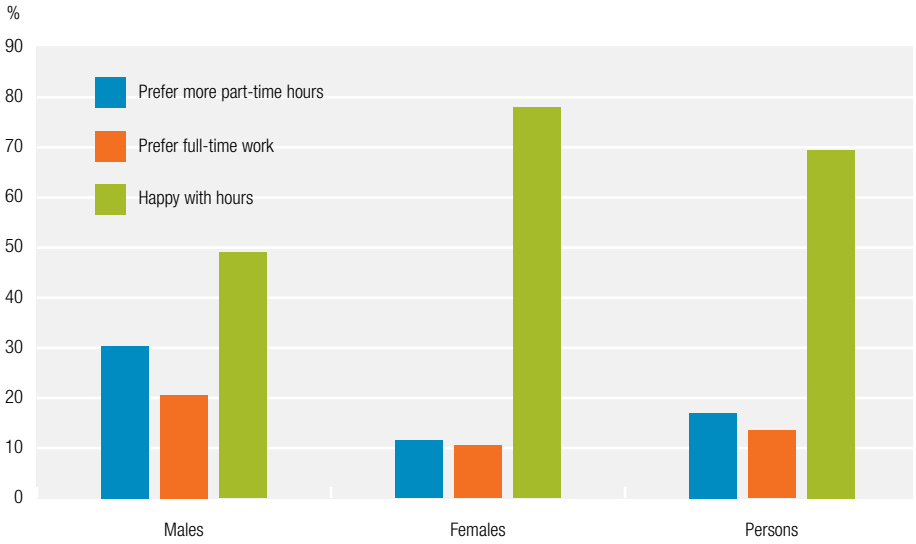
Source: ABS, *Labour Force, Australia*, Cat. No. 6203.0, 6202.0

full-time job for anyone aged 15 to 20 years is now an exception rather than the rule and employment prospects are poor for many displaced older males.

Figure 5 shows that the composition of total employment has changed markedly over time. In the 1970s, over 60 per cent of all those in employment were men working full-time. This had fallen to less than half of all jobs in 2014. Structural change, particularly the relative growth of services and relative decline in manufacturing, together with technological change, has reduced demand for manual labour, which has had the greatest impact on men.

The growth in part-time employment (fewer than 35 hours per week) has been almost continuous since the 1970s when only 10 per cent of all jobs were part-time. The growth in part-time employment appeared to have reached a peak in the early 2000s but began to grow again reaching over 30 per cent of all employment in 2014. Detailed examination of the labour force data shows this latest rise in part-time employment is attributable mainly to more men working part-time.

FIGURE 7
PART-TIME WORKERS PREFERRED HOURS 2012



Source: ABS 2012, *Underemployed workers, Australia*, Cat. No. 6265.0

The long-term trend is largely explained by the change in industry mix towards services. Much demand for labour in the service sector differs according to the time of the day or day of the week, particularly in retail, banking, fast food and restaurants. Therefore, flexibility in hours worked is required to meet peaks in demand, which is greatly facilitated by part-time employees. The reason for the observed increase in part-time work for males in more recent periods is more likely to be the result of the economic downturn following the GFC whereby firms preferred to reduce hours of work rather than lay off workers.

The growth of part-time and casual employment has been the focus of much debate concerning the perceived growing insecurity of work.[13] However, examination of the data suggests that these perceived insecure employment arrangements are regarded as satisfactory for most workers.

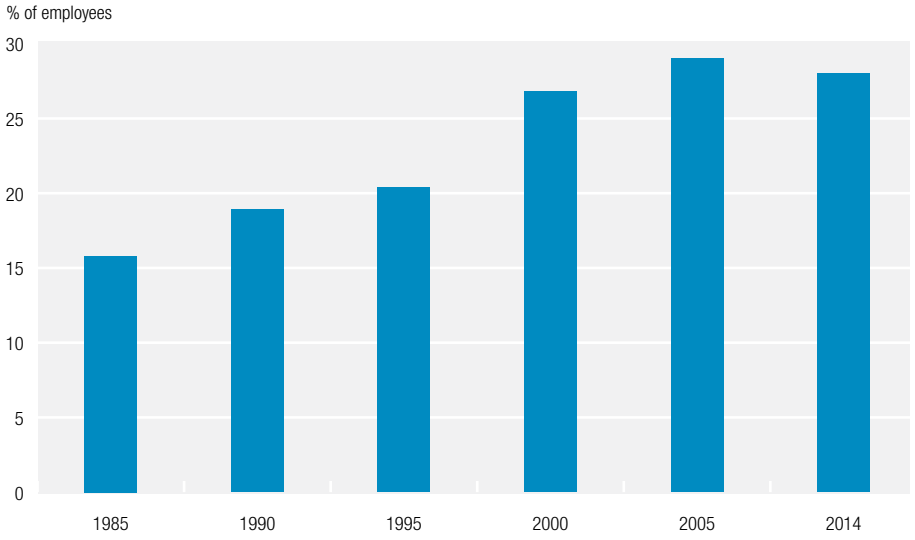
ABS surveys of part-time workers (refer to Figure 7) indicate that most, almost 70 per cent, are happy with the hours they work although females express greater satisfaction (75 per cent) than males (50 per cent). Only 30 per cent of males and 15 per cent of females express a wish to work full-time. These data suggest that only a minority are taking part-time work because they cannot obtain full-time work.

Another major feature of the changing Australian labour market is growth in casual employment. The growth of casual work was an important phenomenon in the 1980s and 1990s, and the proportion of the workforce that is casual reached about 25 per cent by 2010 (refer to Figure 8).

According to Wilkins and Wooden,[14] there appears to be no noticeable increase in casualisation recently or even a small decline. They also show that job tenure is not necessarily short in casual jobs, with a quarter of all casuals having worked in the same job for 10 years or more. Clearly, although part-time and casual work is now a key feature of the Australian labour market, employment is not necessarily insecure, although more flexible.

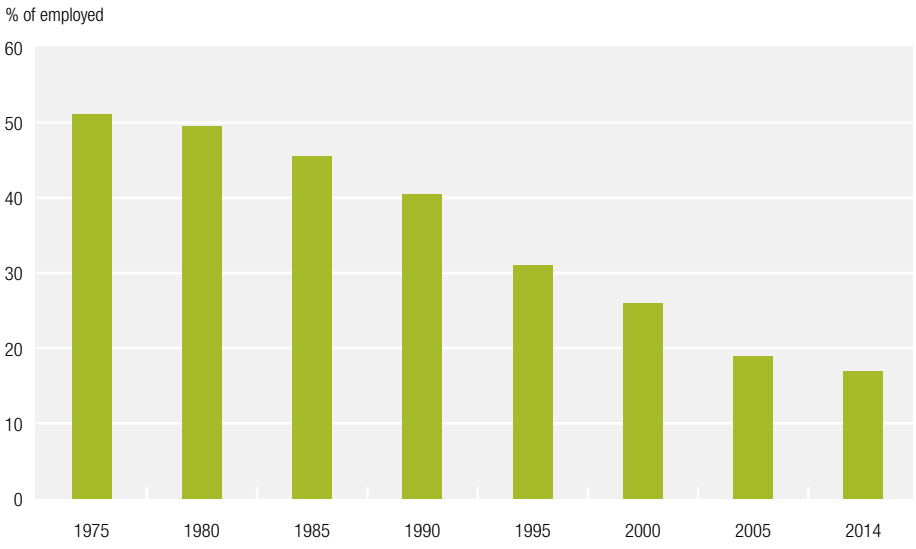
Another important change in the Australian labour market is the decline in union density (the percentage of the workforce who are union members) from over 50 per cent in the 1970s to less than 17 per cent in 2014. In the private sector, union density

FIGURE 8
CASUAL EMPLOYMENT 1978–2014



Source: ABS, *Employee Earnings, Benefits and Trade Union Membership, Australia*, Cat. No. 6310.0

FIGURE 9
UNION DENSITY



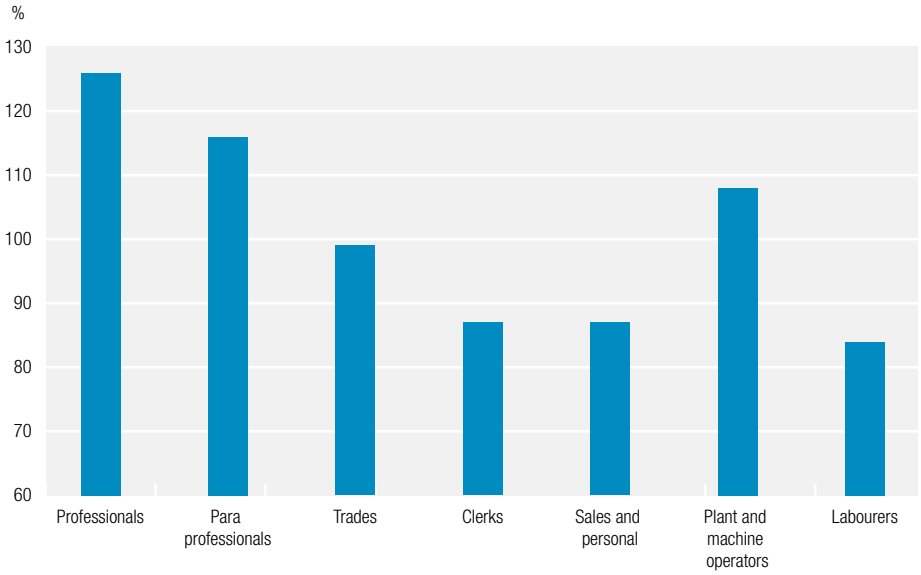
Source: ABS, *Employee Earnings, Benefits and Trade Union Membership, Australia*, Cat. No. 6310.0

is below 12 per cent with over 90 per cent of businesses having no union members employed at all.[15] Trade union membership is higher in the public sector, at 42 per cent of all employees. Employees in the education and training industry have the highest proportion of trade union membership in their main job (37 per cent), followed by public administration and safety (34 per cent). Union power has significantly diminished, particularly since employment has shifted from the public sector to the private sector. Clearly, union membership is being seen as less relevant for employees generally and, in particular, for casual employees and for those in the service sector where the growth of part-time, female and youth employment has been greatest.

It is interesting to examine to what extent these changes in demand have affected relative prices (salaries, wages, earnings). It is hard to determine what has happened to relative earnings for different occupations since, as mentioned, the ABS changed its definitions of occupations in 2006. Nevertheless, Figures 10a and 10b do allow

FIGURE 10A

EARNINGS BY OCCUPATION RELATIVE TO MEDIAN EARNINGS 1993*

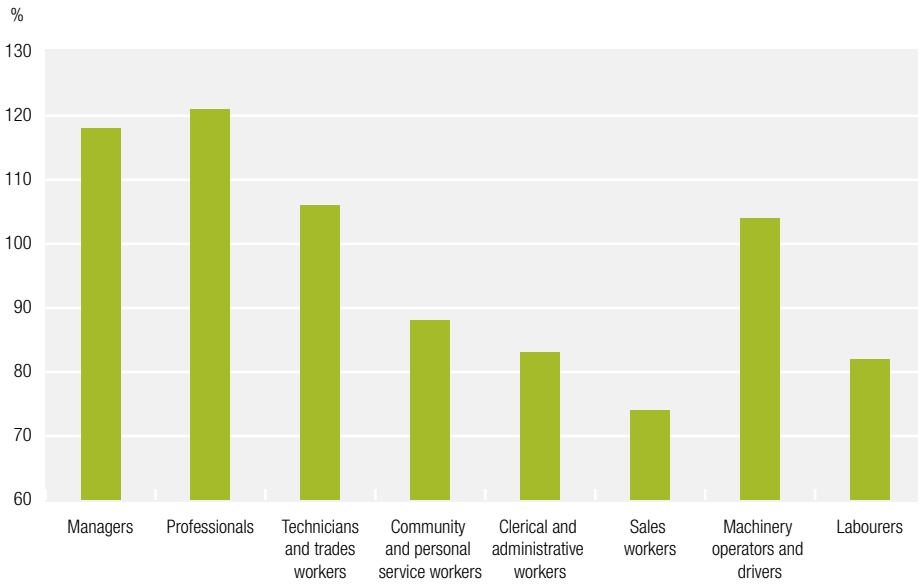


*Adult average weekly full-time earnings, all occupations = 100 per cent

Source: ABS 1994, *Distribution and composition of earnings and hours, Australia*, Cat. No. 6306.0

FIGURE 10B

EARNINGS BY OCCUPATION RELATIVE TO MEDIAN EARNINGS 2014*

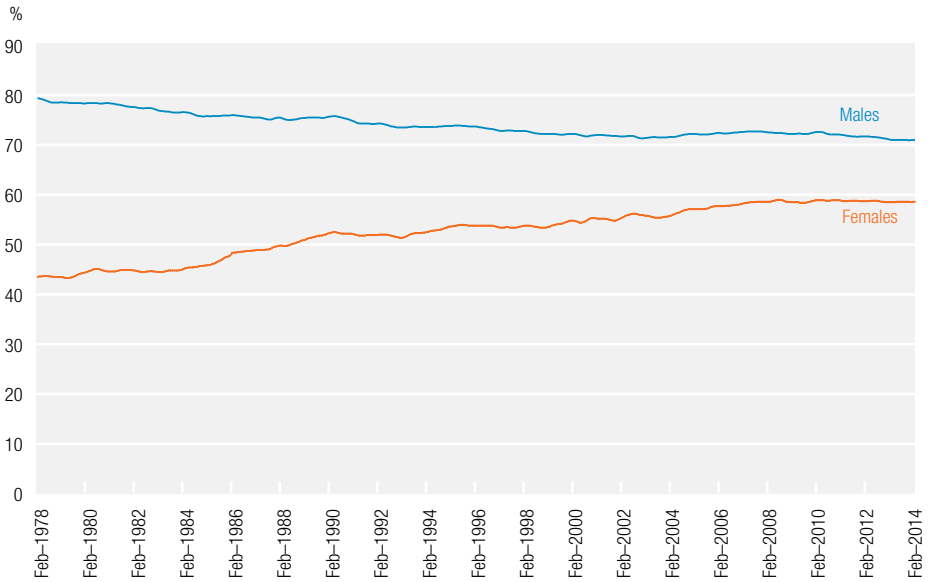


*Average weekly total earnings, all occupations = 100 per cent

Source: ABS 2014, *Employee Earnings and Hours, Australia*, May 2014, Cat. No. 63060DO006_201405

general movements in earnings by broad occupational groups to be determined. In 1993, the highest paid occupational group (professionals) earned 25 per cent more than median earnings while the lowest paid (labourers) earned about 80 per cent of the median. By 2014, the earnings differentials between the lowest earners highest earners and the median had hardly changed. The implication is that although the demand for workers with greater education and training has risen, raising the stock of human capital, the supply has also increased so that there is little change in the earnings premium to skills.

FIGURE 11
LABOUR FORCE PARTICIPATION RATE 1978–2014



Source: ABS 2009, *Labour Force, Australia*, Detailed, Quarterly, Nov 2014, Cat. No. 6291.0.55.003

Labour supply

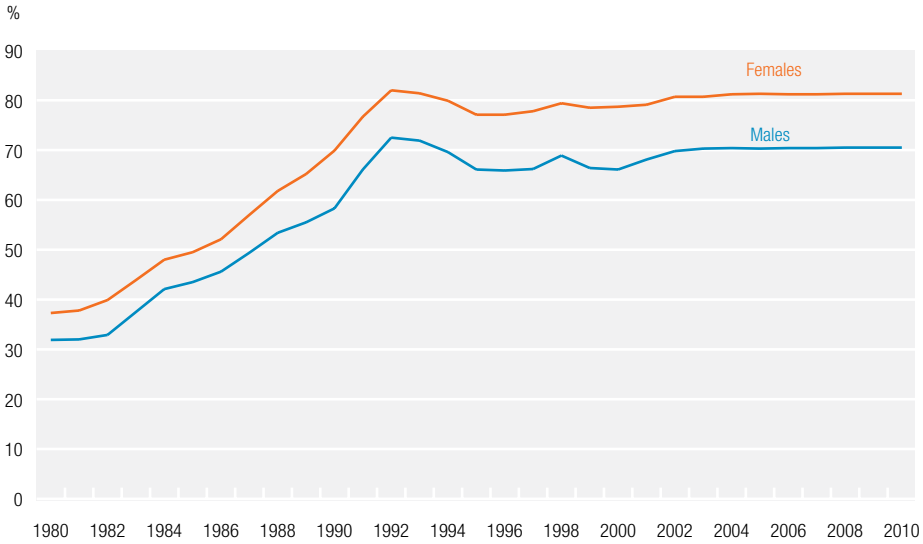
For most Australians, the labour market and its education and training system have facilitated the adjustment of labour supply to meet changes in demand. The increased participation of women (particularly women with children) and students in the workforce has greatly facilitated the increased demand for part-time workers and those with interactive skills.[16] In addition, the education system has significantly increased the average cognitive and education levels. Labour supply has, generally, adjusted well to labour demand due to structural and technological change.

The participation rate (the percentage of the population in the labour force – employed or unemployed) for men fell almost continuously up until the boom of the early to mid-2000s before falling again post-GFC (refer to Figure 11). For women, the participation rate had been rising strongly but appears to have plateaued post-GFC.

Wilkins and Wooden[17] broke down these aggregate changes by age. Participation rates for males have been falling for younger ages (under 35 years) but rising markedly for older ages (over 54 years). Participation rates have risen for prime-age (24 to 54 years) and for older (over 54 years) females. The reasons for these patterns are not clear but one reason is likely due to increased participation in education. This lowers labour force participation of younger people but the greater skillset of older workers means they can extend their workforce participation longer. Also likely to be important is that the number of jobs requiring manual labour has declined significantly while opportunities for part-time and casual work have increased, particularly in the service sector.

The changes in demand for labour, particularly with respect to skills, have largely been matched by changes in supply. There has been a growing supply of women in the labour force, which has been complementary to the fall in demand for those jobs with strength and manual skills, and growth in demand for those with cognitive and interactive skills. The other major change in supply has been the growth in students combining work and study.

FIGURE 12
YEAR 12 RETENTION RATE

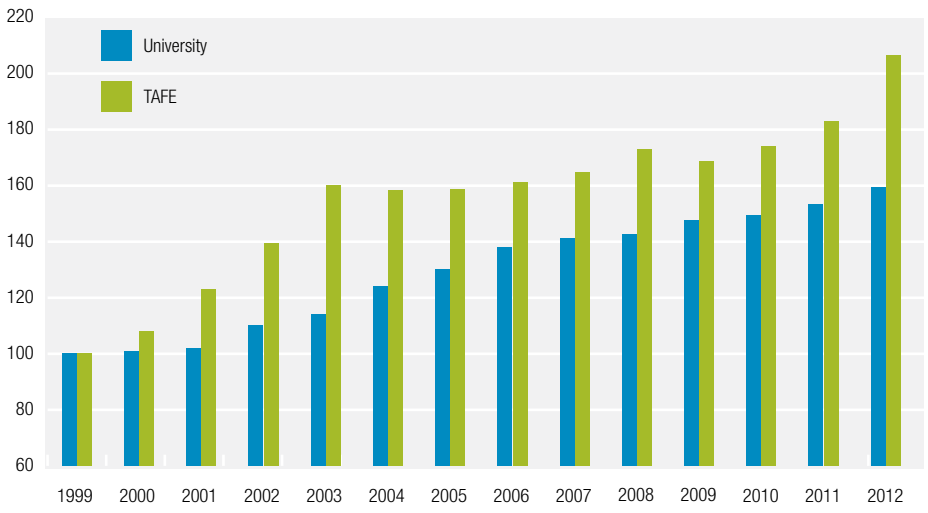


Source: ABS 2012, *Schools, Australia*, Cat. No. 4221.0

Figure 12 shows the Year 12 apparent retention rates for males and females over time. The apparent retention (or simply retention rate) is the percentage of the cohort of students entering high school who are still in school until Year 12. The retention rate rose sharply as youth full-time employment opportunities declined and part-time jobs increased. The increase in the retention rate was further boosted by the huge expansion in TAFE and university places that occurred in the 1980s.

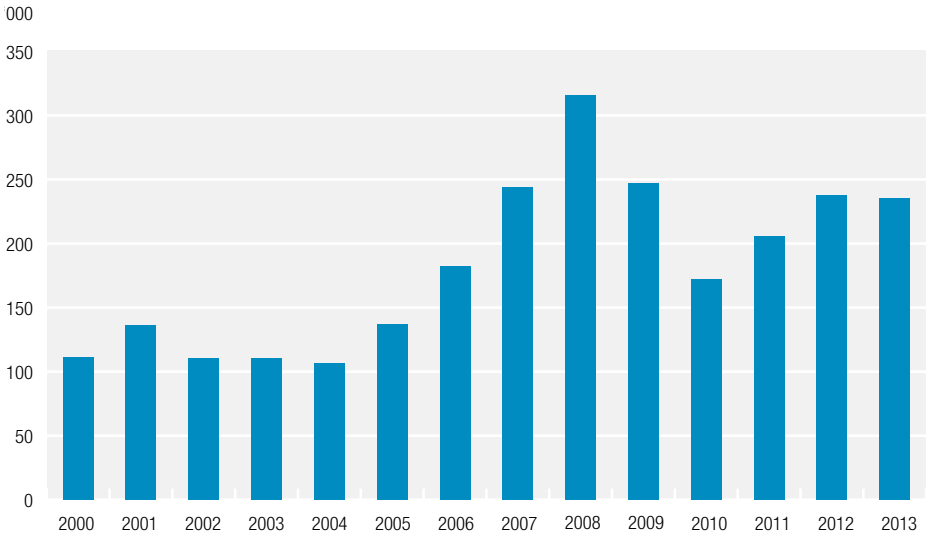
Most young people, 80 per cent of females and 70 per cent of males, are now completing 12 years of schooling in Australia. Particularly noticeable is the higher retention rate for females than for males. The gender pattern of school retention is reflected in participation in tertiary education – in universities women account for over 55 per cent of all enrolments and are predominantly in areas of study most associated with service-based occupations.

FIGURE 13
ENROLMENTS IN TERTIARY EDUCATION (1999=100)



Source: Department of Education and Training, *Higher Education Statistics, education.gov.au/higher-education-statistics*; NCVER 2014, VOCSTATS, *Students and Courses, www.ncver.edu.au*

FIGURE 14
NET OVERSEAS MIGRATION



Source: ABS, *Migration, Australia 2011-12 and 2012-13*, Cat. No. 3412.0

Corliss et al[18] present estimates of the rate of return to bachelor degrees in Australia over time. The results show that, generally, a degree is a profitable investment for individuals. While returns to university education are generally high, there are large differences between disciplines. For instance, the rates of return to a bachelor degree are particularly large in some fields of study, notably dentistry, medicine and information technology (IT).

The results show that the completion of some arts and humanities degrees, for example, visual and performing arts, is not a good financial investment for either men or women. Also, not all students receive considerable benefits from obtaining a university degree. For instance, many of the lowest paid university graduates would have done better finishing their education at Year 12 and entering full-time employment. The results also suggest that these conclusions are robust over time.

While it would be expected that rates of return to university education would have been reduced by the huge growth in supply of university graduates post-1990, this has not been the case. The only really evident reduction in rates of return in 2006 were for IT degrees where a dramatic increase in the private rate of return in the previous period may have caused an oversupply of undergraduates, which by 2006, resulted in a large fall in the rate of return during the boom period.

Corliss and Lewis[19] carried out a similar analysis for trades. The results are somewhat mixed with some trades yielding very good returns and others low or negative returns. There is also considerable variation between the best and worst paid tradespersons.

An important aspect of labour supply in Australia is migration. In the decade leading up to the GFC in 2008, labour shortages were a significant problem for the Australian economy. This was reflected in the lowest unemployment rate in three decades and record net migration. Shortages were reported in both the private and public sectors, including for skilled and unskilled labour. Occupations affected included accountants, medical practitioners, nurses, school teachers, pilots, economists, tradespersons and engineers through to agricultural workers and shop assistants.[20]

A major response to alleviate skill shortages is to increase the intake of migrants and temporary residents. In 2006, the net inflow of new migrants was 186,118, up 32 per cent from 2003. This rose further to reach a peak in 2008 to a net inflow of 298,648

(refer to Figure 14). At this point, migrants represented over 50 per cent of Australian population growth. Of the total permanent migration to Australia, more than 45 per cent were skilled settler arrivals. After two years of decline, in 2011, net migration began to rise again and was forecast to be 250,500 by the end of 2014.[21]

Post-GFC, there has been more concern about unemployment as the national rate of unemployment rose slightly compared with the boom years. Unemployment has not affected all industries and occupations equally. Most vulnerable are those with low levels of education or those who possess specific skills for which demand is in decline. Shortages of skilled labour in some areas still exist in many trades and professions.[22] Indeed, these shortages tend to hinder economic growth and make it harder to create jobs for the unemployed. A well-functioning labour market for skilled labour is necessary for a prosperous low-unemployment economy.

Unemployment and underemployment

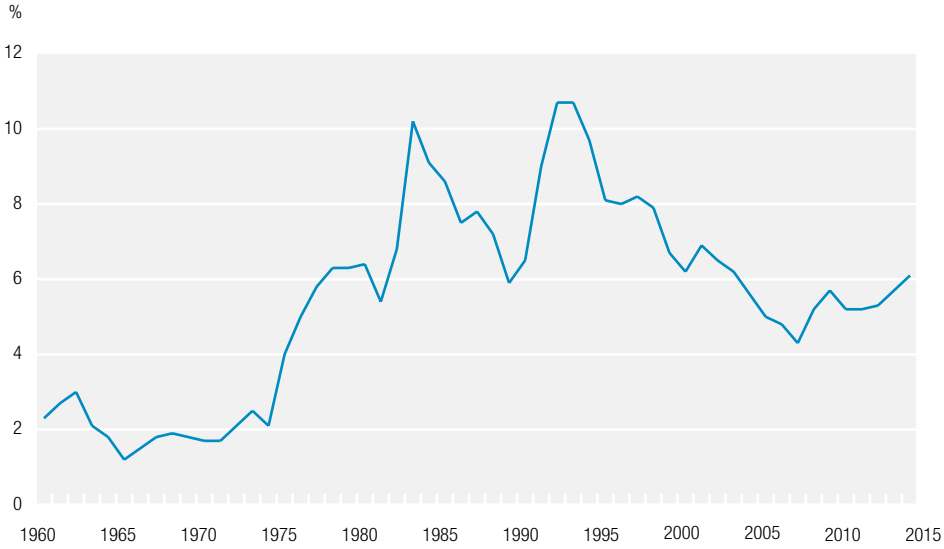
Poor labour market outcomes are not experienced by the large majority of Australians but by particular groups of people who are particularly disadvantaged and, according to a large body of research, are fairly easily identifiable.[23] The biggest single factor determining the likelihood of poor labour market outcomes, particularly unemployment, is the lack of education for all age groups, but most evident for teenagers. The disadvantaged group is, however, quite large, perhaps as high as 1.3 million in Australia, and is a major challenge for labour market and education reform.[24]

The degree of unemployment, usually proxied by the unemployment rate, is a key indicator of the health of the labour market but needs to be interpreted with care. The Australian economy creates and destroys hundreds of thousands of jobs every year. Job creation and destruction is what we would expect in a vibrant market system where new firms are constantly being started, some existing firms are expanding, some existing firms are contracting and some firms are going out of business. The creation and destruction of jobs result from changes in consumer tastes, structural change, technological progress, together with the successes and failures of entrepreneurs in responding to the opportunities and challenges of these changes. The volume of job creation and job destruction helps explain why during most years the typical person who loses a job is unemployed for a relatively brief period of time.

The ABS provides an internationally recognised measure of the unemployment rate. Figure 15 shows the history of the unemployment rate in Australia since the 1960s. Clearly, the historical average until the mid-1970s was about two per cent but rose almost continuously until the early 1980s. The so-called oil shock demanded considerable structural adjustment, which was hindered by excessive regulation, including protection, plus lack of labour market flexibility, particularly downward wage rigidity, and possibly inappropriate macroeconomic policy. The impact of the Prices and Income Accord[25] in reducing real wages can be seen in the early 1980s and the impact of the huge rise in interest rates in the early 1990s is clearly evident.

Over 20 years of extraordinary (by Organisation for Economic Co-operation and Development [OECD] standards) economic growth have been accompanied by a decline in the unemployment rate to below five per cent in 2006 before it began to rise post-GFC to over six per cent in 2014.

FIGURE 15
UNEMPLOYMENT RATE



Source: ABS, *Labour Force, Australia*, Cat. No. 6202.0

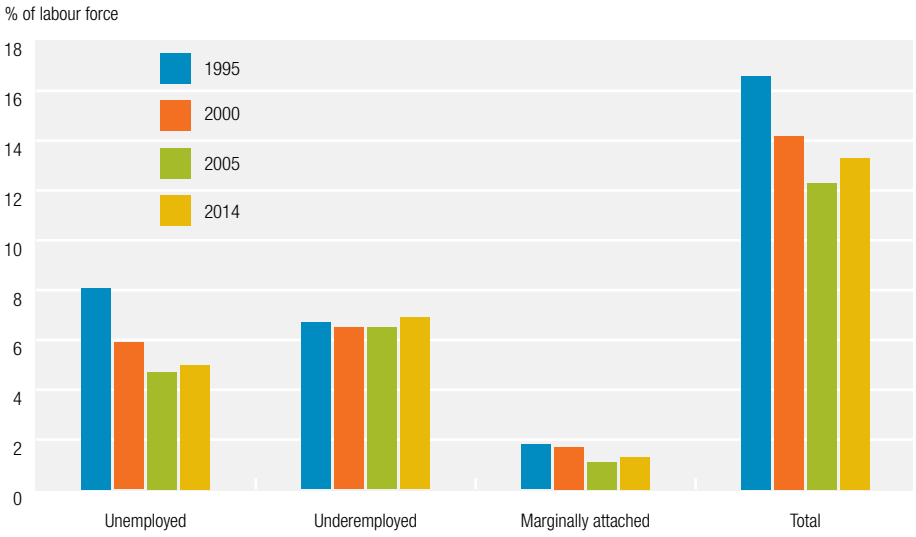
Three observations from Figure 15 are clear:

1. Macroeconomic policy can be very effective in increasing unemployment, as witnessed by 'the recession we had to have' in the late 1980s;
2. There is hysteresis in unemployment – one-off shocks have long lasting and possibly irreversible effects – so policymakers must be extremely careful in tightening monetary policy; and
3. As evident from over 20 years of remarkable economic growth, unemployment cannot to be solved by macroeconomic policy alone – there is a fundamental structural problem in the labour market that has the natural or full employment unemployment rate stuck at about five per cent.

In Australia, the percentage of workers in manual jobs has declined over several decades with the decline in manufacturing output and increases in productivity in other industrial areas such as utilities, telecommunications and agriculture. To become employed again, many of the people need to become skilled in other jobs. Until these people are retrained they are unemployed. Others have been unable to find alternative work, particularly older men, since the skills in new jobs that have been created, mainly in the service sector, do not match theirs. Economists consider these people *structurally unemployed*. There is a persistent mismatch between the job skills or attributes of workers and the requirements of jobs. Structural unemployment can last for long periods because workers need time to learn new skills and some may never acquire these. Some workers lack even basic skills, such as literacy or people skills, making it difficult for them to adequately perform the duties of almost any job available.

The shortcomings of the unemployment rate as an estimate of excess supply of labour are well known to labour economists but not widely understood by the community as a whole or even among those regarded as informed commentators. For instance, in the *ABS Labour Force Survey*,[26] from which the unemployment estimates are derived, it is only necessary to have worked for one hour in the survey week to be classified employed. To be classified as unemployed, respondents must pass a number of tests regarding their readiness for work and their efforts to actively seek work.

FIGURE 16
UNDERUTILISED LABOUR



Source: ABS, *Australian Labour Market Statistics*, Cat. No. 6105.0, *Labour Force, Australia*, Detailed – Electronic Delivery, Cat. No. 6291.0.55.003

Many other measures throw light on the extent of underutilisation of labour. One of these is the *underemployed*, those who are employed part-time but who would like to, and are ready to, work full-time; plus those who normally work full-time but at the time of the survey, because of economic circumstances, are working part-time. Another measure is the *marginally attached*, those who want to work but do not satisfy the strict availability criteria. They are those who are actively looking for work, but not available at the time of the survey or are available to start work but did not believe they could find a job.

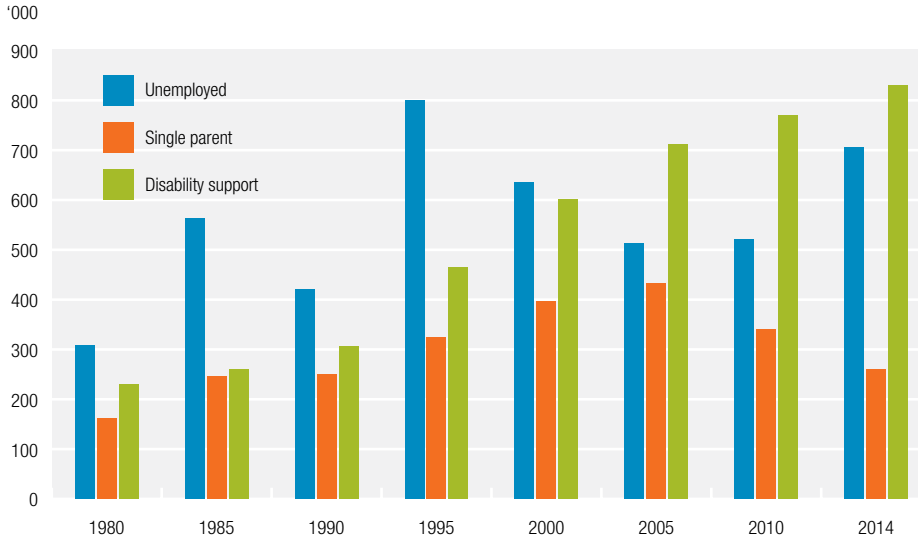
Figure 16 shows how these different measures have changed over the almost two decades to 2014. The unemployment rate fell significantly over the period until a small rise post-GFC. The underemployment rate actually rose over the period of falling unemployment while there was little change in the marginally attached. Adding the underemployed and marginally attached more than doubles the official number of unemployed to about 1.3 million.

The number receiving social security payments is another possible indicator of unemployment. The ABS bases its estimates of the unemployed according to individuals' responses to survey questions. However, eligibility for social security payments is determined by an individual's awareness of, and the ability to convince Centrelink of eligibility for, benefits. Figure 17 shows how the number of people receiving certain benefits – namely sole parent, disability and unemployment benefits – has changed over time.

The number of people on unemployment benefit tracks roughly the ABS unemployment estimates. The number of people receiving single parent pensions almost tripled between 1980 and 2005 but fell in the following years, mainly due to the tightening of eligibility to sole parent benefit.

Perhaps most interesting is the rise in people on disability pensions in inverse relation to those on unemployment benefit. There appears to have been a movement from unemployment benefits to pensions. Many older workers are effectively structurally unemployed as industries employing people with manual skills, such as manufacturing, have been in decline. Many of these older workers typically move from unemployment benefit to disability pension and, finally aged pension.[27]

FIGURE 17
SOCIAL SECURITY RECIPIENTS 1980–2014

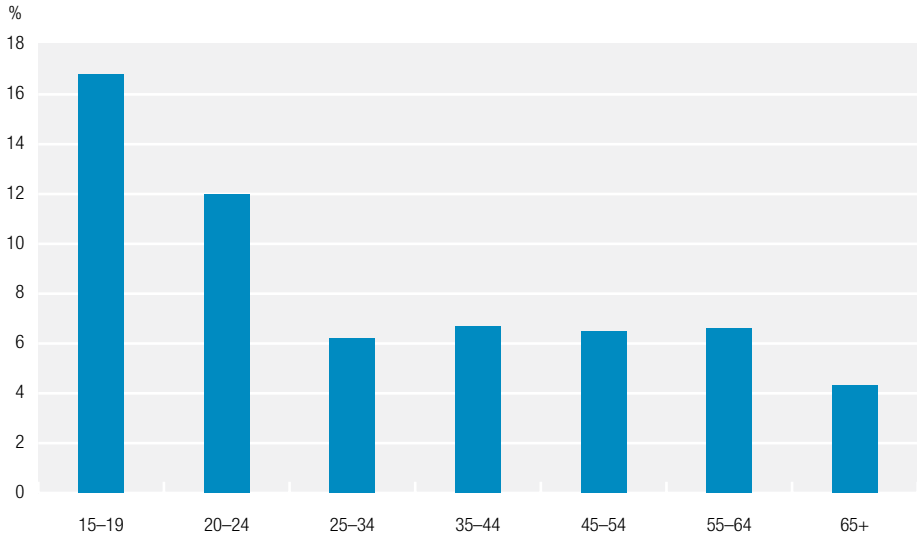


Source: Department of Social Services, *Income support recipients, www.dss.gov.au/about-the-department/publications-articles/research-publications*

While reducing the figures for those on unemployment benefits, this change in categories is costly for government since pensions are indexed to average weekly earnings while unemployment benefits are indexed to the Consumer Price Index. Since average weekly earnings have been rising at a rate faster than the rate of inflation, the rate of increase in income received from a pension has been increasing faster than the rate of increase in the income received from the unemployment benefit. It is also more attractive to be on a pension than on unemployment benefits not only because the payments are greater, but because the requirements to look for work are less for people on pensions.

The extent of the unemployment problem is somewhere between about 700,000 and 1.7 million people. Even given the shortcomings of the unemployment rate as a measure of aggregate excess labour market supply, it remains the best data source

FIGURE 18
UNEMPLOYMENT RATES BY AGE 2013



Source: ABS 2014, *Australian Labour Market Statistics*, Cat. No. 6105.0

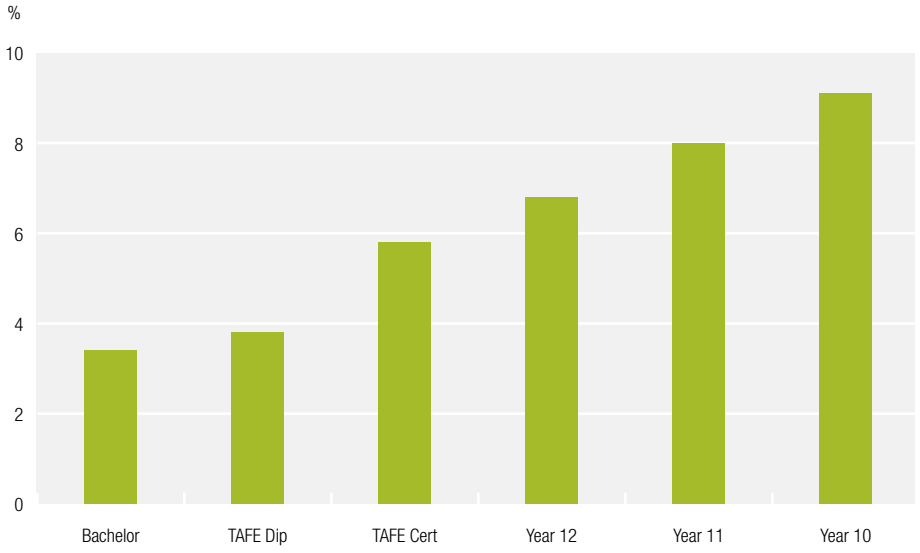
for examining the composition and causes of labour market disadvantage. While there is not space for a comprehensive analysis, some general themes emerge. The rate of unemployment is significantly higher among the youngest in the labour force, higher among those who have relatively lower levels of formal education and has averaged about the same for females as males in recent years. Indigenous Australians also have a higher than average rate of unemployment and generally have lower levels of education than non-Indigenous Australians.

The unemployment rates imply that unemployment is highest for younger people and diminishes with age. However, you must be very careful when interpreting youth unemployment statistics. For instance, in December 2014, the unemployment rate for 15 to 19-year olds was 19.7 per cent and the unemployment rate among those looking for full-time work was 29.2 per cent. However, of the youth population, only 4.3 per cent were unemployed. Seventy-five per cent of the youth population were in full-time education. For 20 to 24-year olds, the unemployment rates were 10.4 per cent for those not in full-time education and 11.6 per cent for those participating in any education (full-time or part-time).

The deceptively high unemployment rates for youth arise because the unemployment rate is measured as the number unemployed divided by number employed plus unemployed (the labour force). Because most young people are in education, the number of unemployed is small but make up a large percentage of those who are not in education. Therefore, unemployment is not a problem for most young people. The higher the level of education, the greater their career prospects, including lower probability of unemployment. Young people pursuing education opportunities improve national productivity and reduce total unemployment in later years.

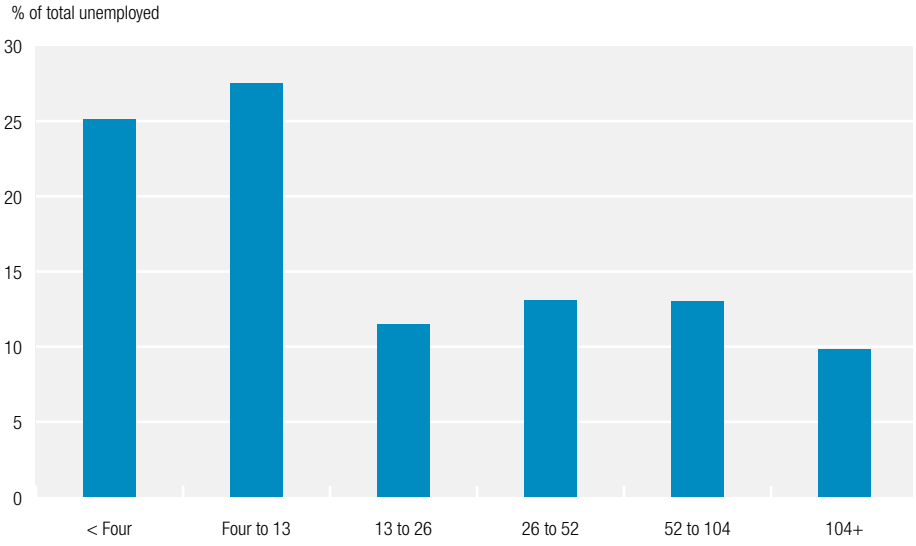
The problem of youth unemployment is concentrated among the most disadvantaged. This group has little or no skills or work experience. Australian economic studies have also found that the chances of being unemployed are much higher if a person lives in a lower socioeconomic income area and if a person's parents have a lower level of education.[28] Clearly unemployment is a contributing factor to inequity in society.

FIGURE 19
UNEMPLOYMENT RATE BY HIGHEST LEVEL OF EDUCATION 2013



Source: ABS 2014, *Education and Work, Australia*, Cat. No. 6227.0

FIGURE 20
UNEMPLOYMENT DURATION IN WEEKS – JANUARY 2015

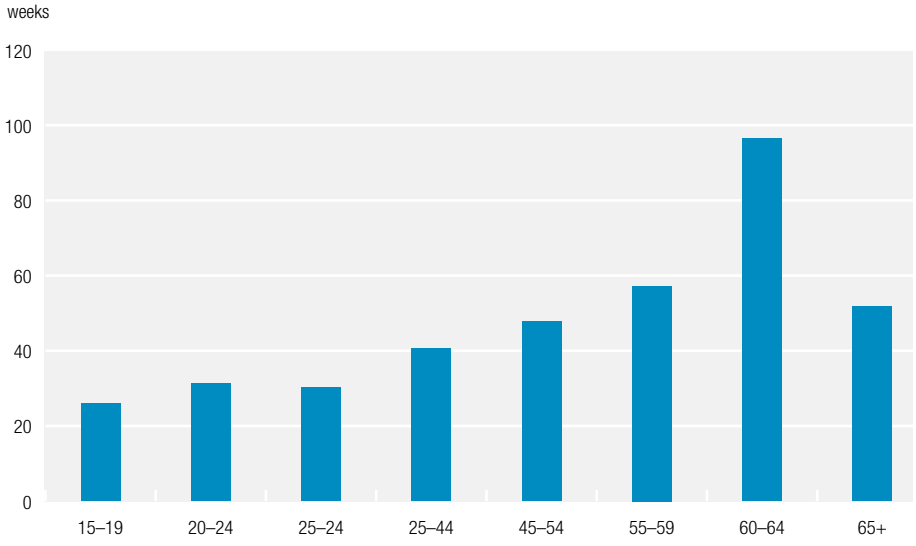


Source: ABS 2015, *Labour Force, Australia*, Cat. No. 6202.0

The most important thing to note from Figure 20 is that most people who become unemployed will get a new job fairly quickly. Over 25 per cent will leave unemployment within a month and over 50 per cent within three months. Of great concern is the number of people who are unemployed for a long time. The percentage of all unemployed who had been continuously unemployed for a year or more, the long-term unemployed, stood at around 20 per cent in 2015 and of these, two-thirds have been unemployed for over two years. These are the truly disadvantaged in the labour market and they have quite different characteristics to the rest of the labour force.

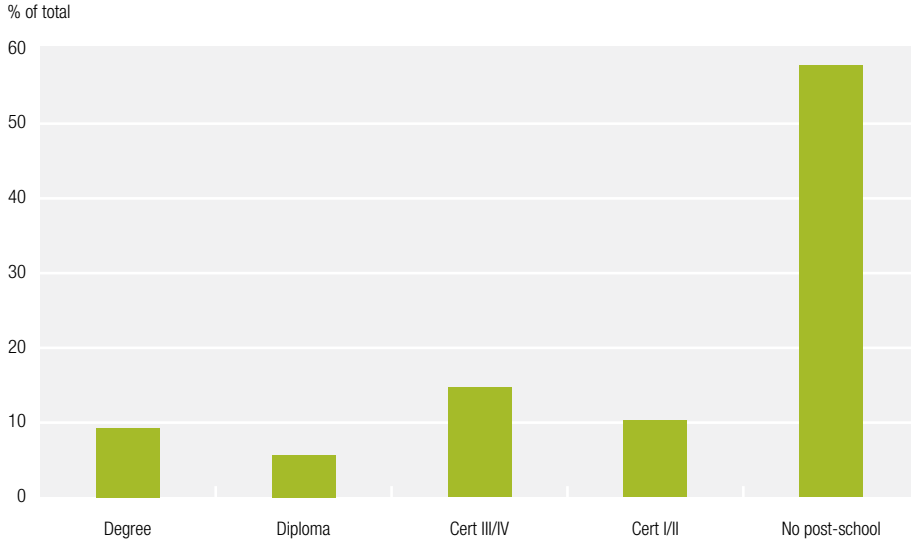
Of the long-term unemployed, just over 50 per cent have the lowest level of education, leaving school having completed high school, Year 10 or less (refer to Figure 22). Age is also an important factor in long-term unemployment. The older a person is, the more likely they are to become long-term unemployed. Of those who are aged over 55 and unemployed, the majority are long-term unemployed.

FIGURE 21
UNEMPLOYMENT DURATION BY AGE 2013



Source: ABS 2014, *Australian Labour Market Statistics*, Cat. No. 6105.0

FIGURE 22
LONG-TERM UNEMPLOYED BY HIGHEST LEVEL OF EDUCATION 2014



Source: ABS 2014, *Job Search Experience, Australia*, Cat. No. 6222.0

Although for most Australians the labour market has demonstrated adjustment of labour supply to meet changes in demand, there are (relatively large) groups of people who are particularly disadvantaged and are fairly easily identifiable. This group is a major challenge for labour market reform. However, the biggest single factor determining your chances of being unemployed, particularly long-term unemployed, is your level of education, suggesting this is where policy should focus.

Conclusion

There have been very important changes in employment by industry, occupation, skill mix and hours worked in the Australian economy. Of the change in skills due to structural change in the recovery and boom period, this was most apparent in the boom period from 2001 to 2006. Technological change continues to be a key influence on the pattern of skill demand but recent Australian experience was also clearly influenced by patterns of trade and industry structure.

A combination of external shocks, globalisation and technical change has significantly changed the nature of demand for labour while certain inflexibilities in the labour market have prevented adjustment to these demand changes. This has been most manifest in the:

- Relative growth in service sector employment;
- Growth of part-time and casual work;
- Relative decline in demand for manual skills;
- Growth in demand for knowledge-based and people skills; and
- Decline in trade unionism.

Technological change, particularly information and communication technologies, has allowed a substantial reordering of occupations within industries. That is, they are enabling a reorganisation of the workplace to place greater emphasis on skills, particularly interactive and cognitive skills. Although highly likely that other factors, such as institutional change, have allowed firms to significantly change the employment mix of their workforces, it is unlikely that changes in soft technologies (such as restructuring the banking industry workforce) would have been possible without the introduction of hard technologies (such as ATMs and the internet).

The extent to which these skills are able to be diffused through formal training and education needs to be explored. This chapter suggests that specific occupations – those characterised by performing routine cognitive or manual tasks – will continue to be at risk in the years ahead. Career guidance and allocation of training places should be cognisant of the potential downside for employment in these occupations.

It would be expected that emphasis on high-skilled employment with opportunities for firms to exploit labour-saving technologies will continue or even increase. Demand for traditional blue-collar skills would be expected to continue to decline, which will test the ability of the labour market to adjust and absorb the existing supply of these skills. Without appropriate policy response, the inability of many individuals to adjust to the current and expected skill demands of industry will continue to increase the degree of structural unemployment in Australia. When the skills of workers become obsolete, the social consequences are serious, with unemployment, financial hardship and marginalisation likely.

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2.3

Information technology and the Australian labour market

Professor Jeff Borland and Dr Michael Coelli

Professor Jeff Borland is Truby Williams Professor of Economics at the University of Melbourne. His research on the operation of labour markets in Australia has included topics such as earnings inequality, the causes of unemployment, outcomes from labour market programs and job security. He publishes a monthly *Labour Market Snapshot* at *sites.google.com/site/borlandjum/labour-market-snapshots*

Dr Michael Coelli is a lecturer and researcher in economics and applied econometrics at the University of Melbourne. His main fields of research are in labour economics and the economics of education. One focus of his research is labour market outcomes in Australia, particularly regarding the relationship between education and earnings, earnings inequality, skills and occupation change.

Introduction

Over the past 40 years, new technologies that greatly increase the speed of information processing and the capacity for storage and transmission of information have been adopted in many production and household consumption activities.

Substantial debate has occurred regarding the significance of the new information technologies for economic activity. Some commentators have argued that the consequences are epoch-shaping:

> "… the key building blocks are already in place for digital technologies to be as important and transformational as the steam engine."[1]

> "Our simple model illustrates the range of things that smart machines can do for us and to us. Its central message is disturbing. Absent appropriate fiscal policy that redistributes from winners to losers, smart machines can mean long-term misery for all."[2]

At the same time, sceptics have suggested that such claims exaggerate the impact of the new information technologies:

> "Most of the inventions that replaced tedious and repetitive clerical labour by computers happened a long time ago, in the 1970s and 1980s. Invention since 2000 has centred on entertainment and communications devices that … do not fundamentally change labour productivity …"[3]

One place this debate has played out is in analysis of labour market outcomes. Beginning in the early 1990s, studies for a variety of industrialised economies have found evidence of large increases in earnings inequality and changes in the skill composition of employment. In seeking to understand why those changes have occurred, a major potential explanation that has been investigated is the effect of the new information technologies on the demand for labour.

In this chapter, we present evidence for Australia on the relation between the introduction of new information technologies and the skill composition of employment. The evidence is taken primarily from detailed research we have recently undertaken on this topic.[4]

This chapter will:

- Give a brief overview of theoretical perspectives on the effect of new information technologies on the labour market;
- Describe changes in the skill composition of employment that have occurred in Australia;
- Present findings from analysis of the relation between the new information technologies and changes in the composition of employment; and
- Provide concluding remarks.

How information technologies can affect the labour market

The theory developed in the early 1990s to describe how computers and information technologies should be expected to affect the labour market is known as the Skill Biased Technical Change (SBTC) hypothesis.[5] The effect predicted by this theory is relatively straightforward: New information technologies are assumed to change a worker's productivity in a way that varies monotonically with their skill levels. The technologies are regarded as substituting for tasks undertaken by low-skill workers whereas the productivity of high-skill workers in undertaking their jobs is raised by the new technologies. Hence the SBTC hypothesis implies that information technologies raise the relative demand for high-skill workers and lower the relative demand for low-skill workers. It follows that the share of low-skill jobs in the workforce should decline and high-skill jobs should increase.

About a decade later, a theory that presents a more nuanced interpretation of how information technologies affect the labour market, known as the routinisation hypothesis, was developed.[6] This theory interprets the main impact of new information technologies to be the capacity to implement commands that can be coded into routines. Hence the direct impact of the technologies is to provide a cheaper substitute for workers who undertake what are referred to as routine tasks. This might be routine cognitive tasks, such as basic clerical jobs, or routine non-cognitive tasks, such as operation of basic machinery. The substitution of the information technologies for workers performing routine tasks may to some extent involve off-shoring those tasks.

The information technologies may also raise the productivity of some types of high-skill workers performing non-routine tasks – for example, the workers who create the computer codes for routinisation – or by expanding the potential span of control of managers. The other potential effect may be a spill-over from increased demand for high-skill workers being for those workers to raise their demand for services provided by low-skill workers doing tasks that are not routinisable, such as gardening, cooking or care.

Where jobs that are routinisable and non-routinisable vary in where they are located in the skill distribution, it follows that the introduction of information technologies can affect the skill distribution of employment. Most notably, it has been suggested that the new technologies may give rise to what has become known as job polarisation – a pattern of changes in the composition of employment whereby there is an increase in the share of high-skill jobs, a decrease in the share of middle-skill jobs, and an increase in the share of low-skill jobs. Job polarisation could occur where jobs that are routinisable are located in the middle of the skill distribution; or where jobs at the bottom and middle of the skill distribution are routinisable and the higher earnings in middle-skill jobs gives employers an incentive to initially focus the substitution of the new technologies for those jobs.[7]

The skill composition of employment in Australia

Overview

Over the past 50 years in Australia there have been large changes in the skill composition of employment. The share of employment of high-skill workers has increased consistently and by a substantial amount. There has been a large decline in the share of middle-skill workers and a smaller decline in the employment share of low-skill workers. A comparison with Europe, using the same methods of classifying jobs by skill level as used in the major study for that region, suggests that the extent of job polarisation has been similar in Australia to Europe.

Looking at individual decades, or separately at males and females, changes the story somewhat. For the 1980s and 1990s, the pattern of changes in employment in Australia exhibited job polarisation; whereas in the 1970s and 2000s, the changes in employment share were strictly ordered by skill level. The job polarisation observed is also found to be exclusively associated with changes to the skill composition of male employment.

How to measure changes in the skill composition of employment

In our study, workers are classified into skill categories according to the average earnings of their occupation in a base period. Occupations with higher average earnings are assigned to higher skill categories. Using that classification, changes over time in the proportion of the workforce by occupation provide a measure of the change in the share of employment by skill level.

As an example, suppose that in the base period there are three occupations – managers, clerks and personal care workers – and in each occupation there are 400 workers. Managers have the highest average earnings so are defined as high-skill, clerks are middle-ranked in their average earnings and defined as middle-skill, and personal care workers have the lowest average earnings and are defined as low-skill. Hence we would conclude that in the base period, one-third of the workforce was in each of the skill categories. Then suppose we look at employment by occupation sometime after the base period. Assume that at that time there are 600 managers, 300 clerks and 300 personal care workers. Using our method of classifying workers into skill categories, we would now say that the share of high-skill workers has increased to one-half and that the shares of medium and low-skill workers has decreased to one-quarter.

We use data on employment by occupation in Australia from the Australian Bureau of Statistics (ABS) Censuses, which occurred at five-year intervals from 1966. Definitions of occupation categories changed several times over the period from 1966, so a major task in doing this research was to create a data series of employment by occupation that uses a consistent definition of occupation. The skill level of occupations is ranked using their average weekly earnings in 1986. Occupations were classified into five quintiles representing different skill levels (low to high), with each quintile having 20 per cent of workers in the base period. Using changes in employment by occupation compared with the base period, while retaining the same base period skill category for each occupation, allows us to map out changes in shares of employment by skill level in Australia.

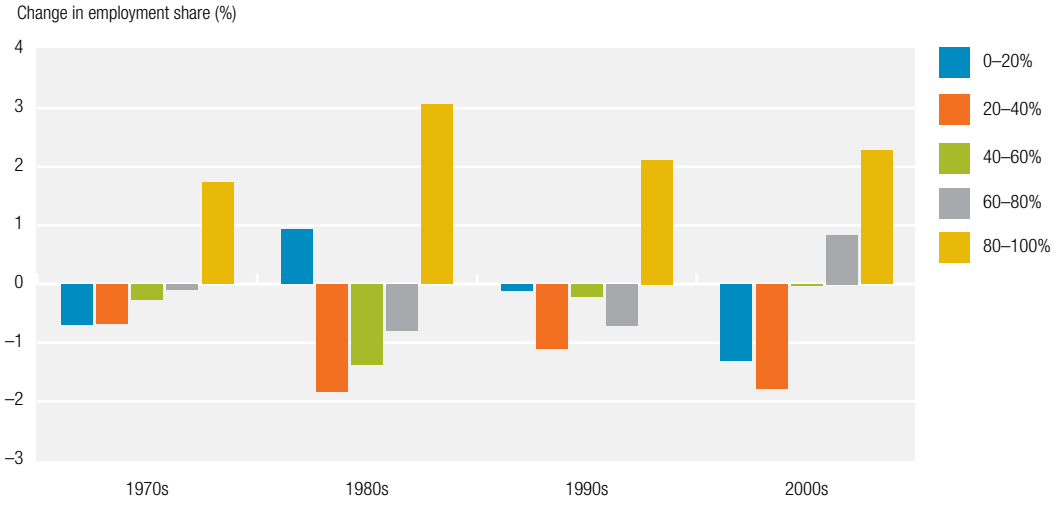
FIGURE 1

CHANGES IN SHARES OF EMPLOYMENT BY (EARNINGS) SKILL CATEGORY 1966–2011

Source: Coelli and Borland.[8]

FIGURE 2

CHANGES IN SHARES OF EMPLOYMENT BY (EARNINGS) SKILL CATEGORY (BY DECADE)



Source: Coelli and Borland.[9]

Evidence

We begin with a long-run perspective on changes in the distribution of employment by skill level. Figure 1 depicts changes in employment shares by skill category in Australia from 1966 to 2011. The changes that occurred can be described as having a J-curve with respect to skill. The gains at the top of the skill distribution were large – the employment share of the highest skill quintile increased by 9.7 percentage points during this period. The gains at the top outweighed the losses in the middle of the skill distribution, and hence the employment share of low-skill occupations declined moderately.

It is also possible to look at what happened to the skill composition of employment in Australia within shorter time periods. Figure 2 shows changes in employment shares by skill level for separate decades from the 1970s to 2000s. Strong growth is observed in the share of employment in the top quintile in each of the past four decades.

TABLE 1
CHANGES IN EMPLOYMENT SHARES BY OCCUPATIONAL SKILL LEVEL

	Lowest pay occupations	Middle pay occupations	Highest pay occupations
Australia (1966–2011)	+2.2	–19.2	+17.0
Australia (1991–2011)	+1.5	–8.5	+7.0
Europe average (1993–2010)	+2.7	–9.9	+7.2

Source: Coelli and Borland.[11]

The employment shares of the second lowest and middle quintiles decreased in all decades. For occupations in the lowest quintile, the employment share fell in the 1970s and 2000s, was essentially unchanged in the 1990s, but rose considerably in the 1980s. One interpretation of these findings is that there is evidence of job polarisation in the 1980s and 1990s; whereas the pattern of changes in employment shares in the 1970s and 2000s is more consistent with the SBTC hypothesis.

Analysis that we report in our detailed study also indicates that job polarisation in Australia has been mainly a male phenomenon. Job polarisation occurred for males in essentially all four decades from the 1970s to the 2000s. Changes in employment shares for females, however, show changes that increase monotonically with the skill level of jobs.

How does Australia's experience fit with international experience? One major recent study by Goos et al.[10] reports changes in employment shares by skill category for Western European countries for 1993 to 2010. To compare against that experience, Table 1 shows changes in employment shares when occupations are classified in the same way for Australia over a comparable time period to the Goos et al. study. It can be seen that in both Australia and Europe there is a common pattern of job polarisation and the size of changes in employment shares by skill level are quite close.

Have computers caused the change in the skill composition of employment in Australia?

What we test

In this section, we report findings from a test of the routinisation hypothesis for Australia. Specifically, we set out to answer whether:

1. Computers are substituting for labour in undertaking routine tasks; and
2. How that substitution has affected the skill composition of employment.

In our empirical analysis we undertake these two steps sequentially.

For the first step, our method to examine the role of computers in substituting for labour is to compare changes in the relative demand for workers with the capacity to complete different tasks, especially routine versus non-routine tasks. We use what has become the standard approach for empirical analysis of changes in the demand for labour due to computerisation.[12]

First, measures of task requirements for workers in each occupation were constructed using information from the US Dictionary of Occupation Titles (DOT). The requirements in each occupation are interpreted as revealing the extent of demand for labour with the capacity to complete specific types of tasks in that occupation. For example, the level of mathematical aptitude required in a job is interpreted as revealing the level of demand in that job for workers who can complete abstract cognitive tasks. Using this approach, it is possible to define separate measures of requirements for completing abstract, routine and manual tasks in each occupation.

Second, a measure of the average demand for labour with the capacity to complete each type of task in Australia is constructed. Each measure is essentially an employment-weighted average over occupations of an index of the 'importance' of capacity to complete that task within each occupation. The value of an average demand measure increasing over time shows that changes to the occupational composition of employment are tending to increase the relative demand for labour to perform that task; that is, a relatively greater share of total employment is in occupations that rank above average on the task measure. By contrast, a decrease in the value of the average demand measure reflects a decrease in relative demand for labour to perform that task. Third, we use separate task measures to construct a measure of routine task intensity (RTI) equal to Autor and Dorn[13]:

$$\text{RTI index} = \ln(\text{Routine index}) - \ln(\text{Manual index}) - \ln(\text{Abstract index})$$

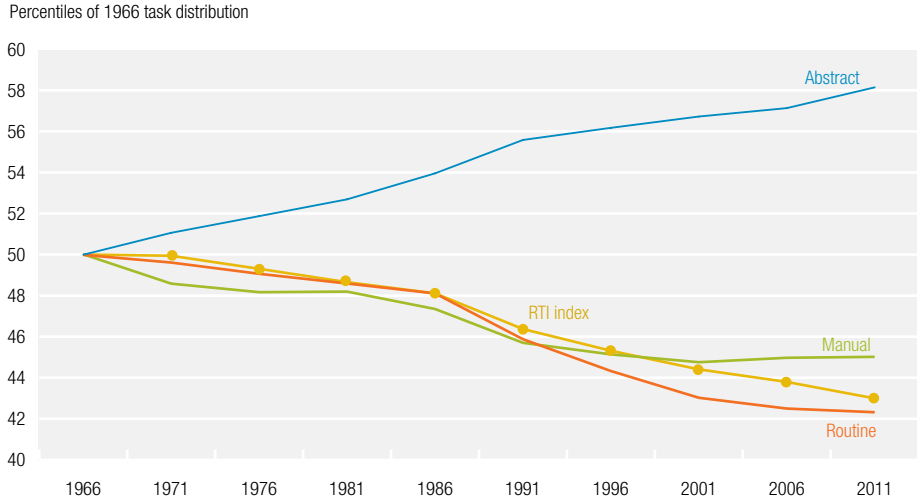
In the second step, we examine how changes in the demand for labour to complete routine tasks have affected the occupational distribution of employment. This is done in two stages:

1. We present the distribution of demand for routine tasks across the skill distribution of jobs; and
2. We show changes in shares of employment by the level of demand for routinisation in jobs.

Together these two stages provide evidence on how changes in the demand for routinisation have affected the skill distribution of employment.

FIGURE 3

MEASURES OF THE AVERAGE DEMAND FOR LABOUR TO COMPLETE TASKS 1966 TO 2011



Source: Coelli and Borland.[14]

1. Evidence: Changes in the demand for labour to complete tasks

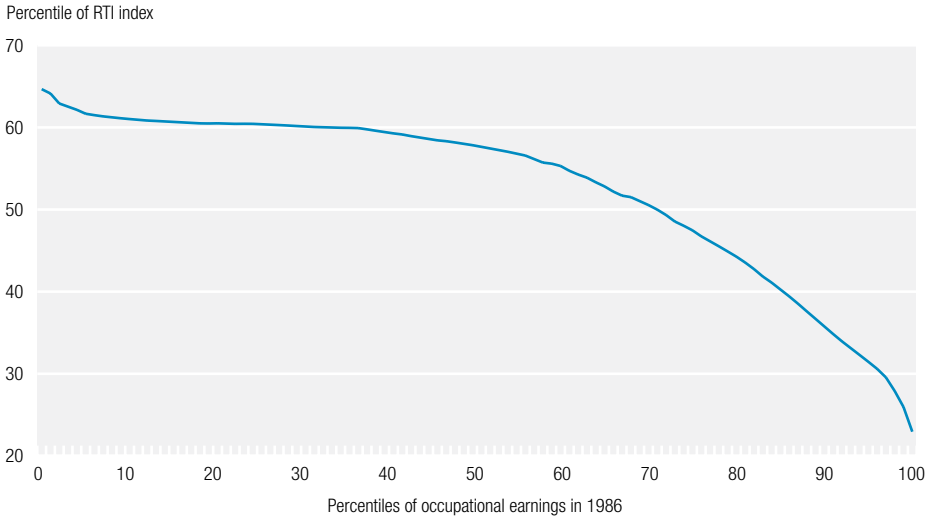
Figure 3 displays the evolution of the demand for labour to complete each type of task from 1966 to 2011. A strong increase in demand for labour to complete abstract tasks is clearly observed, as is a strong decline in demand for routine tasks. A decline in demand for labour to complete manual tasks is also observed up to 2001. Many production and operator jobs had high manual task measures and underwent large decreases in employment over the period. Finally, the overall measure of the demand for completing routine tasks, the RTI index, falls considerably over the period.

2. Evidence: How changes in the demand for labour to complete routine tasks has affected the skill composition of employment

Figure 4 shows the relation between the RTI index and a measure of the skill content of occupations (using average earnings to measure skill). The percentiles of the task measures (using the initial 1966 employment weights) for each occupation have been graphed by order of the skill level of each occupation, and smoothed. The RTI index is relatively stable with occupation skill level until the 40th percentile, after which it falls considerably with skill. Hence the demand for undertaking routine tasks is concentrated in low- and middle-skill jobs.

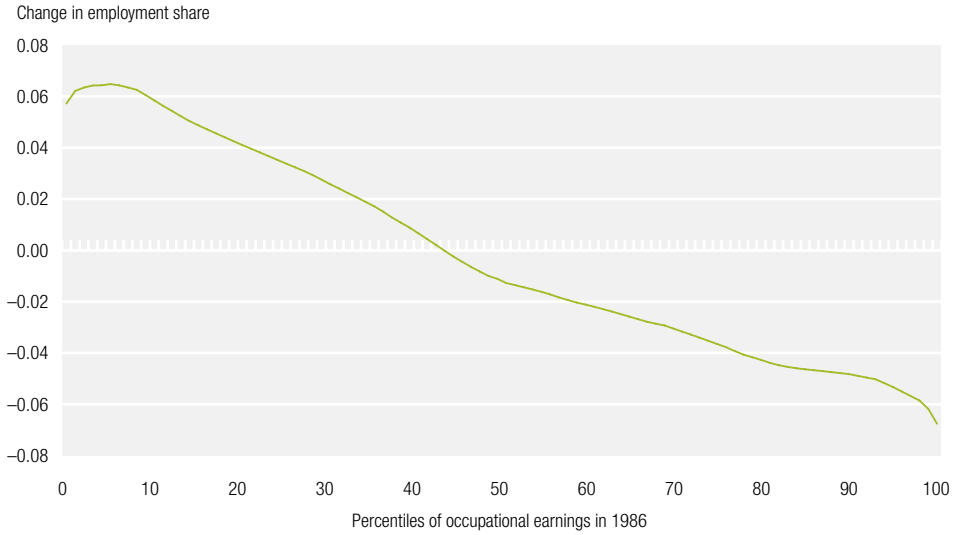
Figure 5 shows how employment shares by occupation in Australia have varied with the level of routine task intensity in those occupations. It is evident that a strong and consistent relation does exist. Growth is strongest among occupations at the very bottom of the RTI Index distribution, and is weakest among occupations at the very top of the distribution. In disaggregated analysis by decade we find that employment growth is negatively related to RTI in all decades, with the relationship being most negative from the mid-1980s to the early 2000s.

FIGURE 4
RTI INDEX BY THE SKILL LEVEL OF OCCUPATIONS, AUSTRALIA, 1986



Source: Coelli and Borland.[15]

FIGURE 5
CHANGES IN EMPLOYMENT SHARES BY THE ROUTINE TASK INTENSITY OF JOBS, AUSTRALIA 1966 TO 2011



Source: Coelli and Borland.[16]

Summary

These separate pieces of evidence can be put together to tell an overall story of how new information technologies have affected the skill composition of employment in Australia. Since the mid-1960s there has been a steady decrease in the demand for labour to complete routine tasks. Occupations that are intensive in routine tasks are concentrated at the bottom and middle of the skill distribution. Jobs that have the highest intensity of routine tasks have had the largest declines in their shares of employment, whereas jobs with the lowest intensities have had the largest increases in employment shares. Hence it does seem the new information technologies have a role to play in explaining changes in the skill composition of employment in Australia – primarily a shift towards high-skill jobs and away from low- and middle-skill jobs.

Conclusion

Over the past four decades in Australia there has been a large shift in the skill composition of employment:

- The share of high-skill jobs has increased by a large amount;
- The share of middle skill jobs has fallen by almost as much; and
- There has been a small decrease in the share of low-skill jobs.

At least for part of the period since the early 1970s, this pattern of changes fits what has come to be known internationally as job polarisation.

Our analysis indicates that increased use of new information technologies has played an important role in explaining the changes in the skill composition of employment that have occurred. Consistent with those new technologies replacing workers who perform routine tasks, we find that there has been a decrease in the demand for labour to complete routine tasks. Jobs that most require the completion of routine tasks are concentrated at the bottom and middle of the skill distribution. Hence the decrease in demand for routine tasks provides one reason why the employment shares of low- and middle-skill jobs have declined.

In our major investigation,[17] we also establish that these changes to the occupation composition of employment – and the associated changes in earnings by occupation – have contributed significantly to an overall increase in earnings inequality in Australia over the period since 1990. The labour market consequences of the new information technologies are therefore likely to extend beyond changes in occupation composition of employment. Determining whether these trends will continue in future years will be a difficult task, but will be important for our understanding of future labour market outcomes.

Endnotes

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6 Autor, D, Levy, F & Murnane, R 2003, 'The skill content of recent technological change: an empirical investigation', *Quarterly Journal of Economics*, 118(4), pp 1279–1333.

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11 Coelli, M & Borland, J 2015, op cit, Table 2.

12 Autor, D & Dorn, D 2013, 'The growth of low-skill service jobs and the polarization of the US labor market', *American Economic Review*, 103, p 1553–1597; Autor, D 2013, 'The 'task' approach to labor markets', *Journal of Labour Market Research*, 46, 185–199; Goos, M, Manning, A & Salomons, A 2014, op cit.

13 Autor, D & Dorn, D 2013, op cit.

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15 Ibid, Figure 9.

16 Ibid, Figure 10, Panel A.

17 Ibid.

2.4

Stability of education earnings gaps in Australia

Dr Michael Coelli

Dr Michael Coelli is a lecturer and researcher in economics and applied econometrics at the University of Melbourne. His main fields of research are in labour economics and the economics of education. One focus of his research is labour market outcomes in Australia, particularly regarding the relationship between education and earnings, earnings inequality, skills and occupation change.

Introduction

Technological change, particularly due to rapid computerisation, has arguably been one of the most pervasive features of the economic landscape over the past 40 years. The influence this change has had on the types of tasks that workers undertake has been considerable. The purpose of this chapter is to seek to understand to what extent these changes have affected the earnings received by different groups of workers in Australia, particularly with respect to the education qualifications these workers possess.

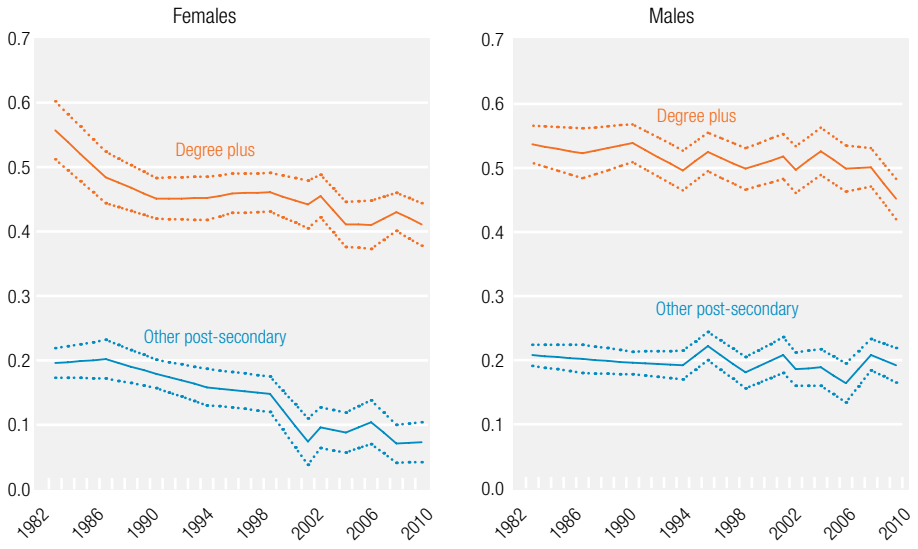
The concept of skill-biased technological change has become embedded in the economics lexicon. This concept refers to changes in modes of production that have increased the demand for highly skilled (highly educated) workers relative to low-skilled (less educated) workers. The concept had its inception in attempting to explain the sharp increase in the earnings gap between skilled and unskilled workers in the United States (US) since the beginning of the 1980s. The college–high school wage gap increased markedly over the 1980s in the US, and continued to rise over the 1990s, albeit at a slower pace.[1]

There is also evidence that education earnings gaps have increased in other developed countries since the start of the 1980s: the United Kingdom,[2] Canada,[3] and Germany[4], but not until the 1990s.

In Australia, however, Coelli and Wilkins[5] report that the university/no post-secondary education earnings gap remained remarkably stable for men over the 1982-to-2004 period, while it fell for women in the 1980s. These trends are in stark contrast to the US experience.

This chapter provides updated education earnings gap measures for Australia. These gaps remained stable up to 2011, and even fell for men since the mid-2000s among some post-secondary education groups. The chapter also provides measures of employment rates and full-time employment probabilities by education group over time for Australia. Several potential explanations of why Australia's experience appears to be so different from the experiences of other major developed economies, particularly the US, are then discussed.

FIGURE 1
EDUCATION MEAN LOG EARNINGS GAPS OVER TIME (IDS DATA)



Note: Author calculations are from Australian Bureau of Statistics (ABS) Confidentialised Unit Record Files (CURF) micro-data from Income Distribution Surveys and Surveys of Income and Housing from 1982 to 2011. All full-time employees aged 15 to 64 with positive earnings who are not full-time students are included. The measures are mean log wages relative to the base education category of workers with no post-secondary education, holding constant the age composition of employment within education categories at average levels from 1982 to 2011. 1994–1995, 1996–1997 and 1999–2000 were combined when calculations were made to improve precision. The earnings measure is usual weekly earnings in main and second job, except for 1982 (actual earnings). The dashed lines are 95 per cent confidence intervals.

Education earnings gaps

Following Coelli and Wilkins[6], I construct education earnings gaps using two data sources:

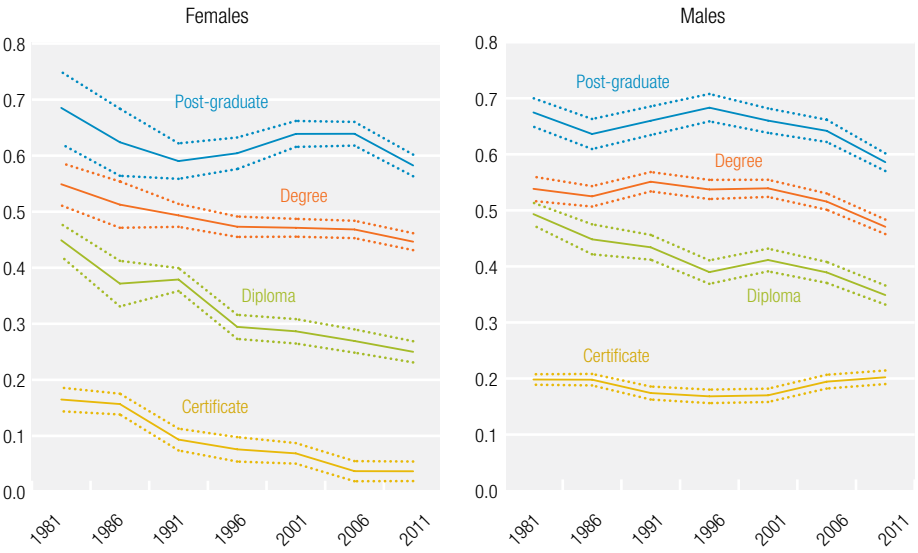
1. The Income Distribution Surveys (IDS, referred to as Surveys of Income and Housing in more recent years); and
2. The Australian Censuses.

The advantages and disadvantages of these two data sets for measuring education earnings gaps are discussed in Coelli and Wilkins.[7] The measures I construct here cover all full-time employees aged 15 to 64, and ensure that changes over time in the age composition of employees within each education category have no effect.[8]

Education earnings gaps constructed using IDS data from 1982 to 2011 are presented in Figure 1. For males (right panel), these gaps remained remarkably constant over the period. The mean log earnings difference of around 0.5 for university-educated males relative to those with no post-secondary education – the base category – equates to around a 65 per cent earnings difference. There is a small decline in the gap for university-educated males in the last few years. The other post-secondary education versus no post-secondary education earnings gap of around 0.2 log points equates to around a 22 per cent earnings difference.

For females (left panel), both earnings gaps declined over the period. The female university log earnings gap of 0.41 at the end of the period equates to around a 50 per cent earnings gap. Note that the education groups depicted in Figure 1 are the most detailed that can be constructed in a consistent manner over the sample period using the IDS data.

FIGURE 2
EDUCATION MEAN LOG INCOME GAPS OVER TIME (CENSUS DATA)



Note: Author calculations from ABS CURF micro-data from the Australian Censuses from 1981 to 2011. All full-time employees aged 15 to 64 with positive income and are not full-time students were included. The measures are mean log total weekly income relative to the base education category of workers with no post-secondary qualifications, holding constant the age composition of employment within education categories at average levels over the 1981–2011 period. The dashed lines are 95 per cent confidence intervals.

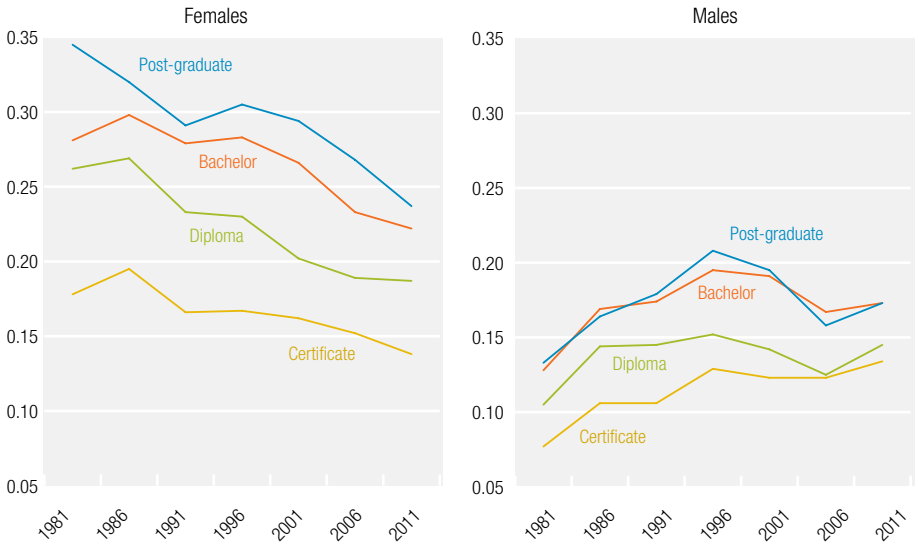
Education earnings gaps constructed using the Australian Census micro-data from 1981 to 2011 are presented in Figure 2. The main advantage of this data source over the IDS is that more education categories can be separately identified. The main drawbacks are that the earnings measure is total income rather than purely earnings from employment, and income is recorded in categories rather than continuously. I confine the measures to full-time employees (not self-employed) to ensure as far as possible that this income reflects labour market earnings.[9]

The trends in education income gaps depicted in Figure 2 are consistent with the earnings gaps depicted in Figure 1. These gaps have generally fallen among females in all post-secondary education groups (left panel). Income gaps for females with a post-graduate qualification did rise over the 1990s, but have declined more recently.

Income gaps for males with a certificate have increased marginally since 2001 after falling slightly during the 1980s. The income advantage of diploma-holders has fallen by nearly 15 log points over the 1981 to 2011 period. Bachelor degree-holders versus no post-secondary education income gaps remained quite stable over most of the period, but also showed a decline in recent years. Even the income advantage of post-graduate qualification-holders declined since the mid-1990s.

Despite this stability/decline in education earnings gaps in Australia from 1981 to 2011, the overall dispersion of earnings (earnings inequality) increased since the start of the 1990s at least, as it did in many developed countries.[10] Rising dispersion of earnings within all education groups is the source of this overall increase in earnings inequality. It is not known whether this increasing within-group dispersion is due to increases in returns to unobserved skills (i.e. skills not measured simply by education levels) or to increases in the dispersion of these unobserved skills within education groups. Identifying the sources of increased earnings dispersion may be a fruitful area for future research.

FIGURE 3
EMPLOYMENT RATE GAPS BY EDUCATION GROUP IN AUSTRALIA OVER TIME



Notes: Author calculations from ABS CURF micro-data from the Australian Censuses from 1981 to 2011. All individuals aged 15 to 64 who are not full-time students are included. The measures are mean proportions of each education group that are employed relative to individuals with no post-secondary education, holding constant the age composition of the working age population within education categories at average levels over the 1981-2011 period.

Employment rates and education

While economics literature focuses on earnings gaps between workers with different education levels, labour market responses to changes in demand for workers of different education levels may not be confined to earnings rates among the employed (price responses). Such relative demand changes may also affect the probability of being employed (quantity responses).

In Figure 3, I present differences in employment rates by education category over time for Australia. As in Figures 1 and 2, these employment rate gaps also hold constant the age structure within education groups over time. The lines represent the difference in the proportion of working age individuals in each education category that are employed relative to individuals with no post-secondary education. The underlying levels of these employment rates by education category are documented in Table 1.

Education employment rate gaps among females (left panel) are generally higher than among males (right panel), but these gaps generally fell from 1986 to 2011. The exception is the 1991-to-1996 period. Employment rates themselves have increased over time among females (refer to Table 1), but there remain large differences in employment rates by education category. Females with no post-secondary education are much less likely to be working than females with higher levels of education.

Among males, education employment rate gaps rose from 1981 to 1996.[11] This was a period of falling employment rates among all working age males (refer to Table 1), with the largest falls among the least educated. These gaps declined between 1996 and 2006 as the Australian economy expanded. Employment rates among the least educated males increased over this period, while employment rates among the most educated remained stable, albeit at higher levels (refer to Table 1). Education employment rate gaps among males widened slightly since 2006 as the economy slowed, reducing employment rates among the least educated. Over the whole period from 1981 to 2011, employment rate gaps between males with no post-secondary

TABLE 1

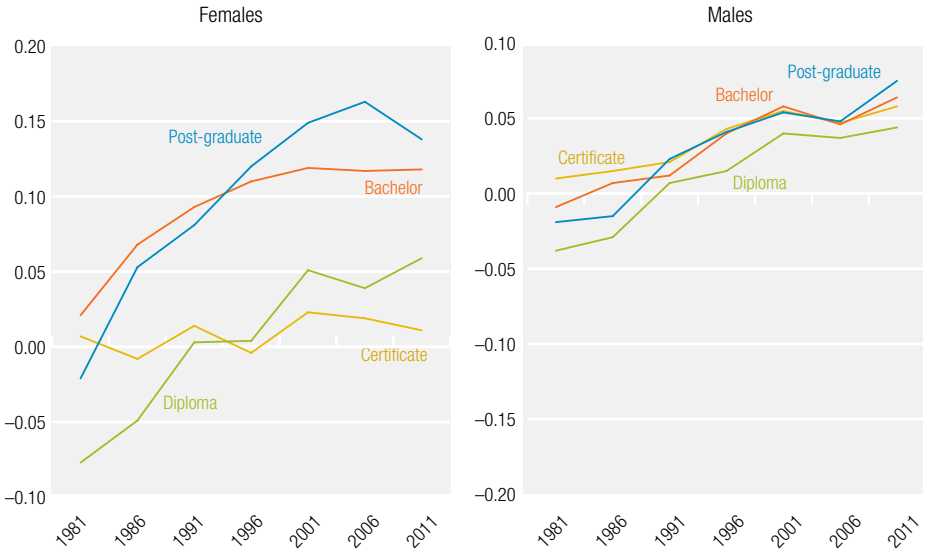
EMPLOYMENT AND FULL-TIME EMPLOYMENT RATES BY EDUCATION CATEGORY, AUSTRALIA

	1981	1986	1991	1996	2001	2006	2011
Probability of employment							
Females							
Post-graduate	0.810	0.786	0.810	0.829	0.844	0.857	0.840
Bachelor	0.746	0.764	0.798	0.807	0.816	0.822	0.825
Diploma	0.728	0.735	0.751	0.753	0.753	0.778	0.790
Certificate	0.643	0.662	0.685	0.691	0.712	0.742	0.741
No post-secondary education	0.465	0.466	0.519	0.524	0.550	0.589	0.603
Males							
Post-graduate	0.958	0.931	0.909	0.917	0.917	0.915	0.918
Bachelor	0.953	0.937	0.904	0.904	0.913	0.924	0.918
Diploma	0.929	0.911	0.875	0.862	0.864	0.882	0.890
Certificate	0.901	0.873	0.836	0.839	0.845	0.879	0.880
No post-secondary education	0.824	0.767	0.730	0.709	0.722	0.756	0.745
Probability of working full-time if working							
Females							
Post-graduate	0.624	0.684	0.675	0.688	0.692	0.698	0.667
Bachelor	0.667	0.699	0.687	0.679	0.662	0.652	0.647
Diploma	0.569	0.583	0.598	0.572	0.594	0.574	0.588
Certificate	0.652	0.624	0.609	0.564	0.566	0.555	0.540
No post-secondary education	0.645	0.631	0.595	0.568	0.543	0.535	0.529
Males							
Post-graduate	0.901	0.902	0.910	0.897	0.886	0.887	0.896
Bachelor	0.911	0.923	0.899	0.896	0.890	0.885	0.885
Diploma	0.882	0.888	0.894	0.871	0.872	0.877	0.865
Certificate	0.930	0.932	0.907	0.899	0.887	0.886	0.879
No post-secondary education	0.920	0.917	0.887	0.857	0.832	0.839	0.821

Note: Author calculations from ABS CURF micro-data from the Australian Censuses from 1981 to 2011. All individuals aged 15 to 64 who are not full-time students are included. The measures are mean proportions of each education group that are employed (top panel) and mean proportions of those employed that are employed full-time (bottom panel), holding constant the age composition of the working age population within education categories at average levels over the 1981–2011 period.

FIGURE 4

FULL-TIME EMPLOYMENT RATE GAPS BY EDUCATION GROUP IN AUSTRALIA OVER TIME



Note: Author calculations from ABS CURF micro-data from the Australian Censuses from 1981 to 2011. All employed individuals aged 15 to 64 who are not full-time students are included. The measures are mean proportions of each education group that are employed full-time among those that are employed, holding constant the age composition of the employed population at average levels over the 1981–2011 period.

education and males with higher education levels widened by approximately four to six percentage points.

Hours of work (the intensive margin) may also have adjusted in response to skill-biased technological change. In Figure 4, I present full-time employment rate gaps over time by education category. Among females (left panel), these gaps increased considerably among all but the certificate category. Full-time employment rates among females in the lowest two education categories fell considerably over the period (refer to Table 1, bottom panel), but remained relatively stable among the higher three categories.

Among males (right panel), full-time employment rate gaps increased among all education categories relative to males with no post-secondary education. While full-time rates decreased among males in all but the post-graduate category (Table 1), the decrease is by far the largest among males with no post-secondary education. There thus appears to be considerable adjustment in the intensive margin of work that is consistent with an increase in the relative demand for more educated workers.

It must be kept in mind, however, that the outcome of not working or only working part-time may be in part due to choice, not just to employment opportunities. Certain individuals may choose not to work, or to only work part-time, if the wages on offer are not above what they require to induce them into work (not above their 'reservation wage'). This may be more likely among the least educated, as wage levels among that group are the lowest. Certain individuals may decide that welfare payments (unemployment benefits or disability pensions) are preferred to working. Whether such preferences have changed over time is not known. It is not the case, however, that real earnings levels have declined among employed individuals with no post-secondary education.

It is possible that average productivity levels among individuals with no post-secondary education may have declined over time. In 1981, individuals with no post-secondary education comprised 64 per cent of the Australian working age population, while in 2011 they comprised just 37 per cent. The fraction of this no post-secondary education group that are very low ability (potentially not employable) is likely to be higher in 2011 than in 1981, as the no post-secondary education group has become relatively more 'negatively selected'. Thus the decline in employment rates among the no post-secondary education group may in part reflect falls in the average productivity (employability) of workers within it.

Potential explanations for difference between Australia and the US

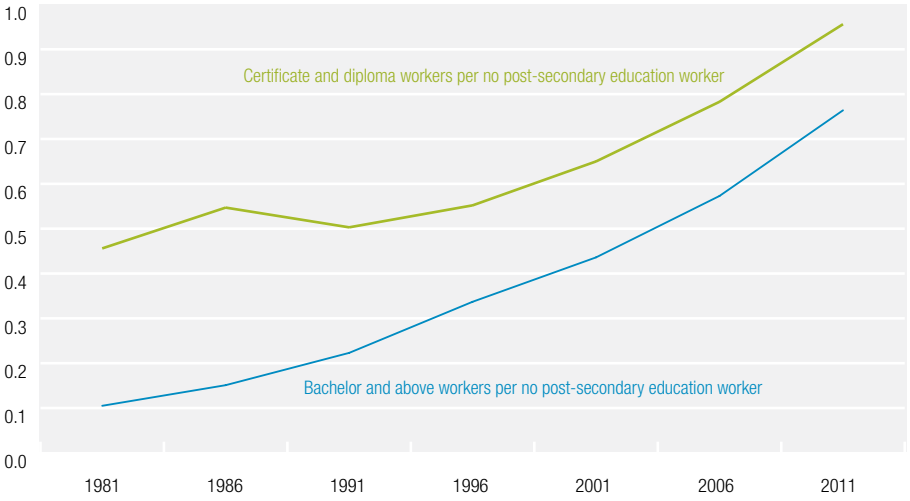
The leading explanation for the rising education earnings gaps observed in the US and several other major developed countries is the skill-biased technological change hypothesis. Technological change due in no small part to rapid adoption of computer technologies in response to enormous reductions in the costs of such technology has, according to this hypothesis, increased the relative demand for educated workers. The skills of educated workers are likely complementary to computing technology. This increase in relative demand accelerated in the 1980s at the same time as growth in the relative supply of educated workers in the US decelerated. Tinbergen[12] originally discussed this 'race' between education and technology: between the supply of and demand for skill. In the US of the 1980s, demand appeared to win that race.

Acemoglu and Autor[13] outline four explanations for the slowdown in the growth of the relative supply of highly educated workers in the US since the start of the 1980s:

1. The Vietnam War encouraged men in particular to enter college to avoid service in the late 1960s and early 1970s. This temporary boost to supply ended in the mid-1970s.
2. The college premium fell considerably in the 1970s, which also may have discouraged college enrolment. Freeman[14] noted that the supply of educated workers in the US far outstripped demand during the 1970s (supply was winning the race in that earlier decade).
3. The baby boomer cohort was highly educated and large, affecting relative supply considerably. This cohort is now moving its way through the labour force, with the overall supply of educated workers still increasing but at a slower rate.
4. US male college-going rates have fallen from their peak at the start of the 1980s, offsetting increases in college-going rates among US females.

The leading explanation for the stability of education earnings gaps in Australia is that the acceleration in demand for skilled workers since 1980 was met by an exceptional increase in the relative supply of skilled workers.[15] Thus supply kept up with demand in the race between education and technology in Australia. The expansion in higher education occurred much earlier in the US than it did in Australia, such that the relative increase in supply since 1981 has been more subdued in the US, albeit starting from a considerably higher base.

FIGURE 5
RELATIVE SUPPLY OF EDUCATED WORKERS IN AUSTRALIA OVER TIME



Note: Author calculations from ABS CURF micro-data from Australian Censuses for 1981 to 2011. All employed individuals (either self-employed or employees) aged 15 to 64 are included. Part-time workers were given half the weight of full-time workers in these measures.

In Figure 5, I present measures of the relative supply of highly educated versus less educated workers for Australia from 1981 to 2011. The relative supply of workers with university-level education increased substantially. While there was only one university-educated worker for every 10 workers with no post-secondary education in 1981, this increased to 7.6 such workers per 10 without post-secondary education in 2011. The percentage of the Australian workforce with a bachelor degree or higher increased from just seven per cent in 1981 to 28 per cent in 2011. The relative supply of workers with certificates and diplomas also increased substantially. The percentage of the workforce holding a certificate or diploma increased from 29 per cent to 35 per cent from 1981 to 2011, while the percentage with no post-secondary education qualifications decreased from 64 per cent to 37 per cent.[16]

This rapid rise in the relative supply of educated workers in Australia from 1981 came from a particularly low base. In the US, the relative supply of workers with a bachelor degree or higher per worker with no post-secondary education was already 0.3 in 1980. University-educated workers comprised nearly 18 per cent of the US workforce in 1980, triple the figure in Australia at the same time. By 2011, the relative supply of workers in the US with a bachelor degree or above had reached 0.92. This is still higher than in Australia at 0.76, but the relative gap closed considerably. The percentage of workers with a bachelor degree or above in the US was 32 per cent in 2011, not much higher than the 28 per cent in Australia.[17] Thus, Australia has nearly caught up with the US in terms of the relative supply of educated workers.[18] This rapid increase has provided Australian employers with the educated workforce they were demanding in response to skill-biased technological change, and is more than likely the key reason the relative earnings of educated workers did not increase in Australia.

One feature of the rapid rise in the college/high school earnings gap in the US during the 1980s was the fall in the real value of earnings among less educated males. Skill-biased technological change potentially reduced demand for less educated workers (males in particular), as the tasks previously undertaken by such workers are now completed using new technologies requiring less labour input. This reduced demand likely pushed down the wages of such workers. Thus the expanding male earnings gap was as much due to the real earnings of less educated males falling as it was to the real earnings of the more educated rising.[19]

In Australia, the dominant feature of wage setting in the 1980s was the Prices and Incomes Accord. This Accord put a floor under real earnings at the bottom of the earnings distribution in particular. While real earnings fell by around four per cent among males with no post-secondary education in Australia between 1982 and 1990 (using IDS data), this is much less than the 12 per cent and 20 per cent reductions over the 1980s among US males with a high school degree and high school dropouts respectively. Differences in wage-setting institutions are thus a second potential explanation for differences in the evolution of education earnings gaps between Australia and the US.

The nominal value of minimum wages remained quite constant in the US over the 1980s, allowing general inflation to erode minimum wages in real terms.[21] In Australia, although the concept of a single minimum wage did not crystallise until the middle of the 1990s, the earnings of the lowest paid increased in the 1980s due to the Accord and changes in Award payment rates.[22]

If differences between Australia and the US in wage-setting institutions can rationalise in part the observed differences in the evolution of education earnings gaps, then the evolution of quantities of employment by education category are also likely to differ across the two countries. If institutions in Australia were such that the earnings of the least educated were unable to decline in response to decreases in demand for such workers due to skill-biased technological change, then employment rates among the least educated are likely to have been the margin of adjustment. We observed quantity responses consistent with skill-biased technological change among males in Figure 3 (employment rates), and skill-biased technological change-consistent responses were observed for both genders in Figure 4 (full-time employment probabilities). But were these quantity responses larger than in the US, where earnings among the least skilled males did decline in the 1980s at least?

In Table 2, I present employment rates and full-time employment probabilities by education group over time for the US. These are constructed using the same strategy used for Figures 3 and 4 (i.e. holding the age distribution within education categories constant over time). Among males, employment rates and full-time employment rates decreased the most among the least educated. Among females, employment rates increased among all education groups, with the largest increases among the least educated (similar to in Australia). Female full-time employment rates fell considerably among the least educated but increased a little among the most educated.

While a significant portion of the large changes between 2000 and 2011 are likely due to the impacts of the Global Financial Crisis (GFC), these changes do not drive these findings. The same trends existed prior to the GFC, albeit in more moderate forms. Overall, quantity changes consistent with skill-biased technological change were also occurring in the US from 1980 to 2011.

Focusing on the pre-GFC period (up to 2006), male quantity responses were more muted in the US than in Australia, while female quantity responses were similar in the two countries. Thus differences in wage-setting institutions may have played some role in determining differences in earnings responses to skill-biased technological change among males.

TABLE 2

EMPLOYMENT AND FULL-TIME EMPLOYMENT RATES BY EDUCATION GROUP OVER TIME, US

	LEVELS			GAPS WITH NO POST-SECONDARY EDUCATION	
	No post-secondary education	Other post-secondary education	Bachelor +	Other post-secondary education	Bachelor +
Employment rates by education group					
Males					
1980	0.870	0.935	0.957	0.065	0.087
1990	0.848	0.928	0.956	0.081	0.108
2000	0.809	0.909	0.945	0.100	0.136
2006	0.832	0.914	0.946	0.082	0.115
2011	0.714	0.851	0.932	0.136	0.218
Females					
1980	0.517	0.630	0.739	0.113	0.222
1990	0.681	0.732	0.822	0.050	0.141
2000	0.687	0.739	0.819	0.052	0.132
2006	0.708	0.738	0.816	0.030	0.108
2011	0.635	0.704	0.816	0.068	0.180
Full-time employment rates by education group					
Males					
1980	0.932	0.946	0.948	0.014	0.015
1990	0.911	0.935	0.943	0.024	0.032
2000	0.909	0.928	0.937	0.019	0.027
2006	0.892	0.919	0.937	0.027	0.045
2011	0.825	0.875	0.922	0.051	0.097
Females					
1980	0.755	0.751	0.756	-0.004	0.001
1990	0.704	0.772	0.791	0.068	0.086
2000	0.727	0.787	0.807	0.060	0.080
2006	0.698	0.772	0.801	0.074	0.103
2011	0.640	0.744	0.801	0.104	0.161

Note: Author calculations from the US Census Bureau micro-data from the US Censuses for 1980, 1990 and 2000, and from the American Community Survey in 2006 and 2011. All individuals aged 15 to 64 who are not at school are included in the top panel. All employed individuals aged 15 to 64 who are not at school are included in the bottom panel. The measures are mean proportions of each education group that are employed in the top panel, and mean proportions of the employed that are employed full-time in the bottom panel, holding constant the age composition of the relevant populations at average levels over the 1980–2011 period.

While differences in wage-setting institutions may help explain why the real earnings of the least educated males did not fall to any large extent in Australia during the 1980s, institutional differences are unlikely to have affected earnings of the more educated in Australia, particularly in the 1990s and beyond. The Accord was replaced with enterprise-level bargaining in the 1990s, and the Award system is currently little more than a support for earnings at the bottom of the earnings distribution. Real earnings among the least educated also stabilised in the US in the 1990s, and even increased up to the mid-2000s.

While both the US and Australia have experienced skill-biased technological change and growing manufactured goods competition from Asia, the countries differ with regards to their trade patterns. Australia is more heavily reliant on commodity exports. Production of such commodities, and the construction associated with mining expansion, has potentially fuelled some demand for less educated workers in Australia, underpinning earnings levels among these groups. More research is required, however, to fully understand the role of trade differences in influencing labour market outcomes in the US and Australia.

Coelli and Wilkins[23] argued that changes in the education qualifications conferred for specific studies (teaching and nursing in particular) have put some downward pressure on education earnings gaps in Australia, particularly for females. These credential changes, while important, cannot explain the stark difference between education earnings gap trends experienced in the US (large increases) and in Australia (stability/declines).

Conclusions

Earnings gaps by education category in Australia either remained stable or in some cases declined over the 1981–82 to 2011 period. This is in stark contrast to trends observed in the US, where the college–high school wage gap increased considerably since the early 1980s.

The most plausible explanation for these contrasting trends is divergent trends in the relative supply of educated workers in the two countries. The expansion in higher education occurred later in Australia than it did in the US, and it appears to have occurred precisely at the same time that skill-biased technological change increased the relative demand for skilled workers across the developed world. Differences in wage-setting institutions and in trade patterns may also have contributed to the divergent education earnings gap trends experienced in Australia and the US, but more work is required to establish the relative contributions of these potential explanations.

A more nuanced hypothesis regarding the impact of technology on labour markets gained in prominence over the past 10 to 15 years. This view is based on the observation that job growth has been polarised in many developed countries: growth in employment in the least and most skilled occupations and relative decline in middle skill occupations. Autor[24] provides a nice description of this view, which is based on certain routine tasks being increasingly undertaken using new technologies that require less labour input. Coelli and Borland[25] provide evidence on potential job polarisation in Australia (refer to Chapter 2.3). The link between job polarisation trends and trends in education earnings gaps is, however, yet to be established. More research in this area is thus required before a complete explanation for stability in education earnings gaps in Australia can be formed.

Endnotes

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4 Dustmann, C, Ludsteck, J & Schonberg, U 2009, Revisiting the German wage structure', *Quarterly Journal of Economics*, Vol 124, No 2, pp 809–842.

5 Coelli, M & Wilkins, R 2009, 'Credential changes and education earnings Premia in Australia', *Economic Record*, Vol 85, No 270, pp 239–259.

6 Ibid.

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8 Construction began by calculating separate mean log earnings measures for each education group within each five-year age group cell in each year. A weighted average log earnings measure for each education category in each year was then constructed using the average proportions of each age group within each education category over the entire 1981–82 to 2011 period used as weights. This estimation technique also ensures that earnings profiles over age within education categories are constructed with complete flexibility.

9 Note also that the income data provided in the Censuses are in income categories rather than a continuous measure. Mid-points in each category were employed during estimation, while for the highest income category, I followed the procedure in Coelli, M & Wilkins, R 2009, op cit.

10 For details of this increase in overall earnings inequality, see Coelli, M & Borland, J 2015, *Job polarisation and earnings inequality in Australia*, University of Melbourne, Department of Economics Working Paper No 1192.

11 Gregory noted these differential responses in employment rates across education categories in Australia over this earlier period: Gregory, R 1995, 'Higher education expansion and economic change', *Australian Bulletin of Labour*, Vol 21, No 4, pp 295–322.

12 Tinbergen, J 1974, *Substitution of graduate by other labor*, Kyklos 27, pp 217–226; Tinbergen, J 1975, *Income Difference: Recent Research*, North-Holland Publishing Company, Amsterdam.

13 Acemoglu, D & Autor, D 2011, op cit, p 1053.

14 Freeman, R 1976, *The Overeducated American*, Academic Press, New York.

15 Borland, J 1996, 'Education and the structure of earnings in Australia', *Economic Record*, Vol 72, No 219, pp 370–380; Borland, J 1999, 'Earnings inequality in Australia: changes, causes and consequences', *Economic Record*, Vol 75, No 229, pp 177–202.

16 Note that these labour supply figures cover the population of employed individuals aged 15 to 64, with part-time workers allocated half the weight of a full-time worker.

17 The 1980 measures for the US were constructed from the 1980 US Census five per cent micro-data sample. The 2011 measures were constructed using the American Community Survey (ACS) micro-data. These measures were constructed in the same manner as those in Figure 3.

18 For workers with other post-secondary education credentials, the relative supply in the US was 0.39 in 1980 (slightly lower than the figure in Australia of 0.46), rising to 0.92 in 2011 (again slightly lower than the Australian figure of 0.96).

19 For more details, see Acemoglu, D & Autor, D 2011, op cit.

20 For females, real wages among the least educated remained stable in both countries in the 1980s.

21 For evidence of the influence of minimum wage laws on the earnings distribution in the US over the 1980s, see DiNardo, J, Fortin, N & Lemieux, T 1996, 'Labor market institutions and the distribution of wages, 1973-1992: A semiparametric approach', *Econometrica*, Vol 64, No 5, pp 1001–1044.

22 Details of changes over time in real earnings across the earnings distribution are provided in Coelli, M & Borland, J 2015, op cit.

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SECTION

3.0

The future worker

3.1

Developing the capacity to adapt to industry transformation

Sue Beitz

Sue Beitz has over 15 years' experience in developing public policy across the fields of workplace relations, employment policy and education policy.

Sue was Head of Secretariat (2009–2014) at the Australian Workforce and Productivity Agency (formerly Skills Australia) providing advice to the Commonwealth Government on Australia's current and future skills needs. In this role, she led the development of two national workforce development strategies: *Australian Workforce Futures* (2010) and *Future Focus* (2013). These strategies modelled the long-term future skills needs for the Australian economy to 2025 and made recommendations to plan for changing industry need. Sue also led the development of industry reports that examined at the micro level the implications of factors such as demographics, technology and the rise of Asia.

Most recently, Sue co-authored a secretariat staff working paper on the topic of *Industry Transformation* for an Academy of Social Science in Australia (ASSA) publication. The research undertaken for ASSA has informed this chapter.

Sue has a degree in Psychology and Sociology from Flinders University and has graduate qualifications in Business Management from Monash University. She is currently working as an independent consultant.

Introduction

Technology has long influenced the way we live and work. Ever since the time of the industrial revolution, technological change has delivered productivity-enhancing machinery, new business processes and improved communication methods.

More recently, technology has reduced the costs for businesses to diversify their operations in different locations across the world enabling greater globalisation of production, capital and labour markets. Individuals too now use the internet to connect with others across the globe for new social, market and employment opportunities, and they can readily access limitless information to enhance their skills and knowledge.

As well as providing benefits, technology also disrupts. It often augments or replaces labour through automation, changing the way we work and rendering old skills and business approaches irrelevant.

History shows that overall we have managed to successfully adapt to technological change. While there have been large job losses in some occupations, particularly in lower skilled production and administration roles, the gains generated by productivity-enhancing technologies tended to create demand via higher incomes and lower prices. This has generated new jobs economy-wide.[1]

However, it remains to be seen whether the productivity dividend can be maintained in the future, especially as technology permeates almost all sectors of the economy and automates not only lower skilled jobs but also has the potential to replace higher skilled jobs and open those jobs to more global competition.

This chapter seeks to explore how government, industry and individuals can best develop their capacity to adapt to future technological changes in an increasingly global workplace.[2] Many of the consequences of technological change cannot be easily predicted. Nevertheless, they are expected to affect almost all aspects of our economic and social life, increasing the competition for work and jobs, expanding the resources available to businesses, creating new market opportunities, and bringing about challenges and risks.

Technological change has transformed the workplace

The digital revolution – including the rise of the personal computer, the ubiquity of mobile devices, computers embedded in everyday appliances, the commercialisation of the internet, and continued advances in information and communications technology (ICT) in the workplace and in society in general – has resulted in huge transformations in business, communications and the workplace.

The speed and global spread of technological change across business, government and individuals have largely been enabled by the rapid expansion of the internet.[3]

The number of internet users in the Organisation for Economic Co-operation and Development (OECD) countries increased from less than 60 per cent of adults in 2005 to about 80 per cent in 2013. Usage is highest for young people at around 95 per cent. Mobile broadband penetration rose to an average of 78.2 per cent in OECD countries. In Australia, mobile broadband subscriptions are above the 100 per cent penetration threshold.[4] In 2012–13, 77 per cent of enterprises in the OECD had a website or home page, 21 per cent sold products electronically and over 80 per cent of businesses used e-government services.

The technologies likely to have the biggest impact on work and workplaces over the next two decades have most likely already been developed.[5] However, forecasting just exactly how and when technology will be implemented, and the type of change it will deliver, can be an uncertain business. Increasing use of technology within workplaces will be affected by many factors, including:

- The relative cost of capital to labour;
- Alternatives such as outsourcing to lower cost locations;
- Consumer preferences; and
- The capability and capacity of Australian businesses to innovate and fully exploit the benefits of new technology.

Emerging technologies – driving change across the economy

McKinsey has identified several technologies that it sees as being the most influential in driving change for consumers and economies in the years to 2025.[6] Many of these technologies are already transforming existing activities across a range of industry sectors. The technologies have implications for the work people will do in the future. For example, the performance of 3D manufacturing is improving. The range of materials that can be used in 3D manufacturing is expanding and the prices (for both printers and materials) are declining. Using 3D manufacturing, an idea can go directly from a design file to a finished part or product, potentially skipping many traditional manufacturing steps. The capacity to produce on-demand means that sales and maintenance staff can use mobile 3D printers to make and replace parts in situ, thereby reducing the costs of warehousing and logistics. 3D printing also has the potential to expand into fields beyond traditional product manufacturing. For example, scientists have 'bio-printed' organs using an inkjet printing technique to layer human stem cells along with supporting scaffolding.[7]

Based on these changes, it is expected that software development and design skills will become a more dominant feature of manufacturing in the future.

Similarly, the 'Internet of Things' allows businesses and organisations across a range of industries to manage assets, optimise performance and create new business models. Automated identification technology uses embedded sensors and readers in machines and other physical objects to enable machine-to-machine connections to generate data that can be analysed and used for management and planning purposes.[8] The use of this technology can range from monitoring the flow of products through a factory, to measuring the moisture in a field of crops, to tracking the flow of water through utility pipes. It is also used to monitor the health of patients and the well-being of elderly people in their own homes, which helps address a major cause of rising healthcare costs.[9]

The data produced due to this technology has implications for skills needs in analytics, organisational skills, strategic management and business coordination.

Some technologies will allow businesses to change the way they engage the skills and capabilities they require. Cloud computing, for example, allows companies to rent and draw on technologies and associated skills that are pooled between firms. The high-level skills needed to design, install and maintain these systems (or other aspects of a company's work) may not need to be maintained within the organisation but instead

accessed on a temporary basis through contracting or outsourcing arrangements, and accessed by workers anywhere in the world.

The rapid pace of technological change will have implications for the ongoing professional development to ensure that qualified and experienced practitioners continue to adapt their skills. For example, the emergence of advanced robotics (i.e. increasingly capable robots or robotic tools) with enhanced 'senses', dexterity and intelligence means that robots can now do tasks once thought too delicate or uneconomical to automate. This includes robotic surgical systems that augment procedures to make them less invasive.[10]

When we consider that it takes around 10 to 12 years to develop the skills to become a surgeon, the benefits of this new technology will be best realised by upskilling those surgeons already working in the field so that they can start to incorporate robotic technology into their current practice.

An increasingly connected world

Global production

Global value chains, now a dominant feature of the world economy, allow for the diffusion of each stage of production (i.e. research, development, design, assembly, production of parts, marketing and branding of goods). Each stage can take place in a different part of the world and under different regulatory conditions, carried out wherever the necessary skills and materials are available at competitive cost and quality.[11]

The international flows of capital, information, products, skills and technology are important aspects of globalisation.[12] Having immediate access to information around the world and at lower cost has affected the rate of diffusion of technology and innovation.

The global labour market

The flow of skilled human capital is increasingly moving in multiple directions, with emerging economies such as China, India and Brazil beginning to compete for talent and provide the skills sought by organisations at a competitive cost.[13]

The liberalisation of trade and capital flows, and improvements in communications and transportation, mean that workers and employers are increasingly competing on a global market to sell the output of their labour.[14]

Global mobility will also play a significant role in hiring practices as employers look internationally to recruit talented workers.[15]

Crowdsourcing, which enlists the sporadic services of people either paid or unpaid via the internet, is becoming an important way of using global mobility to advantage. Australia has been at the forefront of this development.[16] The total revenue of crowdsourcing is estimated to have grown by 75 per cent to $376 million between 2010 and 2011.[17] The sectors using crowdsourcing are internet services (29 per cent), media and entertainment (20 per cent), and technology (18 per cent). The businesses are largely start-ups and small companies (60 per cent of total revenue). The total number of crowdsourcing workers doubled from 2010 to 2011 to 6.3 million. The majority of these workers were highly educated, predominantly male and living in North America.[18]

Some predict that future innovations in crowdsourcing arrangements are likely to lead to arrangements such as retainers for workers to remain on call and development of arrangements whereby top-performing workers manage and approve the work of other workers.[19] Other researchers take a much more pessimistic view whereby the bidding for workers becomes a 'reverse auction' where a large number of skilled workers make themselves available for jobs at the lowest cost.[20]

Building knowledge in the connected world

More people from across the world are connected to each other through mobile devices and can download apparently limitless information. This 'hyper-connectivity' allows access not only to the information facilitated by areas such as Google Books but also to the knowledge held by institutions and individuals shared through the web and available free.[21]

This will have a profound impact on the way people are educated, compete for work, and collaborate on innovations in the knowledge economy – even if they live in remote areas (assuming adequate infrastructure). It is expected that people will be attracted to cluster where they can work with people of similar or complementary skillsets.[22]

Jobs are changing

The impacts of technological change take time to appear, and they vary across industries and jobs. Some workers find their skills are complementary to new technologies while others find themselves out of work.

In Australia, the composition of economic activity has shifted from goods producing industries (as reflected in the decline of manufacturing) to the rise of person and knowledge-based service industries. Research by Wilkens and Wooden shows the importance of services industries over the last two decades in Australia has been dominated by just two sectors – professional, scientific and technical services, and healthcare and social assistance[23] – and that economic change has favoured jobs in the most skill-intensive occupations.[24]

The digital revolution so far has mainly created jobs for highly skilled workers in entirely new occupations and industries. 'Big Data' architects, information operating system developers, digital marketing specialists and data scientists are all jobs that barely existed five years ago. Furthermore, video and audio streaming, internet auctions and social networking services are all new industries that have emerged in response to recent technological developments. Most of the jobs in these occupations and industries share one common characteristic: they are more skill-intensive than the jobs they replace.[25]

However, the competitive aspect of technological change means that high-skilled workers cannot assume they are immune to its effects. As Reich has observed: "Never before have so many had access to so much so easily in 'The Age of The Terrific Deal' it is easy to find a better deal and switch instantly, meaning companies have to dramatically and continuously improve to innovate their market offer and take costs out of the business." In this environment, increased competition can and often equates to moving work to areas of lower wages.[26]

As well as looking for lower wage cost markets, firms are experimenting with new technologies and production processes. Experimentation with these techniques requires flexibility – one critical advantage of the human worker. Yet over time, as the practices are worked out and codified, it becomes easier to break production down into routine components.

Machines are becoming clever and they have access to far more data and the combination of smart machines and Big Data is expected to allow firms to do more with less and to displace professional jobs in legal services, medical diagnosis, financial analytics and media content.[27]

As co-founder of Atlassian, Scott Farquhar says:

> "Every company is becoming, or already is a software company. Even if they don't know it yet. We buy TVs online with Kogan. We bet online … we buy cars, property and insurance online … We can get a degree online now with Open Universities, and then go on to find a job with Seek. Each of these is disrupting billion dollar industries with software."[28]

The view that into the future more jobs across the economy will be affected by technology is supported by the research of Frey and Osborne. They find that 47 per cent of job categories will be open to automation within two decades. Those jobs with high levels of education and that require higher levels of creativity are harder to automate and therefore more likely to survive.[29]

Economist Tyler Cowen observes that rich economies seem to be bifurcating into a small group of workers with skills that are highly complementary with machine intelligence, for whom he has high hopes, and the rest for whom not so much.[30]

The necessary conditions to adapt to change

Productivity and employment growth into the future depend on the conditions for economy-wide diffusion of new products and processes. Policy settings need to focus on ensuring that our education systems support people to gain the skills needed for future industry demand and, in particular, support gaining higher level skills and specialised technical and creative skills and knowledge. It is also important that our infrastructure supports businesses, individuals and regions to harness technological change and global opportunities. Business conditions also need to support entrepreneurial activity, and a more technological and global business environment.

Investing for smart people

The areas of jobs growth require people with higher levels of skill and education. This trend has been evident for some time and is projected to continue into the future.[31] We adapt through learning. Adapting to a more technological world requires us to have the fundamentals of an excellent education system in which we ensure we keep pace with literacy and numeracy as well as ensuring that excellent science, technology, engineering and mathematics (STEM) skills best equip people to participate in the digital economy and build science and innovation in Australia.

For individuals to ensure their careers are resilient in a rapidly changing environment, they may need to treat their career as a business, taking on more responsibility for their own education and investing in skills and professional development to keep adapting their skills to match industry need.

Australia's education policy settings largely support individuals to gain the skills and qualifications for employment. The demand-based system enables people (who meet the prerequisite requirements) to enter a tertiary education course of their choice. While there is a cost to the individual through an income-contingent loan, the system does not prohibit people who come from a disadvantaged background from participating in education.

A potential weakness in the system is that the open market approach currently operating in the vocational education sector and proposed for the university sector allows more private education providers to offer courses using the Higher Education Loan Program (HELP). This has the potential benefit of increasing competition among providers and driving efficiencies in the education market. However, experience shows that in the absence of good information for consumers and proper regulation of the system, outcomes can be poor.

To operate effectively, consumers need to understand the obligations and implications of signing up for HELP loans. They should also be informed of the income earning potential in the jobs for which people train, and be informed about the employment outcomes achieved for students enrolled with each education provider.

Education and employment outcomes, quality and costs should also be monitored by government due to the large tax-payer investment in this expanded market. Poor outcomes and unscrupulous providers could lead to consumers being discouraged from investing in their education.

Greater demand for some specific types of skills

STEM skills

Data from the Australian Bureau of Statistics (ABS) point to the growing importance of STEM skills in the labour market. Between 2006 and 2011, the total number of people (both with and without higher level STEM qualifications) employed in the 10 most common STEM occupations grew 14 per cent. This was greater than the nine per cent growth across all other occupation groups.[32]

The number of people employed as design, engineering, science and transport professionals increased 23 per cent between 2006 and 2011. There was also strong growth among ICT professionals (19 per cent), and engineering, ICT and science technicians (19 per cent).

The importance of STEM skills and issues of maintaining students' engagement in STEM subjects have been well documented. An active learning approach can help improve engagement. According to ACER, a large part of the problem lies in showing students the need for, and applications of, STEM knowledge beyond the classroom.[33] Inclusion of hands-on, visible activities that place learning in real-world contexts are important for sparking an interest in STEM at secondary school level and in the retention of university students.

Digital skills

In its report into the future demand for ICT skills, the Australian Workforce and Productivity Agency noted that ICT skills and capabilities are important for all workers, not just those engaged in specialist ICT roles. It found that digital literacy needs to be included as a core component of school education, both in terms of content and delivery, as distinct from the teaching of specialised ICT, technology and computer science subjects. The teaching of digital literacy skills must continue into tertiary education and be a core component of ongoing workplace skills development.[34]

Analysis undertaken in the United Kingdom (UK) also supports a greater focus on digital skills in the curriculum. The UK Digital Skills Taskforce developed a framework for discussing the skills required as skills become more pervasive across the labour

market and society in general.[35] The framework was then used to analyse all of the 361 Standard Occupation Codes, which cover the entire 30 million people employed in the UK (refer to Table 1). The analysis – which shows that almost everyone in the workforce will in the future need the ability to use technology to do their job – led to the recommendation that digital literacy be a core component of the school curriculum, alongside English and maths.[36]

TABLE 1
DIGITAL SKILL LEVEL CATEGORIES

Skill level	Definition	Population
Digital muggle	"no digital skills required – digital technology may as well be magic."	2.2 million people (seven per cent of the workforce)
Digital citizen	"the ability to use digital technology purposefully and confidently to communicate, find information and purchase goods/services."	10.8 million people (37 per cent of the workforce)
Digital worker	"at the higher end, the ability to evaluate, configure and use complex digital systems. Elementary programming skills such as scripting are often required for these tasks."	13.6 million people (46 per cent of the workforce)
Digital maker	"skills sufficient to build digital technology (typically software development)."	2.9 million people (10 per cent of the workforce)

Source: UK Parliament Select Committee on Digital Skills – Report of Session 2014–15.

Changing demands from firms, consumers, students and communities means that apprenticeships, vocational qualifications and degrees need to deliver more general and also specific digital capabilities.

Creativity and entrepreneurial skills

Evidence to the UK Digital Skills Taskforce showed that more employers were looking for creativity alongside technical skills, and that successful digital companies now 'fuse' the technical and creative skills of their staff. One suggestion to the Taskforce was to expand the STEM package to include art (STEAM), or even art, entrepreneurship and design (STEAMED) to meet this change. This is in line with a recent study from Nesta that showed that creativity is important in a wide range of growth occupations.

Technology disrupts and creates new ways of learning

Technology challenges traditional methods of delivering education, meaning educational institutions and educators will have to adapt. New models of learning – such as increased online learning and employer-designed short courses – need to keep pace with evolving technology and digital change. Learners can also be expected to be much more self directed and operate outside formal education institutions to gain and share their knowledge in a more connected world.

Adults need more opportunities to learn throughout their lives to adjust to a world changing in ways as yet unknown. This means we need to equip our population with high-quality education and good critical skills as well as specific skills.

These skills must also match what business needs. Greater involvement of business working with education providers to invest to get the skills they want will assist this end. An example is the recent announcement by Cisco that it will invest up to $31 million in Australia in a bid to increase the pool of talent available with skills in STEM. The main pillar of this is a training program for 100,000 tertiary and school students in STEM-related areas. It will introduce subjects such as cybersecurity, cloud and the Internet of Things. [37]

Informal channels provide relevant, specific and timely skills development

Collaboration and communities of practice for timely professional development can be supported by technology. The recent live broadcasting of robotic surgery across the world is one illustration of the way in which the global community of robotic surgeons have been collaborating to share techniques, experiences and their results. The broadcasting of live surgeries will also help train the surgeons of the future.[38]

Better use of skills

Beyond getting the fundamentals right, bridging the gap between education systems and demands of the modern workplace is crucial to ensuring that we best use the skills of our workforce, and support the transition of students to employment and workers changing jobs.

Programs such as work-integrated learning enable students to engage with employers as part of their studies, and can help improve employment outcomes by ensuring that new entrants to the workforce are gaining skills and experience that are work relevant.

These arrangements have a secondary benefit of creating closer links between employers and education providers, which can inform the relevance and currency of the education curriculum.

Business conditions must support innovation and entrepreneurship

It is often the intermediate or enabling factors of innovation – such as collaboration, industry to research linkages, availability of capital and management capabilities – where there is room for improvement. [39]

Australian business conditions have generally been shown to support innovation, competitiveness and investment. *The Australian Innovation System Report*[40] shows that Australia's regulatory environment, research capacity and skills base provide a generally favourable framework for entrepreneurship and innovation. For example, the rates of business creation in Australia remain high by world standards, ranking between first and fifth depending on the measure used. Australia ranks second only to the United States (US) on the rate of innovation-driven entrepreneurship.[41]

However, the most commonly identified and ongoing barrier to innovation in Australia is a lack of access to funds (20.3 per cent of all businesses). Venture capital investment in particular remains low by OECD standards: Australia ranks 16th in the OECD for the number of venture capital deals relative to gross domestic product (GDP).[42]

Australia's superannuation savings pool is around $1.8 trillion and could potentially be used as a source of investing in venture capital. Naturally, each investment opportunity needs to be assessed on its merits, but more broadly, the Government could examine the laws and regulations around superannuation investment to ensure there are no unintended barriers to investment in venture capital.[43]

Management capability and challenges

The landscape of Australian business is predominantly characterised by small business. In the past this may have limited capacity to purchase and implement technology, but now the reduced cost and increased availability of technology – particularly digital technology along with the opportunities to collaborate – represent great opportunity for Australian businesses, including the potential to overcome the 'tyranny of distance'.

However, these changes require a cultural change in the way work is done and managed. In the past, much of the role of a senior manager was tied up in expertise and knowledge. Now that is becoming less important and instead it is the ability to locate knowledge, assess how valid it is and then put it to use in collaboration with other people that are becoming the key criteria. An increasingly global workplace is also likely to create some specific people-management challenges.

The new world of 24/7 working

In the future, flexible work arrangements such as teleworking, outsourcing, virtual teams, international placements and contracting, crowdsourcing and job sharing will be supported by technologies to make work, rather than workers, mobile.

There are benefits to enterprises, including access to an expanded pool of resources and talent, and reduced capital expenditure on physical resources and energy. However, this change is also likely to present management challenges, including developing new work practices to manage a global workforce and a huge variety of inputs. The 24/7 nature of work that will eventuate as workers in one location begin the work day just as those on the other side of the world are packing up for the day is likely to increase the intensity of work. Workers across the world still need to respond to each other's emails, meet and teleconference occasionally, which will lead to some work outside regular working times. Managing the resilience of the workforce, the diversity of the team and minimising conflict is looming as a major concern for senior managers.

The potential labour market disruption arising from the interaction of technological change and increasing global competition may be greater than anything we have seen in the past. It is critical that Australia has in place the necessary conditions to adapt to, and indeed embrace, these changes. Investment in education and skills development relevant to changing industry needs is a key to our continued adaptation. Failure to get the settings right means we risk falling behind.

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3.2

Closing the gender gap in labour supply

Professor Patricia Apps

Professor Patricia Apps is Professor of Public Economics, Faculty of Law, University of Sydney; Adjunct Professor, Australian National University and University of Technology, Sydney; Fellow of the Academy of Social Sciences in Australia; and Research Fellow of the Institute of Labor Economics, Germany. Her research covers a wide range of areas in public economics. She has undertaken extensive analysis of the effects of tax policy on household labour supply, saving and fertility decisions, and has been a major contributor to the new literature on the economics of the household. Her publications have appeared in leading international journals including the *American Economic Review* and *Journal of Political Economy*. She is joint author of *Public Economics and the Household*.[1]

Introduction

The Organisation for Economic Co-operation and Development (OECD) statistics for Australian labour force participation rates in 2012 report a female rate of 70.4 per cent and a male rate that is only 12.1 percentage points higher.[2] These figures conceal a far wider 'gender gap' in actual hours of labour supply – a gap that is in the order of 40 to 50 per cent during the prime-age working years – due to the high proportion of women in part-time work.

According to the Australian Government's *2015 Intergenerational Report*,[3] around 66 per cent of women aged 15 to 64 are currently employed and by 2054–55, female employment will increase to around 70 per cent. This projection can be interpreted to imply there will be little change over the next 30 years.

It is something of a puzzle that successive Intergenerational Reports focus almost exclusively on potential budget deficits with a rising Aged Dependency Ratio (ADR) – the ratio of people aged 65 and over to those aged 15 to 64 – with little consideration of the potential gains from a falling Child Dependency Ratio (CDR) – the ratio of those aged zero to 14 to those aged 15 to 64.

To assess the true effects of demographic change, the CDR and ADR need to be weighted by cost. It is straightforward to calculate that a child is, on average, far more costly than a retiree. Every child requires at least a decade of parental and public investment in her or his education. Most importantly, every preschool child requires full-time care. It is evident from time use data that a child is extremely costly in terms of parental time. Given these data, the decline in the CDR with the dramatic fall in the fertility rate since the 1960s[4] creates the potential for a significant 'social dividend'.[5]

The key challenge is to put in place a set of reforms that allows the reallocation of parental time, primarily female labour, from the home to the market. Under the required reforms, we would expect an increase in productivity and an expansion of the tax base that would provide additional revenue for productivity-improving investments in child care, education, healthcare and the economy's infrastructure.

This chapter draws on household survey data to support the argument that existing policy settings in two key areas – child care and taxation – have seriously inhibited the rate of growth in female labour supply.

First we begin with evidence drawn from time use and household expenditure survey data to give an indication of the strongly negative effects of a high-cost and inadequately developed child care system on female labour supply and household saving and, in turn, on the tax base and future revenues (refer to *Child care and the gender gap in labour supply*). This section also explains the key role of a high-quality public child care and education system in achieving both a reallocation of female labour from the home to the market, and improved child outcomes.

Next we turn to the ongoing tax policy agenda of shifting a larger share of the burden towards working mothers and average wage families (refer to *'Quasi-joint' taxation*). This section begins with the family tax reforms of the Howard Government that transformed the personal income tax and family payment system into one of 'quasi-joint' taxation with many partnered mothers facing effective marginal rates well above the top rate on personal income.

We then highlight the billions of dollars of tax cuts directed towards the top percentiles of income as the cause not only of the current budget deficit but also of the mistaken perception that a far higher level of public investment in child care and education is too costly (refer to *Tax cuts for the top with rising inequality* and *Capital taxation and the GST*).

Child care and the gender gap in labour supply

The gender gap in market labour supply begins, as we would expect, with the arrival of the first child. That event creates an additional work choice. One parent, typically the mother on a lower wage, can work at home providing child care and domestic services as an alternative to working in the market and buying in care and related services. The choice will depend critically on the availability of child care at an affordable price and acceptable quality, and on the net-of-tax gender wage gap.

The impact of child care on female labour supply is evident from the time use decisions families make over a life cycle defined not on the age of 'head of household', as in the economics literature,[6] but on the presence of dependent children and age of the youngest child.

Figures 1 and 2 plot data means for male and female time allocations to market work, domestic work and child care in each of the following five life cycle family phases[7]:

1. Pre-children;
2. At least one child of preschool age is present;
3. Children are of school age or older but still dependent;
4. Parents are of working age but with no dependent children in the household; and
5. Retirement.

The time use profiles reveal the strong substitution of child care at home for market work in phase two. They also reveal the long hours of child care in this phase. When time spent on domestic work and child care is added to market hours, we find that total hours of work are far higher, and therefore hours of leisure far lower, in the preschool phase than in any other phase.

The profiles in Figures 1 and 2 are based on averages and therefore conceal the high degree of heterogeneity in female labour supply across phases two to four. According to data for couples selected from the Australian Bureau of Statistics (ABS) 2009-10 Household Expenditure Survey, in phase one, both partners typically work full-time for close to the same wage rates. Across the child-rearing phases, full-time and part-time female employment rates drop to 26 per cent and 40 per cent, respectively.[8] The remaining third are non-participants.

In the pre-retirement phase, 30 per cent are non-participants and 35 per cent are working part-time. These figures reflect both the high degree of heterogeneity in female labour supply and the persistence of decisions made during the early child-rearing years, which the literature attributes to loss of human capital.[9] When viewed from a life cycle perspective, we would expect the resulting loss in gross domestic product (GDP) to be well above the relatively low estimates frequently cited.

FIGURE 1
LIFE CYCLE LABOUR SUPPLY

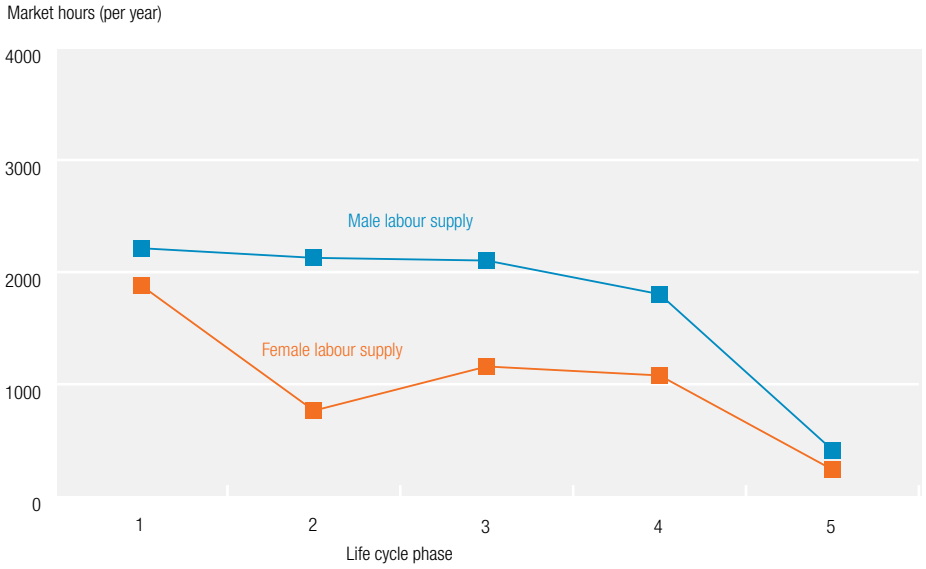
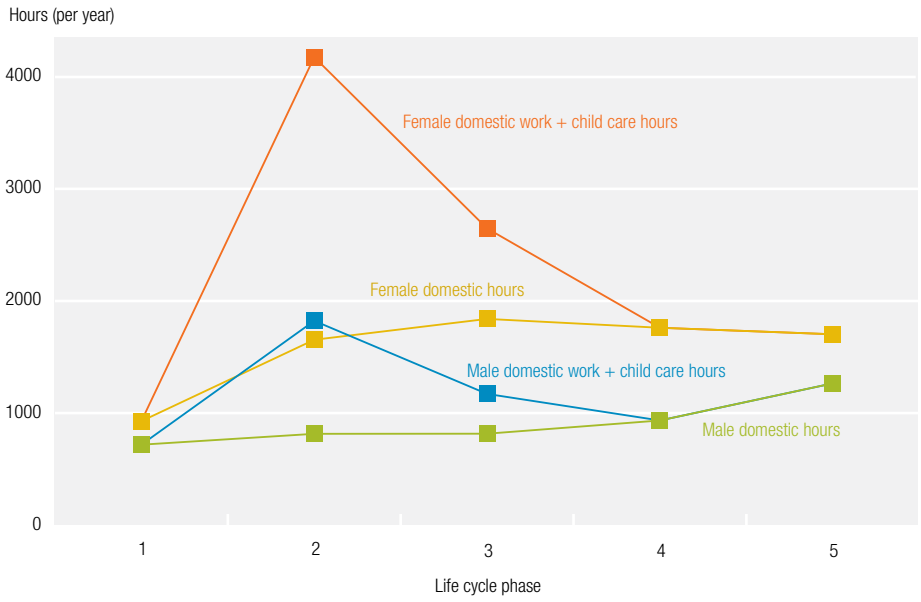


FIGURE 2
LIFE CYCLE DOMESTIC WORK AND CHILD CARE



Further losses become evident when we consider the impact of female labour supply choices on household private income and, in turn, on saving. When household expenditure survey data are organised according to the five phases in Figures 1 and 2, we find that saving tracks household income, which tracks female labour supply.

Table 1 reports life cycle profiles of median household income,[10] saving and female earnings based on data for a sample of couples selected from the 2009–10 Household Expenditure Survey on the criteria that the male partner is aged 25 years or older and neither partner reports negative incomes.[11] Saving, calculated as the difference between disposable income and consumption expenditure, is at its highest level in phase one and falls to its lowest level in phase two. While saving begins to rise in phase three, it never returns to its phase one level.

TABLE 1
HOUSEHOLD INCOME, SAVING AND FEMALE EARNINGS (2009–10 HES)

Phase	Household income ($)	Saving ($)	Female earnings ($)
1	116,141	19,760	47,502
2	83,824	5824	6240
3	110,244	9776	30,212
4	94,744	14,040	26,208
5	6980	1404	0

When we rank couples by quintiles of 'primary income', defined as the private income[12] of the partner with the higher earnings (typically the male), we find that household saving also strongly tracks second earner labour supply within each quintile. This becomes evident when we split the sample of households in phases two to four into two types according to median second hours within each quintile. Table 2 reports quintile data means of second earnings by type, with those below the median labelled type H1 and those at or above the median, type H2.[13] The table also reports quintile regression estimates of household saving that control for the number and age of children.

The results show the strong positive relationship between saving and second earnings across the entire distribution of primary income. The aggregate level of saving across quintiles two to four by H2 households exceeds that of the top quintile of H1 households.

TABLE 2
SECOND EARNINGS AND SAVING BY PRIMARY INCOME, PHASES 2 TO 4 (2009–10 HES)

Primary income quintiles		34,265	54,701	71,982	96,648	201,855
H1:	2nd earnings ($ per year)	330	9745	9494	16,794	12,835
	Saving ($ per year)	–8227	331	4095	14,268	54,642
H2:	2nd earnings ($ per year)	24,425	37,410	43,001	60,451	67,281
	Saving ($ per year)	297	9075	16,167	30,634	76,973

These data provide compelling evidence that a costly child care system for parents, together with high effective tax rates on partnered mothers as second earners, limits productivity and GDP growth due not only to negative effects on labour supply and human capital, but also to limiting the saving capacity of many low and average wage families.

The life cycle profiles provide in addition strong evidence of a capital market that is far from perfect, in the textbook sense of allowing all households to lend or borrow as much as they want[14] at the same market interest rate, and in doing so to smooth their consumption level over their entire life cycle. Instead of using the capital market to smooth consumption, many parents are cutting back on consumption and leisure in the early child-rearing years.

In Apps and Rees[15] we show that their choices are consistent with a capital market in which borrowing rates are above lending rates, with the difference negatively correlated with the level of collateral parents can provide. We also find that many families are borrowing short term at high interest rates to finance consumption while employers are making mandatory contributions to their superannuation fund.

These imperfections in capital markets apply with particular force to investment in child care because the costs occur at a stage in the life cycle when family resources are relatively low. Therefore we argue that a precondition for enabling the transfer of labour supply from household to market that has been made possible by the decline in fertility is a major state-funded expansion in full-day preschool and child care facilities. The proposal of the Productivity Commission[16] to rely on fine-tuning income-related subsidies for a largely privatised system, averaging an estimated annual cost of less than $8 billion over the next four years, will inevitably fail. With prices driven by rising property values and rent seeking, an increasing proportion of parents will have insufficient collateral to borrow at an affordable interest rate during the preschool years. The solution lies in the incremental expansion of the public education system to include the preschool years as proposed, but not implemented, by the previous Labor Government. Without a change in direction, the constraints placed on female labour supply by inadequate child care availability will transform opportunity into crisis.

'Quasi-joint' taxation

Recent decades have seen a major transformation of Australia's family tax system. In the early 1980s, families received universal child payments and were taxed under a highly progressive individual-based income tax. During the Howard Government years, universal child allowances were completely replaced with payments withdrawn on joint income, and the rate scale of the Personal Income Tax (PIT) became far less progressive.[17] We now have a system of 'quasi-joint' family taxation, with the highest marginal tax rates applying across average incomes and to the income of the second earner, creating a net-of-tax gender wage gap that makes the continuing gender gap in pre-tax pay look insignificant.[18]

With these reforms we lost the well-established efficiency merits of a progressive individual-based income tax.[19] Individual taxation is recognised as superior to joint taxation because the partner with the lower earnings and higher labour supply elasticity, typically the female, faces a lower marginal tax rate under a progressive rate scale. This is consistent with the Ramsey rule for efficiency.[20] Given that male labour supply is found to be relatively unresponsive to a change in the net wage, a strongly progressive rate scale, together with universal family payments, minimises the gender gap in labour supply for a given degree of redistribution or revenue constraint.

Under a conventional joint income tax, the second partner contemplating going out to work faces, on the first dollar earned, the marginal tax rate on the last dollar earned by the primary earner. This conflicts with the Ramsey rule. A system of quasi-joint taxation tends towards the same effect, but more erratically. For example, under the current Family Tax Benefit Part A (FTB-A) system, Medicare Levy and PIT rate scale, a second earner with an income of $40,000 in a family with two dependent children and a primary income of $65,000 faces a marginal tax rate of 66 cents in the dollar, a rate significantly above the top rate of 49 cents. Not even under a conventional system of joint taxation does the second earner face this kind of tax penalty.

As well as providing inefficiently high disincentives to second earner labour supply, this quasi-joint taxation is also unfair. As is well known, under a system of income aggregation or income splitting, the amount of tax paid by couples with the same total income is the same, regardless how much is earned by each partner. A high wage single-earner household therefore pays the same amount in tax as one containing two lower wage earners working longer hours for the same total income and, with a child in the preschool years, buying in child care and related services out of their post-tax income. For horizontal equity we require a system that imposes a lower tax burden on two-earner households working longer hours to earn a given joint income. This outcome is achieved under a progressive individual-based income tax, and the more progressive the rate scale, the higher the degree of horizontal as well as vertical equity.

The argument for income testing is typically based on purported cost and revenue savings from reducing 'middle class welfare'. The view reflects a profound ignorance of modern public finance. As in most OECD countries, Australia has a piecewise linear income tax. A key lesson from modern tax theory is that under such a system, the tax an individual pays is set by two parameters: a marginal rate and a lump sum. A universal cash transfer is a component of the lump sum. Any tax system that gives a transfer and then withdraws it at so many cents in the dollar as income rises is equivalent to one with the same universal payment and a new structure of marginal tax rates and lump sums.

It is not the 'universality' of the payment, but the value of the payment and the structure of marginal tax rates that is the relevant basis for evaluating the cost of a tax system. What matters is the way in which a particular tax structure trades off fairness of the distribution of tax burdens against deadweight welfare losses arising from its effects on work incentives due to a change in the net wage.[21] A trade-off of this kind was clearly not a consideration in the design of the Howard Government's family tax reforms.

Tax cuts for the top with rising inequality

While the shift to a less progressive PIT also began in the 1980s, the major changes were introduced during the second term of the Howard Government. The reforms provided large cuts in taxes for those in the top percentiles of the distribution of income and shifted the overall tax burden towards the middle percentiles and to working partnered mothers.

From 2004–05 to 2008–09 alone, the top bracket limit rose from $70,000 to $180,000 and the top marginal rate fell another two percentage points, concentrating billions of dollars of tax cuts in the upper percentiles of the income distribution. Those in the middle of the distribution gained little to nothing, an outcome achieved by combining tax cuts at the top with the Low Income Tax Offset (LITO). The LITO raised the zero-rated threshold for those on very low incomes while denying gains for the middle by raising rates further along the distribution through its withdrawal rate of four cents in the dollar.[22]

This direction of tax reform is difficult to understand in the light of the evidence of increasing inequality over this period. During the short interval between the two most recent ABS Household Expenditure Surveys, 2003–04 and 2009–10, we find a significant increase in inequality, based on the nominal change in the distribution of primary incomes of couples over the six-year period. The analysis here draws on data for

FIGURE 3
RISING INEQUALITY

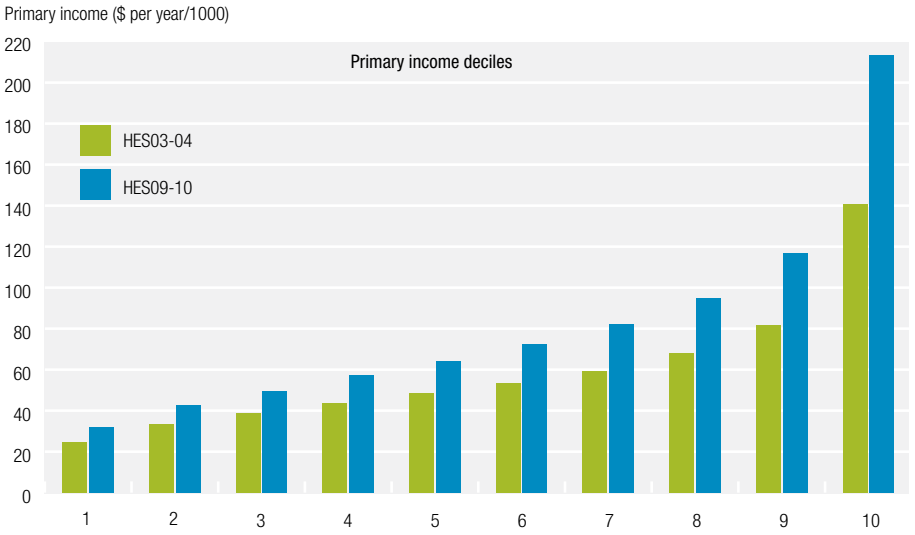
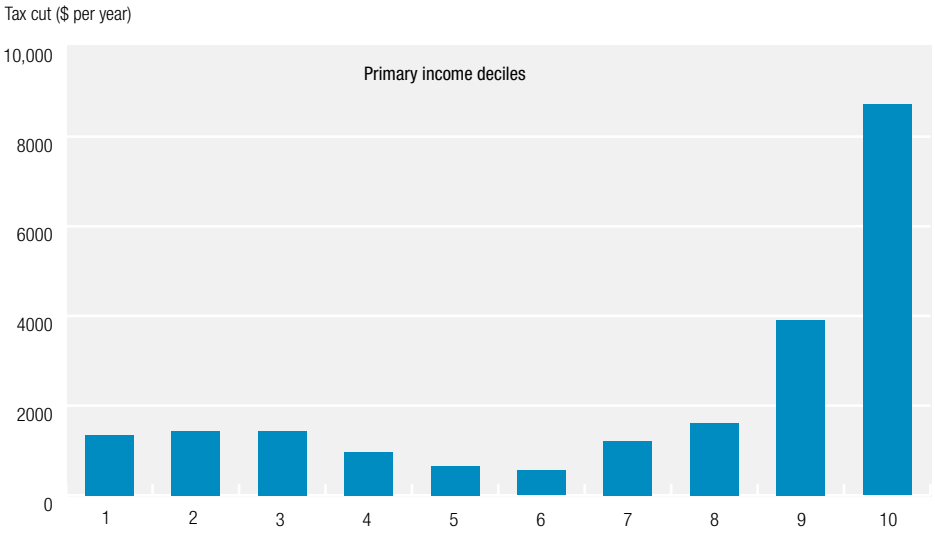


FIGURE 4
SHIFT IN TAX BURDEN TOWARDS THE 'MIDDLE'



samples of couples selected from each survey on the criteria that both partners are aged from 20 to 60 years and the primary income partner is employed for at least 25 hours per week.[23] The rise in inequality over the period can be observed in Figure 3.

In decile one, there is a 28.6 per cent increase in nominal primary income. This is followed by small increments up to decile five, in which the rise is 32.7 per cent. The percentage gains are slightly larger in the next three deciles. However, thereafter the gains rise more steeply and quite dramatically towards the top percentile. In decile nine, the nominal increase is 42.37 per cent and in decile 10, 52.17 per cent. The nominal rise in the top percentile is 71.02 per cent.

Figure 3 plots the decile distribution of nominal tax cuts over the period. The profile reflects the concentration of billions of dollars of tax cuts in the top percentiles and the shift in the tax burden towards the middle. The lowest gains appear in decile six, at less than $600. In decile 10, the gain is around $9000 (40 per cent of total) and in the top percentile, close to $50,000.

While income taxes fell over the period, it is important to note that the GST brought with it a tax mix change from income to consumption, and therefore many in the 'middle' are likely to have lost. Full compensation for a shift towards consumption taxation requires a more progressive rate scale across the entire distribution of income, which clearly did not happen.

Support for lower tax rates on top incomes is usually based on the claim that there are efficiency gains from reduced labour supply disincentive effects. However, it is difficult to support this view because neither cross-section nor panel data show a sufficiently large increase in top earners' labour supply with rising top wage rates.[24]

In response to this difficulty, Brewer et al.,[25] estimate *earnings* elasticities based on data for the Thatcher years of tax cuts and CEO pay rises. The authors attribute their strongly positive estimates of earnings elasticities in the top percentiles to a greater input of "unobservable effort", which they claim is responsive to marginal tax rates. Since during this period there was a large-scale process of deregulation of financial markets, there is a major statistical problem in identifying the growth of top earnings as being due to a large increase in unobservable effort.

More recently, Piketty, Saez and Stantcheva[26] argue that a fall in earnings or taxable income in response to a higher tax rate is largely a reflection of an increase in tax avoidance and evasion as income is underreported or diverted to forms that are subject to lower tax rates, or to weakened bargaining power and consequently a lower share of rents, for example of senior executives in diverting rents from company shareholders to themselves. The authors recommend that tax avoidance and evasion be dealt with directly and not through the tax scale. Based on low estimates of labour supply elasticities at the top, they propose a higher top tax rate in response to rising inequality, a recommendation that is consistent with the results for the structure of optimal tax rates reported in Andrienko, Apps and Rees.[27]

Capital taxation and the GST

In addition to the billions of dollars of tax cuts for top incomes under the Howard Government's income tax reforms, Australia's defined contribution superannuation system, with employer contributions and entity earnings taxed at 15 per cent, has also directed billions of dollars towards the top percentiles of income.

According to modern public economic theory, the key objective of a retirement incomes policy is the provision of insurance against longevity and aggregate (or social) risk. A defined contribution superannuation system fails on both counts. The system is essentially a tax advantaged saving scheme that provides the greatest gains for those with the most income to save. Given the gender gap in both pay and labour supply, women as a group cannot gain from tax advantaged superannuation. Overall, the system widens the net-of-tax gender pay gap.

As the limitations of the system become increasingly recognised, we can observe a shift in the argument used to support much of its preferential tax treatment. Recent Budget estimates of the tax expenditure on superannuation concessions have exceeded $30 billion based on the comprehensive income tax benchmark. This figure is rejected by those who argue that the calculation should take account of opportunities for tax avoidance, for example through the use of trusts and negative gearing, to give a more reliable estimate in the order of $25 billion. As a standalone criticism, one might ask why reducing opportunities for tax avoidance has not become more central in the tax reform debate.

More fundamentally, the *Retirement Income Consultation Paper* for the Henry Review[28] goes further in critiquing the estimate. The paper argues for an expenditure tax benchmark on the basis of the proposition that the ideal tax system is one that exempts capital income. Under this approach, the estimate of the tax expenditure falls dramatically. The view that, for efficiency, capital income should not be taxed underpins the ongoing support for a shift away from a progressive individual-based income tax towards taxing consumption, implying an increase in the rate and/or base of the GST, a regressive reform that would impact relatively lightly on those in the top percentiles engaged in tax avoidance.

The proposition that the optimal tax rate on capital is zero contradicts the central tenet of modern tax theory, that the optimal tax rate on a given source of income, whether labour or capital, can only be determined on the basis of empirical evidence on distributional outcomes and behavioural effects because we are in a 'second-best' setting. Even if capital were highly mobile, which is very much open to question in a number of important contexts, this does not imply an optimal rate of zero.

There is a further fallacy. As explained in the Henry Review, capital income is tax exempt under a consumption tax and under a labour earnings tax. The two are said to be equivalent. This view reflects very poor powers of observation. With the increase in female workforce participation over the last half century, the majority of prime working-age adults live in couple households with two earners. With information on earnings we can have an individual-based tax that is not only progressive but applies a lower rate to the earnings of the partner with a lower income, typically the female on a lower wage, as required for both equity and efficiency. In contrast, we cannot observe individual consumptions (or saving) in two-person households. A consumption tax is inevitably limited to a flat rate tax on joint consumption and therefore cannot be superior to a well-designed labour income tax.

The evidence on wage elasticities suggests that female labour is the most mobile factor of production. Expanding the GST will, as a regressive tax, not only add to the already excessively high tax rates faced by partnered mothers under the FTB-A system, but the provision of targeted compensation for those on low incomes will exacerbate the problem. Effective tax rates on partnered mothers as second earners need to be lowered, not raised by an expanded GST.[29] If the ongoing policy agenda of directing billions of dollars of tax cuts towards the top percentiles of income were reversed, the current budget deficit would quickly disappear.

Concluding comment

This chapter has argued that the focus on the growing ADR and the implied consequences for future tax and expenditure policy in successive Intergenerational Reports is misdirected. The fall in the fertility rate, and therefore in family size, that is the main cause of the growth in the ADR provides the opportunity for significant productivity gains from a reallocation of resources, primarily female labour, from the home to the market that would raise aggregate income and the tax base, and allow a significant growth in public expenditure without incurring budget deficits.

The discussion focused on two policy failures that inhibit the rate of growth in female labour supply:

1. The failure to invest in a learning-focused public child care and preschool system that is affordable for successive generations of parents and that they regard an acceptable quality; and
2. The deliberate construction of a quasi-joint family tax system that is not only unfair in the way that it has redistributed the burden of taxation from the top to the middle of the income distribution, but is also inefficient in the high marginal tax rates it imposes on mothers who want to work.

We emphasise that an expansion of the GST and the abolition of taxes on capital income would simply reinforce the latter policy failure. A more progressive income tax system that offers fewer opportunities for avoidance and evasion and is strictly based on individual incomes would help fund a much improved child care system in the short run, and promote saving, investment and growth in the longer term, as well as restoring some degree of fairness to the income distribution in an age of increasing inequality.

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Endnotes

1 Apps, P & Rees, R 2009, *Public economics and the household*, Cambridge University Press, United Kingdom.

2 OECD 2014, A*chieving stronger growth by promoting a more gender balanced economy*, Report prepared for the G20 Labour and Employment Ministerial Meeting, 10–11 September, Melbourne.

3 Commonwealth of Australia 2015, *2015 Intergenerational Report – Australia in 2055*, March, Canberra.

4 The total fertility rate of around 3.5 in 1961 has fallen by almost 50 per cent and, according to IGR15, will stabilise at around 1.9 up to 2055. Note that the IGR15's projections imply a 2055 total dependency ratio (the ratio of those aged 0–14 and 65+ to those aged 15–64) that will be close to that of the early 1960s.

5 There is also a social dividend from the increase in longevity. The gains from parental and public investments in child care and education last longer.

6 Life cycle models defined on the age of 'head' result in a misreading of the data. For a survey of the literature, see Attanasio, O & Weber, G 2010, 'Consumption and saving: models of intertemporal allocation and their implications for public policy', *Journal of Economic Literature*, 48, pp 693–751.

The studies find that male and female labour supplies and household consumption initially rise together with age and then fall towards retirement. The approach misses the large fall in female supply that takes place after the arrival of the first child because consumption and labour supplies are averaged across couples over what we call here phases 1 and 2. For a detailed analysis see Apps, P & Rees, R 2009, op cit, chapter 5; Apps, P & Rees, R 2010, 'Family labor supply, taxation and saving in an imperfect capital market', *Review of Economics of the Household*, 8, pp 297–323, accessible at: *www.springerlink.com/openurl.asp?genre=article&id=doi:10.1007/s11150-010-9094-1*.

7 The analysis draws on data from the ABS 2005–06 Time Use Survey. For further details, see Apps, P 2010, 'Why the Henry Review fails on family tax reform', in Evans, C, Krever, R & Mellor, P (eds), *Australia's future tax system: the prospects after Henry*, Thomson Reuters Australia, pp 103–127.

8 The figures are based on data for a sample of couples selected from the 2009–10 HES on the criteria that both partners are aged from 25 to 59 years. For further details, see Apps, P & Rees, R 2013, 'Raise top tax rates, not the GST', *Australian Tax Forum,* 28, pp 679–693.

9 See, for example, Shaw, K 1994, 'The persistence of female labor supply: empirical evidence and implications', *Journal of Human Resources*, 29, pp 348–378.

10 The household income variable is private income from wages, investments, etc. Government benefits, including pensions, are excluded. These variables tend to be less well matched in phase 5 due to differences in source of income for funding retirement. For the definition of private income, see ABS 2011, Household Expenditure Survey and Survey of Income and Housing, User Guide, Australia, 2009–10, ABS Cat No 6503.0.

11 The sample contains 4830 records.

12 We use the data for total current weekly income from all sources, excluding government pensions and allowances, for each person record.

13 We find that both types have close to the same predicted second wage within each quintile and therefore conclude that the high degree of heterogeneity at a given primary income is not driven by the second wage.

14 Subject of course to being able to repay the amounts borrowed out of future income.

15 Apps, P & Rees, R 2010, op cit.

16 Productivity Commission 2015, *Childcare and early childhood learning*, Canberra.

17 For a detailed analysis of the rate structure of the system and critique of the recommendations of the Henry Review (Australia's Future Tax System Review Panel, 2009) that would consolidate the system, see Apps 2010, op cit.

18 The first step towards joint income tested child payments was the introduction of the 'Family Income Supplement' during the Hawke and Keating years. Family cash benefits under this reform were initially paid together with universal family allowances which were no longer indexed. In 2000, the Howard Government combined the two payments in Family Tax Benefit Part A and in subsequent budgets completely eliminated universality.

19 See, for example, Boskin, M & Sheshinski, E 1983, 'Optimal tax treatment of the family: married couples', *Journal of Public Economics*, 20, pp 281–297. For a survey, see Apps, P & Rees, R 2009, op cit.

20 This says that the tax imposed on a source of labour should be smaller, the larger the (compensated) labour supply effect, an effect that is found to be significantly higher for women than for men.

21 There is also the misconception that a system of universal benefits creates higher administration costs of the tax system, as if the uniform payment is physically made to everyone and then the withdrawn portions have to be physically returned to the tax authority. If the uniform payment and withdrawal rates are incorporated into the tax system, no such costs arise.

22 The LITO has served the sole purpose of reducing the transparency of the true rate scale. The scale is no longer strictly progressive.

23 Records reporting negative incomes are also excluded. The HES 2003–04 sample contains 2447 couple income unit records and the HES 2009–10 sample, 2408 records. For the details of the study, see Apps, P & Rees, R 2013, op cit.

24 See, for example, the profiles of earnings and hours of work based on the ABS HES data samples of couples in Apps and Rees (2013, Table 2.6). Studies for other countries report similar findings. See for example, Moffitt, R & Wilhelm, MO 2000, 'Taxation and the labor supply decisions of the affluent', in Slemrod, J (ed), Does Atlas shrug? *The economic consequences of taxing the rich*, Russell Sage Foundation, New York; Harvard University Press, Cambridge and London, pp 193–234. For further discussion, see Saez, E, Slemrod, J & Giertz, S 2012, 'The elasticity of taxable income with respect to marginal tax rates: a critical review', *Journal of Economic Literature*, 50(1), pp 3–50.

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3.3

Your future employer – yourself

Ken Phillips

Ken Phillips is co-founder and Executive Director of Independent Contractors of Australia (ICA).[1] Ken has been a small business operator and consultant for more than 30 years, and for more than 20 years, he has operated as an independent contractor conducting research, commentary and advocacy on small business issues, in particular, regulatory reform and workplace management.

Ken is a published authority on independent contractor issues and directs research on related commercial and competition issues. He has been a contributor to several books on economic and management issues, and he wrote *Independence and the Death of Employment*.[2] Ken was ICA's representative at the 2003 and 2006 International Labour Organisation (ILO) debate on the 'Scope of Employment Relationship'. The ILO outcomes formed the conceptual basis for Australia's *Independent Contractors Act*.

In partnership with the Canadian-based Frontier Centre for Public Policy, Ken conceived and developed the *Entrepreneurial Index*.[3] Launched in late 2013, the Index measures and compares across jurisdictions the extent to which regulations affect the ability of individuals to be self-employed and hence entrepreneurial.

Introduction

More and more, self-employment is becoming the way of doing business. Look at the challenge to the taxi industry occurring because of the ride-sharing systems of Uber, Lyft and others. The ride-sharing business model is not just the result of a technological application. The business model is structured around their driver workforces being entirely self-employed independent contractors.

The Uber/Lyft development is just one example of exciting but also challenging times. What's happening globally is that technological change combined with attitudinal shifts in the worker–boss relationship are resulting in new business models that are competing with the traditional command-and-control employment pyramid structures of firms.

Seen through one prism, command-and-control firms were in large part products of military-style organisational thinking born of persistent war environments of the first half of the 20th century. Such organisational thinking at the firm level, combined with free-market macroeconomics, produced spectacular economic results post-World War II. Yet it can be argued that the command-and-control firm has reached the limits of its productivity-delivering capacity.

Self-employment can be seen as a 'rising-star', not just because of increasing numbers of self-employed people. It's more because self-employed individuals are at the cutting-edge of cultural and attitudinal change in global workforces. The supremacy of the organisation is fading and being replaced with the authority of the individual. It's a confronting idea particularly for corporations, government organisations and macro-policymakers.

However, this chapter is not primarily intended to argue or defend this assertion. Rather, the chapter looks at the statistics, profiling and trends apparent in the world of self-employment. For example, across Europe, the number of professional self-employed independent contractors has risen 45 per cent since 2004 – a statistic that should cause interest in the sector. This chapter aims to bring some facts to an investigation and discussion of self-employment that so far is cursory and has barely started to stir.

Statistics and trends

Australia

The Australian Bureau of Statistics (ABS) identifies self-employed people as those people working for themselves, that is, they are not employees. This is about 18 per cent of the Australian workforce. Surprisingly perhaps, given the public impression that self-employment is rising, this figure is down on the numbers of self-employed in 1998, which stood at more than 20 per cent of the workforce.

What has occurred, however, is an increase in the number of independent contractors, defined by the ABS as self-employed people who do not employ others, that is, sole traders. These people are often referred to as micro-businesses, freelancers, contract workers and other terms. The numbers in this group rose from 6.7 per cent of the workforce in 1978 to approaching nine per cent in 2013, after peaking at 10 per cent in 2010.[4] The number of self-employed people who are employers was down from 11.8 per cent in 1998 to 8.7 per cent in 2013.

When looked at in the broader context of the total workforce, the picture portrays an Australian economy dominated by the small business sector, with the structure in Table 1.

TABLE 1
BREAKDOWN OF THE AUSTRALIAN SMALL BUSINESS SECTOR

	Million people
Self-employed independent contractors (non-employers)	0.9
Self-employed employers	1.0
– Employees working for self-employed employers (1–5 employees)	3.3
– Employees working for self-employed employers (6–20 employees)	1.9
Total workers in small businesses	7.1
– Workers in large businesses	2.6
– Workers in public sector	1.8
Total workforce (2010)	**11.5**

Specifically, what can be seen is the importance of the self-employed employers because, even though their numbers are down on a few years ago, they still do the heavy hauling when it comes to employing others. This group consists of people operating the (easily understood) notion of 'small business', for example, retailers, tradespeople, small manufacturers and those in the hospitality sector.

A recent review of the Australian Taxation Office treatment of self-employed people gave some further illuminating statistics on the small business make-up. The Board of Taxation identifies that:

- 97.5 per cent of businesses (around 2.7 million) have a turnover of $2 million or less; and
- Only 72,000 businesses have a turnover between $2 million and $5 million.

Of all small businesses:

- 36 per cent are sole traders;
- 13 per cent are partnerships;
- 23 per cent are trusts; and
- 28 per cent are companies.

In addition:

- 61 per cent of small businesses are non-employing;
- 28 per cent employ between one and four employees; and
- 10 per cent have between five and 19 employees.[5]

The Board of Taxation says:

> "The profile of Australian workers is also evolving more generally, with more 'white-collar' workers adopting forms of contracting and self-employment in many sectors such as management consultancy and financial services. Closely connected to the proliferation of contractors is the growth in the provision of personal services.
>
> "… employment structures and work patterns evolve over time (with contracting and other forms of self-employment becoming increasingly widespread in the Australian workforce)…"[6]

The trend identified by the Board of Taxation and highlighted in the ABS figures is something that's emerging globally, at least in developed economies.

World overview

According to a Kelly Services report[7], 20 per cent of the workforce is self-employed across 29 countries in Europe, North America and Asia/Pacific. Furthermore, an additional 50 per cent of employees indicated they would like to be self-employed. This shows that the desire to be self-employed is higher than the actual incidence.

This perhaps may partly explain why there's a growing interest in policy and public debate about self-employment. Looking at the Australian data, the percentage of self-employed is not actually substantially larger than, say, 20 years ago and I suspect, although can't be sure, that this is the global situation. What has happened perhaps is a shift in attitudes among employees somewhat against employment with self-employment increasingly seen as an aspirational goal. That is, self-employment has become a 'desire' as much as it is a reality.

But still the Australian shift in self-employment, at least, from being employers to being independent contractors (non-employers) is important. Further, the evidence is overwhelming that independent contracting is heavily dominated by white-collar, high-paid, professionals. This destroys the long-held belief (almost myth) that independent contracting is located in low-paid, blue-collar jobs.

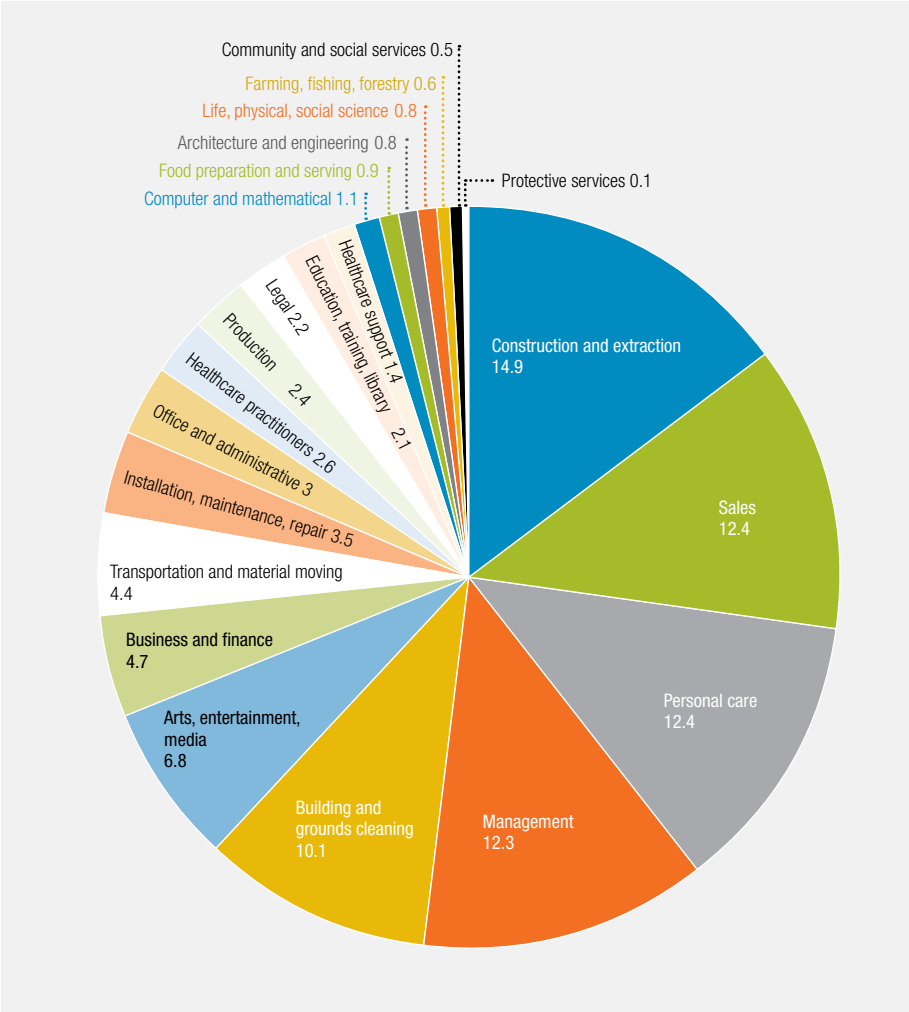
Put these two factors together and where independent contracting has become significant is in the high-end servicing of, quite often, large firms and government departments. These days there's probably not a multinational business across the globe that doesn't have a significant dependence on independent contractors in vital areas of the business. The 'norm' has rapidly become firms with blended workforces of employees and independent contractors. This is most apparent in the United States (US).

United States

In the US, much of the commentary in this area refers to 'freelancers' – defined as people who work for themselves and don't employ anyone. As mentioned earlier, in Australia we use the term 'independent contractor' for this group. The US figures can vary substantially depending what data sources and definitions have been used and how the data are interpreted.

For example, a 2013 report[8] estimates there are about 17 million US fully engaged freelancers/independent workers. However, that number "swells to more than 40 million, roughly a third of the workforce, when you include temps, part-timers, contractors, contingent workers, and those who are under-employed or work without employer-sponsored health insurance, 401Ks or FLEX accounts"[9], according to the *Harvard Business Review*.[10]

FIGURE 1
TOTAL US INDEPENDENT CONTRACTORS BY OCCUPATION (% OF TOTAL)



Another report[11] says that slightly more than 10 million American workers, or seven per cent of the workforce, are freelancers. This figure is based on data from the US Census. The break-up of the group is shown in Figure 1.

This occupational split is similar to that in Australia. Note further that with construction and extraction being the largest occupational group, based on Australian data, my expectation is that the much larger percentage in this group is white-collar professional engineers and other consultants. In other words, look through the occupational spread and independent contractors are dominated by the professional groups.

A 2015 survey report[12] by the Freelancers Union, a lobby group for the self-employed, says that 34 per cent of US workers are freelancers. Their break-up of the data shows how confusion can occur because of selection of different parts of the same data and the application of the same terminology in different contexts. For example, the Freelancers Unions says that of the total US workforce of around 155 million:

- 21.1 million are independent contractors;
- 14.3 million are 'moonlighters' (also have traditional job);
- 9.3 million are 'diversified' workers (multiple mix of incomes);
- 5.5 million are temporary workers; and
- 2.8 million are freelance business owners.

Again, the data reflect that the shift away from the permanent, steady status of 'employment' is more widespread than simply a move towards independent contractors. There is an entire mix of terms being used to describe this move, but it highlights perhaps the reason why 50 per cent of employees report a desire to be self-employed. Many are classified as employees in one way or another but their work environment has most of the features of self-employed independent contracting.

United Kingdom

In the United Kingdom (UK), there is a shift directly to independent contracting and it's causing quite a fuss in some circles.

The UK is experiencing a jobs resurgence as it pulls out of the 'great recession' of 2008. Over the last four years, all new jobs the UK added to its workforce have been accounted for entirely by self-employed people. The self-employed sector has grown by 570,000, to around 4.5 million, a 14.2 per cent increase compared with a 4.3 per cent increase in the number of employees. Of the UK workforce, 14.7 per cent is now self-employed – the highest percentage since records began.

It's difficult to extract from the data whether the growth is with (non-employing) independent contractors or the employing self-employed. However, I surmise that given actual employment has grown at only a fraction of the self-employment rate, the self-employment growth is mostly from independent contractors.

Whatever the trend, it signals a significant shift in the nature and make-up of the UK workforce, probably reflecting a structural shift in the nature of the economy itself. Margaret Thatcher once proudly described the UK as a nation of shopkeepers. Now it seems to be changing, as it is in Australia. Is the UK moving towards a nation of lone entrepreneurs?

This trend needs to be kept in context. Clearly the economy is dominated by 'employment' relationships, but there's a movement going on at the core base of the economy. And this movement has attracted criticism and generated a major debate in the UK.

The criticism[13] comes principally from UK unions and left-leaning academics and media outlets. Their argument is that self-employment is low paid, that people are forced into it because of a 'conspiracy' among employers not to use employees, and that the shift threatens the institutional and moral structures of society.

Canada

This UK debate has emerged in Canada as well, where a similar but more recent surge in self-employment has been witnessed.

In Canada, the percentage of self-employed employers is markedly lower than in Australia – with self-employed in Canada making up 6.5 per cent of the workforce, and 8.7 per cent in Australia (2012 comparisons). But the percentage of independent contractors is identical at 8.5 per cent of both workforces.

However, in January 2015, the Canadian jobless rate dropped to 6.6 per cent adding 34,500 jobs. This was entirely accounted for by the fact that self-employed numbers had risen by 41,000. But again, and as in the UK, the shift is proving controversial with claims[14] that this is all about low pay and the undermining of society.

Europe

Across Europe as well there appears to be a steady increase in self-employment, but from a lower base than seen in the UK, US and Australia. What's helpful in this analysis is some research that's looked deeper into the self-employed makeup. The research[15] looks at only one part of the independent contractor sector: independent contractors (non-employers) who are professionals. The research refers to these people as iPros (i.e. independent professionals).

What's been observed is that the growth in iPros in the European Union (EU) since 2004 has been remarkable. Numbers increased by 45 per cent from just fewer than 6.2 million to 8.9 million in 2013, making iPros the fastest growing group in the EU labour market (refer to Table 2).

TABLE 2
GROWTH IN IPROS BY SELECTED REGIONS

Region	%
EU	45
Belgium	53
Finland	56
France	85
Germany	43
Italy	12
Netherlands	93
Poland	88
Spain	51
UK	63

TABLE 3
INCIDENCE OF IPROS BY PROFESSIONAL SECTOR

Sector	%
Administration support	9
Arts and entertainment	22
Education	4
Financial insurance	6
Human health	6
Information technology	12
Professional, scientific and technical	25
Real estate	16

This research also identifies the reasons for self-employment. When asked why they wished to be self-employed, the iPros responded as follows:

- Independence and fulfilment (68 per cent);
- Flexibility over work (35 per cent);
- Income prospects (20 per cent); and
- Business opportunities (nine per cent).

The high score for 'independence and fulfilment' is consistent with all other research available on the motivating factors for being self-employed. This shouldn't be a surprise because independence and fulfilment are near identical attitudinal drivers of democracy and consumerism for example. People's attitudes under 'private' aspects of their lives are transferring to their work attitudes.

Self-employed demographics and motivations

When the demographics and motivations of self-employed people are studied, many myths and miscomprehensions are exploded by the facts. In this section, I draw on research from Australia and the US, both of which reinforce the evidence from the EU.

Contrary to what is often stated, self-employed people are overwhelmingly:

- Older (i.e. not young highflyers);
- Highly experienced in business;
- White-collar and professional (i.e. not all tradies);
- Active seekers of information and analytical (i.e. not needing to be mollycoddled by government); and
- Above-average income earners.

But it is true that self-employment is heavily skewed towards males.

A combination of research in Australia[16] profiles the self-employed as:

- Two-thirds male and one-third female;
- Mature – people predominantly become self-employed from age 35;
- Working longer hours than employees;
- Having a higher skills base than employees;
- Often having been in business three years or more (57 per cent);
- Operating across all industries but mostly in the services areas – even when in construction, for example, which is the highest sector;
- Often having no children living at home (51 per cent); and
- Overwhelmingly choosing to be self-employed.

Other features of the self-employed include:

- They are motivated to control their own destiny;
- Self-employment gives them lifestyle flexibility;
- Their business cycles do not follow traditional patterns of business cycles but instead are tied to their life cycles;
- They are big spenders and optimistic and willing to spend;
- Business competency is high; and

- They take a holistic approach to their work and see a need to be multi-skilled and knowledgeable.

It's interesting to observe how large organisations (government or private sector) need to relate and communicate with the self-employed, particularly where the large organisations use the self-employed as service providers. Large organisations have to operate in 'silos' of responsibility and decision-making; employees specialise.

Self-employed people operate with different decision-making processes. They must take in everything and be holistic in understanding business. In this respect, self-employed people must develop and have high-level business competency in every aspect of business. Problems happen when the systems used to run large organisations limit the control that self-employed people are able to exercise over their business.

US research from 2013[17] quite closely replicates the Australian observations. The research looks at the self-employed who do not employ others (independent contractors).

The report says of independent contractors:

> "The simultaneous growth in size, satisfaction, commitment and intent to choose the path, together suggest independence is far from a cyclical economic choice. It instead appears to signal a conscious structural shift and recognition of a new model of work and engagement by innovative Americans.
>
> "… independent workers continued to creatively forge their own economic opportunities and perceived that the drawbacks to independence were less daunting than the anticipated benefits.
>
> "In 2012, it is clear America continues its march toward a new age of career independence where individuals will not just move from job to job, but rather move from engagement to engagement and client to client as masters of their own career destiny."

The research report says that its findings "debunk the popular misconception that workers are forced into independence due to job loss or lack of alternatives".

These findings include the following:

- 86 per cent of independent workers are satisfied with their work;
- They know the challenges of independence – uncertain income 51 per cent, retirement 40 per cent, job security 36 per cent – but are up for the challenge;
- 57 per cent say it's their choice to be independent;
- 75 per cent want to continue as an independent worker;
- Only 12 per cent will build their business into an employer business (this unsettles the public policy notion that policies to grow small business ought to be about creating employing businesses; much of the growth in fact will come from non-employing small businesses); and
- One in 10 intend to grow their business to engage more independents.

The US profiling follows that identified in Australia, namely:

- 21 per cent are aged 21 to 32, and this increases as people become older, peaking at 36 per cent for 50–66 years;
- Independent workers have a higher level of skills specialisation than employees do; and
- Younger independents have the highest education.

However, the gender mix is different from Australia, with:

- 48 per cent women and 52 per cent men; but
- There is a smaller percentage of women who become employers (one-third).

The overwhelming motivation is the same as that found in Australia, the UK and Europe: "Independent workers actually choose the path because they want to be their own boss, control their own schedule and sculpt their own professional path."[18]

The report classifies this large group as entrepreneurs but entrepreneurs who work on their own:

> "There is no employer providing a steady income, benefits, retirement programs and job security. They are on their own and responsible for all aspects of their professional lives … Only 13 per cent stated that they would rather have a regular, permanent traditional job than be on their own. This is down from 19 per cent in 2011."

What's truly interesting is the take independent contractors have on security. The report observes:

> "First, because they're their own boss, many independent workers feel in control of their destiny and free from random corporate actions, such as layoffs, reorganisations, and relocations. They also feel they are no longer at risk from the behaviour of bad bosses.
>
> "Second, independent workers have multiple clients and feel more secure because they aren't tied to the fortunes of a single company.
>
> "Third, many independents feel that, while their income may go down, they are unlikely to see their income go away entirely as it would if they were laid off from traditional employment."

This alternative view of job security reflects the continued breakdown in the traditional employment contract. It tears apart the thesis of the commentaries mentioned earlier that view self-employment as dangerous for society because it challenges the social fabric built around job security. Self-employed people seem rather to be acting on the idea of job security (with one employer) being a social myth. Self-employed people see themselves as more secure because they control their own destiny and spread the job risk across multiple clients.

Technology interfacing with shifting attitudes and aspirations

The data and research indicate there is a perceptible shift in the way work is being organised. Permanent, full-time employment, particularly the idea of 'a job for life' is very much a 'yesterday' idea.

People working in the public sector are probably living remnants of a work concept that is crumbling, if not crumbled, in the private sector. Even in big businesses, the idea of permanency is more imagination than reality. There are few CEOs of large listed companies who last more than five years, for example. Permanency for employees in those companies lasts as long as the next downsizing or restructuring as firms adjust to the dictates of the market.

In small business, this is much more so the case. For small businesses, the impact of market changes is immediate and personal. There is no 'protection', theoretical or real, from the realities of the market, best explained as the whims of consumers. And

it's small business that is most important because it's here where the major percentage of people work by a significant factor.

Within the small business demographic there's one group that probably best highlights the reality of change in market economies: the independent contractor. These people work for themselves as 'businesses of one'. They operate by being entirely adaptable to their clients' needs. They are and have to be, personally and individually, one with the market.

The statistics show that this group – independent contractors – is growing. The growth is not as large as some might think, particularly seemingly panicked social commentators who oppose the development. It's a relatively small but identifiable trend yet it reflects a much larger shift in societies: the death of employment long-term, perhaps?

The significant reasons for this are the existence of freer and better functioning market economies where no one can ignore consumers. There's a major attitudinal shift that recognises 'secure' work as myth and that instead security comes from the self. And there are technological developments.

Technology is creating massive economic freedom for the individual. The impact of the internet and all that goes with it, such as mobile and cloud technology, cannot be understated.

People can and do run businesses from home or their local coffee shop. Skype enables phone and video phone communication across the globe at almost less than the cost of local calls. Any individual can run a consultancy, servicing business from home with clients around the world, and they do.

Mass media has become truly 'mass'. The big newspaper, television and entertainment giants are all challenged and threatened by what individuals are able to do on YouTube, Facebook, Twitter and more. Anyone can be a media business of one. Individual musicians, bloggers, comedians and whoever else do their own thing in direct competition with the multinational giants. People make money out of this. Some people make substantial money. These technologies mean that the size of the collective mass of individuals overwhelms the big conglomerates.

Online and mobile banking, insurance, credit cards and other financial services have reduced the risks of being in business as an individual. Anyone can provide a service and have their customer pay on the spot, almost eliminating bad debt risk and also invoicing delays and record-keeping.

The online shopping breakout means that individuals can create their own product, market it online, have it manufactured anywhere in the world it is cheapest, have it shipped and delivered without ever touching the product. There's no need to fund stock build-up because there's no need to hold stock. Payments happen online instantly, significantly reducing credit and debt risk.

So far, commentary about online shopping has focused on the big players such as Amazon. But no one looks at what's happening at the micro level. Watch this area explode for independent contractors with the full development of 3D printing.

Conceive of a time, not many years away, where every home will have a 3D printer. For example, if someone needs a button for their shirt, they will go online and find the button they need, print it and pay for it faster than going to the shops. I predict this will result in an explosion of new micro 'manufacturers'. Individuals will design products, showcase them online, sell the products, but not hold stock or have to 'manufacture'. Big business will rush into this, but individuals in their millions will do the same. 3D

printing is about to liberate the individual as a business, shattering the manufacturing sector in the same way that the internet and mobile technology turned the newspaper and music industries upside down.

Macro and micro policy challenge

In all of this, there are pretty substantial challenges. The big challenges don't really affect the small business sector. People in this sector (the significantly larger numbers of workforces) individually adjust, re-orientate and shift their attitudes and activities to reflect market (their individual customers) demands on a constant basis. It's not easy or 'relaxing'. But it's what they have to do to survive and financially succeed.

For large firms, the challenge is huge. The idea of maintaining the authority of the firm while the individuals within or supplying to the firm 'rule supreme' is a total conceptual conflict. Yet I observe many (not all) at the 'big end of town' recognising the trend and adapting. They do this because they are listening not just to the consumer marketplace but to the workforce marketplace as well. Some unusual examples, such as Koch Industries, have moved ahead of this idea and they claim to have grown as a result.

For government organisations however, the idea of the supremacy of the individual worker is a conceptual threat to their very existence. Again my observation is that government entities are failing to even attempt to adapt, and are in fact resisting adaptation.

The challenge to macroeconomic policy and policymakers is huge. Since World War II at least, macroeconomic thought has largely held the line that free-market competition is made up of command-and-control firms competing for consumers' largess. But globally, around 97 per cent of businesses are small (with fewer than five employees) and around 60 per cent of businesses are non-employing businesses of one. The people who run the dominant number of businesses are not command-and-control firms. They are more 'consumer-like' than anything else in the way they behave. This must turn on its head the prevailing acceptance by economists of how a market economy operates. To date, there's little evidence that economic policymakers see this, understand it or have even adapted any of their thinking in this direction.

Conclusion

This is a brave new world of work. There's a challenge to established local and global institutions built around the presumption of employment and the suppression of the desires of the individual to the dictates of big organisational structures. Just as individual consumers are the heroes that drive competition, there is a refocusing on the supremacy and authority of the individual in the work environment. This is happening in a layered way through the work situation. However, it's independent contractors who most highlight the social and economic movement underway.

Endnotes

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3.4
Where the jobs are

Phil Ruthven AM

Phil Ruthven AM is chairman of IBISWorld, an online business information and forecasting corporation specialising in industry, market, procurement and business environment information. He started the business in 1971 and it now operates in the United States, Canada, the United Kingdom, China and Australia, with further expansion to other countries planned in the future.

For 40 years, Phil has been a keynote speaker at congresses, conventions and seminars. He is an adjunct professor at the University of Technology, and a past board member of the Committee for Economic Development of Australia, the Melbourne Institute and charities. Phil is noted as a long-range forecaster in areas of economics, social trends, political directions and world affairs.

He was awarded an Order of Australia honour in 2014 for his contribution to business and the community.

Introduction

Will there be enough workers in the future or too many? Will there be lost jobs or new jobs? How will the new jobs be created? What sort of industries will flourish? What will be the impact of new technology? These are all questions looking for answers. How do we predict and make sense of a fast-changing workforce in a fast-changing economy and society? And should we be frightened?

It is extraordinary how vulnerable we are to scaremongering. Industrialisation (manufacturing) initially scared the British labour force in the late 18th century, especially the craftsmen and artisans. Luddism flourished for some time. Dire predictions were made about the impact of computers several decades ago and the forecast that it could lead to massive unemployment. It didn't happen. Now robots, androids, artificial intelligence and cognitive learning software are going to do the same, some say. They will be smarter than any humans and make them subservient and unemployed as we enter the next century. This won't happen quite like that, either.

We have been surviving system and technology revolutions for several centuries now. It is often forgotten that the fastest decline in jobs came via the tractor and fertiliser pre- and post-World War II. Once employing well over 30 per cent of the workforce in Australia, that industry now employs less than three per cent in 2015. Manufacturing employed some 30 per cent of the workforce in 1960. Now, 55 years later, it employs less than eight per cent due to technology, productivity, consumer saturation and import displacement. Yet our standard of living has increased fivefold in 100 years.

Some things about jobs don't change

There are a number of interesting constants when it comes to work that seem never to change.

Firstly, society needs four out of 10 of its members to work to support themselves and the other six, be they dependents, too young, too old or disabled. That hasn't changed for centuries. These days we have a higher proportion in the labour force, indeed 52 per cent of which 49 per cent have jobs. This is due to over 30 per cent of workers being part-time or casual, but still the equivalent of a little over four out of 10 full-time.

At the time of Federation in 1901, the population was too young, and life was short (53 years) meaning it was a struggle to get up to 40 per cent of the population into the labour force, so we employed children as young as 11, and retirement was out of the question for nearly everyone.

Secondly, as males or females, we have been working 130,000 hours per lifetime over the same long period. The only difference is that we now spread that over twice as many years at less than half that number of hours per year since we live to 80+ years compared with 38 years in 1800. And, of course, the ratio between paid and unpaid hours (household work) varies between men and women. Men work around 80,000 paid hours and 50,000 household hours. For women it is almost the reverse.

It is often forgotten that a normal working week for the breadwinner, ticket-of-leave or convict in 1800 was 60 to 65 hours. Nowadays, the average working week is less than half that at 29 hours on average after deducting the two months off each year (four weeks' annual leave, two weeks of public holidays, two weeks' sick leave and for

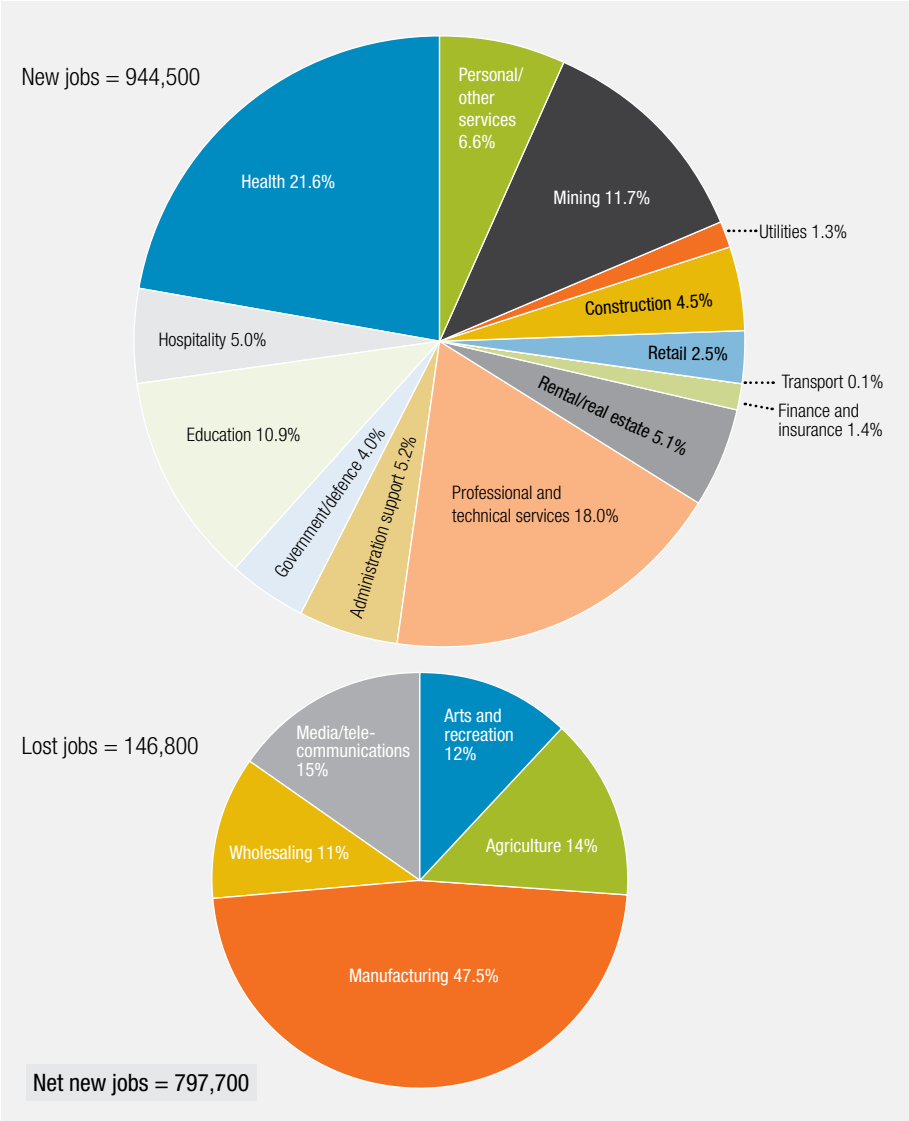
some, long service leave) and allowing for the part-time workers. This halving of work hours each year is one of the explanations of full employment in the modern era; a clear case of job sharing and a win-win-win situation in terms of work, leisure and an increasing standard of living (SOL).

Apart from those constants, everything has been 'up for grabs' as they say. The continued use of a 'working age' definition of the labour force is an anachronism. Why 15 to 65 in this day and age? Since brains are more important than brawn, the only way to wear out the brain is to stop using it; so many will work on well into their 70s and 80s. And why shouldn't children be recognised as workers if they can invent new apps for our mobile and tablet world or do a part-time job somewhere while still being educated?

Losing and creating jobs

Are we creating enough jobs these days to replace the lost ones? Well, yes we are, as Figure 1 proves.

FIGURE 1
AUSTRALIA'S NEW AND LOST JOBS BY INDUSTRY (FIVE YEARS TO JUNE 2014)



The nation created over six times the number of jobs it lost over the five years to June 2014. It could be expected to do the same to the end of this decade and beyond. Unemployment crept up beyond 'full' (five per cent) into 2015 largely due to these net jobs being not enough to match labour market growth and also due to the need for more appropriate industrial relations legislation for the new age we are in. But by world standards, our unemployment rate is easily in the Organisation for Economic Co-operation and Development (OECD) best 10.

We generally know where the jobs are being lost; and knowing which jobs are a lost cause is important to avoid investing expensive tertiary education in the wrong areas and scarce investment capital that could go into growth industries. Ditto for any tax-payer-funded government subsidies and feather-bedding. But knowing the reason why more jobs are being created and where they are is more important.

Ages of development

Australia is fascinating in many ways, as most nations are. One of the unique features is the co-existence of original Aboriginal settlers of over 50 millenniums ago – who were time-warped in the Hunting, Fishing and Trapping Age – with European settlers of a mere two-and-a-quarter centuries ago that had entered the industrial age in the United Kingdom in the late 18th century before coming to Australia, having also passed through the long Agrarian Age of agriculture, mining, trade and banking.

The ages of development and progress, with new industries and new jobs, are due to two phenomena: outsourcing and new utilities (pervasive technologies that became ubiquitous across all industries in the economy).

No nation would have had an agricultural industry if tribespeople or householders had remained self-sufficient in food-producing, timber-getting and fishing. That outsourcing, coupled with new agronomic initiatives, led to growth that took that industry in Australia to 50 per cent of our gross domestic product (GDP) in the 1820s, and the main source of our exports. This became our Agrarian Age up to the mid-1860s.

And, again, no nation would have had a manufacturing industry if households had remained self-sufficient in making furniture, clothes, preserving food, etcetera. Once the outsourcing did commence, and aided by the power utility (initially water and steam power, then electricity), that industry went on to account for just over 29 per cent of GDP in 1960. This became our Industrial Age until the mid-1960s

The current new age to the late 2040s – sometimes called the Infotronics Age due to the criticality of information and electronics – is again involving outsourcing and the creation of another new enabling utility (information and communications technology [ICT] with fast broadband on the way). This time, the outsourcing is primarily to do with services rather than goods, but not exclusively, as we will see shortly in the case of our exports, which are the result of other countries outsourcing their needs to us.

Outsourcing and the key markets

It is important to know that outsourcing is dependent on quite a number of factors. Has the cost of outsourcing in the previous age come down to allow discretionary spending on new products?

Have entrepreneurs found cheaper and/or faster ways – via unique intellectual property – to provide products that are currently insourced (do it yourself [DIY])? Is there a supporting new utility to help create and/or distribute products?

In the Agrarian Age, there were two markets for outsourced products: overseas nations sought our agricultural and mineral products; and households were prepared to switch from DIY to do-it-for-me (DIFM). In the Industrial Age, it was reversed: households moved to DIFM and bought products they could never have done on a DIY basis anyway; and other nations were prepared to outsource value-added (manufactured) agricultural and mineral products.

In the Infotronics Age there are three markets. Nations are outsourcing to us yet again for new minerals, new agricultural products, and also new services such as tourism, education and professional services. Households are also outsourcing their DIY service activities. But these two markets have been joined by businesses outsourcing their non-core activities.

In this new age since the mid-1960s, the nation has:

- Added seven million new jobs (not all new-age jobs, but well over half that number);
- Added over $1.2 trillion in new annual revenue;
- Doubled the nation's productivity (output per hour worked); and
- Increased our standard of living by more than two-and-a-half times.

It is now useful to explore the new outsourcing in more depth to get a clearer picture of the plethora of new jobs created and being created by outsourcing, the unique intellectual property of entrepreneurs and our new utility (ICT, advanced software and emerging fast broadband).

Household outsourcing and new jobs

Activities that have been outsourced by households over the past 50 years – and that are continuing to be outsourced by households surrendering their DIY habits – are categorised by sector in Figure 2.

Only around one-third of these activities has been outsourced by the 9.3 million households thus far, so there are millions of jobs still to come in the industries created to provide these services.

Already the outsourced household activities generate business revenues of over $325 billion in 2015 and over 2.5 million jobs.

Figure 3 shows the expenditure on outsourcing each sector in the 2014 financial year, reminding us again of the diversity of the outsourcing. It is interesting to note that the spending on these outsourced services of the new age actually exceeded the entire retail spending (excluding motor vehicles) in the 2013 calendar year for the first time ever.

FIGURE 2
HOUSEHOLD OUTSOURCING IN THE NEW AGE

Entertainment:
– Hospitality clubs
– Taverns, pubs and bars
– Casinos and other gambling

Tourism:
– Hotels, motels, guesthouses, and so on
– Entertainment centres and theme parks
– Air travel, boat travel and car rental

Meals:
– Fast food outlets
– Theme restaurants
– Home delivery (of fast food)

Finance, investment and legal:
– Investment advice and management
– Tax planning and returns
– Home nursing and aged care
– Home masseur treatment

Child-minding:
– Nanny services and child-minding

Maintenance:
– Room/house painting
– Home repairs
– Electrical
– Plumbing

Gardening/exterior:
– Landscaping and clean-ups
– Lawn mowing
– Pool maintenance

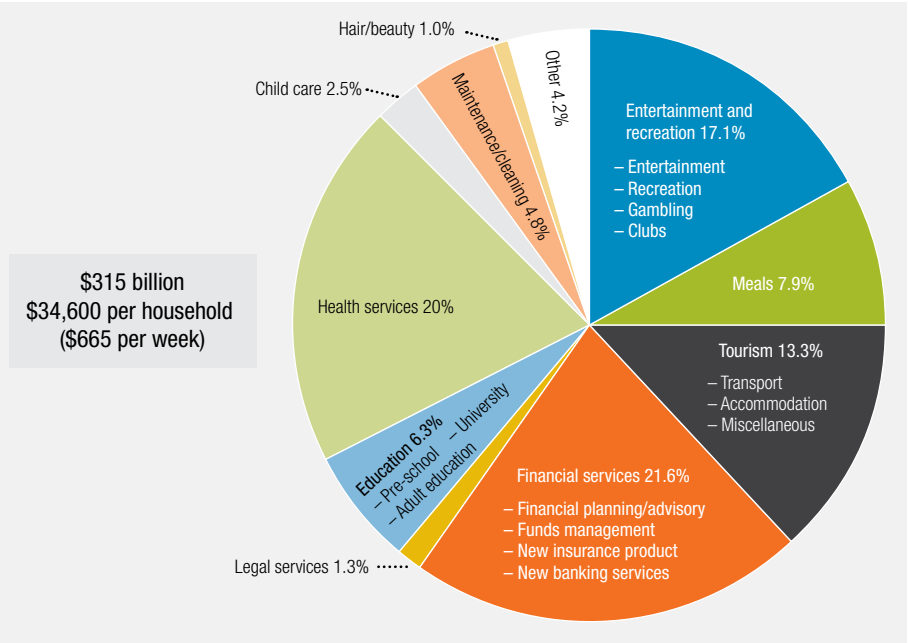
Hair and beauty:
– Hairdressers/beauty salons
– Hair restoration

Sexual services:
– Sexual services

Cleaning:
– Laundry, dry cleaning services
– Internal cleaning
– External cleaning

Car maintenance:
– Detailing, oil changes, brakes, and so on

FIGURE 3
HOUSEHOLD OUTSOURCING IN THE NEW AGE (2013–14)



Note: Spending on services, new since 1965. Included new government-provided services with our taxes.
Source: IBISWorld

Business outsourcing

Then there is outsourcing by businesses. These activities are categorised by sector in Figure 4.

FIGURE 4
BUSINESS OUTSOURCING IN THE NEW AGE

- Trucking:
  - – Road transport industry
- Cleaning:
  - – Office, factory, hotel, and so on
  - – Laundry, work clothes
- Canteens, dining rooms:
  - – Caterers
- Maintenance:
  - – Painting
  - – Engineering
  - – Carpentry
- Contract mining
- Security:
  - – Security systems
  - – Surveillance services
- Personnel:
  - – Recruitment
  - – Out-placement
  - – Training
- Reception:
  - – Serviced offices
- Accounting:
  - – Payroll, invoicing, share registers
  - – Full contract accounting
  - – Superannuation administration
- Computing (ICT):
  - – Software development and writing
  - – Computer services (IT outsourcing)
  - – Cloud computing
- Property:
  - – Property trusts
  - – Property management
- Marketing:
  - – Advertising, media buying
  - – Call centres
- Distribution:
  - – Warehousing and delivery
- Information and planning:
  - – Database services
  - – Strategic and other consulting
- Other:
  - – Franchising
  - – Other functions and activities

The value of these services in the new industries is valued at over $570 billion in 2015. Yes, there are net new jobs here, but less than the revenue figure might imply. This is due to the fact that much of the value pre-existed when these activities were done internally within businesses on a DIY basis.

The major benefits of this outsourcing lie in such things as:

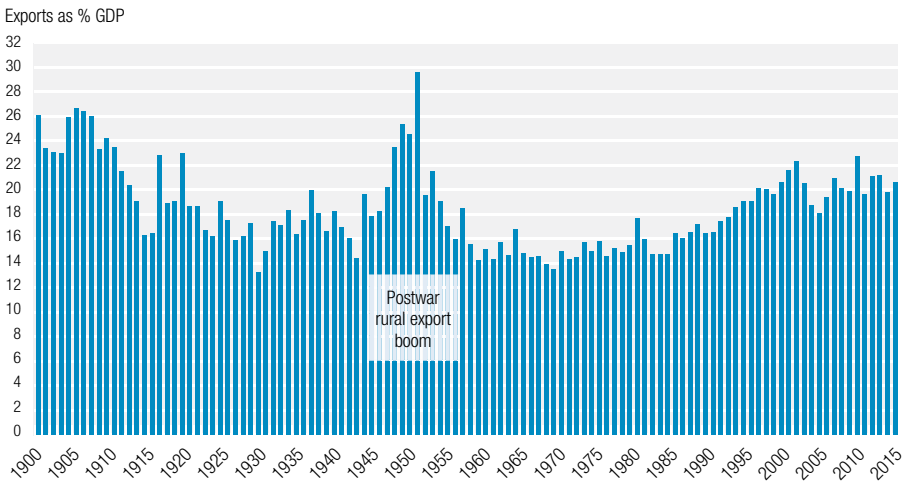
- Greater skilling of employees by specialist supplying firms where the activities are core to the new supplier, unlike the outsourcing firms;
- More focus by the outsourcers on their core activities; and
- Better services and lower costs in due course to businesses and the nation.

Overseas outsourcing

Finally there is new outsourcing by overseas nations to add to existing outsourcing, creating even greater exports. This is clearly evident in the following exhibit which shows the recovering importance in our exports as a share of GDP in the new age after 1965 aided by freer trade with lower tariffs and other barriers and a growing number of free trade agreements. This obviously leads to more jobs, balancing those lost through increased imports.

The new outsourcing by overseas nations to us since the beginning of the new age comprises the activities in Figure 6.

FIGURE 5
AUSTRALIA'S EXPORT PERFORMANCE (1900–2014)



Source: ABS Cat No 5422.0 and IBISWorld (8 October 2014).

FIGURE 6
OVERSEAS OUTSOURCING TO AUSTRALIA

Tourism:
- Incoming visitors

Intellectual property and business services:
- Designs, patents (for example, Orbital Engine Co.)
- Systems intellectual property (for example, franchises and licences)
- Technical know-how

Education:
- Tertiary and lower education (incoming students and outgoing teachers)
- Electronic education (satellite, diskettes, CDs, videos, and so on)

Health:
- Surgery and recuperation/sanatorium services

ICT:
- Software, selected hardware, online information
- Meteorological information, and so on
- Communications services

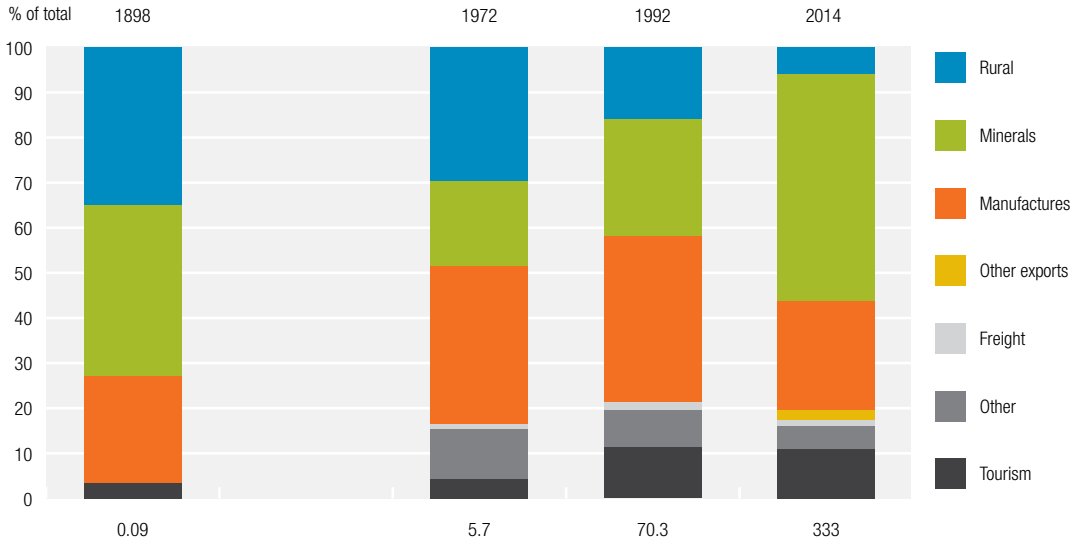
Sport:
- Competitive (regional and world events)

Manufacturing:
- Value added resources
- Downstream manufactures (from resource strengths)
- Unique manufactures
- Services (advisory)

Mining:
- Energy minerals (oil, gas, uranium, coal)
- Metals (iron ore, alumina, nickel, gold)
- Non-metallic (rare earths)
- Services

Agriculture:
- Crops (cotton, new fruit and vegetable, sorghum, oilseeds, rice)
- Livestock (beef)
- Fishing (fish farming)

FIGURE 7
AUSTRALIA'S EXPORT MARKET BY CATEGORY



Source: ABS and IBISWorld.

Figure 7 shows the changing nature of our exports over the past century or more.

Few would know that Australia's first ever export was coal, as back-loading on a French ship in Port Jackson, long before our renowned agricultural exports (especially wool and wheat), and minerals (especially gold in the 1850s and onwards).

The value of our new age exports with new agricultural products (more niche products), new minerals (especially energy minerals) and new services (especially tourism) in 2015 is well over $250 billion.

By the time we reach the middle of this century, it is likely that our service exports will exceed our mineral exports, and they are more labour-intensive than the capital-intensive primary industries, meaning a huge well of job opportunities. China is rapidly heading to be our biggest single source of inbound tourists. That country is already the highest touring nation, heading for over 110 million departing tourists each year in the 2020s. A 10 per cent share of that number plus other Asian tourists would soon see exports valued at well over $150 billion per annum.

Indeed, being now integrated into the Asian economy and enjoying more free trade agreements in this mega-region is extraordinarily prospective. Already some 80 per cent of our exports are to Asia, and some two-thirds of our immigration and inbound tourists are from Asia. Asia has been growing its GDP at twice the world average, and three times the rate of the OECD developed economies.

Jobs galore?

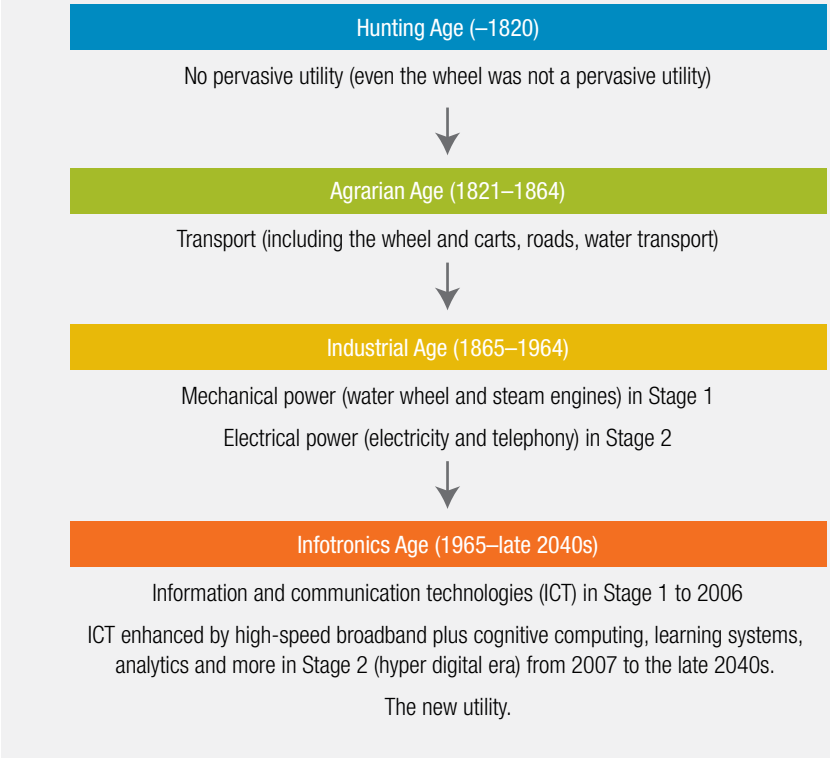
The role of utilities

It is important in this short dissertation on jobs growth to recognise the role of utilities in each new age, as summarised in Figure 8.

If there is any concern emerging in this second decade of the 21st century, it is the paucity of fast broadband, one of the keys to information dissemination, higher education, creativity and productivity. While our nation has one of the world's highest SOL levels (in the Top 10 among 230 nations, sovereign states and principalities), we had dropped out of the top 40 on broadband speeds by the end of 2014. This threatens our progress in the most dynamic regions of the world in which we are a member (the Asia Pacific and Indian subcontinent, the Asian meg-region), and threatens our SOL position.

Jobs growth is not in question for reasons outlined. We now need to ensure creativity, productivity and competitiveness in a freer trading world with the appropriate pervasive utility (ICT and fast broadband of over 100mb/second) that is already holding us back from faster growth through lack of investment and speed of availability to our 2.2 million businesses (over one million employing staff other than owners); and our 9.3 million households facing an inevitable online world for information, education, working, spending and communicating.

FIGURE 8
ENABLING UTILITIES IN EACH AGE OF DEVELOPMENT

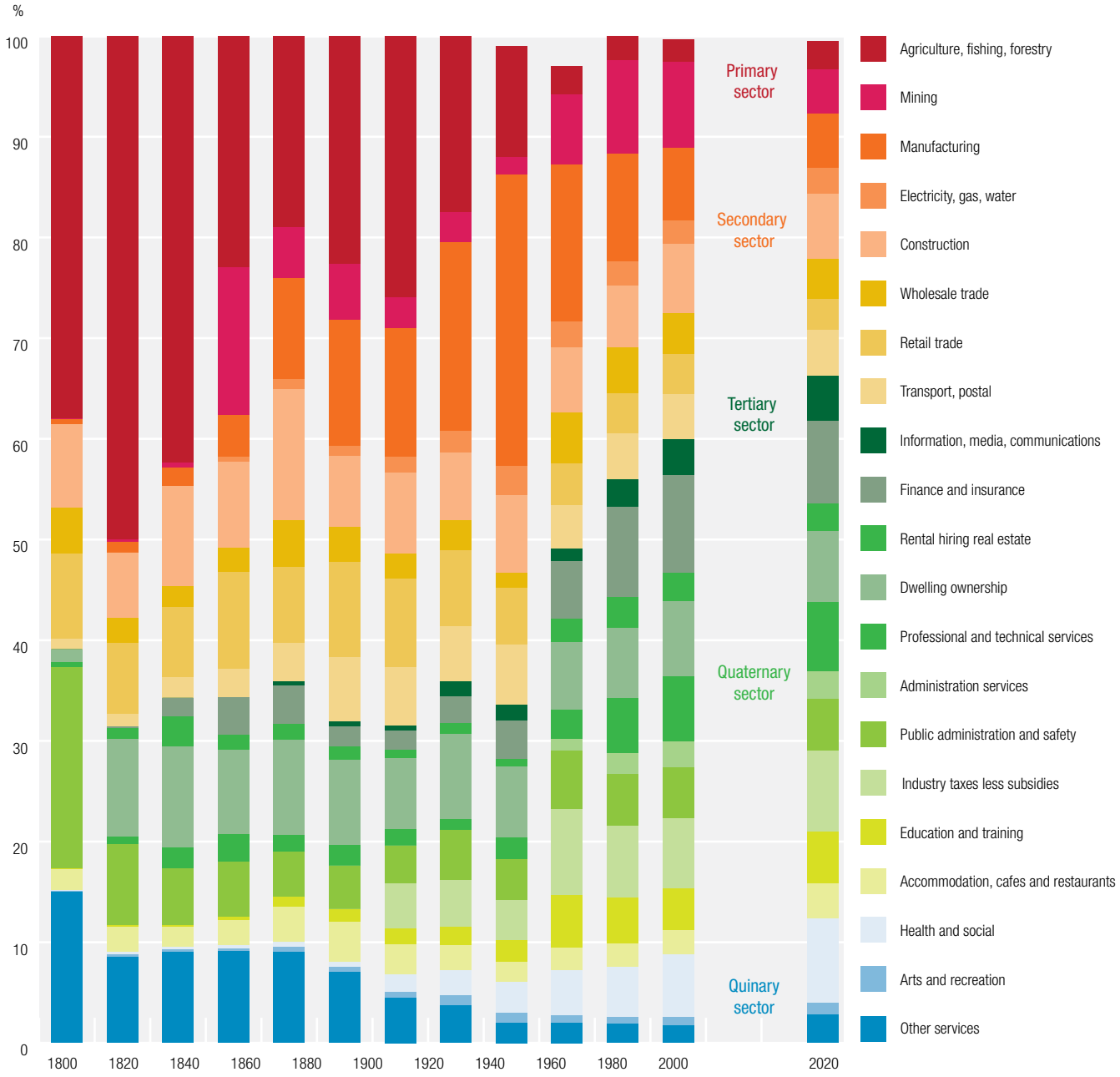


A fascinating journey, still in progress

Figure 9 shows how our Australian economy has changed its industry mix and the jobs that go with them over a very long period: back to 1800, onward to 2050. A journey taking us ever forwards not backwards.

The best is yet to come.

FIGURE 9
IMPORTANCE OF INDUSTRIES 1800–2050 (SHARES OF GDP BY INDUSTRY DIVISION)

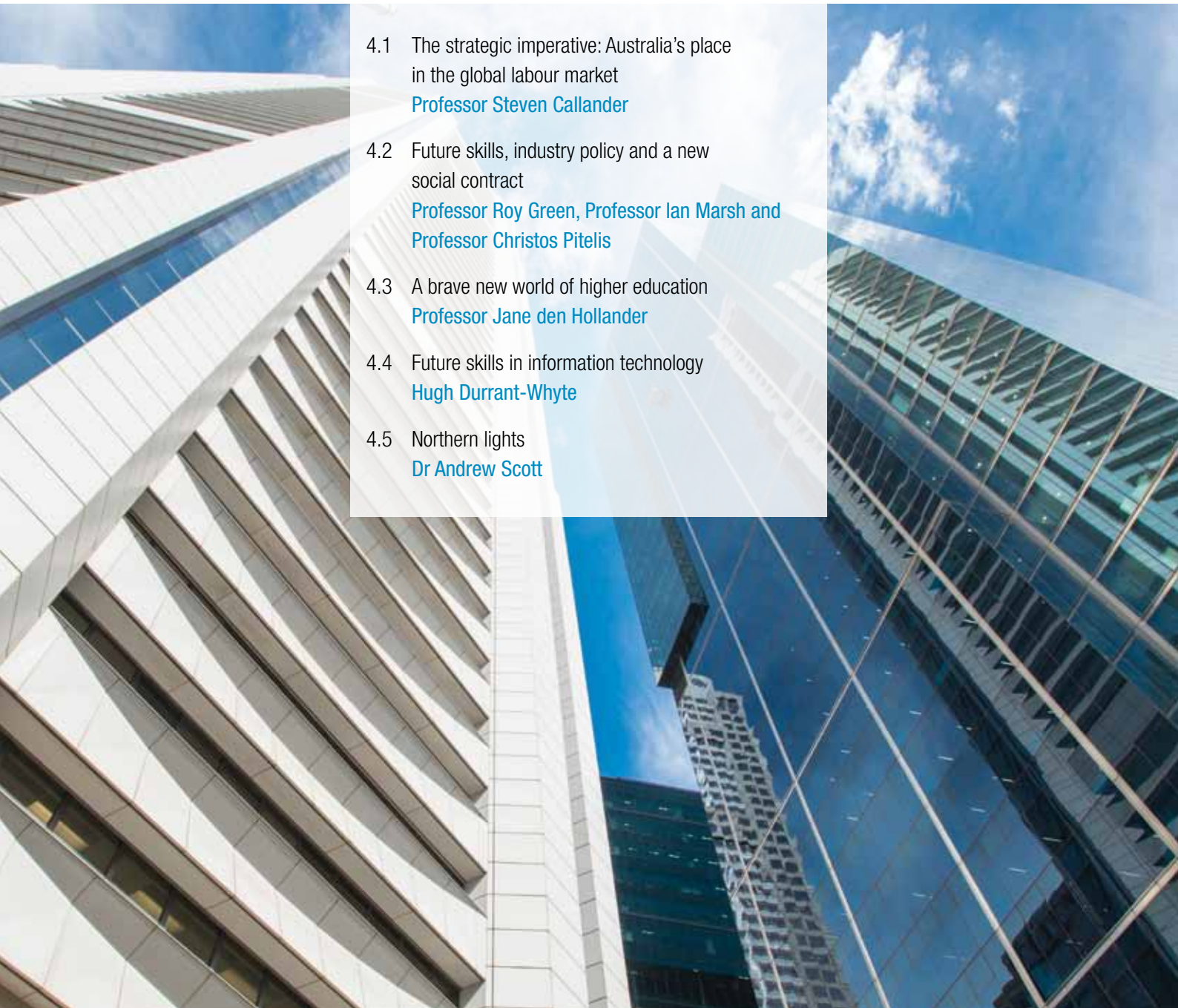


Note: At market prices to 1940, at factor cost thereafter.
Source: NG Butlin, ABS and IBISWorld.

SECTION

4.0

Policy response



4.1

The strategic imperative: Australia's place in the global labour market

Professor Steven Callander

Steven Callander is a Professor of Political Economy at the Stanford University Graduate School of Business. His research and teaching interests lay at the intersection of business, government and society. His research has appeared in leading journals of economics and political science, and he sits on the editorial board of the American Economic Review. Professor Callander obtained a PhD and MS from the California Institute of Technology (Caltech) and a Bachelor of Commerce (Honours) in economics and finance from the University of New South Wales.

The strategic imperative

Innovation is hard. Setting oneself an objective to innovate is more likely to end with a headache than it is to produce an important breakthrough. The goal of making a country more innovative is ever more difficult. Much ink has been spilled on this challenge, with precious little actionable and repeatable insight to show for it.

Despite the difficulty, it is not within our responsibility to put the question aside. For while innovation has always been valuable (who doesn't want an automatic dishwasher?), today innovation is an imperative. In the modern economy of reduced transportation costs, global markets, and infinitely reproducible products, knowledge – in particular, newly created knowledge – is the singular route to prosperity. In the modern 'knowledge economy', those who don't innovate are condemned to be commoditised.

This is the strategic dilemma facing Australia. How can the country become more innovative? Can we make the leap to the first tier of economies and remain there? How can the Australian workforce be positioned to take advantage of the new opportunities and not be run over on the road to the future?

Innovation is more than a goal, it is a starting point. To solve the strategic imperative, we must begin with innovation and think backwards to how we achieve it.

The new global economy

The idea of the new 'knowledge economy' has achieved such ubiquity that it is in danger of tipping over into vacuity. Yet like all important ideas, it contains a kernel of essential truth. In recent decades, the world economy has changed dramatically – not just in the superficial sense of iPods and YouTube, but in the manner in which the economy is organised and the spoils of productivity distributed.

A particularly striking feature of this change is that – after generations of stability – the global share of labour income has been declining. This decline is evident not only at the global level but it appears in most major countries. Australia's experience is representative.[1] In the 35 years from 1975 to near-present day, the share of labour income in Australia declined steadily from 57 per cent to 47 per cent, with that additional 10th of gross domestic product (GDP) flowing to the owners of capital, both physical and more recently, intellectual.

This decline in labour share, which evinces no indication of halting, reflects a decline in the price of investment goods. The decline is much larger than can be attributed to developments in new technology. And the fact that developing economies, such as India, China and Mexico, have also experienced declines implies the effect is not easily attributable to freer trade or outsourcing. Rather, the steady decline in labour share reflects a secular trend in the modern economy as the bargaining power of labour is steadily driven to zero.

Long ago, Alfred Marshall anticipated the onset of 'superstar economics'.[2] For much of the 20th century, the presence of superstar economics was limited to familiar examples from the entertainment industry (for example, Katy Perry can reach teenage girls all across the globe) and the world of sport (for example, the jerseys of NBA superstar LeBron James sell untold millions per year in China), with the winners taking most and the rest left to squabble over the crumbs. It is only now that superstar-driven markets

are coming to pass in a way that broadly affects the economy. In the 21st century, the logic of superstar economics is touching every industry, from factory workers to accountants, from lawyers to builders.

No industry or occupation is immune. A popular remedy is to prescribe more training of students in technical disciplines. Science, technology, engineering and mathematics (STEM) graduates are said to be the future, as only technical training will protect one from the winds of global change. Yet evidence from the United States (US) demonstrates that these workers have not escaped the winds of change. Even for these workers, wage growth has not kept pace with economy-wide productivity growth. These changes are beginning to lap at the shores even here at Stanford University. The advent of massive open online courses (MOOCs) and an awareness of the tenuous place workers hold in the modern economy, leads even our students to question the logic of a graduate degree.

Clearly, success in the modern economy is not a function solely of education but rather what one does with that education, and what a country enables and empowers its citizens to do. Increasing STEM graduates is by no means a bad thing, but it is more akin to a first step than a sufficient strategy. The rapid rate at which China and India are training STEM graduates provides more than enough evidence that the protected status of STEM graduates is withering.

This brings us to the question of what to do about it. While a difficult problem, it is becoming increasingly evident what won't work. A frequent and successful strategy throughout history – adopted largely by Australia (outside of the agriculture and resources sectors) – has been to imitate. To imitate and copy quickly technological and process innovations made elsewhere, rather than develop new breakthroughs directly. This strategy can explain why a country like Australia can appear so technically sophisticated yet have few breakthroughs of our own to boast about. This strategy gives a false impression of convergence: We may be close to the technological frontier but, in many respects, we are a long way from being able to move that frontier forwards.

The great theorist of economic change, Joseph Schumpeter, placed change at the centre of his economic worldview and created a language through which to talk about it. In addition to 'creative destruction', his most famous turn of phrase, he argued that organisations – be they companies, government agencies, partnerships, or indeed, countries – face the choice between exploring and exploiting. Explorers search out new solutions to problems that already exist and to problems yet to be discovered. In contrast, exploiters take the technology and capability the world has – often through imitation of explorers – and seek to exploit existing ideas to the fullest capability. Australia has, by and large, been an exploiter. There has been no shame in such a choice. Our size and geographic position has more often than not demanded that we follow this strategy and it has served us well for many generations.

What is clear in the new global economy is that the utility of such a strategy is much diminished, if not at an end altogether. In coming generations, exploiters will fall further and further behind the explorers of the world. Exploiters will not become the basket-cases of world development. Indeed, exploiters are unlikely to ever be considered poor, but their pursuit of prosperity will forever be contained.

The path to prosperity in this new global order will be innovation. The commodity in scarce supply will be ideas, and the creators and holders of those ideas will reap outsize rewards in superstar winner-take-most markets. Yet, the choice to become an explorer still remains a non-obvious one. Many countries will choose to be exploiters, in effect if not by proclamation. There is space for only so many explorers on the world stage and the path of the explorer is fraught with risk. How Australia is to make this choice is the question of our time.

Innovating towards innovation

A country can't legislate innovation as much as an individual can exhort him or herself to be more innovative. Innovation requires serendipity, often in large dollops. Yet it is a mistake to defer fully to the good fortune of serendipity. It may not be possible to innovate on cue, yet it is entirely possible to create the conditions where serendipity is more likely to strike. As the Nobel prize-winning Hungarian physiologist, Albert Szent-Györgyi, observed: "A discovery is said to be an accident meeting a prepared mind." Countries too can be prepared. The strategy imperative for Australia is to develop the ingredients necessary for serendipity. We must innovate towards innovation.

Silicon Valley is home to Stanford University and many of the world's most innovative companies. Apple, Facebook, Google and Twitter do not leave innovation to chance. They hire the best talent, they relax budgetary constraints and they organise their businesses around facilitating innovation. Despite their past success, these companies know that innovation cannot be expected. The experience of these companies is illuminating, with two key themes emerging: complementarity and dynamics.

Complementarities describe the effect when things work well together, when two or more practices enhance each other beyond how they would perform in isolation. Thinking about innovation means thinking about complementarities. Google's famous labour policy provides a perfect example. Engineers at Google are allowed 20 per cent of their time to devote to their own ideas. This works as a labour practice only because Google has great engineers. Yet Google has great engineers, in part, because the 20 per cent policy provides freedom that great engineers value. With less capable engineers, the 20 per cent policy would be a competitive disadvantage, whereas with talented engineers, it becomes a fantastic tool of recruitment and the source of some of the company's greatest innovations. What works at the company level can be translated to the level of nations. To put Australia on a footing towards innovation, we need to think of economic development in the same light, through complementarities.

Complementarities also drive the dynamic path, presenting organisations with a chicken-and-egg style problem. Many firms would love to have the combination of a 20 per cent policy and outstanding engineering talent, but which one will come first? Can they afford to provide such an expensive labour policy? Can they afford *not* to provide it? How can they achieve the coordination to obtain a Google-like workforce? This same conundrum operates at the national level, although the coordination required is even more difficult. Identifying the set of practices necessary to achieve economic development is the easy part. The hard part is to figure out how to nudge people and institutions on the path towards that goal.

This problem manifests most clearly in the development of an entrepreneurial ecology. It is difficult, if not impossible, to create a flourishing entrepreneurial community without a deep pool of investors. Yet it is clearly difficult to be a venture capitalist without a flourishing set of entrepreneurs to back. The existence of both parts can sustain an innovation ecology, but getting to that end position is the challenge of economic development.

The forces conspiring against this evolution are substantial. One only need tour any start-up 'accelerator' or new venture incubator in Australia and the conversation quickly turns to the question of uprooting and moving to the US. Australia has produced successful start-up companies that have succeeded on the world stage, yet those success stories almost invariably have found the road to success detouring through California's Silicon Valley. Australia's experience is not unique. Here in Silicon Valley, an entirely new career has evolved of people who act purely as facilitators,

providing the bridge between their home country and the investors of Silicon Valley. They connect start-ups to investors and help the companies move here. This strategy provides economic value and serves the interests of many a foreign entrepreneur. But such a strategy is not enough to put Australia on a path to prosperity and sustainable economic development.

How then can a city or a country avoid this fate? Many have tried to become the 'next Silicon Valley'. Unfortunately, the path to failure has been swift and inevitable. The secret to success is to understand the complementarities necessary to foster an innovation ecology, and to seek out to find a way on the path to the ideal combination rather than attempting to build directly to the end point. Economic development has long favoured theories of all at once or 'big bang' development. Yet their record of success is spotty at best, if not downright miserable. The success stories of the world have been those countries that have inched towards their goal, focusing on the co-development of the important complementary pieces.

Innovating on a paved road: An example

To find examples of a labour force that has faced disruptive change yet adapted and flourished, one need not leave Australia's shores. A niche yet illuminating example is the market for professional rugby league players.[3] In the 1980s, Sydney and Brisbane provided essentially distinct labour markets for rugby league players, with separate professional leagues and a limited flow of talent between them.[4] The evolution of a national market through improvements in travel and the expansion of television parallel the changes flowing from the new global economy described earlier. In the 1980s, these changes left the future of rugby league in Queensland in a precarious state.

The solution in Brisbane was relatively clear. To keep top-level talent based in Brisbane – and to ensure the game at the highest level was played in Brisbane regularly – reality had to be admitted and change instituted. The innovation was to enter a single Brisbane team – the Brisbane Broncos – into the Sydney competition, a team that could compete with the best Sydney clubs and thrive.[5] The Queensland Rugby League could have pushed for multiple teams yet they understood that to staunch the flow of talent, and to inspire interest in a new entity, there had to be a team that was competitive from the get-go.

This innovation worked remarkably well. The Broncos have not only held their own in the expanded competition, but thrived, dominating the competition. Since their inception, they have been the most successful team in the competition, capturing six premierships. A large part of this success is that now the complementarities worked in their favour: The strength of the single team ensured that Queensland's best talent found it desirable to stay home, and that the best players chose to remain in Brisbane ensured that the team was strong and successful.

The parallel with the challenges facing Australian labour markets should be clear. Also clear should be the stark differences. The nature of the job – playing rugby league – did not change at all. Moreover, the presence of a controlling authority (the Queensland Rugby League) ensured that the workers, managers and firms (the players, coaches, administrators and the clubs) all coordinated on a course of action, and also ensured that the solution was enforced (for example, no Brisbane club could deviate and enter the Sydney competition independently). This solution involved a lot of displacement in the labour force as an entire league had to be condensed to a single 'firm', yet the workers did not have recourse through the political or legal system as they do more broadly across the labour force today.

The experience of the Queensland Rugby League is best thought of as innovating on a paved road. The direction is clear and the road smooth. All that is necessary is the momentum to head down the road. The success of the Brisbane Broncos establishes proof of a possibility, yet it is far from dispositive in providing a map for other industries. The challenge to Australia is to find a solution as successful as that found by the Queensland Rugby League. Yet, to continue the analogy, Australia's challenge is to do so in a setting where it must switch to an entirely new sport, one with unknown rules, in a different and perhaps yet uncreated league, and with a central authority of limited power to guide the way. The innovation required in this setting is more akin to innovating on a dirt road, if not the outright wilderness. Innovation cannot come from the dictates of a centralised authority. Indeed, the role of the Government is to provide guidelines, barriers, and frequent nudging to get the country pointed in the right direction and to provide the necessary conditions for the market to find its own way.

Policy recommendations

Let me begin with an obvious recommendation that exposes most clearly the importance of complementarities yet that is seemingly unrelated: To be great at innovation, Australia needs liveable cities. Workers who produce ideas capable of being sold on the global market live where the living is good. These 'knowledge workers' are the mobile class. Turning a city into a great place to live is often taken as an end in itself, and in many respects it can and should be. Yet it is also a starting point for innovation. The emerging field of economic geography shows that making a city highly liveable is a strong predictor of GDP and wage growth and the creation of new ventures.[6] Moreover, the benefits are widespread: When a city becomes a 'brain hub', jobs for plumbers, teachers, nurses and other local services are created at a rate of five to one over other cities, raising salaries and standards of living for all.[7] A more liveable city attracts knowledge workers who affect change that makes the city ever more liveable. The power of complementarities is then working in our favour.

Australia is well positioned in this regard, with favourable weather, and an abundance of coastline and open space. Yet planning failures limit the upside. An innovative country requires liveable cities, and liveable cities require that the trains run on time. Political failures are always costly, but when they constrain our quality of life, they also constrain our ability to innovate. Australia needs more thoughtful infrastructure investment; we need better city planning, with the introduction of congestion pricing in city centres a long-overdue need. Acknowledging the importance of liveable cities beyond the obvious may help solve these failings.

A second essential complementarity for Australia is the creation and maintenance of great universities. Again, on a basic level, this is an obvious point. Yet what it means for a university to be great, and how Australia should go about producing them, is less straightforward. A full understanding of the value in creating great universities lies in understanding the complementarities. The field of economic geography has provided a second compelling finding: the connection between strong educational institutions, particularly at the tertiary level, and economic development is tight.[8] Too often, the emphasis in Australian policy towards universities is to push, if not outright shove, the sector towards more industry engagement. This is a fine goal, yet a direct push in this direction is typically ineffective and often outright destructive.

Stanford University, where I sit professionally, is the envy of many institutions in its engagement with industry and the economic value that has had its flowering on campus (Google, Yahoo!, Hewlett Packard, Snapchat, to name a few). Yet never once,

in considering a faculty appointment, have I heard the point raised whether the candidate will engage effectively with industry. The breakthrough ideas come from those in tune with basic research, and for those with the ability to engage with basic research and push its boundaries, money is rarely a primary motivation. Money is, of course, an attractive bonus, and the involvement of faculty in outside ventures is a testament to that desire, yet many of these researchers would not be attracted, and quite possibly turned off, by a university for which industry engagement is a primary goal.

How then does Stanford do it? A large part has surely been serendipity, but much was due to planning. Stanford provides the space, the ramp and the opportunity for faculty to explore outside opportunities, and the university is very generous in sharing the spoils of intellectual property. Nevertheless, all faculty must teach a full course load, regardless of success or otherwise in outside ventures. The university never loses sight of what is essential: the need to maintain a thriving environment for basic research. Paradoxically, to achieve the goal of industry engagement, it is often necessary to not focus directly on that goal.

Another important complementarity for Australia is that between investors and entrepreneurs. As mentioned earlier, investors need entrepreneurs and entrepreneurs need investors, and each is powerless without the other. Starting a venture capital (VC) industry from scratch is all-but impossible and the VC industry in Australia has struggled to get a foot-hold. With every start-up looking to move to the US, it is increasingly difficult to justify keeping that VC money invested in Australian-based prospects.

What can be done about it? Fortunately, Australia possesses a pool of money of such enormous size that redirecting only a mere fraction could solve the problem. One of the policy successes of modern Australia is the creation of the compulsory superannuation scheme. This has secured the retirements of millions of Australians and at the same time generated a pool of investment funds in excess of $1.5 trillion. Remarkably, this money has not been activated to support local entrepreneurs. It is easy to see why: the super fund industry lacks expertise and there simply isn't the scale of investment opportunities to justify the attention it would require. Yet what is optimal investment behaviour for the industry players is terribly inefficient at the societal level. This is where a policy 'nudge' can work wonders. A relatively minor requirement that some fraction of investment support entrepreneurial ventures has the potential to start a trickle of funds towards Australian-based entrepreneurs. And with that flow guaranteed, entrepreneurs can strike out on their own confident that funding is possible, and the virtuous cycle of complementarities that is currently working against innovation in Australia can be reengineered to work in its favour.

Many times in history, countries have resorted to industrial policy, as governments sought to 'pick winners' to overcome economic competition. These policies have always failed simply due to the fact that governments do not possess the knowledge or skill or, indeed, the incentive to get things right, too often opting to support the politically powerful. By empowering the super fund industry, these incentive problems can be alleviated. Once the fund industry gains expertise, the sheer scale of the money they manage offers the scope for regional competitive advantage. Precedent exists for this type of involvement. One of the largest backers of venture capital funds is the California Public Employees Retirement System (knowns CalPERS), which has $300 billion under management. CalPERS got into entrepreneurial investing largely due to geographic proximity, yet there is no reason Australia cannot achieve the same ends, albeit with a bit of policy engineering to overcome geographic disadvantage.

Ideas of even smaller scale should be pursued, hoping to spark the virtuous cycle of complementarities. One such example is government procurement. A tour through the history of technological innovation reveals a remarkably important role for government

funding. It is well known that the necessities of war spark golden ages of technological innovation. Less well appreciated is how peacetime procurement, in the military and throughout all branches of government, has had significant impacts on innovation. It was in the years immediately following World War II that the US Government funded the construction of the first general purpose computer, and several decades later it was a government procurement contract that funded the creation of the ARPANET, the precursor to the internet.[9] Indeed, this is not a one-off experience unique to computers or the US. A quick reading of the history of technological innovation reveals many connections. Famously, it was government procurement policy in the United Kingdom (UK) in the 19th century to subsidise mail carriage that led to the technological advances in boat design and development that allowed Britain to regain dominance of its Continental rivals and command of the high seas.[10]

The success of procurement policy in the US has come from two sources. The first, and more obvious, source is that the Government has demanded solutions to thorny military and civilian challenges and this induced innovation. The second source is less direct. It has long been US government policy to explicitly favour small companies in the awarding of contracts. By supporting the competitive fringe, an ecology of entrepreneurs and start-ups was fostered that led to many bold and unexpected innovations. Would similar successes follow from tweaks to Australian government procurement policy? Of course, it is impossible to say, and surely any accomplishments would pale in comparison to the examples just provided. But progress that is a fraction of these examples would make the program worthwhile.

Competition policy provides another opportunity to foster innovation. All too often, competition policy treats smaller players – the competitive fringe – as a minor element in the calculations of industry structure. An appreciation of how smaller companies – when they are more entrepreneurial and innovative – can facilitate technological progress, leads immediately to the conclusion that their creation and preservation should be a goal of policy. A way to achieve this, in small part, is by enhancing the value placed on the competitive fringe in the backbone of competition policy, even when the economic value of this industry segment is not yet entirely visible.

My final recommendation pursues an altogether different tack, although it is sufficiently important, verging on being a necessity: the need to reform the institutions of Australian legislative government. The greatest threat to Australian prosperity is a dysfunctional policymaking process, and the dysfunctions of the Australian federal legislature are making that increasingly a certainty. I recommend nothing less than the abolition of the Federal Senate. Short of that, the system of voting must be changed to remove the elements of proportional representation that were as inadvertent as they are destructive.

It has taken over a century for the flaws in our political system to fully reveal themselves. The Senate induces a multi-party-ism that clashes with the otherwise stable two-party structure in the lower house that reflects the intentions of the original Constitutional Convention. The repercussions of this institutional mismatch are enormous. The fracturing of power within the system has led to a US-style fracturing of accountability. If the voters do not know who to blame, each side of politics has the incentive to create problems to lie at the doorsteps of their opponents. This is the wrong time to imitate a system of gridlock and partisan manoeuvring. Inertial gridlock served the US well throughout the 20th century as more responsive systems led countries down many blind alleys. With the 21st century shaping up to be very different, Australia is moving in the direction of legislative gridlock and dysfunction at exactly the moment when bold action is required.

Conclusion

The recommendations I offer here range from the small to the large, and they reach well beyond the standard domain of labour force policies. The solution to growth and adaption in the face of the new global realities lies in understanding complementarities and the importance of setting Australia on the right path. To help labour in the new global economy, a more vibrant and innovative industry base is required. Only then can the power of the Australian workforce be unleashed to orient itself towards the solution.

The path is open, and Australia is starting at (or near) the front of the pack. Competition will be fierce and we will be passed soon if momentum is not established. Countries themselves are in competition and there exists a first-mover advantage. Our previous strategy of exploitation may lead us into a rose-coloured view of our current level of sophistication. It is imperative that this does not lull us into a false sense of permanency – or entitlement – as a member of the global economic elite.

Endnotes

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3 Substitute Australian rules football and the West Coast Eagles should the reader's sporting preferences incline towards AFL.

4 For instance, the greatest player of all, Wally Lewis, remained in the Brisbane competition until the inauguration of the Brisbane Broncos and their entry into the Sydney-based competition.

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4.2

Future skills, industry policy and a new social contract

Roy Green
Ian Marsh
Christos Pitelis

Professor Roy Green is Dean of the UTS Business School at the University of Technology, Sydney. His doctorate is from the University of Cambridge, and he has worked in universities, business and government in Australia and overseas. Professor Green has published in the areas of innovation policy and management, productivity, skills and digital transformation. He has also undertaken projects with the Organisation for Economic Co-operation and Development (OECD) and European Commission. He chaired the Australian Government's Innovative Regions Centre, CSIRO Manufacturing Sector Advisory Council and NSW Manufacturing Council, and served on the Prime Minister's Manufacturing Taskforce and ABS Innovation Reference Group.

Professor Ian Marsh is an Adjunct Professor at University of Technology, Sydney. His most recent book, *Democratic Decline and Democratic Renewal: Political Change in Britain, Australia and New Zealand*[1], concerns the fractured condition of Australian politics.

Professor Christos Pitelis is Professor of Sustainable Global Business at the Bath School of Management and the University of Technology, Sydney; and a Life Fellow at Queens' College, University of Cambridge. He is the Director of the Centre for International Business and Management (CIBAM). Professor Pitelis has published and edited 10 books, and written and edited for many scholarly journals. He has researched, consulted and coordinated projects for governments, the European Commission, the United Nations, USAID, the Commonwealth Secretariat and private companies, and he has been Visiting Professor in Australia, Europe, Russia, China, Latin America and the United States. He has been President of the Organisation of Small and Medium-sized Enterprises in Greece.

Introduction

For much of the 20th century, the social contract guiding Australia's economic development linked wages, skills formation and industry protection. This arrangement was terminated politically in the 1980s and 1990s with a view to transforming our competitiveness through a microeconomic reform strategy based on an 'accord' with the trade union movement. There followed a period of unparalleled prosperity coinciding with the rise of China and a massive commodity boom. Improved terms of trade and diffusion of windfall gains through tax cuts created a consumer bonanza. But the high dollar and demands of the mining sector correspondingly 'hollowed out' other sectors, notably manufacturing.

With the end of the resources boom and reversal of Australia's terms of trade, new dynamics are refashioning the policy challenge. The changing nature of workforce skills, the future of non-mining trade-exposed sectors and the implications of our proximity to Asia are all increasingly relevant. In turn, these factors are themselves being reshaped by an underlying mix of technical, social and global forces.

This chapter asks: Is it time for a new social contract that recognises the importance of industry development policy and prioritises productive capabilities, among the most critical of which are workforce skills?

In answering this question, this chapter:

- Clarifies three framing ideas that figure in current policy debates;
- Examines the emerging outlook for jobs and skills in a changing economy;
- Sketches out forces reshaping industry, including manufacturing; and
- Addresses the challenge of building national consensus around a policy agenda.

Concepts

The unwinding of the resources boom has stimulated a necessary if limited conversation about policy implications.[2] Past and present senior public servants, like Ken Henry, Gary Banks[3] and Martin Parkinson[4], have also weighed in personally. Three terms figure prominently in this discussion: innovation, productivity and competitiveness.

Many contributors treat these terms as interchangeable, or address just one or two. Thus, Ross Garnaut and John Edwards, while differing in detail, prioritise productivity and assume there are no sufficiently distinctive issues involved in competitiveness or innovation to warrant specific policy attention. The BCA-McKinsey report, by contrast, looks closely at competitiveness but barely touches the public policy implications. Other reports variously focus on competitiveness and innovation. While the three concepts are clearly interdependent, a wide literature points to the importance of separate consideration. Failure to tailor policy appropriately to address all three could involve significant unintended and potentially counterproductive consequences.

The first step is to clarify the concepts:

Innovation

Innovation is a broad concept, which the Organisation for Economic Co-operation and Development (OECD) defines as "the implementation of a new or significantly improved product (that is, a physical good or service), process, a new marketing method, or a new organisational method in business practices, workplace organisation, or external relations". This definition goes back to Joseph Schumpeter in 1942. Innovations can arise at many different levels, including conception, research and development (R&D), technology transfer (the shift of the 'technology' to the production organisation), production and deployment or marketplace use. More recently, non-technological innovation – such as new business models, systems integration and high-performance work and management practices – has been seen as critical for organisational strategy.[5] Innovation usually drives productivity[6], but this need not always be the case. Consider, for example, how unproductive many financial innovations (such as derivatives) turned out to be.

Productivity

Productivity is a key component of national income growth. Economies have three ways to enhance this over the medium to long term:

1. Growth in number of workers;
2. Growth in productivity across-the-board ('total factor productivity' or TFP); and
3. Growth in the share of activity in high-productivity industries.

The first is hard to sustain and does nothing by itself to increase efficiency. As for the second and third, productivity growth in most countries results not only from changing the sectoral mix to higher productivity industries, but also from increasing TFP in all sectors and activities, including so called low-tech industries.

To the extent that innovation drives productivity at firm level, research in German manufacturing shows that most of this occurs through non-technological innovation in low and medium tech firms.[7] The former approach is implicit in much Treasury and Productivity Commission thinking. Even if it was appropriate to the post-1983 transformation, whether it continues to be sufficient for Australia's economic future is questionable. Future productivity growth will increasingly take place "via the diffusion of innovations at the global frontier to national frontier firms … facilitated by trade openness, participation in global value chains and the international mobility of skilled workers".[8] A further element will be innovation that promotes environmental sustainability, which implies doing more with less.

Competitiveness

Competitiveness encapsulates how successfully a region or a nation engages in trade and production domestically and cross-border, and succeeds in capturing value from its advantages in a sustained way. This signifies more than the traditional concept of comparative advantage, based on natural endowments, and includes gains through 'competitive advantage' that rely on superior knowledge and ingenuity.

Strangely, this is an area for which there are no clear and generally accepted definitions. However, one definition of competitiveness that brings together different aspects and approaches emphasises the ability of a region to export more in value added terms than it imports, namely to specialise in tradeable sectors and activities.[9] In addition to a focus on tradeables, competitiveness also includes the ability to appropriate value in global markets and value chains through effective industrial and corporate strategies.[10]

Workforce and skills challenges

In today's globalised, intangible assets-based economy, workforce skills and capabilities have become key to the sustained competitive advantage of firms, cities, regions and nations. Technical change leads increasingly to the 'commoditisation' of certain skills, which can be offshored or displaced by robots and powerful computers. Others are becoming rarer, harder to imitate and hence more valuable. Firms and nations with the right skills and capabilities redeployed at the right time are likely to emerge as winners. The development of such skills involves an appreciation of existing sources of comparative and competitive advantage, foresight as to where the changing global landscape and technical change are heading, and alignment between areas of desired future competitive advantage and current policy, by business, government and the 'polity' as a whole.

The need for foresight and policy is highlighted by recent trends that show, for example, that by the 2030s there is a high probability that occupations such as accountants, estate agents and even economists will not exist or will be significantly depleted. The evidence reported by Frey and Osborne[11] (refer to Table 1) suggests that in terms of projected future needs, the focus should be on training for skills that are unique and unlikely to be replaced by computers and automation. Scaling up across the economy, this could mean recreational therapists and dentists.

TABLE 1
PROBABILITY OF JOB COMPUTERISATION

Job	Probability
Recreational therapists	0.0028
Dentists	0.0044
Athletic trainers	0.0071
Clergy	0.0081
Chemical engineers	0.017
Editors	0.055
Firefighters	0.17
Actors	0.37
Health technologists and technicians	0.4
Economists	0.43
Commercial pilots	0.55
Machinists	0.65
Word processors and typists	0.81
Real estate sales agents	0.86
Technical writers	0.89
Retail salespersons	0.92
Accountants and auditors	0.94
Telemarketers	0.99

Source: Frey and Osborne [12]

On a smaller scale, jobs associated with high levels of knowledge, education and cognition are also more likely to survive, and certainly to provide most of the rewards in the future labour market. The ability to interface, interact and combine human with machine intelligence will be a key factor. The development of markets for ideas, alongside crowdfunding and 3D printing technology, is even more likely to tilt the balance in favour of brainpower. Yet that may not guarantee employment for everyone who wants work, unless imaginative solutions are found.

Berger and Frey[13] report that new industries created in the 21st century such as internet publishing and broadcasting, shopping, data processing, hosting and related services and electronic options employ a mere 0.5 per cent of the United States (US) workforce, though it is also the case that they support other contributing jobs. How can we grow these new industries to provide employment opportunities either directly or through related supply chains and supporting ecosystems, and more generally generate employment in the economy as a whole? And how can we address the danger to social cohesion of a permanent underclass, without mechanisms for the fair distribution of gains from economy-wide productivity improvements?

These trends and their implications have barely figured in Australian public policy discussion. The now disbanded Australian Workforce and Productivity Agency (AWPA) identified growth sectors to 2025, including personal and health services and technical, professional and managerial jobs. It pointed to the substantial emergent opportunities in manufacturing, but emphasised the essential role of science, technology, engineering and mathematics (STEM) as well as managerial and bespoke skills. The agency has now been abolished and its report appears to have had little impact on government thinking. This is a major reason to think in terms of a new social contract: such an approach could create the necessary framework through which linkages between education, skills, and workforce and industry development issues can be anticipated and addressed.

Industry and ecosystems

Similar considerations apply to industry development. Consider the alternatives: either markets alone are permitted to mediate all the necessary adjustments, spill overs and linkages; or the state complements markets by co-designing policy to facilitate alignment between technological change, changes in the global business environment, emergent skills needs, and changes in capabilities and potential competitive advantage. A new social contract would create an appropriate framework and license for this thinking, with potentially momentous consequences in releasing the talent and creativity of Australia's entrepreneurs and workforces.

Today's global competition is repositioning to specialised, interdependent activities in global value chains, with an emphasis on design and business model innovation as well as technological proficiency. A key characteristic of the latest phase of globalisation involves the slicing of value chains in increasingly finer activities by multinational enterprises, which orchestrate and largely control the process. Competition in terms of final products and services is being superseded by competition in increasingly specialised activities in global value chains, sometimes comprising a single specialised part of a final product.[14]

However, this must be a 'bottleneck' part, meaning something no one else can do as well. For example, Rolls Royce produces a part for airline engines that cannot be replicated due to the tacit knowledge involved in producing it, even if a competitor

gained access to the blueprints. The same company now makes more money from servicing its engines than from selling them. Again, the Swiss company Swatch is a virtual global monopoly in producing some parts for watches, without which no watch can function, to the point where all but two brands have to buy from Swatch.

Can this also be done through a focus on services? Clearly, a dollar from services is as good as a dollar from manufacturing. But which source of a dollar is more sustainable and likely to lead to two or three dollars because of its high 'income elasticity'? The answer is the one gained from activities and products that are harder to replicate, which involve tacit, non-modifiable knowledge, which are embedded in system architectures that are hard to fathom, let alone copy, and which are more highly demanded the richer people become. These require manufacturing, or at least can benefit from a combination of manufacturing and services (or 'manuservices', as it is sometimes called), with even agriculture, making it harder for competitors to decipher. And while exploiting such capabilities, whenever present, firms and research institutions must simultaneously explore future opportunities in collaborative arrangements. Governments cannot prescribe this, let alone do it themselves, but can provide the framework to *enable* innovation, collaboration and co-creation to occur. As Dow Chemical CEO Andrew Liveris has pointed out, innovation requires people actually doing things on the shopfloor.[15]

Nor can businesses, especially smaller ones, do everything on their own. They need information on, for instance, emerging markets, new business models, such as manuservices, and new technologies. They need skilled workers and managers, professional and engineering services, and advice to build their 'absorptive capacity' for adapting and diffusing technologies, global value chains and supporting ecosystems. And they need soft infrastructure for networks and cluster development. For example, a creative digital cluster is emerging around the University of Technology, Sydney, with three times the density of entrepreneurial start-up activity of the next ranked cluster in Australia, accounting for 40 per cent of Australia's creative industries employment. Like the UK Tech City in London and Cornell Tech initiative in New York City, this cluster comprises both large and small enterprises in high tech and finance, and together with related services, it contributes $64 billion to gross domestic product (GDP). The characteristic of such clusters is that professional service firms, investors and property developers all flock in – success breeds success.

There are many more such clusters and cluster opportunities, requiring research and innovation infrastructure and 'network broking' support. In the era of globalisation, location becomes more not less important. Cities, regions and business ecosystems are the order of the day. These must connect to, complement and underpin value chain activities, while challenging them through disruptive innovations. In addition, small and medium firm growth requires anti-trust, regulatory policy that can help establish a level playing field. As Friedrich Hayek once observed, government should be pro-competition not just pro-business. For markets to work, competition is a key ingredient, as is collaboration and cooperation. This is the complex set of factors that will be energised by a social contract among the key stakeholders and broader polity. For Australia, a third world scenario of reliance on the export of unprocessed raw materials will not sustain a first world lifestyle based on imported consumer goods.

Australians have everything required to generate and capture wealth sustainably. Proximity to Asia with huge potential for health-related services and tourism as well as medical technologies, advanced manufacturing, food processing, information and communications technology (ICT), renewable energy technologies and higher education all provide opportunities beyond the mining boom. However, it is crucial for these opportunities to be brought together in business ecosystems and local production

systems that combine, for instance, health, with tourism, agriculture and food, medical instruments and financial services. Such 'mega-clusters' often emerge organically in specific regions. But they need to be diagnosed, mapped and nurtured. 'Market failures' inhibiting their growth must be identified and addressed through policy intervention and more far-reaching 'systems failures' must be overcome through a better understanding of the interconnections.[16]

In this context, manufacturing should not be written off as it can help us reimagine and recalibrate our future. In becoming more globalised, knowledge intensive and interdependent with service design, robotics and digitisation, manufacturing matters more than ever for advanced economies. This is firstly because it drives innovation and technological change, and secondly because it contributes to the external trade balance. Currently, manufacturing accounts for a quarter of Australia's private sector R&D expenditure. Even more is spent on 'non-R&D' innovation, such as new business models, systems integration and high-performance work, and management practices, with diffusion effects throughout the economy.

Without a manufacturing base, Australia would need to import more consumer and capital goods, reinforcing our chronic inability to run a positive trade balance. Additional borrowing to do so, together with the repatriation of resource profits, would expose serious vulnerabilities in our external position. Before the Global Financial Crisis, conventional wisdom viewed the current account deficit as irrelevant. Since then, economic opinion has switched as financial markets savaged countries excessively dependent on foreign borrowings.

It is increasingly recognised that accelerating deindustrialisation results in countries going backwards technologically with a diminished capacity for innovation. Other industries cannot substitute for this loss in capacity. While the resources sector increased its R&D spending to match manufacturing, it has mostly been directed at tax minimisation rather than 'technology maximisation'.[17] Also, sales of locally made equipment to the resources sector amount to just two per cent of total annual manufacturing sales. The mining boom was never going to save or substitute a robust manufacturing sector.

Without manufacturing, we face the prospect of losing science and engineering expertise that has taken generations to nurture in research and production. Manufacturing directly employs one in five engineers in Australia, and many more indirectly.[18] These skills are not only critical to new growth industries but are core infrastructure skills on which every modern economy depends. Many people initially trained in manufacturing now move to other industries. Where will the engineers, technicians, maintenance fitters and machinists come from to install and maintain our telecommunications, power stations, water plants, transport and defence systems? The resources sector does not train for these skills, but 'buys them in'.[19]

Taxpayer-funded research in solar energy, aerospace, microelectronics, advanced materials, nanotechnology and biotechnology may well struggle to bear anticipated fruits when the industries using these high-level skills to innovate and make new products have disappeared. The Productivity Commission has already questioned public support for science and engineering when the benefits of resulting knowledge accrue to other nations. Recent experience should be sufficient to dispel the myth that advanced economies can offshore their manufacturing base and retain high-value design and marketing.[20] Asian firms that started as cheap no-name makers of western-designed and branded products have quickly become global manufacturing leaders.

Manufacturing is changing the world and is itself changing as the prime source of transformational products and services. Australia's commodity boom was, and could still be, an opportunity to build this transformational capacity. We must do so now even under less favourable circumstances. Despite over two decades of trade liberalisation, Australia has a predominance of low to medium tech manufacturing, in steel, non-ferrous processing, building products, basic chemicals and food processing. These are the activities most threatened by international competition, especially from emerging economies. On the other hand, we scarcely register in high-tech manufacturing, despite some notable success stories. Around the world, 'micro-multinationals' are superseding vertically integrated corporations through niche production in global networks and value chains. This is the future of manufacturing, but also the largest component of Australia's trade deficit.

The alternative is manufacturing decline. Some claim on the basis of a static equilibrium model of the economy that this is not a problem at all but simply 'structural change', which results in a re-allocation of labour and capital, leaving us all better off. The main deficiency of this approach is that it confines itself to asking how a fixed quantity of resources can be efficiently allocated. Consequently, it sees industry assistance policy as a zero-sum game, with some firms benefiting at the expense of other producers and consumers, with no net economic gain. Influenced by Joseph Schumpeter, many economists are instead beginning to model capitalism as a 'dynamic system', where change is the only constant. It is increasingly understood that because innovation is risky and expensive, and information is costly to acquire and use, government has a role in reducing risk and encouraging the uptake of new technologies and skills. This is the role of the 'entrepreneurial state'.[21]

Politics

The state has played a significant role in economic development at least since the industrial revolution. Its role was conceptualised by Friedrich List in his *National System of Political Economy*, which influenced policymaking in Germany and laid the foundation for an understanding of modern national innovation systems. Earlier, in France, Jean-Baptiste Colbert anticipated the *dirigiste* role of the state in securing competitive advantage in specific technologies and skills, and forcing the pace of capital accumulation more generally. Even Charles Babbage in England highlighted the benefits of state intervention to promote manufacturing and to improve the organisation of production. Interest has now been revived with the increasing focus on innovation and technological change, and how these may be enabled by well-calibrated public policy.

Elements of this approach have found their way into modern evolutionary growth economics and into national and supranational frameworks of industry and innovation policy, whether prescriptively in 'command' economies or as an enabling factor in contemporary market economies. We are now seeing industrial policy becoming more rather than less relevant with the fragmentation of large vertically integrated corporations, and with the emergence of networks and clusters of smaller interdependent, knowledge-based production units – 'micro-multinationals' – fulfilling increasingly specialised functions in global markets and value chains. Essentially, the significance of industry policy is that it provides a mechanism for identifying current and future areas of competitive advantage for advanced economies, developing a coordinated and effective strategy to capitalise on these areas, and for building enterprise capability and performance in the context of a collaborative innovation ecosystem.

In an era of information overflow, it takes the combined efforts of all concerned to drive sustainable desired change based on current and potential areas of competitive advantage in global markets and value chains. Prime Minister of the United Kingdom (UK), David Cameron, observed that government is involved anyway, so rather than quibbling about whether it does, why not determine how to maximise the net benefits from this involvement.[22] As a result, the UK proceeded to devise a 'new industrial strategy' with a view to learning from Germany and other countries that promote advanced manufacturing as the key driver of a more competitive, dynamic economy.[23] They identified sectors that can serve as future manufacturing leaders and provided support to emerging clusters and Catapult Centres to be vehicles to implement this strategy. They called in a wide array of academics, business and policy experts to contribute towards a 'foresight' program that visualised Britain 10 years from now. This was all part of a realisation that the UK needed to diversify from financial services to rebalance its economy. Other advanced countries also undertake such knowledge and technology foresight exercises, even the US most recently in the context of concern about its technological proficiency.[24]

How does Australia fare? It is not exactly that we lack an industry strategy ourselves, as we lavish resources on the mining sector through fuel rebates, investment incentives and infrastructure spending in an old style and discredited 'national champions' approach. Similar considerations apply to financial services and agriculture, but is this the right approach to industrial strategy for a very different future? The centrepiece of the Government's latest rethinking of policy is five new 'Growth Centres', including one for advanced manufacturing, which will be designed to encourage business-university collaboration. Whatever the merits of the emerging policy architecture, these have been allocated a mere $190 million over a four-year period, compared with almost $3 billion over the same period for the UK Catapult Centres, on which they are modelled, and, even larger allocations for the German Fraunhofer network, the Netherlands' 'Top Sectors' strategy and US National Manufacturing Institutes. Perhaps the only chance of providing adequate resources for such priority areas is a radical reorganisation of the entire national budget for science, research and innovation.

What could a shared vision of future growth, employment and competitiveness in Australia look like? Certainly, it should intensify the engagement of industry with research and educational institutions given the importance of public research in our innovation system.[25] Recent cuts to the Commonwealth Scientific and Industrial Research Organisation (CSIRO), suspension of the Cooperative Research Centre program and the failure to promote entrepreneurial start-up activity do not augur well, and are not compensated by the introduction of an underfunded Growth Centres program. Further, such a vision should enhance the 'absorptive capacity' of domestic industry, particularly manufacturing firms, along with more effective public procurement, so they are better placed to participate in global markets and supply chains.[26] Again, reductions in funding to the successful Enterprise Connect Program are disguised by the merging of this program with Commercialisation Australia and Researchers in Business, and the efficiencies gained by the new combined 'Entrepreneurs' Infrastructure Program' are unlikely to make up for the loss in overall effectiveness in the absence of proper resourcing.

Finally, there should be a renewed emphasis on management and workplace innovation as the key to a competitive, knowledge-based economy. This must encompass not only workforce skills for the future but also capability building in management. A recent analysis of Australian small and medium enterprises, as part of a global study led by the London School of Economics, showed that the area where managers here

most lag world best practice is in the category titled 'instilling a talent mindset'.[27] This suggests that our education system should pay more attention to development of talent and creativity through the provision of 'boundary-crossing' skills of communication, leadership, problem-solving and design thinking, as well as specialised technical knowledge.[28] Our argument is that the real deficit in our economy has less to do with a 'budget emergency' than with the performance of our innovation system, the imagination of our policymakers and the capacity of our managers to nurture talent and deploy it to fuller potential.

Politically, this approach calls for a 'narrative' capable of mobilising ideas and commitment and legitimising action on the required scale among business, unions, governments, educational institutions and the broader polity. In other words, what is needed is a new social contract for the next challenging stage of Australia's social and economic development. In this context, federal-state collaboration should also be better orchestrated. Patterns of action evident in the much more diverse US show this can be accomplished.[29] More ambitiously, agile responses are required within the narrative framework, and here public-private collaboration is the key to success. Any new framework must be able to reconcile contextualised action and continuous improvement as well as proper accountability, but this will entail a step change in public policy practice.[30] If Australia is to fully realise the transformative opportunities of new technologies, skills and business models, political leadership on a scale and in a form that is not so far evident, will be required. A new social contract is necessary and overdue.

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4.3

A brave new world of higher education

Professor Jane den Hollander

Professor Jane den Hollander has been Vice-Chancellor and President of Deakin University since July 2010. At Deakin, Professor den Hollander introduced LIVE the future, an aspiration for Deakin to drive the digital frontier in higher education, harnessing the power, opportunity and reach of new and emerging technologies in all that it does.

Professor den Hollander holds a BSc (Honours) First Class in Zoology and a Master of Science degree from Wits University, Johannesburg. Her PhD is from the University of Wales, Cardiff.

Professor den Hollander is currently a board member and Deputy Chair of Universities Australia, a director of Education Australia and UniSuper. She is Deputy Chair and trustee of the Geelong Performing Arts Council and Chair of Skilling the Bay, a Ministerial Advisory Group focused on ensuring the skills and jobs of the future for Geelong in a transitional economy.

Prior to taking up her appointment as Vice-Chancellor of Deakin University, Professor den Hollander was Deputy Vice-Chancellor (Academic) at Curtin University in Western Australia.

On the cusp of a brave and different world?

Towards the end of last century, Clark Kerr, an exceptional president of the University of California, wrote: "everything else changes, but universities mostly endure".[1] Kerr had calculated that since 1520, there were 85 institutions still in existence, all with similar functions and unbroken histories: the Catholic Church; the Parliaments of the Isle of Mann, Iceland and Great Britain; several Swiss cantons and around 70 universities. Kerr reflected that those 70 universities were still in the same locations (often the same buildings), their professors and students were doing much the same things, their governance was much the same and they were producing essentially the same product.

Largely unchanged for centuries, events of the last few years suggest universities, and higher education more broadly, are now confronting transformational change in terms of their function in society, their business models and, importantly, a reassessment of the value they deliver to the communities they serve. The age old established models of operation are being questioned in every corner of the globe.

The second decade of the 21st century may well debunk Kerr's observation, albeit for some of us it is considered foolhardy to write off universities so quickly. Each painful turn of the economic wheel from agrarian to industrial to digital has seen universities grow and prosper by aligning to national and international workforce needs. Why should the new information age, the age of machines, be any different? Is it possible for the academy to evolve and keep its place in the community? If so, how and doing what? Providing content and paper-based in-person assessment, publishing ever faster and marching to an ecclesiastical calendar irrelevant for much of the world, is probably not going to cut it.

An increasingly complex and crowded market

History shows that global competition is not particularly new, it has existed and formed society down the ages but today's global market represents something of a paradigm shift, particularly for Australian business, and that includes higher education. The global focus has shifted to Australia's half of the globe. The Asia Pacific contribution to global gross domestic product (GDP) rose from 9.1 per cent to 22.8 per cent in the last 50 years[2], and nations that for decades have been Australia's major source countries for international students are becoming our major competitors. China is now the third most popular international study destination (behind the United States [US] and the United Kingdom [UK])[3], with Australia slipping to sixth place behind France and Germany.

At a time when universities in most western countries including Australia are experiencing increasingly constrained public funding, our Asian neighbours have strategically and systematically increased expenditure. The amount of money India now allocates to higher education is nine times the amount of previous years, and China's research and development budget has more than quadrupled.[4] We, the Australian academy, also operate in a much more complex market. Until recently, Australian universities only faced competition from other universities, but today they compete with many privately funded providers, public vocational colleges and of course, international institutions that see Australia as an interesting market, perhaps as a time zone friendly launch pad for their operations into the wider region. At least two Australian stock

market listed companies, Navitas and SEEK, operate in higher education, and according to its 2013–14 Annual Report[5], Navitas has higher education revenues of $499 million with profits of $122 million. Added to this, the introduction of a demand-driven funding model in Australia in 2012 has driven new levels of competition, the full impact of which is yet to be experienced. Already four Victorian universities have lost 3.5 per cent or more of their market share.[6]

The university student cohort is changing

Higher education used to be a privilege reserved for the elite, but since the 1970s, this has altered for good. Globally, the number of students enrolled in higher education is forecast to rise from 99.4 million in 2000 to 414.2 million in 2030, an increase of 314 per cent. In Australia, domestic enrolments exceeded one million for the first time in 2014, with 37 per cent of Australians aged 25 to 34 having a bachelor degree or above (up from only three per cent in 1970). The massification of university education is a global phenomenon. While it began in the west, the greatest growth today is in Asia and the Pacific. The number of university students in China grew from 12.3 million students in 2000 to 34.6 million in 2013[7], and India has plans to increase its participation rate to 30 per cent by 2025.

The success of equity participation strategies means that university populations are more diverse than they were last century, and with lifelong learning, numbers of mature age students are also expected to grow. The job of a lifetime no longer lasts a lifetime and all graduates can expect to cycle through multiple career shifts requiring multiple skill changes.

The higher education sector is experiencing evolutionary change

Throughout history, economies have been shaped by revolutionary inventions: the printing press, the steam engine, the telephone, the electric light bulb, the silicone chip and most recently, the internet and the iPhone. These innovations have changed our world and now enable smart machines to begin their inexorable rise. Each innovation has sparked a 'virtuous circle' of economic growth for those who could take advantage. Each successive wave of change has meant the drastic and sudden elimination of jobs and the demand for new and different skills elsewhere – millions left agriculture but many more went into manufacturing. Each successive change has fostered new ways of doing business – the Oxford dons were worried the printing press and the access it provided to printed word would make them redundant, instead it led to new ways of engaging with knowledge and with a new class of learners.

The introduction of the silicone chip and the internet manifests critical differences to previous revolutionary changes, and its ubiquity has crept up seemingly by stealth for those not paying attention. It began quite slowly in the 1990s but in its maturity presents us with a series of megatrends including the introduction of mobile technology, Big Data, robotics, social media, and most compellingly, customisation and personalisation. The internet is inherently global and currently links around 40 per cent of the world's population. The rate and pace of internet penetration has been remarkable; the first billion internet connections were reached in 2005, the second billion in 2010 and the third billion in 2014.[8]

As the world's economic power shifts east, the digital divide has reversed, with over half of the world's internet users now in the developing world (48.5 per cent in Asia and 9.8 per cent in Africa).[9] India has 243 million internet users, more than the US and second only to China.[10] Smartphones are a relatively recent phenomenon (the

first iPhone was introduced in 2007) but access to the internet is increasingly via smartphone and tablet; in Asia, 26.6 per cent and in Africa, 23.7 per cent of web traffic today comes from mobile devices.[11] Many millions in Asia and Africa will never use a land-based telephone, having leap-frogged a hugely expensive and now almost redundant technology.

The impact of the internet also traverses multiple industries, with few businesses left untouched by the digital economy. And its reach is deepening; while early computerisation affected employment only in labour-intensive, readily coded repetitive tasks, the evolution of cognitive computing moves into areas previously believed to be uniquely and exclusively human, beyond the touch of technology and machines. Google's driverless car and cognitive computer IBM Watson show just how far and how fast digital pattern recognition abilities have advanced. In healthcare diagnostics, IBM Watson can assist patient decision-making using knowledge from 600,000 medical evidence reports, 1.5 million patient records and clinical trials, and two million pages from medical journals. This wave of innovation means more is being done with less to the benefit of more people than ever before. Deakin University has partnered with IBM Watson to surf the megatrends of automation, Big Data and customisation. It is a partnership that will enable us to personalise the student experience in ways previously unimaginable – just in time, just for me, anytime, anywhere and on any device. Cognitive analytics will enable Deakin students to receive personalised and seemingly prescient answers to their questions 24/7, 365 days a year. For the first time in history, machines can learn from experience – as Watson learns, so will Deakin.

Google Chairman, Eric Schmidt, claimed in 2010 that every two days we create as much information as we did from the dawn of civilisation up until 2003. The world contains an imaginably vast amount of information, much of it user generated through Tweets, Facebook and Instant Messaging. In this era of Big Data and analytics, we can segment, target, predict and describe information in ways unimagined a few short years ago. The availability of Big Data means that businesses and customers (and that includes universities and their stakeholders) can implement a continuous cycle of understanding and improvement. It gives us new ways to collect and think about data, and new ways to link data sets to generate new insights.

The other major megatrend is the infiltration of social media into our lives. From a 2004 starting base of one million users, in September 2014 Facebook reported 1.35 billion active monthly users.[12] Instagram, Snapchat and Yik Yak are the next wave, and for many, online communication is now personalised, highly visual and almost always interactive. Social networking services such as Facebook, blogging, YouTube, mobile phone applications and the use of gaming technology enable a depth and breadth of engagement that even five years ago did not exist. While many might say there is too much 'screen time', it has become a major part of our social lives. Alongside this phenomenon, the new media delivers high-quality and cheap business intelligence, and client relationship management support, and is the catalyst for global access to research data and collaboration.

Social media presents universities with important new opportunities for lifelong engagement: from future student to undergraduate to postgraduate to alumni to business partner. However, Forrester Research Principal Analyst, Julie Ask, advises that organisations "think of being big mother and being helpful rather than big brother and creepy".[13] Either way, the future has arrived for our generation. How we embrace it will be critical to our wellbeing and our economic success.

What does the digital age mean for universities?

Universities are now operating in the age of Google. The internet is the primary platform for creating and sharing information, and universities are no longer the gatekeepers of knowledge. Consumers of information are not passive observers but active contributors who co-create knowledge, evolve markets, have opinions, and influence elections and hence governments.

Gallagher and Garrett remind us that technology-enabled higher education requires a mindset change[14] for which universities must focus more strongly on what their students want and what employers are looking for in graduates. They cite Jeff Bezos, founder of Amazon: "You can't stop at 'what are we good at?' You have to ask 'What do our customers want'. And no matter how hard it is you better get good at those things."[15] Vice-chancellors today know that students expect from universities what they have come to expect in other aspects of their lives: services that are responsive, customer-focused and available 24/7. They also expect to be educated to compete for the jobs of the future. By 2020, this will in all likelihood be in a machine-dominated future and herein lays a significant hurdle.

The rise and rise of massive open online courses

Online education is not new, but the rise of massive open online courses (MOOCs) from 2012 represented the first wave of disruptive change for educators. While the early MOOCs are certainly massive, they are not selective, they don't carry academic credit, they are not particularly innovative in curriculum design, and they take no responsibility for learning outcomes but rather rely on their partner organisations for this. As the first wave of change hit, universities globally raced to adopt new technologies, with many universities developing purpose-built platforms to enable curriculum innovation in assessment and curriculum design. We're about to experience MOOC mark two, and while the US may have dominated the early MOOCs, the large Asian markets have shown great interest in the capacity for MOOCs to offer a cost-effective alternative for large populations previously without access to higher education. China and India are the economic powerhouses of the future and they certainly have the scale, energy and potential to become a digital laboratory and growth engine for the world.

The analogy with music is useful in understanding the impact of MOOCs on higher education. Since the invention of the gramophone, music lovers have seen the quality of sound as a primary goal. With the advent of iPods and smartphones, the focus shifted inexorably to accessibility – the particular songs we want, when we want and where we want to hear them have taken precedence over quality. Once the iTunes business model took hold, it fundamentally changed how people think about and buy music. MOOCs are the iTunes of education; they won't replace a quality campus-based education but they can provide all those with access to an internet connection with the opportunity to learn from the most charismatic teachers at the world's highest ranking universities with no travel costs, no accommodation costs and no fees. In the space of two years, online education has gone from poor relation to cutting edge, from drab and second best to sexy and 'must have'.

MOOCs present wonderful opportunities for universities to contribute to the three megatrends mentioned earlier: automation, Big Data and customisation. They enable truly international 'cloud classrooms' and cross-cultural learning. They provide students with an opportunity to 'try before they buy', get customised feedback from peers and only engage when they want. MOOCs generate massive data sets of information that can inform curriculum design and redesign. They are a springboard for

developing new and more authentic ways of assessing students; for example, using computer simulations to link assessment to solving real-world problems – credentialed with peer-assessed digital badging.

We can now disaggregate or 'unbundle' within courses so that students undertake only those courses they require, uncoupling 'learning' from credentialing. With the advent of *MOOC.org*, employers and other non-education providers can tailor their own executive education courses; something major companies like McKinsey & Company have been doing successfully for many years.

These changes bring into question long-held beliefs about the nature of a university education. If a series of digital badges from a selection of MOOCs could provide an internationally recognised assessment of achievement, what does this mean for three- and four-year degrees? In a global market, why should courses be tied to a western ecclesiastical calendar? Will employers prefer to deal directly with MOOCs, accessing rich analytical data to determine students who will best match their skill requirements? Employers are already beginning to see digital badges from MOOCs on a résumé and university admissions officers are beginning to see them on university applications.

Interesting questions, but MOOCs represent only one pathway to education and good universities have always had a multiplicity of approaches. As Stanford Professor Susan Holmes said: "I don't think you can get a Stanford education online, just as I don't think Facebook gives you a social life."[16]

The technology-enabled university

Few university students are solely 'on-campus' with no access to the cloud or 'off-campus' simply receiving and absorbing learning resources digitally. When students travel to a university site, they expect technology-rich learning spaces with ubiquitous Wi-Fi and when they access their university's learning platform, they want seamless single sign on access to a wide range of resources. Integrated communication and collaboration platforms enable students and staff to create documents and files; store, access and share files; and communicate and collaborate on multiple devices. They expect to videoconference with peers and lecturers, jointly work on documents, book a computer or order a coffee from the cafeteria – anywhere, anytime, from any device and with no hassle.

The increasingly used flipped classroom model lets students build their knowledge outside the classroom, allowing them to manage lecture content in their own time while using campus time for discussion and the development of generic skills. Leadership skills, cross-cultural communication, problem solving, internships and teamwork are all highly valued by employers, and are skills that can't readily be commoditised. In the digital age, the richness of campus life (student services, libraries, sporting activities and catching up in the cafeteria) is an even more important 'value add', particularly for school leavers. An element of university life unchanged for centuries is that friendships forged at university can be life long and can form the business networks of the future. A key difference today is that cyberspace facilitates the continuation of relationships across geographical boundaries.

Flexibility is important in the digital age and place-based learning needn't be restricted to a campus, but can include industry placements and localised learning centres. For example, Deakin's learning centres are located in regional shopping centres and town centres, allowing people to study without incurring costs of leaving home thus making education accessible for those with families and jobs – providing students with education at their own pace in their own place.

Preparing for life and work in the machine age

New industries are emerging. The United States Department of Labor reported[17] that 65 per cent of primary school aged children in America will end up in jobs that haven't been invented yet and it's a pattern replicated globally. Frey and Osborne[18] suggest that almost 47 per cent of jobs in the US will be computerised within one or two decades. Universities today are preparing young people to be app developers, data scientists and social media managers – jobs unheard of a decade ago. Universities will need the agility to manage accelerated change if they are to meet the challenges of a complex and often ambiguous future.

In preparing students for 21st century lives and careers, some things are clear. Firstly, we will need people with a firm grounding in science, technology, engineering and mathematics (STEM) including computer science skills such as coding. A recent report from the Australian Government[19] suggests that 75 per cent of the fastest growing occupations will require STEM skills and knowledge. A difficulty for Australia is that Australia's performance in mathematical literacy is falling and participation in science subjects is at record lows.[20] The report also notes the importance for Australia of promoting an entrepreneurial culture, and integrating innovation and entrepreneurship into mainstream school and assessment.

Secondly, in an age when vast quantities of information are available instantaneously and outdated almost immediately, the ability to deal nimbly with complex and often ambiguous knowledge is far more important than an accumulation of facts. In a flat, connected world, graduates will need the cultural awareness, global contacts and skills essential for a global market place. Most graduates will either work in an international company or spend part of their career overseas – to be global business savvy, to be worldly, is no longer a 'nice to have', it's a competitive advantage.

Finally, universities will also need deeper relationships with industry and employers. In a fast evolving technology landscape, the connection between work and learning will become closer, and work-based learning opportunities will have a critical place in preparing students for the jobs and skills of the future. Often described somewhat pejoratively as 'soft skills', leadership, cross-cultural communication, problem solving and teamwork are all highly valued by employers and will be a critical element in preparing graduates to compete in the global war for smart talent. For a wide range of reasons – including the increasing number of university graduates with oversupply in some areas and diminishing employment opportunities in others – universities will need to take the employability of their graduates much more seriously.

The future for the Australian higher education sector?

If the Australian university sector is to thrive, indeed survive, it must develop organisational structures and business models that leverage ever advancing technology with complementary human capital – the creativity, entrepreneurism, intuition and cross cultural understanding that are uniquely human.

We need regulatory structures that will be sufficiently flexible to support the disaggregation of learning – systems based on authentic and measurable assessment that are focused on the outcomes that a global market needs rather than a calendar year or institutional prestige.

Australia currently has a reasonably rigid regulatory environment: the Tertiary Education and Quality Standards Agency (TEQSA) is the regulator and the Australian Qualifications Framework Council (AQFC) sets the framework within which universities

operate. Rules about the volume of learning and the time required to receive an award may have less relevance when students are pacing their own learning online. Incorporating technology-driven innovations within our current regulatory framework is difficult; for example, the degree in its current form may soon be constructed using digital badges and micro badges collected globally and locally from educational institutions, from industry and from other activities. All of this will count towards employability and a modern education as part of an ePortfolio. There may be a new generation who does not want a whole degree. Does Australia, in its quest for accessible innovation, need whole degrees? Should its universities be allowed to experiment with what is needed for the future rather than what has always been 'the way we do things'?

The current fiscal constraints experienced by Australian universities are likely to continue, and universities need to be seen as partners with government, stimulating innovation and economic growth both in terms of commercialising research and preparing an internationally competitive workforce. As Australian Treasurer Joe Hockey observed in his May 2015 Budget speech: "Australia's universities provide the platform for our nation's innovation, for creativity and productivity."[21]

Over the last 20 years, higher education has become a significant export industry with publicly funded universities earning $5.1 billion from international students in 2013.[22] The market is changing and Australian universities must work to their strengths to take advantage of the opportunities that digital change presents. For example, the global language learning market is expected to grow at 20 per cent per annum to $247.5 billion in 2017, with English language learning growing at 25 per cent. Australia is particularly well placed geographically to take advantage of this growth. A holistic Australian campus experience (but not necessarily a three-year international degree) will be increasingly attractive to international students. Perhaps the trick is to look for affordable excellence since we cannot do everything for everyone, but we can do some things brilliantly, and we do know how to educate at scale and at a price that is efficient on the global stage.

Digital technologies have changed the way education services are delivered, supported, accessed, assessed, perceived and afforded. The knowledge economy needs a delivery model that is flexible and accessible from anywhere. Education is one of the 'Long Fuse Big Bang' industries identified by Deloitte in its analysis of the impact of digital disruption on industries[23] (subject to major transformation but over a longer time period) and now is the perfect time to capitalise on the opportunities of digital change. The biggest risk of all for Australian universities is complacency. As social commentator and actor Will Rogers famously said in the 1930s: "even if you are on the right track, you will get run over if you just sit there".[24]

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4.4

Future skills in information technology

Hugh Durrant-Whyte

Hugh Durrant-Whyte is a Professor and ARC Federation Fellow at the University of Sydney. He was CEO of National ICT Australia (NICTA) from 2010 to 2014, Director of the Australian Research Council (ARC) Centre of Excellence for Autonomous Systems and of the Australian Centre for Field Robotics (ACFR) at the University of Sydney from 1995 to 2010, and University Lecturer in Engineering Science at the University of Oxford from 1986 to 1995. Hugh Durrant-Whyte was named the 2008 Professional Engineer of the Year by the Institute of Engineers Australia, Sydney, and the 2010 NSW State Scientist of the Year. He is a Fellow of the Australian Academy of Science (FAA) and a Fellow of the Royal Society (FRS).

The future of information technology in Australia

Information and computing technology is disrupting and transforming all sectors of the Australian and world economy from media to mining, from energy to health, and from manufacturing to financial services. This pervasive use of information technology is now the most important driver of future productivity and wealth creation, affecting every area of our economy and society.

Broadly, future information and communications technology (ICT) will affect Australia in two ways:

1. Through the *application* of ICT to existing industries and businesses; and
2. Through the *development* of new technology companies and products.

Evidence suggests that Australia will almost certainly see much more economic impact and social disruption through the application of information technology to existing industry sectors than through the development of new technology companies. This means that the future ICT skills required of Australia will be much more in the area of clever application of technology to problems than in the fundamental development of new technologies.

There are two main reasons why application rather than development of ICT will likely have the biggest impact in Australia. First, the relative economic scale of sectors including resources, agriculture, financial services and transport mean that even modest productivity improvements achieved through the application of ICT result in substantial improvements to the competitiveness of these sectors and the wealth of Australia more generally. Second, the development of broad technology sectors requires a scale of skills and funding (also 'ecosystem' and culture) rarely found in Australia. With a few niche exceptions, Australia just does not have the density and intensity of skills, talent and funding for the development of deep ICT technologies available in the United States (US), China, Japan, Europe and many other places.

While ICT applications are broad ranging, there are a number of specific domains where Australia is likely to play a technology leadership role. Most clearly is in the mining and resources sector where the mining equipment, technology and services (METS) sector is already a major global industry worth approximately $90 billion and supporting 400,000 jobs.[1] Australia has a major comparative advantage in the resources sector that includes an increasingly substantial portion of information technology. Agriculture is another key application area where Australia will have a comparative advantage in applying ICT – through precision farming, decision support, supply chain logistics and automation.[2] Other areas where Australia has a degree of comparative advantage in the application of information technology include financial services (FinTech), infrastructure including utilities (smart infrastructure), and medical devices (MedTech). Together these application areas are likely to be the main drivers for information technologies in Australia in the next 20 years.

These application areas draw on a number of core information and computing technology areas. Robotics and automation are key to productivity in a number of primary sector industries including mining, agriculture and materials handling, where Australia can claim significant technical leadership. Notable is the mining automation work being undertaken by Rio Tinto and others, and the automated cargo-handling systems developed for the Port of Brisbane and Port Botany. Machine learning and Big Data technology is playing an important role in the primary sector, financial services, media, infrastructure and health. This includes the development of algorithms

for event or correlation detection, and the use of large-scale computing including cloud-computing technologies. Other areas of ICT that will see broad application in Australia include optimisation and logistics, networks and wireless (driven by investment in the National Broadband Network), spatial data analytics aimed at resource and environment modelling, and software engineering.

Australia's comparative advantage in specific industry sectors can be a driver for technical leadership in key areas of information and computing, both locally and potentially at a global scale. In turn, expertise in applying ICT to specific industry sectors can be a catalyst for building a range of new technology companies. The METS sector is a good example of this, but so are the growing number of companies in areas such as analytics as applied to financial services and health, MedTech, and the significant expertise in optimisation as applied to infrastructure and supply chains.

Future information technology skills and jobs

The disruption caused by information technology is resulting in massive changes in the employment landscape – for all industries and all individuals. This disruption will have a profound impact on both the type of skills required in the future as well as how future jobs will be undertaken. A recent much-cited report has estimated that nearly 50 per cent of current jobs in the US will be computerised or automated within the next 10 to 20 years.[3] At the same time, many routine jobs are being offshored and an increasing number of creative jobs are being freelanced through the global marketplace of the internet.[4]

Understanding the future of information technology in Australia leads to the inexorable conclusion that future skills and jobs will most often be concerned with the creative application of technology to solving problems. That is, the key future skillsets in information technology will be about creativity, originality and problem-solving across a broad range of business sectors. These are skillsets that play to Australia's most likely comparative advantages, are least likely to be computerised or offshored, and offer the opportunity to create real wealth and value, as well as affecting the productivity and sustainability of all industry sectors.

Broad technical skills

Across the broader population, every individual in a future society will need an appreciation of technology and how it can be used. This will need to be reflected in the science, technology, engineering and mathematics (STEM) training context with more focus on broad appreciation of science and technology and how it can be applied. At primary school, this means teaching technology, creativity and problem-solving. At secondary school, this means offering technology as well as science, and indeed technology for those students who are not and never will be scientists or engineers.

In tertiary education, there will need to be a much stronger focus on using technology to solve problems, not just for those in the hard-core science and engineering disciplines (although we need these too), but also those in disciplines from the arts and humanities, to education and social service, to economics and business. It is a heresy to say so, but the reality is that we already have enough individuals who can do integral calculus, who wish to be astronomers or marine scientists, or who can program a computer and design electronics – and too many of them are in retail or driving taxis (soon to be automated).[5] These individuals need also to be trained or to learn how to

creatively reapply these hard-won STEM skills to solving adjacent problems in new domains, and to create wealth in new businesses and industries.

Deep technical skills

The deeper technical skills most likely to be required in Australia's digital future can be characterised as 'architecting, designing and analysing'. These are key skills in applying information technology in every business sector:

Architecting: Putting together components to build bigger, generally bespoke, systems. Architecting is a 'systems engineering' skill, knowing how to integrate computing and communication resource with both off-the-shelf and significant bespoke software engineering. Typical are projects and products that involve data storage and management, cloud computing, provision of (mobile) services, integration of automation into processes. Architecting skills are generally well represented in companies in Australia and are generally well taught in current undergraduate computing degree programs.

Designing: Conceptualising new solutions, developing algorithms and optimising processes. Designing requires deep understanding of a problem space, of users and customers. At one level, this includes user experience (UX) and user interface design skills more generally found in someone with a pure design background. At another level, design requires deep knowledge of sophisticated mathematics and algorithms in areas including modelling, optimisation, privacy and security. Designing will be a key area of future jobs creation in Australia – an area that is hard to automate or offshore.

Analysing: Making sense of data, applying analytics to make predictions and enabling systems to be adaptable, semantic and contextual understanding of information. There is a large and growing demand for expertise in data science and analytics.[6] Analysing requires a deep understanding of areas including probability, statistics, algebra and geometry. The applications, like data itself, are growing at a substantial pace, from banking to health, from environment to energy and resources. Data analytics will have a major impact on almost all areas of business in Australia.

Future jobs in information technology

The main future jobs in information technology in Australia will be around architecting, designing and analysing. A large part of these will be with existing non-IT companies, especially banks and insurance (and other financial services), and engineering, especially energy and resources, health and social services, media and entertainment. This reflects the fact that the major role of information technology in Australia is to transform existing companies and existing ways of doing business. Especially in these non-IT companies, creative application of technology to solving problems will be required of all staff and thus all will need a working knowledge of technology and how it can be used in business – like reading and writing, this will be fundamental in all jobs. Retraining and additional training for graduates with other STEM qualifications need to be a major part of creating an information technology jobs pool for existing businesses.

Simultaneously, there will be a need for specialist information technology companies to support and build existing business. While there will always be a major role for large international information technology companies, indigenous companies are likely to be much more specialised around specific technologies (for example, analytics, software checking and security) to be competitive in the international arena[7], as the Australian

market is too small to be competitive by itself. Jobs in these companies will require deep skills in areas such as programming, data analytics and security – skillsets that are not readily available in Australia at present – that will need to be provided by tertiary education.

Finally, there will need to be a much stronger focus on entrepreneurship at all levels and in all sectors of education. It will no longer be enough to have a single skill or profession deployed in a single company, rather people will need to be able to assemble skills from many sources and rapidly put these together to solve problems in an agile and flexible manner.

Skills, technology and the broader strategic impact

Digital disruption is the fifth horseman of the apocalypse, wreaking havoc in all areas of the economy and society. For all organisations, digital technology is commoditising core business, challenging accepted ways of delivering outcomes, and at the same time providing new opportunities for products and services not yet dreamed of. This technology is driving massive social and economic change; people no longer interact with each other or with their employers in the ways of the past.

Any future skills and jobs strategy needs to recognise that digital technologies are destroying jobs as fast, if not faster, than these technologies are creating new opportunities. It has been estimated that over the next two decades, digital technologies and automation will eliminate over 45 per cent of jobs in the US and 35 per cent in the United Kingdom (UK) and Australia. Furthermore, the nature of digital job creation and destruction is not the same as previous technology-driven change. Artificial intelligence and related technologies are 'hollowing out' the job market rather than automation simply pushing skill levels up from the bottom.[8] That is, there is a polarisation of jobs and skills, with high-end professional jobs at one end, low qualified service jobs at the other end, but with many middle-tier jobs in processing or servicing being computerised or automated. Beyond this is the casualisation of work through outsourcing and freelancing which, while good for the consumer, reinforces this polarisation.[9] Job polarisation has been a trend in the US, UK and Europe but has yet to be felt fully in Australia.[10]

Brynjolfsson and McAfee state:

> "Digital technologies change rapidly, but organisations and skills aren't keeping pace. As a result, millions of people are being left behind. Their incomes and jobs are being destroyed, leaving them worse off than before the digital revolution. While the foundation of our economic system presumes a strong link between value creation and job creation, the Great Recession reveals the weakening or breakage of that link."[9]

What does this mean for future workplace skills and jobs? Future schools and universities face a double task: how to adapt to and embrace new agile technologies, and deliver the skills that students and employers want, while remaining true to the deeper ethic and culture of learning. In future, everyone will need to be a technology generalist and a few technology specialists. Everyone will need to be creative and agile with the application of technology to problems and be able, at some level, to 'architect, design and analyse'. This will be true of all productive jobs that will not themselves be hollowed out by information technology. This is a radical departure from current schooling and training practice and is different again from the simple slogan of 'more STEM'.

It is much easier to predict which jobs will be lost than those that will be gained. Many future products, services and jobs have not yet been imagined. New jobs may be in designing online avatars and persona, jobs that service individuals' management of security and privacy, yet more that assist in managing and delivering personalised entertainment. All of these suggest that given the high levels of productivity and automation enabled by information technology, future human jobs may be focused on personalising technology for other humans.[11]

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4.5
Northern lights

Dr Andrew Scott

Dr Andrew Scott is Associate Professor in Politics and Policy at Deakin University, Melbourne. Dr Scott is author of five books and numerous book chapters and articles on aspects of politics, policy and history, frequently involving international comparisons. He is also a former national policy adviser on employment and training issues. For several years, Dr Scott has been researching English-speaking nations' past interest in, and lessons from, the policy achievements of the Nordic European nations.

Introduction

Individual nation states can continue to play a significant role to ensure the continuation of jobs, and to boost levels of workforce participation, if they pursue effective policies for skills retraining. Australia, for instance, can learn much from Denmark about providing substantial skills retraining and new employment opportunities for the mature-age unemployed.

The numbers of mature-age unemployed are set to rise further in Australia following an estimated fall in national employment of as many as 200,000 people because of the planned closure of all three Australian carmakers by 2017.[1] This will be in addition to the loss of that industry's considerable research and development activity.

There has been a dramatic decline of employment in many steel and manufacturing locations in Australia since the 1970s. One of the lessons learned from these experiences is that you cannot just take middle-aged workers out of factory environments, put them into classrooms and then expect them to immediately learn new skills for new jobs in that unfamiliar setting. Denmark has had to grapple with a similar decline of heavy industry, including shipbuilding, over recent decades.

Case study: South Australia

One part of Australia affected by employment decline was the southern suburbs of Adelaide early this century after it was hit by the closure of Mitsubishi car-making operations. Of those workers made redundant, one-third never worked again. The shutdown of Mitsubishi's Lonsdale foundry in 2004 and then its Tonsley Park engine-making plant in 2008 had a devastating impact on the lives of many workers. Adelaide's southern suburbs suffered an economic shock, which is still being felt. It is important for decision-makers to keep such effects in mind when considering car workers' futures around Australia now.

Professor Andrew Beer says: "Often you hear relatively dry economics arguments around 'well this is just a process of structural adjustment', but in fact these are real people having their lives affected in a very real way". He makes a very important point that needs to be registered by those who smooth over aggregate employment statistics to minimise and downplay the deep human hardship felt by the many who go prematurely from paid work into the ranks of the often hidden unemployed. Beer warns that the imminent exit of all carmakers from Australia will be felt for generations. He urges governments to move quickly to ensure that workers are given the opportunity to learn new skills before the plants close.[2] He adds that these upcoming closures will be worse in their impact than previous shutdowns because of the fact that three major car manufacturers will be closing across Australia at a similar time.[3]

The Danish approach

Another analyst of adaptations to past downturns in the South Australian economy, since the international economic recession of the 1990s, is Rodin Genoff. He has worked as a practitioner in economic adjustment initiatives in another hard-hit former car-making region in that state: Elizabeth, north of Adelaide. Genoff has since gone on to carry out regional development analyses and projects in central and northern

Denmark, following interest taken in his work by the Organisation for Economic Co-operation and Development (OECD).

The Danish approach and the substantially higher public investment in skills retraining opportunities makes a massively positive difference to the prospects of mature-aged unemployed workers in Denmark compared with Australia, Genoff says. This is particularly for workers in (former) manufacturing regions.[4]

Denmark's approach includes active programs to provide support *before* the workers leave their old jobs through local employment services working constructively and early with the company and using a combination of public and company funds.[5]

A basis of economic security crucially underpins Danish workers' flexibility between particular jobs.[6] Denmark's three-pronged approach to employment policy involves flexible rules for hiring and firing. It also crucially involves the provision of generous unemployment benefits for those who have lost jobs. Just as crucially, it involves the provision of substantial and effective Active Labour Market Programs (ALMPs) to help unemployed people gain new skills for new jobs. The Danish approach came to be closely identified with the term 'flexicurity', after the OECD held Denmark up as a shining example in 2004. In reality though, this three-pronged employment policy is a very longstanding approach reached as a result of contests and compromises between unions and employers. It has evolved in Denmark over more than a century. The balance did, however, change somewhat in Denmark from the mid-1990s when the Social Democratic Party then in government considerably boosted spending on the ALMPs component.

Australia has the lowest level of unemployment benefits in the OECD for a single person recently unemployed. Denmark has one of the highest levels.[7] Australia's employment services system, meanwhile, tends to reward private businesses that give priority to the most easily placed of the unemployed. It does not give enough resources to providers that can offer the most disadvantaged jobseekers the intensive, individually tailored services and help they need.[8] Case management often does not start until long into unemployment, and it is not as comprehensive as it was in association with the short-lived suite of ALMPs introduced by the Labor Government in Australia in the early to mid-1990s.

Denmark has much more supportive employment assistance and active labour market arrangements to assist the jobless. The scale of investment in reskilling programs in Denmark enables job centre caseworkers to be broad-minded about the possibilities for fundamental career change, which they can suggest to unemployed workers. They can, for instance, support, and have in some cases supported, the transition of male workers from the industry of shipbuilding, which has declined, into working in care for the elderly, which is growing.

A comparative study of employment services in the two nations has found that:

> "Danish case managers operated quite differently to their Australian counterparts. They were, for example, more attuned and responsive to the social and environmental issues confronting their clients, and they displayed considerably more discretion and autonomy in the way they worked to take into account 'social' factors in their understanding of unemployment".[9]

By contrast:

> "Australian case managers … were significantly more constrained, and operated in a manner congruent with the punitive policy context that they work within. They were also less able to use discretion to mitigate the effects of these policies because they themselves were subject to a range of organisational performance measures that focused on achieving certain output targets".

A 2014 report from the Danish Government Expert Committee on active labour market policy recommends – in contrast to the ever more punitive direction of policy in Australia – the introduction into Denmark of certain *rights* to education and training for the unemployed who do not have formal competencies, as they are most at risk of long-term unemployment. These include the right to an assessment of real (non-formal) competencies, the right to basic courses in reading, writing and mathematics, as well as the right to vocational education for unemployed persons most in need, who it identifies as being lower skilled unemployed people aged 30 or over.

Significantly, and also in clear contrast with the direction of Australian policy, the Danish Expert Committee recommends the abolition of procedural requirements on the unemployed regarding interviews, and the abolition of obligations to participate in repeated active measures. It makes this recommendation to achieve "a greater focus on contents and results". If that proposal is adopted, unemployed persons in Denmark will only be obliged to participate in one activating course after six months of unemployment, and this course will always be connected to an enterprise, as such measures prove most effective.[10]

Former economics editor of *The Age*, Tim Colebatch, wrote in 2005:

> "Since the mid-1990s, Denmark has tackled skills shortages and unemployment by its own ambitious version of mutual obligation. It requires unemployed people to undergo education and training to equip them with the skills the economy needs, and which they need to find work. In Australia, mutual obligation has done nothing to meet the country's skills shortage because we are doing it on the cheap, sending people off to work-for-the-dole projects that do little or nothing for their job prospects. Denmark has done it seriously, and it works".[11]

The Working Nation ALMPs – introduced under the Keating Government following Australia's descent into the international recession of the early 1990s but abolished by the Howard Government – envisaged the Government's obligation as extending to providing skills training for the unemployed. The programs were based on a premise that a Government's obligation to unemployed people is more than just the payment of a bare subsistence unemployment benefit.

The unemployment rate in Denmark, with its high investment in ALMPs, was lower in all but one of the 14 years of economic upswing from the early 1990s recession, until the effects of the Global Financial Crisis (GFC) were felt in 2009, than was the unemployment rate in Australia, with its non-investment in ALMPs.[12] The Danish policy approach was clearly superior at channelling economic growth into jobs growth.

The Danish National Centre for Labour Market Research (CARMA) at Aalborg University in Denmark brings a welcome, broadening social policy dimension into the analysis of ALMPs. Orthodox labour market economists often tend to be too narrow and technical in their measurements. Denmark does nevertheless rigorously review its programs to ensure they are being effective. For example, 17 out of 19 Danish and international studies have found positive effects from its private wage-subsidy programs.[13]

Denmark now spends nearly eight times the public funds than Australia does on ALMPs.[14] In Denmark, retrenched workers do not receive redundancy payments, they instead receive immediate retraining. The retraining is supported with public funds, often in the form of wage subsidies, as well as the intensive publicly funded help for the workers to find new jobs. These active measures mean that Denmark has one of the Western world's highest rates of 'older' people who are still in paid work. Labour force participation rates in Denmark in general – and for 'prime-age' persons (those aged 25 to 54) – have long been very much higher than the rates in Australia.[15]

A move to Danish-style spending on ALMPs will initially cost money, but it will bring Australia much medium and long-term economic benefit. Denmark regards it as a key role for government to manage transitional labour markets, to minimise the risks facing displaced workers and to "make transitions pay" by lifetime learning to increase those workers' continuing employment prospects.[16]

People's lives are characterised by major transitions. As well as the major change many people make at particular points in their lives to become parents, the transitions include:

- From formal education to employment;
- Often at some point from employed to unemployed;
- From health to some form and degree of incapacity; and
- From full-time paid work to reduced paid work and then retirement.

Governments can help people manage those transitions better by substantially investing in lifelong learning. Hence ideas have been put forward for 'lifelong learning accounts'. This is an approach similar to superannuation, with funds being built up to finance further education and training throughout peoples' working lives, with "matching contributions of one per cent of salary (to) be contributed by employers and employees, with a one per cent government contribution for low-wage workers".[17]

Specific practical proposals for policy change in Australia along similar lines have recently been made by ACTU officer Grant Belchamber. He proposes that "by adopting a social insurance model, Australia can raise significantly the income support available to unemployed workers". In Denmark, "unions stress that 'flexicurity' means flexibility *for* workers, not of workers". Further, in the Danish context, "flexibility does not mean wage concessions". Rather, "it is a means by which life cycle considerations and transitions (come into) managing work-life balance … Fairly and properly constructed provisions on working time flexibility are essential components of the … (policy) that operates in … Denmark." The nation has a "focus on life-long learning and skills acquisition through working life (which) delivers a high-skill and high-competence workforce and society, with correspondingly high average earnings".[18]

In Denmark, "all workers can opt in to unemployment insurance schemes (in which) benefit payments rise according to earnings in the previous job". Through that means "the minimum payment delivers a 'replacement rate' (i.e. the proportion of the person's wage earnings in her or his previous job) of around 90 per cent for low paid workers … These benefits are delivered out of dedicated funds." The proportion of the workforce covered by unemployment insurance funds in Denmark is approximately 75 per cent. The "funds are also used to provide top-up pay for employees on shortened hours who are engaged in workplace training".[19]

In Denmark:

> "More than 95 per cent of the workforce will access unemployment insurance, social assistance or both at one or more points during their working lives. While there is a measure of job security in their labour markets, the emphasis in the Nordic countries is overtly and overwhelmingly on employment security".

According to Belchamber, "countries with low unemployment benefit payments", such as Australia, therefore now "should raise them relative to wage incomes", thus increasing the extent to which those benefits replace previous wage earnings. In Australia, "the median length of job duration is around three years, well below most OECD economies and broadly in line with Denmark". Australia already has a flexible labour market, but it does not have either substantial investment in ALMPs or adequate unemployment benefits, so it can now benefit from the *addition* of those elements.[20]

In Denmark, "soon after losing a job, workers have the capacity … and obligation … to undertake a program of (re)training, to upgrade their skills or acquire an entirely new skill set". This is possible because the adequate "unemployment benefits available to them provide motivation and income support for the duration of the training program". Further, for its part, the state has an obligation to provide an adequate range of quality skills training programs for the unemployed. At present:

> "Australia('s) unemployment benefit is so abysmally low … (that it) is … insufficient for an unemployed person – whether a displaced worker or long-term jobless – to find a good new job, let alone undertake any career-renewing training or skills program of quality and substance. Further, the application of strict income and assets tests conditions (for) eligibility for receipt of … (unemployment) benefits … (means that) a prime age worker displaced from their job by economic crisis or restructuring must first expend their cash savings, and in addition their partner's income must be extremely low".[21]

Belchamber argues:

> "A new, comprehensive … unemployment insurance scheme in … Australia … has great long-term promise … The many possible variants of a viable national scheme … (include) premium levels, benefit payments, activation requirements, degree of compulsion, eligibility criteria, the role of government and more. The ACTU (has) investigated the level of benefit that would be available under an illustrative scheme in which a payment of one per cent of gross wages was made for unemployment income insurance cover in a nationally pooled scheme".[22]

Based on various "modelling specifications … (this) exploratory actuarial costing (indicates) the scheme is economically feasible and sustainable".

Denmark has an orientation to on-the-job practical training. The Danish vocational training approach is a practically oriented combination of practice and theory that does not over-emphasise classroom teaching and mostly involves hands-on work with relevant vocational equipment.

Denmark also, very importantly, emphasises the *recognition of prior learning* and experience to add to classroom-type learning to give certified new qualifications. Educational institutions assess and acknowledge what Danish workers have already done, which shortens the period required to fulfil the more theoretical school component of their upgrading of skills to a diploma or other level.

Case study: Lindø shipyard

An estimated 8000 direct and indirect jobs were lost in southern Denmark when the Lindø shipyard, owned by the Maersk company and located in the city of Odense, was closed in early 2012. The policy response taken by the Danish Government has been supportive of the workers' futures. The intention has been to try to preserve employees' skills in the local area and to redirect those into the development of large-scale renewable energy.

Denmark has a Business Innovation Fund, which is "to promote growth, employment and export by supporting business opportunities within green growth and welfare as well as providing support for changeover to … (take advantage of) new business and growth opportunities in less favoured areas of the country".

The Fund focuses on "large, cross-funded innovation programs … through grants and guarantees to firms". From this Fund, southern Denmark received 37 million Danish kroner ($6.9 million) to develop the area where the shipyard is located "into a brand new Lindø Renewable Energy Centre with incubation facilities for start-ups, a test centre, and other facilities that can attract new businesses and job opportunities … in renewable energy to the area".[24]

The Danish Government supplements money provided by the European Globalisation Adjustment Fund to help fund vocational training for, and reskilling of, the retrenched Lindø shipyard workers.

The renewable energy plans for the region focus on wind turbine production and operation. The many wind turbines visible on the horizon, looking in all directions, in many parts of Denmark, are positive environmentally, in addition to their considerable job-creating benefits. The construction and installation of new wind turbines in the Danish part of the North Sea is one of several major infrastructure projects on which Denmark is now embarking as part of further reducing its reliance on fossil energy sources. Many former Lindø workers will be well suited to work on that project.

Official government websites indicate that Danish companies have, to date, installed more than 90 per cent of the world's offshore wind turbines; that 28 per cent of the Danish electricity system is now supplied by wind power; and that the Government aims to raise this to 50 per cent by the year 2020 as part of continuing Denmark's world-leading role in using the inexhaustible natural resource of wind power to help meet people's energy needs.[25] In its regeneration of the shipyard premises, "the partnership approach taken in Lindø by the municipalities, the unemployment benefit insurance funds, and also the private initiative around that place, has shown how you can redevelop a site that seemed doomed".[26]

Just as importantly, serious efforts through customised programs are being made to match former Lindø shipyard workers, and other retrenched workers, to as many as possible of the jobs that new infrastructure investments will generate.[27]

Another recommendation made by the Danish Government Expert Committee on labour market policy is for "annual early overviews of ongoing and forthcoming infrastructure projects and other large construction works", and the implementation of "a regional fund for job-targeted upgrading of qualifications", which is specifically "adapted to the demands related to (those) infrastructure projects".

The Lindø regeneration project provides an imaginative example of great interest for the future – and for the possible transition – of Victoria's La Trobe Valley, and other parts of Australia that have traditionally produced energy from non-renewable resources,

such as the coal-mining centres of the Hunter Valley in New South Wales. There is no reason why the engineering and other skills previously used to manufacture cars in Australia could not be adapted, for instance, towards the manufacture of more wind turbines.

Australia may not have the natural advantages of abundant wind in as many places as Denmark does. However, it does have a much greater natural advantage of sunlight than most countries, including some countries that have already developed solar power far more extensively. Australia can create economic, employment and environmental benefits from further large-scale initiatives to capture and utilise solar power in particular locations.[28]

A number of other manufacturing possibilities have been identified, with agreement from both unions and employers, as having growth prospects in Australia.[29] The skills of displaced automotive and other workers should now be linked with these potential growth areas as a matter of urgent priority. Denmark's Lindø project illustrates, more generally, how Australia should now, similarly, prepare to support, preserve and continue to use, as well as to renew and upgrade for national benefit, the skills and experience of its automotive and other manufacturing workers, instead of discarding them.

Conclusion

The Danish Government is continuing to increase investment in education and training for the unemployed. This marks a clear contrast between the constructive Danish approach to supporting the unemployed into new jobs, and current Australian policy.

Australia, like Denmark, can provide successful training transitions for many 'prime age' or 'mature age' workers who have lost their previous jobs in industries such as manufacturing. This training can be for longer periods, and the upskilling can in particular cases be more fundamental, than has previously occurred or even been contemplated in Australia. The detailed work that has been done towards a proper scheme of unemployment insurance for Australia, drawing from Danish experiences, needs now to be revisited and then refined for implementation.

The current Australian Government is abjectly failing to respond to the plight of mature age unemployed workers. Its decision to extend work-for-the-dole projects indicates that it has no serious interest in providing quality skills training for the unemployed. The introduction in Australia of ALMPs, other training programs and new job opportunities informed by Denmark's precedents, can help provide a new, or renewed, set of skills for many of those workers. This will equip them to keep contributing their talents to add valuably to the output – as well as meet the changing demands – of Australia's workforce.

This is an edited excerpt from Dr Andrew Scott's book Northern Lights: The Positive Policy Example of Sweden, Finland, Denmark and Norway.[30]

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National
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GPO Box 2117
Melbourne VIC 3001
Telephone 03 9662 3544
Email info@ceda.com.au

New South Wales and the ACT
Level 14
The John Hunter Building
9 Hunter Street
Sydney NSW 2000
GPO Box 2100
Sydney NSW 2001
Telephone 02 9299 7022
Email info@ceda.com.au

Queensland
Level 17, 300 Adelaide Street
Brisbane QLD 4000
GPO Box 2900
Brisbane QLD 4001
Telephone 07 3229 9955
Email info@ceda.com.au

South Australia and the Northern Territory
Level 7
144 North Terrace
Adelaide SA 5000
PO Box 8248, Station Arcade
Adelaide SA 5000
Telephone 08 8211 7222
Email info@ceda.com.au

Victoria and Tasmania
Level 13, 440 Collins Street
Melbourne VIC 3000
GPO Box 2117
Melbourne VIC 3001
Telephone 03 9662 3544
Email info@ceda.com.au

Western Australia
Level 5
105 St Georges Terrace
Perth WA 6000
PO Box 5631, St Georges Tce
Perth WA 6831
Telephone 08 9228 2155
Email info@ceda.com.au