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Christian Dustmann

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The Changes and Challenges Facing Regional Labour Markets
The Role of Labour Market and Household Dynamics

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the CENTRE for
LABOUR MARKET RESEARCH

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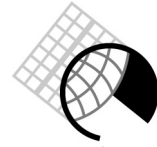
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From the Managing Editor

Welcome to the second issue of the Australian Journal of Labour Economics (AJLE) for 2018. We have been experiencing some difficulties which have meant delay in publishing. However, we expect to have the final issue for the year out shortly.

This current issue contains another from our series of interviews with eminent labour economists. This time we talk to Christian Dustmann of University College London and Director of the Centre for Research and Analysis on Migration (CReAM). Anne Garnett has contributed a very interesting and informative examination of what has been happening in regional labour markets in Australia. Sherry Bawa and Michael Dockery, provide an analysis of the labour market outcomes of women holding STEM qualifications. The results are very interesting (and controversial) with important implications for policies promoting women's participation in STEM degrees in Australia.

The editorial team is working on making AJLE more accessible, including online submission, subscription renewals and an efficiently functioning website for the AJLE, the Centre for Labour Market Research (CLMR), the Australian Society of Labour Economists (ASLE) and the Australian Labour Market Research Workshop (ALMR). Hopefully, this will be up and running next year.

Phil Lewis
Managing Editor

Conversations with an Eminent Labour Economist: Christian Dustmann

Christian Dustmann (CD) is Professor of Economics, University College London and Director of the Centre for Research and Analysis of Migration (CRAM). This interview, with Mike Dockery (MD) of the Bankwest Curtin Economics Centre, Curtin University, took place at the inaugural Asian and Australasian Society of Labour Economics (AASLE) meeting in Canberra, December 2017.

MD: What do you think are the key issues in labour economics?

CD: Labour economics is probably the most advanced field in applied economics, at the forefront of developing new methods and approaches, which have then spilled over to other areas in economics. Labour economics has advanced yet further over the last two decades. One important development is that today we take identification and causality much more seriously than we did 20 years ago. This has been helped by the richness of data we have available today. Researchers in this field have developed new methodologies needed to process such data, and we are now able to address questions that seemed unanswerable before. Labour economics is as important as it has always been but researchers today have more tools and methods available and, for most countries, much better data than before.

MD: When you say much better data are you thinking access to administrative data or longitudinal surveys?

CD: Yes, administrative data.

MD: That brings me to some issues regarding the balance in training between theory and history and, increasingly, econometric techniques and the IT skills.

CD: Well, better data requires less sophisticated econometric techniques to analyse it. So, in a way things have become simpler in labour economics. When I started all we had available were survey data, truncated data, data with large measurement error. Maddala (1983)'s book on limited dependent variables is a witness of that period where the lack of identification and data was substituted by assumptions through the structure of econometric models we were imposing on the data. Today we are in a much better position. We have rich data, often of administrative nature, which allows us to use simple statistical techniques to make inferences on causal coefficients.

MD: Do you think young economists are still getting enough grounding in history and theory and the philosophical side of economics? I mean it seems to me I come along to this conference and there are a lot of people who have a lot of data but not really ideas and not translating results to policy.

CD: There have always been economists with different abilities and interests. In any cohort of young scholars or PhD students some instinctively ask questions which are of great policy relevance while others are more interested in the technical side. This was the case 20 years ago and it's the case today. All these different abilities are important for the advancement of our field, and we have to provide young scholars with the training and the possibilities to develop the skills they have in the most efficient way.

MD: What advice would you give to young scholars today?

CD: Read a good informative newspaper, such as the Financial Times, and keep your eyes open. Economics –I am talking as a labour economist – is about people so it is not a technical field. It is a field which is preoccupied with what we see around us. The best questions to ask in labour economics and the most exciting research fields are those that relate to economic and public interest. So, in order to identify what are interesting areas of research we need to understand the political and economic debate. That means we need to follow those debates to develop ideas for research and provide answers to the relevant questions.

MD: This is a great answer and it relates to research topics. Do you think things have changed as far as the mechanics of a career, building a career as an academic economist, in terms of how you need to go about that? It seems very much now it's very much publish or perish whereas, you know, people like Bob Gregory talk about the golden days where they sort of sat around and pondered.

CD: I think it has always been a little bit like that so competition is clearly a feature of economics. We are in the lucky, or unlucky, position that we have global rankings. Each one of us is ranked on different types of ranking criteria, whether that is citations, publications, or some other metric. Now that, of course, leads to strong competition. That incentivises young scholars to work in directions where they can improve their rankings or publication records. But it also leads to our field being – well, very competitive.

And the quality we see at the upper end I think is extremely high. While competition among young scholars may have increased, there are also many more opportunities for young people, in terms of access to good research, through the internet, by attending conferences and going around and talking to other economists. This has certainly become easier.

However, there are large distinctions based on where you graduate and where you are coming from, and these may have slightly increased. One should never underestimate the dramatic impact networks of the top universities in the US have on the careers of their students. Graduating at a top university, of course, reflects ability, it also helps to understand how top researchers conduct research and write

papers. Young scholars at most Australian or Asian universities, or many universities in continental Europe, may not have access to that information and may find it harder to build their careers as top economists. The main reason we founded AASLE is to provide contacts and interaction to young researchers from Asia and Australasia, and to connect them to researchers from Europe and America.

MD: Is there a global community of economists and how can economists from Asia and the Oceanic area best engage with that community?

CD: Yes, we are certainly a global science - you can see that at this conference. Scholars from around the world came to Canberra. And many know each other. So whether people are from Singapore or from the US, from Australia or Canada, from Germany or the UK, at the higher end of our profession I think there is an unbelievable exchange of ideas. With the AASLE conference we want to support this kind of exchange for young scholars as well.

MD: We have seen at this conference a lot of papers with several different authors all from different countries

CD: Absolutely, and this is an increasing trend. One reason why we had the idea to start the society [Asian and Australasian Society of Labour Economics], is to help young scholars from Asia and Australasia to communicate with each other under the umbrella of a society and to allow them to exchange ideas with other scholars from Europe and the US. The society also supports cooperation between researchers from the US and Europe and researchers from Asia and Australasia to work on joint projects, in particular on topics relevant to Asia and Australasia. I think for young researchers these conferences are a very welcome and powerful tool to connect into a larger community and to further their ambitions and their careers.

MD: One last question. What do you think is the best way to engage with policymakers in a constructive debate?

CD: That's a hard question. The difficulty in the engagement with policymakers is that they often have different objectives from us. While we are striving for finding answers to particular questions and to address these in the best and cleanest possible way, policymakers think about policies. Often they consider the output of economists and other social sciences as a shelf from which to choose what serves their objective best. I think we need to be aware of that. For example, in our work on migration in the UK, we are often touching controversial issues in the policy debate and have been criticised for providing answers to policy questions that are inconvenient. We should also be aware that the influence we can have on policy is rather limited. We hardly change the way policymakers think about issues. But what we can do is to provide evidence to policymakers and the public to have an informed debate and uncover false arguments.

To give you an example, when we started looking at the fiscal impact of immigrants in the UK, the numbers which were going around were absurd. There were suggestions that immigrants who come to the UK from Europe are free riding on the welfare system and are a huge public burden. Our work, pointed in exactly the opposite direction: immigration from the EU has been a huge fiscal benefit for the UK, with European migrants who arrived after 2000 contributing far more in terms of taxes than what they received in terms of transfers and benefits. Those people who have opposite beliefs, or who favour a different narrative for their political objectives, will probably not change their views on the basis of our and others' research, and say, "okay, so we got it wrong". But as many media outlets report our results it will now be far more difficult for them to make the same claims, because there might be somebody in the room who says, "okay, but there was this research that says otherwise", and they need to respond to that. That limits the possibilities to make unfounded claims without any evidence – what we can do is limit the level of outrageousness we have on particular topics and issues in the public and policy debate.

MD: Yes, it's definitely a role to call things out. It still amazes me, how the idea that trade is bad still is so easily pushed on - you know, we can't have this trade agreement because China is going to take all our jobs and so on. The public buys that so easily and I think one of our greatest failings is not to have made people understand how much better off we are because of trade.

CD: These are very complex issues, and people who are occupied with different things in their daily lives don't have the time to fully understand them – even economists debate about the details. We see that at the moment in the Brexit debate in the UK. The issues involved are too complex for most people to fully understand. So, they follow their gut feeling and instinct and what they learn from social and print media, and form their views. These views often do not reflect economic reality. That is why we have elected MPs whose job it is to understand these issues and to make decisions in the best public interest, and why we should not have referenda on issues that are so complex, as they can lead to very damaging outcomes.

MD: Most recently we have had the revival of the view that technology must cost jobs.

CD: Yes, that was the view back in the 70's and 80's, and the opposite happened. As economists we should assess such claims and conduct research that addresses these issues, which is what is currently being done. Of course, we also have to be responsible as economists. On topics such as this, trade, or migration, we should be aware that every piece of output we produce provides ammunition for politicians who are looking for justifications for their policy objectives. I feel that responsibility is sometimes not taken sufficiently seriously among economists. If we are not quite sure about some research finding, we phrase that in a way that makes it obvious to academic colleagues, but it may still be misunderstood or misused by the political class. Extra care has to be taken that this will not happen.

MD: On that note. Thank you. That was a wonderful conversation. Thanks for taking the time.

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The Changes and Challenges Facing Regional Labour Markets

Anne Garnett, School of Business and Governance, Murdoch University

Abstract

The Australian economy has experienced a high degree of structural and technological change over the past three decades. Significant changes will continue, with the decline of the manufacturing sector, the increasing use of mechanisation and technology in the mining and agricultural sectors, and with the growing role of computerisation and robotics in the workplace in general. The effects of such changes to date have included better pay and more employment opportunities for those whose skills are in demand, but it has also meant lower relative pay and fewer job opportunities for low-skilled and unskilled workers and for workers whose jobs have been replaced by technological development. Structural change leaves workers in industries that are in long-term relative decline with fewer employment opportunities which can lead to entrenched long-term unemployment. Technological change impacts on the types of jobs available within industries and the skills required. The purpose of this paper is to examine the regional dimension to labour market change and determine which areas are likely to be most at risk as the economy continues to experience changes in sectoral mix and in the types of jobs and the skills required.

Keywords: unemployment, structure of labour force, regional labour markets, education

JEL Classification: R23, J21, J64, I24

1. Introduction

The Australian economy has been through considerable structural and technological change over the past three decades, with significant impacts on both metropolitan and regional areas (Connolly & Lewis 2010; Lewis 2015; Lowe 2012). Structural change over time refers to the change in the way in which an economy operates, with the usual development process involving production moving from primary industries to manufacturing then to service-based industries. Employment growth in Australia has moved from the industrial sector to the service sector and the demand for skills has moved from manual skills to interactive (people) skills and more advanced technological skills as Australia moves toward becoming a knowledge-based economy (Kelly & Lewis 2003, 2010; Mahoney & Lewis 2007). The effects of structural change has therefore meant better pay and more employment opportunities for those whose skills are in demand, but it has also meant lower relative pay and fewer job opportunities for low-skilled and unskilled workers.

Technological change refers to new production techniques, processes and inventions that enable an economy to increase production using the same amount of inputs. Significant change due to new technologies is not new and it has been argued that the current changes due to robotics and computerisation are affecting not only manual (blue-collar) jobs but also white-collar jobs in the service sector in much the same way that mechanisation affected manual jobs from the 1950s to the 1990s in the agriculture, mining and manufacturing sectors (Borland & Coelli 2017; Bradley 2015; Wohl 2017).

There has been substantial research demonstrating a strong regional dimension to economic disadvantage such as unemployment and social exclusion (see for example, Andrews *et.al.* 2004; Baum *et.al.* 2005; Hunter & Daly 2013; Kilmartin 1993; Mangan & Stephen 2007; Sorensen 2000). It follows that it is important to identify regions at high risk of unemployment and negative jobs growth due to structural and technological change if relevant policy is to reach some of the most disadvantaged people. Further, the incidence of unemployment is a good predictor of the likelihood of long-term unemployment (ABS 2011; Chapman & Kapuscinski 2000). As unemployment rises in some industries and regions this is likely to lead to a rise in entrenched long-term unemployment. The long-term unemployed are among the most disadvantaged in the labour market and are generally characterised by low levels of education and training. Due to long absences from paid employment they are not developing skills from labour market experience which is a major determinant of wages and job opportunities (Chapman & Kapuscinski, 2000).

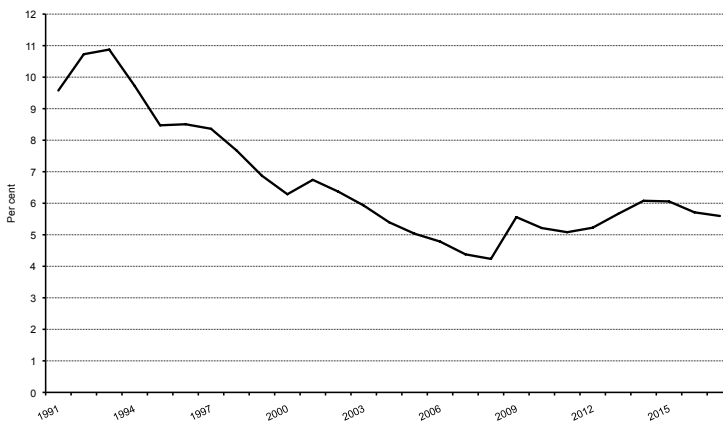
This paper first examines the changes in unemployment due to typical business cycle fluctuations and due to economic shocks. It then investigates the significant structural and technological changes that have occurred over the past few decades in the main sectors across Australia. Following this, the paper identifies those regions in Australia at most risk of low or negative jobs growth given the changing characteristics of jobs and the skills required in the workplace.

2. Unemployment changes over time

The following provides an overview of the fluctuations in unemployment and long-term unemployment since the early 1990s. These changes are largely due to the business cycle and economic shocks. The typical business cycle ups-and-downs in unemployment are not primarily due to structural or technological change, but are none-the-less important to examine, since the business cycle and economic shocks do not affect all industries, types of labour and regions equally (Lewis 2015). Further, economic shocks can be the instigator of structural change if they impact on the choice of inputs used in production, for example, an oil-price shock that leads to reduced reliance on oil and increased investment in alternative sources of energy.

Figure 1 shows the average annual unemployment rate in Australia. The recession of 1990-91 saw the unemployment rate peak at over 12 per cent in February 1993 and average around 11 per cent for that year. After this time Australia experienced a long period of economic growth and unemployment fell almost continuously until shortly after the 2007-08 global financial crisis (GFC). The exception was the temporary rise in unemployment during the 1996-97 Asian Financial Crisis. Following the GFC the unemployment rate jumped in 2009 and 2010, fell following a short economic recovery, before again trending upward until the end of 2015, due to below-trend economic growth.

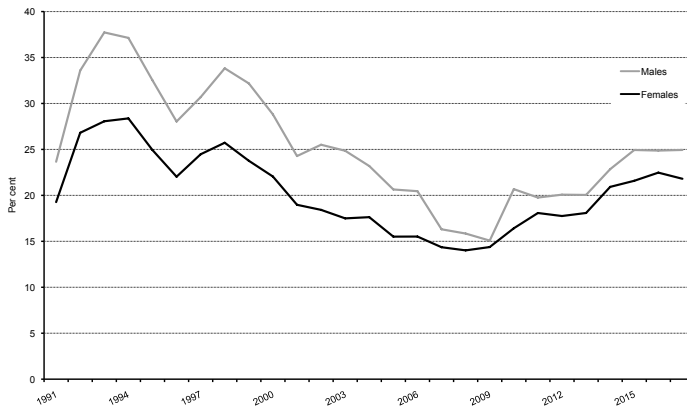
Figure 1: Average annual unemployment rate, Australia, 1991-2017, (per cent)



Source: Australian Bureau of Statistics (2018a).

Figure 2 shows the long-term unemployment ratio, which is the number of long-term unemployed expressed as a proportion of total unemployment. The rise in the long-term unemployment ratio following the 1990-91 recession is clearly evident. It has been well documented that when people become unemployed as the result of a recession, the likelihood of becoming long-term unemployed rises (Chapman 1993; Chapman & Kapuscinski 2000). The decline in long-term unemployment as a proportion of all unemployment occurred during the subsequent period of almost continual economic growth, falling remarkably from around one in three of all who were unemployed to only one in seven by early 2009. Figure 2 also shows that male long-term unemployment is almost always higher than for females, although the directional trend for both is much the same.

Figure 2: Long-term unemployment, Australia, 1991-2017, (per cent)

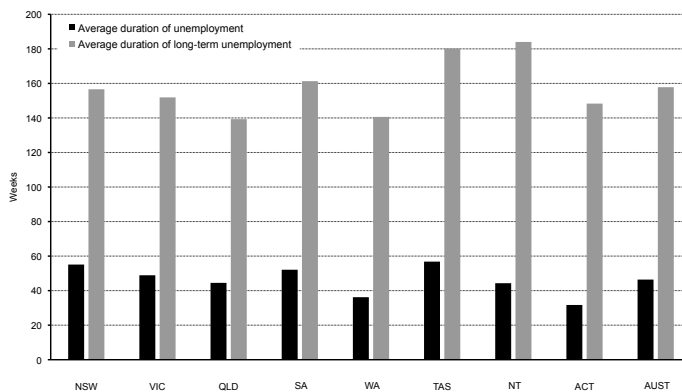


Source: Australian Bureau of Statistics (2018a).

The overall effect of the GFC and subsequent sovereign debt crises in a number of countries, and the wide-spread economic contractions and recessions, flowed on to a lengthy period of economic contraction in Australia. Other factors involved in the contraction included the effect of a slowing Chinese economy on the demand for Australia's minerals, and in particular, iron-ore, with many commodity prices falling during this time. The rise in unemployment and long-term unemployment since 2009 was significant, with the unemployment rate rising from 3.9 per cent in August 2008 (its lowest point) to 6 per cent by March 2009. After a short recovery between 2010 and 2012, the unemployment rate at times reached over 6 per cent in each year from 2013 to 2017, until it began falling during the latter part of 2017. The long-term unemployment ratio for men and women rose from an annual average of around 15 per cent in 2008 to almost 25 per cent for men and 22.5 per cent for women during 2016, or to almost one in four people, falling slightly for women by the end of 2017 (ABS 2018a; ABS 2018b).

Figure 3 shows the average duration of unemployment and long-term unemployment by state and territory. Although long-term unemployment is measured as those who are continuously unemployed for 12 months or more, very often the average duration of long-term unemployment is much longer. Figure 3 shows that in 2017 this was indeed the case, with the duration of long-term unemployment averaging 158 weeks (around 3 years) for Australia as a whole. The average duration of long-term unemployment over the post-GFC (post-2008) period has varied between 1.5 years and 3 years (ABS 2018a). Figure 3 shows that when examining the duration by state and territory, it was longest for the Northern Territory, at 184 weeks (3.5 years) closely followed by Tasmania at 180 weeks. Queensland and Western Australia had the shortest average duration at around 140 weeks (2.7 years).

Figure 3: Average duration of unemployment and long-term unemployment by state and territory, 2017, (weeks)



Source: Australian Bureau of Statistics (2018a).

Interestingly, a high average duration of long-term unemployment is not always associated with a high average duration of unemployment as a whole. For example, Figure 3 shows that although the Northern Territory had by far the longest average duration of long-term unemployment, in contrast, duration in all unemployment was relatively low – 44 weeks – when compared to other states, and even a little below the national average of 46 weeks. This implies that on average, a person in the Northern Territory is likely to find a job relatively quickly, but if they become long-term unemployed, they are likely to stay long-term unemployed for a longer time compared to other states and territories. The lowest average duration of unemployment as a whole was in Canberra (ACT) at a little below 32 weeks.

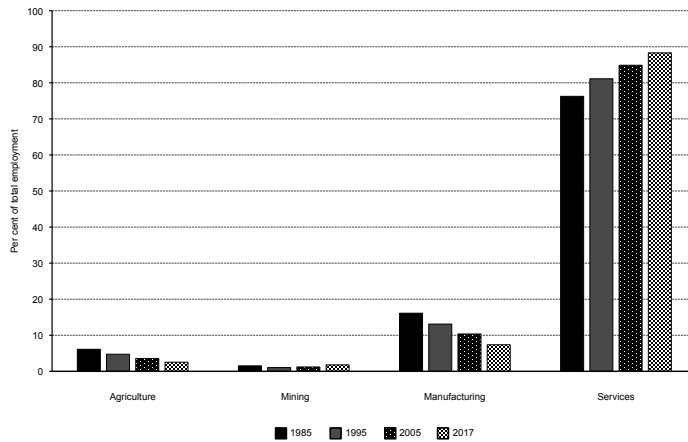
3. Employment changes over time

As outlined earlier, the structural changes in the Australian economy have been extensive in recent decades. The movement of jobs out of industrial sectors into the service sector, which began in earlier decades, has continued in recent years, and the demand for skills has moved from manual skills to interactive and knowledge-based skills. This section provides details of the effect of structural and technological change on jobs to reinforce how extensive the changes have been in a relatively short period of time. This will be followed by an analysis of the effects on jobs at the regional level.

Long-term trends in employment by sector from 1985 to 2017 are shown in Figure 4. There has clearly been a decline in jobs in agriculture as a proportion of total employment, with agriculture employing over 6 per cent of the labour force in 1985 compared with 2.5 per cent in 2017. This decline has also been in absolute numbers, and has accelerated downward since 2007, with the number of jobs in agriculture falling by almost 10 per cent between 2007 and 2017 (ABS 2018b). The fall in jobs in agriculture has primarily occurred in full-time jobs among those who are self-employed. The self-employed comprise around 55 per cent and employees around 45 per cent of jobs in agriculture (ABS 2018e). While the number of full-time self-employed remained stable throughout the 1990s, it began to fall during the 2000s, particularly following the 2002-03 drought, and fell again during the 2010s. For example, over the most recent decade – 2007 and 2017 – full-time self-employed in agriculture fell by 27 per cent (ABS 2018e). The number of employees has fluctuated over time, and as expected, can fluctuate considerably from year to year, depending on agricultural output, falling during drought years, and rising during years of higher than average production levels. It is important to note that the demand for casual, seasonal labour exceeds supply in broadacre farming (cereals, sheep and cattle) and in horticulture industries (NFF 2017). In horticulture, overseas visitors on working holiday visas comprise the majority of its casual workforce (NFF 2017). Seasonal and temporary work visas have also assisted in meeting the shortage in casual labour in agriculture, bringing in people largely from Pacific Island countries.

Mechanisation has progressively reduced the demand for labour in agriculture since the 1950s, but this is continuing today as technology continues to advance, for example, with the use of drones, apps and also of global positioning systems (GPS) for soil sampling and guided tractors. The number of farms has also fallen significantly, with farm size increasing, particularly in broadacre farming. Between 2000 and 2016, the number of farms in Australia fell by over 41 per cent, from 146 371 to 85 681 (ABARES 2017). While this has led to increased efficiency due to economies of scale, it is also a contributing factor in the fall in demand for labour, and as discussed above, is very visible in the fall in the number of full-time self-employed in agriculture. With fewer people working directly in agriculture, this also has flow-on effects, decreasing the demand for goods and services in regional towns, affecting the number of jobs in support industries. Regions with a relatively greater reliance on agriculture have experienced job losses, particularly among the unskilled or low-skilled, and among those who are not mobile between towns and regions.

Figure 4: Employment by sector, 1985 – 2017, (per cent)



Source: Australian Bureau of Statistics (2018b)

Figure 4 shows that employment in mining is generally low, as expected, given the capital-intensive nature of the industry. However the minerals and energy boom from the early 2000s to around 2012, fuelled by the rapid economic growth in Asia, particularly China and India, led to a huge increase in the demand for Australia's minerals and energy. This drove the construction of new mines and the expansion of existing facilities, leading to a large increase in jobs in mining, with the number of jobs rising from around 80 000 in 2000 to over 270 000 by mid-2012, before falling to around 220 000 by the end of 2017. In terms of mining employment as a proportion of the labour force between 2000 and 2017, this doubled from 0.9 per cent to 1.8 per cent (ABS 2018b). Temporary and permanent skilled migrants, under the Regional Sponsored Migration Scheme and Enterprise Migration Agreements, assisted in meeting the increased demand for skilled labour in mining in regional areas, with mining companies unable to find sufficient domestic labour willing to work in these regions (Connolly & Orsmond 2011; Garnett 2012b). Commodity prices fell substantially after the peak of the minerals and energy boom, with the subsequent mining slow-down impacting on jobs in some remote and very remote regions. It is important to note that a large proportion of the fall in jobs from around 2013 onwards was due to the movement from the construction phase to the operational phase of mines, which requires far less workers (Garnett 2012a). While substantial employment was fly-in-fly out, and some was also met by temporary immigration for jobs that were only ever going to be for a few years during the construction phase, the fall in commodity prices and the subsequent reduction in operations and closure of some mines has impacted regional employment, with flow-on effects on the regional localities that provide inputs such as transport, housing, food, health and other support services. However, despite the fall in commodity prices, mining production and employment has remained higher than pre-boom levels.

The decline in the manufacturing sector in Australia is well known, with the move toward offshoring gaining momentum in the 1990s, together with the progressive impact of the removal of the previously high levels of tariff protection from the 1980s onwards, exposing industries that neither had a comparative advantage nor economies of scale. In more recent years it has been the closure of all four motor vehicle companies that has received attention, with all four companies pulling out of Australia by the end of 2017. While as Figure 4 shows, the decline in manufacturing has been occurring since the 1980s, (and although not shown here, also throughout the 1970s), interestingly the most rapid fall in jobs occurred after 2005. For example, in a period of less than 10 years, from 2008 to 2017, employment in manufacturing fell by more than 16 per cent, (ABS 2018b).

Figure 4 also shows the growth in employment in the service sector which characterises the structural change that has occurred in most developed economies. The strong upward trajectory, in stark contrast with other sectors, reflects the move in employment away from industrial skills into people-based, service industries. Employment in services as a proportion of total jobs grew from 76 per cent in 1985 to 88 per cent by 2017. The service sector is large and diverse, comprising many subsectors with vastly different labour requirements, for example, highly skilled managerial and professional workers and relatively low-skilled workers in areas such as retail and data entry. Therefore, the effect of structural and technological change on employment growth will vary between subsectors within the service sector.

While the service sector has seen significant jobs growth up until 2017, the rapid adoption of technology such as software programs in white-collar jobs will lead to marked changes in the skills required for jobs in the future (Beitz 2015; Borland & Coelli 2017). In the past it was developments like the assembly line and advancements in machinery that reduced the demand for physical labour in manufacturing, agriculture and mining. The changes in service industries are predicted to be widespread across professions and regions, as computerisation (also referred to as robotics) has now enabled many services to be moved online and advanced software programs are now capable of knowledge processing. For example, the number and nature of jobs is expected to change in areas such as data entry, tellers, bookkeeping, accounting, legal services and programming services, right through to jobs such as umpiring, taxi drivers, university lecturers and economists (Frey & Osborne 2017; Wohl 2017).

The regional impacts of sectoral changes vary substantially, depending on the industrial structure of the regions. For example, the decline in manufacturing jobs has impacted most on locations near to major cities which have typically been characterised by a greater proportion of manufacturing jobs relative to other areas and are therefore most affected. The decline in jobs in agriculture and mining have a relatively greater effect on rural, remote and very remote areas. The following section uses Census data over a 10-year time period to analyse the impact of sectoral changes on jobs at the regional level.

4. Impact on regional labour markets

As seen above, the changes experienced by the Australian economy over the past three decades or so has clearly reduced jobs in some industries and increased jobs in others. Since some regions in Australia are characterised by a greater proportion of industries in which jobs are in decline, there is likely to be a disparate impact from business cycles, economic shocks, structural change and technological change. This section will first examine the population, employment and industrial structure of regions in Australia, and in particular, highlight changes over time. It will then examine the changes to employment by industry to determine which regions have been most affected and which are likely to continue to be most affected.

When examining labour markets at the regional level, there are many different methods that can be used to create spatial regions (for example, ABS 2001; Department of Health and Ageing 2001; Department of Employment and Workplace Relations 2006; Garnaut et.al. 2001; Productivity Commission 1999). Often, in practice, the choice of classification method depends on the purpose of the research and the availability of data. However, the general aim is to create groupings that have similar characteristics in terms of economic, geographic, social, cultural and possibly environmental amenity characteristics. This study uses the ABS Remoteness Structure (ABS 2018f) which has been widely used in regional analyses. It is based on the Department of Health and Ageing's ARIA Plus (ARIA+) system (1999; 2001), but with some adaptations such as increasing the relative size of the remote categories and changing the names of the categories. Unlike the majority of other (non-ARIA) classification systems, the ABS Remoteness Structure contains both 'remote' and 'very remote' classifications which is important as some remote and very remote localities are characterised by quite a different set of industrial, population, infrastructure and even cultural factors than non-remote areas. The ARIA+ system defines remoteness based on the physical road distance people travel to reach Service Centres (defined as Urban Centres with populations of 5000 or more), which are then categorised into four levels based on the level of services available (Department of Health and Ageing 2001). A population locality is given an ARIA+ score between 0 and 12, based on the shortest road distance between it and each of the four levels of Service Centres, with the higher the score, the greater the degree of remoteness. The ABS Remoteness Structure regions based on Australian Statistical Geography Standard (ASGS) statistical areas at level 1 (ABS 2018f), are:

- Major Cities: ARIA+ value ranges: 0 – 0.2
- Inner Regional: ARIA+ value ranges: >0.2 – 2.4
- Outer Regional: ARIA+ value ranges: >2.4 – 5.92
- Remote: ARIA+ value ranges: >5.92 – 10.53
- Very Remote: ARIA+ value ranges: >10.53

Table 1 provides an overview of population and employment by region, using data from the 2016 Census of Population and Housing (ABS 2018c). This shows that around 29 per cent of the population live outside major cities and around 27 per cent of employment is in regions outside major cities. As expected, remote and very remote regions contain a very small proportion of both the population and jobs, at around 2 per cent combined.

Table 1: Population and employment by region, 2016

<i>Region</i>	<i>Population</i>	<i>Per cent</i>	<i>Employment</i>	<i>Per cent</i>
Major Cities	16 634 082	71.3	7 449 815	73.1
Inner Regional	4 254 984	18.2	1 728 247	16.9
Outer Regional	1 992 712	8.5	823 075	8.1
Remote	282 895	1.2	123 055	1.2
Very Remote	186 331	0.8	70 231	0.7
Australia	23 351 004	100	10 195 053	100

Source: Australian Bureau of Statistics (2018c).

Table 2 shows employment by industry grouping and region based on Census data for 2016. The agricultural and mining sectors are clearly far more important in providing jobs in outer regional, remote and very remote regions than in inner regional areas and major cities. For example, while the agricultural and mining sectors directly employ only 0.6 per cent and 1.1 per cent of the labour force respectively in major cities, they employ 16.6 per cent and 10.9 per cent respectively in remote areas and 13.2 per cent and 16.6 per cent respectively in very remote areas. The percentage of employment in manufacturing is similar in major cities, inner regional and outer regional areas, although highest in inner regional areas, while far less in remote and very remote areas. Jobs in services comprise less than 70 per cent in remote and very remote areas, while reaching over 90 per cent of all jobs in major cities. These differences are significant and will lead to differing effects from sectoral changes on regions throughout Australia.

Table 2: Employment by industry and region, 2016, per cent

<i>Region</i>	<i>Agriculture</i>	<i>Mining</i>	<i>Manufacturing</i>	<i>Services</i>
Major Cities	0.6	1.1	6.7	91.7
Inner Regional	5.4	2.2	7.7	84.8
Outer Regional	12.2	3.8	6.0	78.0
Remote	16.6	10.9	3.0	69.5
Very Remote	13.2	16.6	2.0	68.2
Australia	2.6	1.7	6.7	89.0

Source: Australian Bureau of Statistics (2018c).

Table 3 shows the changes in regional population and employment between the 2006 and 2011 Census period and between the 2011 and 2016 Census period. The effect of the mining boom in Australia during this time is clearly evident, with national jobs growth of 10.8 per cent over the five-year period from 2006 to 2011, while jobs growth in very remote regions, where much direct mining activity is located, was almost three times that level, at 27 per cent. This represents the construction phase of many mines and reflects the huge increase in commodity prices discussed earlier. The impact on the population growth of very remote communities is also significant during the peak mining boom years. The reversal of both the population and employment growth rates is equally clear as captured by the rate of change between 2011 and 2016. Table 3 shows the falling population and jobs growth rates in remote and very remote areas, with the highest negative jobs growth rate, -12.4 per cent, experienced in remote areas, closely followed by very remote areas, at -10.6 per cent. The end of the mining boom had flow-on effects to the demand for services, however, as will be shown in Tables 4(a) and 4(b), the fall in employment was experienced by all sectors, indicating that numerous factors were at play, not just the downturn in mining.

Table 3: Regional population growth and employment growth by region, 2006-2011 and 2011-2016, percentage change

Region	2006 - 2011		2011 - 2016	
	Population	Employment	Population	Employment
Major Cities	10.5	13.0	10.9	6.2
Inner Regional	2.2	4.6	6.4	0.7
Outer Regional	5.0	6.2	1.5	-4.1
Remote	1.8	5.4	-5.7	-12.4
Very Remote	23.9	27.0	-2.1	-10.6
Australia	8.3	10.8	8.8	3.9

Source: Australian Bureau of Statistics (2013; 2018c).

Also important from Table 3 is that the rate of population growth in major cities increased between the 2006-2011 period and the 2011-2016 period, rising from 10.5 per cent to 10.9 per cent, while the rate of employment growth fell from 13 per cent to 6.2 per cent. The fall in the jobs growth rate is consistent with the below-trend economic growth rates that occurred between 2011 and 2016 in the aftermath of the 2007-08 GFC. Employment growth in major cities more than halved during this time, while for inner regional areas, jobs grew by only 0.7 per cent – a result not only from the GFC but also due to the decline in manufacturing.

Tables 4(a) and 4(b) show the percentage changes in employment by sector and region between the Census periods 2006-2011 and 2011-2016, which provide details of the significant structural change that occurred during these years. The rate of growth in employment provides a more useful means of assessing the state of the labour market in the regions than the unemployment rate since inter-regional

migration can lead to the appearance of low unemployment rates, thereby masking the true state of the labour market. In some remote and very remote regions there are also lower participation rates due to the high proportion of discouraged workers and the long-term issue of lower levels of involvement in the labour market by Indigenous Australians (Department of Prime Minister and Cabinet 2018; Hunter 2002; Altman & Daly 1992). In Tables 4(a) and 4(b) the mining and manufacturing sectors stand out. The fortune and then reversal of fortune in the mining sector in terms of employment is clear, with major jobs growth between 2006 and 2011 and the reversal of that jobs growth in non-metropolitan areas between 2011 and 2016. For example, in very remote areas, jobs growth in mining stood at 143.2 per cent between 2006 and 2011, before falling to a negative jobs growth rate, at -15.5 per cent, between 2011 and 2016. It should be remembered that while mining employs a very small proportion of the total labour force at the national level – below 2 per cent – in some regional areas it is far more significant, for example, close to 11 per cent and 17 per cent in remote and very remote areas in 2016 (see Table 2). Hence a fall in direct employment in mining is significant, together with the effects on indirect employment in these regions. However, as previously noted, employment in mining, although declining, remains higher than the pre-boom period (ABS 2018c).

Interestingly, while the mining sector in major cities employs only a little over 1 per cent of the labour force, there has been some growth in jobs, in part due to the technological change occurring in the mining sector due to the advancement of GPS, computer software and robotics. For example, jobs such as truck driving that were previously carried out by truck drivers on-site in remote and very remote areas have increasingly been transferred to major cities, where autonomous (driverless) mining trucks are operated. Similarly, the West Angelas iron ore mine in the Pilbara in Western Australia has all of its large production drills working autonomously and operated remotely (Gollschewski 2015). This type of technological change will continue, as in 2018 the largest iron-ore company in Western Australia, Rio Tinto, began installing ‘AutoHaul’ technology on all 200 of its trains that transport minerals to ports for shipping, operating the driverless trains remotely from offices in Perth, Western Australia (Rio Tinto 2018).

Table 4(a) Employment growth by industry and region, 2006 – 2011, per cent

<i>Region</i>	<i>Agriculture</i>	<i>Mining</i>	<i>Manufacturing</i>	<i>Services</i>
Major Cities	-3.7	85.2	-4.5	14.8
Inner Regional	-11.1	53.4	-7.9	6.6
Outer Regional	-13.6	43.3	-4.4	9.8
Remote	-12.2	28.4	-3.9	8.1
Very Remote	0.1	143.2	-0.9	19.9
Australia	-11.1	65.2	-5.2	12.9

Source: Australian Bureau of Statistics (2013).

Table 4(b) Employment growth by industry and region, 2011 – 2016, per cent

<i>Region</i>	<i>Agriculture</i>	<i>Mining</i>	<i>Manufacturing</i>	<i>Services</i>
Major Cities	44.3	8.5	-24.8	9.2
Inner Regional	8.4	3.5	-20.7	2.7
Outer Regional	0.3	-6.9	-25.5	-2.5
Remote	-11.7	-13.9	-33.4	-11.1
Very Remote	-8.1	-15.5	-51.1	-7.5
Australia	6.8	0.7	-24.3	6.9

Source: Australian Bureau of Statistics (2018c).

In terms of employment, the agricultural sector generally fared badly between both Census periods, with falls in employment in almost all regions between 2006 and 2011, and continual falls in jobs in agriculture between 2011 and 2016 in remote and very remote areas. This is consistent with the ABS survey data shown earlier in Figure 4, which illustrated a general downward trend. As with mining, agriculture is far more important in terms of direct and indirect employment in rural and remote areas than in metropolitan areas, so the continual decline in jobs in these areas has a far greater impact on rural communities. The flow-on effects can lead to the closure of some local services, with local community members needing to travel to larger centres for services. The apparent jobs growth in agriculture in major cities between 2011 and 2016, at over 40 per cent, should be treated with caution, since agriculture employs just 0.6 per cent of the workforce in major cities, and this is actually only an increase from around 0.4 per cent to 0.6 per cent between the 2011 and 2016 period. A similar story is also generally true for inner regional areas, with agriculture employing just 5 per cent of the total workforce in 2016.

The increase in the rate of job losses in the manufacturing sector is dramatic across all regions. Table 4(a) shows single-digit negative jobs growth across all regions between 2006 and 2011. As seen in Table 4(b), this accelerated between the 2011 and 2016 period, with all regions experiencing negative jobs growth ranging between around -20 per cent and -50 per cent in this sector. As the majority of manufacturing jobs are in major cities and inner and outer regional areas, (see Table 2), where the main factories and facilities tend to be located, these areas have borne the brunt of the rapid decline in manufacturing in Australia. The proportion of the labour force working in manufacturing in major cities fell from 9.4 per cent in 2011 to 6.2 per cent by 2016 – close to a reduction of 25 per cent, as shown in Table 4(b). The figures are very similar for inner regional and outer regional areas, where factories and processing plants are often located – it is clear that the reduction in manufacturing jobs has been extraordinary. While it appears the effect has also been large in remote and very remote areas, with falls in manufacturing jobs of over 33 per cent and 51 per cent respectively, it should be noted that in 2016 manufacturing employed only 3 per cent and 2 per cent of the total workforce respectively in these regions (ABS 2018c).

The service sector experienced strong growth in jobs in all regions between 2006 and 2011, although the rate of growth was slowing toward the end of this period as the after-effects of the GFC and the mining slowdown began to be felt (ABS 2018a). Major cities had a rate of jobs growth in services of almost 15 per cent over this time, with very remote regions measuring a growth rate of almost 20 per cent, fuelled by the flow-on demand for services from the mining boom. The 2011 to 2016 Census period was largely a time of below-trend economic growth nationally, which is reflected in the slower rates of jobs growth in services. However, major cities still recorded jobs growth in services, at 9.2 per cent. As seen earlier, the fall in jobs in major cities was experienced most by the manufacturing sector. While major cities still experienced jobs growth in services, most other regions had jobs losses in services during the 2011 and 2016 period, with the exception of inner regional areas, who recorded a meagre growth rate of 2.7 per cent. Outer-regional, remote and very remote regions all lost jobs in the service sector, consistent with the below-trend rate of economic growth, the slow-down in the mining sector, and at times due to severe droughts in rural areas. The overall falls in population in remote and very remote regions as shown previously in Table 3 – falls of almost 6 per cent and 2 per cent respectively – can lead to a continual downward spiral in the demand for services and more job losses in these regions.

5. Future risk of regional unemployment

The above analysis of sectoral changes in section 3 combined with the examination of Census data on employment changes by region and sector in section 4, reveals that remote and very remote regions are most at risk of unemployment and likely long-term unemployment from structural and technological change. The continual fall in employment in agriculture and manufacturing over the past 30 years, and mining in more recent years, has hit hard in remote and very remote regions, and impacts not only the number of jobs in these industries, but importantly, also support services in these regions. This is borne out by the negative jobs growth in service industries between 2011 and 2016 in outer regional, remote and very remote areas (Table 4(b)). The loss in jobs in these regions has accelerated over the 2011 to 2016 Census period.

By using ABS *Labour Force* data that estimate the duration of job search by ASGS more can be learned about the regional dimension of unemployment. ASGS statistical areas (SAs) are far from homogeneous in terms of industry structure, economic, geographic and other amenity characteristics, however, the data can still provide insight into broad areas most at risk of unemployment and long-term unemployment. A detailed analysis of ASGS SAs at level 4 by state and territory reveals that the majority of SAs with job search duration time above the state or territory average are not located within major cities (ABS 2018d). However, there are exceptions to this, with SAs located in major cities in Western Australia and South Australia, together with particular areas within Sydney, such as Sydney's City and Inner South, that have above average job search duration. Table 5 shows those SAs with the average duration of job search (in weeks) for 2017 that are substantially higher than the state or territory average. The second column in the table shows the average duration for the state or territory as a whole which allows for a better

comparison between the SAs and the state average. The area with the highest average duration of job search was Far West and Orana (NSW) – a remote area – where the average duration was more than three times the state average and the national average. Unsurprisingly, outback areas in South Australia, Western Australia and the Northern Territory all experienced higher than average job search time. An examination of data from previous years shows little variation from the 2017 data in which SAs are characterised by above-average duration of job search.

Table 5: Average duration of job search by state/territory and selected statistical area, 2017, (weeks)

	<i>State average (weeks)</i>					
<i>NSW</i>	55.1	Far West and Orana 167.9	Mid North Coast 141.4	Southern Highlands and Shoalhaven 85.7	Murray 79.5	Coffs Harbour – Grafton 69.6
<i>VIC</i>	48.9	Ballarat 111.2	Victoria – North West 89.8	La-Trobe – Gippsland 64.7	Warrnambool and South West 58.5	Bendigo 58.3
<i>QLD</i>	44.5	Wide Bay 70.6	Ipswich 64.8	Toowoomba 53.3	Moreton Bay South 52.6	Moreton Bay North 52.3
<i>SA</i>	52.1	Adelaide – South 68.6	Adelaide – North 61.6	South Australia – Outback 53.5	-	-
<i>WA</i>	36.2	Perth North-West 50.1	Mandurah 47.6	Perth South-West 46.1	Perth South-East 40.5	Western Australia – Outback 40.0
<i>TAS</i>	56.8	Launceston and North East 66.4	Tasmania – South East 64.5	-	-	-
<i>NT</i>	44.3	Northern Territory – Outback 57.0	-	-	-	-
<i>ACT</i>	31.7	na				
<i>AUST</i>	46.4	na				

Note: Empty cells indicate no other regions with job search duration above the state/territory average.
Source: Australian Bureau of Statistics (2018d).

There are a number of coastal areas with above-average job search duration, such as Mid North Coast in New South Wales, Wide Bay in Queensland and Mandurah in Western Australia. These areas are also characterised by higher than average unemployment rates in general and yet often also have higher rates of population growth. Studies indicate that outward migration from rural and remote areas to coastal areas can be due to lack of job opportunities and lack of amenity (push factors), while others move from major cities to coastal outer-metropolitan areas due to amenities and lower living costs (pull factors), (Garnett 2007; Lawson and Dwyer 2002; Rasheed 2000). There is also evidence that unemployed people leave rural and remote areas to live in coastal areas despite coastal areas having high or higher unemployment rates and lower jobs growth rates, which is indicative that some unemployed are likely to be moving to coastal areas due to other factors such as amenities, facilities and the availability of government services (Garnett 2007).

Inter-regional migration occurs to some extent following structural change and job losses, which, as discussed earlier, can mask the full impact of structural change on regional labour markets (Garnett 2007). Importantly, not everyone in remote and very remote regions can easily migrate when jobs become scarce. For example, people in the agricultural sector are sometimes less mobile due to their ownership or lease of stations and properties. Family and cultural links to rural communities and lifestyles also hinder inter-regional migration. Further, Indigenous Australians have a much higher unemployment rate than non-Indigenous Australians and have a higher concentration in remote and very remote regions (ABS 2018c; Hunter 2002; Altman & Daly 1992). They have also demonstrated a low propensity to migrate in search of employment relative to non-Indigenous labour (Taylor & Stanley 2005). There is also evidence that supports the claim that even if Indigenous labour were to migrate, this would not necessarily lead to better labour market outcomes or improved lifestyles (Biddle & Hunter 2006). Clearly there is a strong regional dimension to economic disadvantage such as unemployment and social exclusion, and from the recent data on structural and technological change and negative jobs growth presented here, this is likely to continue.

As discussed earlier, industrial composition is a major reason why employment growth varies between areas. Lawson & Dwyer (2002) and Rasheed (2000) found that the lack of a diversified industrial base in some rural and remote areas is a limiting factor for employment growth. These factors reflect the demand for labour, but there are also supply-side factors such as educational attainment, skills and work experience that characterise the supply of labour in regional and remote areas. As will be shown in the following section, recent data support the continued association between lower levels of educational attainment and the likelihood of long-term unemployment.

In addition to the above economic factors, social factors such as education levels, have an important impact on the likelihood of becoming unemployed (Birch & Marshall 2016; Savvas 2011). This too has an important regional dimension to it, as the following demonstrates. Not all jobs require higher education qualifications or vocational training, however the historic and current changes in manufacturing, mining and agriculture due to mechanisation, automation and robotics has reduced, and continues to reduce, the proportion of jobs requiring skilled manual labour and

semi-skilled and unskilled labour (Beitz 2015; Borland & Coelli 2017; Lewis 2015). Technology and new machinery have seen these industries evolve from labour-intensive industries typically characterised by hard and often dangerous jobs to industries that are highly-capital intensive, employing relatively few workers. With the rapid adoption of computerisation and software programs in the service sector, many jobs, particularly those requiring lower levels of education and training, are now becoming redundant. Much has been written in recent times about software replacing jobs in areas such as data entry, accounts clerks, telemarketers, bank-tellers, stock clerks, meter readers, and checkout operators (see, for example, Coelli 2015; Durrant-Whyte *et.al.* 2015; Frey & Osborne 2013). Software, computerisation and robotics are exceptional at doing the tasks that people often do poorly such as repetitive, monotonous tasks that require concentration for long periods of time. The new technologies are also not limited to jobs that require lower levels of skills and education, since software programs can now replace some work performed by accountants, auditors, book-keepers, legal secretaries, editors, tertiary educators and statisticians. These developments indicate that the nature and types of jobs will continue to change which means that one of the most important labour market issues revolves around education, reskilling and retraining.

When comparing education levels between regions, the highest year of school completion is a useful indicator (OECD 2015; Savvas, *et.al.* 2011). Data from the 2016 Census show that when looking at year 12 as the highest level of educational attainment, this remains much lower in outer-regional, remote and very remote areas than in major cities and outer-metropolitan areas. For example, in New South Wales in 2016, in major cities, 62 per cent of the applicable population had completed year 12 (ABS 2018c). (Note – ABS Censuses measure the applicable or relevant population here as those aged 15 years and over). This compares with 42 per cent for inner regional areas, 37 per cent for both outer regional and remote areas, and below 33 per cent for very remote areas (ABS 2018c). There is a clear significant disparity in year 12 completion levels between major cities and all other areas, with the greatest difference occurring between major cities and very remote areas, where completion rates are almost half that of major cities. The year 12 completion rates differ a little between states, however the consistent trend is that outer-regional, remote and very remote areas have much lower completion rates than major cities and are somewhat lower than inner-regional areas (ABS 2018c).

The following graphs in Figure 5 provide evidence of this by showing the correlation between the average duration of job search (in weeks) and the proportion of the population whose highest level of school completion was year 12. The data are Census data by ASGS statistical areas (SAs) at level 4. Three states are shown – New South Wales, Victoria and Queensland – since they have a sufficient number of observations (SAs) to allow for a trend to be reasonably determined. All other states and territories have only between two and nine SAs, although there is no reason to believe that the general trends would be different. Figures 5(a), 5(b) and 5(c) all show a very similar correlation whereby lower levels of educational attainment are associated with a higher average duration of job search. For example, looking at Figure 5(a), there is a large grouping of SAs where only between 40 per cent and 50 per cent of the

population have completed year 12 and whose job search time ranges from between 40 and 80 weeks. Moving rightwards along the figure, it is clear that, generally, the greater the proportion of the population who have completed year 12, the quicker they are able to obtain jobs, with job search time falling to between 20 and 60 weeks. There are two areas in Figure 5(a) in the top left quadrant with very low completion rates and very high job search time – Mid North Coast (coastal area north of Newcastle), where only around 35 per cent of the population have completed year 12 and it takes, on average, around 144 weeks to find a job, and Far West and Orana (remote and very remote regions) where 37 per cent of the population have completed year 12 and it takes an average of 168 weeks to find a job. Areas with high rates of completion of year 12 and low job search time are in Sydney and include North Sydney and Hornsby, Northern Beaches and Ryde.

In Victoria, as shown in Figure 5(b), there are only two areas that are clear outliers, with very low year 12 completion rates and very high jobs search time – Ballarat (largely inner regional) and North West (outer regional and remote regions). In Queensland, Figure 5(c), the average time for job search among those areas with the lowest levels of educational attainment is, interestingly, generally lower than for both New South Wales and Victoria, while the job search time for those with higher levels of education is consistent with other states.

Figure 5(a) Average duration of job search and proportion of the population who completed year 12, New South Wales, 2016

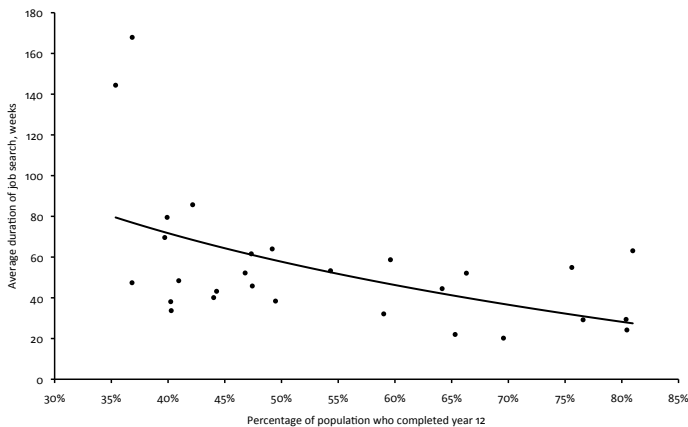


Figure 5(b) Average duration of job search and proportion of the population who completed year 12, Victoria, 2016

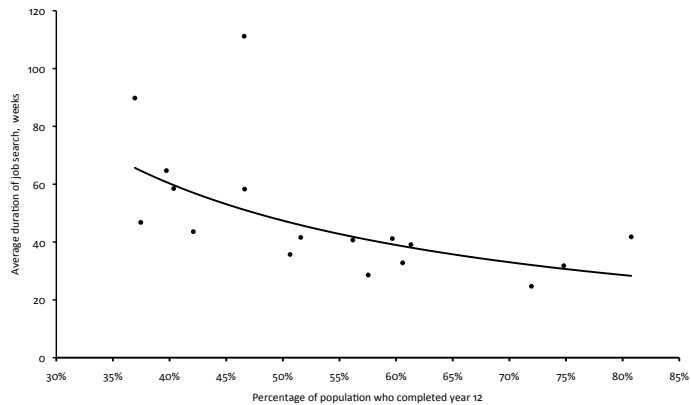
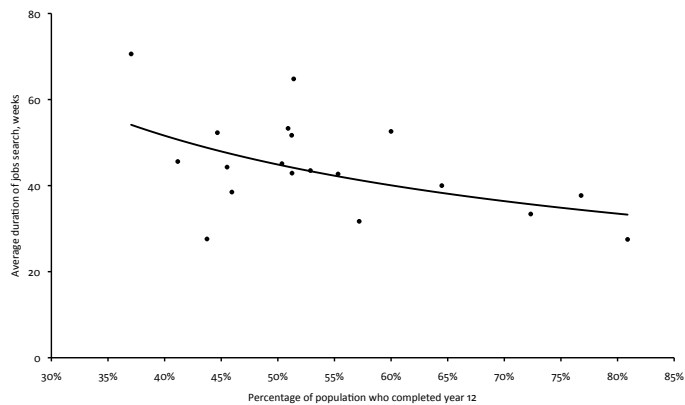


Figure 5(c) Average duration of job search and proportion of the population who completed year 12, Queensland, 2016



Note: Population refers to those aged 15 years and over.

Source: Australian Bureau of Statistics (2018c; 2018d).

Since lower levels of educational attainment are likely to affect employment and long-term unemployment levels, the recent data above show that this will continue to be a problem. Addressing this issue is particularly challenging in remote and very remote areas due to the lack of availability of, and distance to, educational institutions, particularly for upper high school and beyond. The availability and cost of transport, the expense and emotional impact of living away from home, and in some cases, seasonal commitments to family farms are additional complicating factors that can reduce the level of education completed in these areas (Mageean 1993; Scott 1993; Garnett 2007). In addition, the levels of formal education among Indigenous Australians remain lower than non-Indigenous Australians, which contributes to the metropolitan/rural-remote educational gap and to the employment gap (Birch & Marshall 2016; Kalb *et.al.* 2011). The most recent *Closing the Gap* report indicates that this gap has been closing – falling by 12.6 per cent between 2006 and 2016 among 20-24 year olds – with the goal to halve the gap of year 12 completion on track to be reached by 2020 (Department of Prime Minister and Cabinet 2018). However, unfortunately the difference in year 12 completion rates is still substantial, with a 24 percentage point gap between non-Indigenous and Indigenous Australians in 2016. This exacerbates the already large employment gap between non-Indigenous and Indigenous Australians, which has been found to be substantially worse in the remote areas in Australia (Gray *et. al.* 2014).

6. Conclusion

Significant structural change and technological change has occurred in Australia over a relatively short time period. Structural change is not a new phenomenon, with the movement away from jobs in primary industries into tertiary industries characterising the structural change over time of most developed economies. Also, wide-spread technological change involving mechanisation and automation has continued to occur and affect jobs in employment in the agriculture, manufacturing and mining sectors. The effects of technological change have spread further, from the more manual jobs, into ‘white-collar’ service sector jobs with computerisation and software developments making some jobs in services redundant while changing the skills required in other jobs. However, while the characteristics of many jobs have changed, jobs have continued to grow in the service sector, while data from the 2006-2011 and 2011-2016 Census periods show that all other sectors have seen jobs fall, particularly in outer regional, remote and very remote areas.

The huge decline in manufacturing jobs has not only been due to technological development, but also due to the progressive opening up of the economy to international trade which has exposed inefficient industries. As demonstrated here, the decline in jobs in manufacturing has been felt in all regions, but more-so in inner- and outer-regional areas and major cities, since the proportion of jobs in manufacturing has comprised a significantly higher proportion of the labour force than in remote and very remote regions. Some people will retrain and move into the service sector, with government adjustment packages assisting with the transition. However some people may never retrain and are likely to become long-term unemployed, or exit the labour market.

Remote and very remote regions have seen falls in jobs in all sectors since 2011, including services, and jobs falling in agriculture since the 1980s. The picture has not been much better for outer-regional areas. The negative jobs growth in agriculture and mining is likely to have a particularly large impact on rural, remote and very remote communities, where jobs in these sectors make up a much greater proportion of the labour market relative to inner-regional areas and major cities. This fall in jobs is likely to lead to an increase in long-term unemployment in these regions since, on average, there are no growth sectors for labour to move into. Further, as discussed earlier, some labour is not mobile and is less able seek employment in other regions.

Educational attainment is a strong predictor of employment, and as has been shown here, lower levels of education attainment is strongly associated with regions having a longer duration of job search and therefore long-term unemployment. Since completing high school to year 12, and indeed gaining other forms of training, is more difficult in rural and remote regions, many of whom are already characterised by economic and social disadvantage, this will further hinder the ability of labour in these regions to adapt to the structural and technological change that is occurring. There are clearly policy implications, not just due to the impact of unemployment and long-term unemployment on macroeconomic efficiency, but to address the regional dimension of current and likely future entrenched unemployment. As has long been the case, relevant education and training will be crucial for all regions to meet the changes in skills and training due to structural and technological change. This appears to be even more urgent in remote and very remote regions, which are characterised by lower levels of education and have been experiencing falls in jobs growth across all sectors.

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Labour Market Implications of Promoting Women's Participation in STEM in Australia

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Abstract

It is commonly argued that maintaining and enhancing Australia's standard of living will require increasing the proportion of the population attaining university level qualifications in science, technology, engineering and mathematics (STEM). Accordingly, governments and universities have been proactive in encouraging women, who represent only around 30 per cent of Australians with STEM qualifications, to enter STEM courses. However, recent analyses of data from the Australian Graduate Survey found that female STEM graduates had relatively poor wage and job-match outcomes upon entering the labour market. This paper presents evidence on career outcomes for women with STEM degrees in Australia from Australian Bureau of Statistics Census data and panel data from the Household, Income and Labour Dynamics in Australia Survey (HILDA). The results provide further evidence that policies to promote female participation in STEM need to be accompanied by measures to address career barriers they face in the labour market. Women who gain STEM qualifications have lower labour market participation rates, higher unemployment rates, are relatively dissatisfied with their employment opportunities and with the extent to which their skills are utilised in their jobs compared to women with other tertiary qualifications. They also face a larger wage gap relative to men with equivalent qualifications.

1. Introduction

It is commonly argued that maintaining and enhancing Australia's standard of living will require increasing the proportion of the population attaining university level qualifications (Dawkins, 1988; Bradley et al. 2008), with qualifications in science, technology, engineering and mathematics (STEM) seen as being of particular strategic importance for promoting competitiveness and productivity (Australian Industry Group, 2013; Office of the Chief Scientist, 2013). The 2008 *Review of Australian Higher Education* (the Bradley Review) identified the need to increase participation in higher education among a number of under-represented groups in order to sufficiently raise overall participation rates in higher education. Following recommendations from that Review, the government adopted targets to increase enrolment shares for a number of 'equity groups', including students from low socio-economic status backgrounds, Aboriginal and Torres Strait Islander Australians and people from rural and isolated regions. One of those equity groups for which participation is now monitored with a view to addressing their stark under-representation, is women studying in STEM courses. Women make up only around 30 per cent of Australians with STEM qualifications.

However, a recent analyses of data from the Australian Graduate Survey linked to university administrative records found that women who had graduated from STEM related courses earned markedly lower wages upon entry to the labour market compared to both female graduates from other fields and compared to male STEM graduates; and were much less likely than their male STEM graduates to report being in a job for which their STEM qualification was a pre-requisite (Li *et al.* 2017). These findings present a quandary for equity policy in higher education. On the one hand, it is seen as important to increase female participation in STEM courses to address occupational segregation by gender and to enhance Australia's STEM workforce. On the other hand, those same policies may be confining women to inferior labour market outcomes and limiting their career prospects. To inform policy in this area, there is a need for richer information on the labour market experiences of women who graduate from university with STEM qualifications.

This paper presents evidence on labour market and career outcomes for women with STEM degrees in Australia using two sources of data: Australian Bureau of Statistics Census data and the Household, Income and Labour Dynamics in Australia Survey (HILDA). The Census data provide near universal coverage of the Australian population, and is ideal for simple comparisons of those with and without STEM qualifications. HILDA has more limited sample sizes, but provides a longitudinal dimension and much richer data in terms of individual characteristics and outcomes. Census data are used to compare the employment status of university qualified women with STEM qualifications to other university qualified women, and to male university qualified graduates with and without STEM qualifications; and how these differentials have changed over time. Longitudinal data from the HILDA survey are now available for 16 years, spanning 2001 to 2016, and data on field of highest qualification was collected in expanded education modules contained in the Wave 12 and Wave 16 surveys, allowing us to identify people holding STEM qualifications in

2012 and 2016. We derive a panel dataset consisting of observations for which STEM status is known, comprised of intervals around 2012 and 2016 in which there is no change in the person's highest level of qualification or new qualifications completed at the degree or post-graduate level. This allows more detailed tests of the effect of gaining STEM qualifications on women's labour market outcomes.

2. Background

A range of interest groups have argued the need for Australia to increase the proportion of the workforce with qualifications in science, technology, engineering and mathematics (Australian Industry Group, 2013; Office of the Chief Scientist, 2013; PwC, 2015). A survey by the Australian Industry Group (2013) found that 75 per cent of the fastest growing occupations require STEM skills and knowledge and that industry experiences difficulty recruiting employees with STEM skills. The Office of the Chief Scientist (2012), argued that governments of other countries are focusing on increasing the supply of STEM graduates in response to the world's increasing dependence on knowledge and innovation. Compared to other OECD countries, it is observed that Australia is lagging behind on a number of key STEM indicators such as the number of enrolments of Year 12 students in mathematics and science and businesses struggling to find STEM qualified employees (Office of the Chief Scientist, 2012; PwC, 2015). Based on their own modelling, PwC claim that increasing Australia's STEM workforce to match that of other leading STEM countries would generate an additional \$57 billion in GDP over 20 years.

According to a report by the Office of the Chief Scientist (2016), there were 2.3 million people with STEM qualifications in Australia, with men making up 84 per cent of that total. Healy, Mavromaras and Zhu (2011) define the STEM qualified population as those with a Bachelor Degree or higher qualification in the fields of Natural and Physical Sciences (NPS), Information Technology (IT) or Engineering and Related Technologies (ERT). By this definition they find that, in 2011, men represented 72 per cent of the STEM-qualified population and overall the STEM-qualified population corresponds to 20 per cent of the tertiary qualified Australian population. The percentage of the Australian population in STEM increases to 28 per cent if Agriculture, Environment and Related Studies is included in the above definition of STEM (Office of the Chief Scientist, 2016).

There is a stark under-representation of women in STEM fields of study and in the STEM workforce. If one accepts arguments of the imperative to expand STEM skills in the Australian labour market overall, it clearly follows that there is a concomitant need to increase female representation in STEM courses of study. Accordingly, encouraging female participation in STEM has been a government priority in recent years. One such investment was \$54 million allocated in the 2012 Federal Budget to support Science, Mathematics and Engineering in response to the Office of the Chief Scientist report. Another \$3.9 million was allocated for projects that encourage more women in STEM related studies in 2016 from a proposed total of \$8 million for women in STEM under the National Innovation and Science Agenda.

Assessing a range of labour market indicators Healy *et al.* (2016) find mixed evidence of the presence of skills shortages in STEM, with the signs of shortages most acute in engineering. Norton (2016) argues that Australia actually has many more science graduates than the labour market can absorb in related jobs and that science graduates remain less likely than other STEM graduates to use their qualifications at work. The study finds that for science coursework graduates, 55 per cent reported a well-matched job in 2014, only slightly above the overall undergraduate rate. In 2015, just over half of science graduates worked in the same field as their degree, another 13 per cent of science graduates regarded their degree as relevant to their work, even though it is not directly in a science field (Norton 2016).

While it has been generally regarded as good policy to 'foster women in STEM', there has been only limited evidence on the labour market outcomes and experiences of women graduates in STEM - evidence that is needed to critically assess the efficacy of such policies. Encouraging women to enter STEM courses will only provide social benefits if those women subsequently become more productive than they would have otherwise been. Presumably, this would be reflected in higher rates of employment and earnings than women gaining qualifications in other fields of study. However, there are reasons to be concerned that this is not the case.

Women entering the STEM workforce face substantial challenges in their career paths ahead. Once in the workplace, pay, progression and job-security issues are barriers to women reaching the higher levels of STEM professions (Prinsley, Beavis and Clifford-Hordacre 2016). STEM qualifications appear to serve as a hedge against unemployment for men, but the reverse is true for women (Office of the Chief Scientist 2016). The *Women in the STEM professions survey report 2015* reveals that strategies to attract, retain and promote professional women may be hampered by cultural barriers, inflexible working practices, systemic bias in advancement strategies and inequities in remuneration (Professionals Australia 2015). The study notes that while women have made considerable inroads into STEM fields over the past three decades in particular, workplace practices have been slow to catch up. Hence there is a need to look at both sides of the coin, encouraging women to enter STEM education and occupations and also facilitating the male dominated STEM-based workplaces to be more equitable to women and more family friendly in order to fully engage women in STEM.

Daly, Lewis, Corliss and Heaslip (2015) provide estimates of the private rate of return to a degree in Australia across different disciplines based largely on 2006 census data on earnings and labour force status. Though the estimates are sensitive to assumptions used, they show a high rate of return for women from completing a university degree of 12 per cent, with similarly high rates for degrees in the fields of science (11 per cent), mathematics and statistics (12 per cent), IT (15 per cent) and engineering (14 per cent). More recently, Li *et al.* (2017) analysed linked data from university records and the Australian Graduate Survey from four Australian universities for graduates who completed bachelor's degrees between 2010 and 2014. They found that men and women who graduated from STEM courses had similar outcomes in terms of employment propensities, but overall they actually had inferior employment rates to non-STEM graduates. Alarming, female graduates from STEM

courses were markedly less likely than their male counterparts to have secured jobs for which their STEM qualifications were important, and earned around 16 per cent lower salaries than women graduates from non-STEM courses.

Based on the 2011 ABS Census, the Office of the Chief Scientist (2016) noted that across all age groups, the unemployment rate for men with STEM qualifications was lower than for those with non-STEM qualifications, while the opposite was true for women. The unemployment rate among women with STEM-qualifications at the university level was 5.2 per cent compared to 3.5 per cent for men; and 6.3 per cent for STEM-qualified women with VET level qualifications, compared to 3.3 per cent for males (Office of the Chief Scientist 2016).

Prinsley *et al.* (2016) find that the gender pay gap in Professional, Scientific and Technical Services in Australia in 2016 was 23.5 per cent as against the national gender pay gap of 16.2 per cent. When comparing the percentage of STEM graduates in the highest income bracket, across all STEM fields as a total, 20 per cent of graduates reported an annual personal income in the highest bracket, but 32 per cent of men earn above \$104,000 compared with just 12 per cent of women. Fewer women STEM graduates earn in the top bracket regardless of age, or whether their highest degree is a bachelor or PhD. The disparity is not accounted for by the percentage of women with children, or by the higher proportion of women who work part-time.

An element of the pay gap results from women tending to work in lower-paid professions, resulting in lower average wages for women. Nevertheless, the evidence suggests that as men move into traditionally female-dominated professions, men's salaries and status levels rise above that of women's. Prinsley *et al.* (2016) argue that women face significant attrition as they progress through their scientific careers. There are strong systemic deterrents to women in scientific research, including a lack of career prospects, job insecurity from short-term contracts, and the impact of leave and part-time work on their careers.

2.1 Women and the challenges of a male dominated STEM workforce

The Women in the STEM Professions Survey Report (Professionals Australia 2015) reports on issues relating to attracting, developing and retaining women in the STEM workforce. Based on a survey of their women members in 2015, the Professionals Australia report states that the three greatest barriers to women's career advancement are balancing work/life responsibilities, workplace culture and the lack of access to senior roles for women. Men appeared to receive significantly higher remuneration packages during the middle stages of their career than their female counterparts and women appeared to be disadvantaged at all levels. Women are more likely to be employed part-time than men across the STEM professions, with women with children less likely to be employed full-time than those without, which in turn has adverse impacts on promotion opportunities and career advancement. Unconscious bias on the part of employers appears to play a role in sidelining women who could otherwise be undertaking further training and professional development activities that would underpin career advancement.

Gendered access to part-time work arrangements was identified in the report as a significant issue, with women who work part-time concentrated in less senior roles and their skills underutilised. Many respondents commented that part-time or flexible work arrangements were only available in lower-paid, less senior roles. A lack of role models and lack of access to senior roles for women were reported by respondents as detrimentally impacting their career advancement. According to the study, 37.9 per cent of respondents (who are all female) said they felt like they had to “become one of the boys” if they wanted to “fit into” their workplace; 55.5 per cent agreed or strongly agreed that in their occupation, women have to prove themselves, where men are assumed to be capable. The study finds that 51.6 per cent of respondents reported having been directly discriminated against during the course of their employment (78.8 per cent of these on the basis of gender); 25.8 per cent of respondents reported that they had been subject to sexual harassment and 42.1 per cent to bullying in the course of their employment (Professionals Australia 2015).

According to the study as long as flexibility and work/life balance provisions operate to entrench systemic bias, and while workplace culture continues to affect employees' ability to access these core working conditions, the types of cultural problems highlighted by respondents to the survey will continue to undermine the attraction and retention of women in STEM professions (Professionals Australia 2015).

International evidence on the causes and consequences of gender bias in STEM is mixed. Ceci, Ginther, Kahn and Williams' (2014) synthesis of the literature dismisses hypotheses of biological differences between the genders in terms of abilities in mathematical or spatial reasoning. Rather, gender differences in attitudes about careers and abilities, forming from early childhood, reduce the likelihood of women entering mathematics intensive fields. Ceci *et al.* (2014) note that women are well represented in science fields such as psychology and the life sciences, but underrepresented in maths-intensive fields, suggesting relative female preferences for fields involving ‘living things’, and relative male preferences for fields involving symbol manipulation influence occupational outcomes.

Numerous studies highlight the potential problems women face in male dominated STEM occupations. In the US, for example, Williams *et al.* (2014) find that 34.5 per cent of women working in science had reported sexual harassment. Scientists conducting fieldwork were at even greater risk, with two-thirds (64 per cent) of researchers surveyed internationally experiencing sexual harassment, mostly at the hands of a senior researcher. Women were 3.5 times more likely than men to report being subject to sexual harassment. Ceci *et al.* suggest that arguments that discrimination and lack of career opportunities in STEM is a major cause of female under-representation must be tempered by the observation that women's career outcomes appear to be relatively better in those science fields in which they are in shortest supply (2014: 125), although this conclusion is based primarily on US evidence relating to academic careers in the sciences. They also acknowledge a potential role of the effects of child-bearing and preferences for part-time work in limiting career prospects for women in male dominated fields.

3. Broad trends: Evidence from the Census

This section provides an update on some of those previous studies by presenting recently released data from the 2016 ABS Census. Comparisons are made to 2006 Census data to give an indication of longer term trends in the STEM workforce. The Census records individuals' highest level of non-school qualification and the field of study of that qualification based on the 2001 Australian Standard Classification of Education (see ABS 2001 and Table 3 below). Following Healy *et al.* (2011) and others, we define the STEM qualified population as those with a Bachelor Degree or higher qualification in the fields of Natural and Physical Sciences (NPS), Information Technology (IT) or Engineering and Related Technologies (ERT). Table 1 shows the number of STEM qualified persons by gender in 2006 and 2016. Overall the number of graduates with STEM as their field of highest qualification increased from 497,000 persons in 2006 to 844,500 in 2016. This represents an increase of 69.8 per cent over the 10 years, marginally greater than the 68.1 per cent increase in the number of graduates in other fields. Consequently the proportion of tertiary qualified persons with STEM qualifications rose from 20.0 per cent in 2006 to 20.2 per cent in 2016.

Women are well represented among people with NPS qualifications, but comprise just 26.2 per cent and 16.1 per cent of people with IT and engineering and related qualifications, respectively. The share of women in each of these fields increased between 2006 and 2016, but only marginally in the case of IT. On a proportionate basis, growth was highest for women in ERT, increasing 134 per cent and leading to the female share in ERT expanding from 12.3 per cent in 2006 to 16.1 per cent in the latest Census.

The labour force status of men and women conditional upon STEM status is shown in Table 2. Women with STEM qualifications had a marginally lower labour force participation rate than other tertiary qualified women in both 2006 and 2016. In contrast STEM qualified men had almost the same participation rate as men with non-STEM qualifications in 2006, but by 2016 a gap of 3.3 percentage points had emerged in favour of STEM qualified men. While the IT qualified workforce has relatively high participation rates for women, it also displays the greatest gender gap in participation rates. That gap grew from 9.9 percentage points in 2006 to 13.1 percentage points in 2016.

In terms of unemployment rates, STEM qualifications are associated with more favourable outcomes for men relative to non-STEM qualified men, but the reverse is true for women. As noted, this was also the case with participation rates. Between 2006 and 2016 the unemployment rate increased more for persons with non-STEM degrees than for STEM qualified persons. However, a gap in unemployment rates persisted in the two censuses in which women with STEM qualifications have a higher unemployment rate than men with STEM qualifications. This applied in each of the three sub-fields of study, but is most pronounced for those with IT qualifications. Furthermore, those gender gaps widened in all three fields to be quite substantial in 2016: the female unemployment rate in IT was 2.3 percentage points above the male rate of 3.9 per cent; and for those with qualifications in an engineering and related field, the female unemployment was 2.9 percentage points above the male rate of 3.2 per cent.

Table 1: The Australian STEM population by gender: 2006 and 2016, ABS Census.

	2006				2016			
	Male	Female	Total	% Female	Male	Female	Total	% Female
Natural & physical sciences	104,034	84,866	188,900	44.9%	146,587	138,283	284,870	48.5%
Information technology	88,055	29,123	117,178	24.9%	161,741	57,365	219,106	26.2%
Engineering & related Tech.	167,674	23,498	191,172	12.3%	285,577	54,954	340,531	16.1%
STEM	359,763	137,487	497,250	27.6%	593,905	250,602	844,507	29.7%
Other fields ^a	786,979	1,198,060	1,985,039	60.4%	1,255,673	2,081,218	3,336,891	62.4%
All graduates	1,146,742	1,335,547	2,482,289	53.8%	1,849,578	2,331,820	4,181,398	55.8%
STEM share all graduates	31.4%	10.3%	20.0%		32.1%	10.7%	20.2%	

Notes: a. includes field of study inadequately described and not stated.

These differences in the incidence of unemployment are even more significant in light of women already having lower participation rates and the fact that within the non-STEM labour force women have lower unemployment rates than men.

Table 2: Labour force Status – STEM and non-STEM qualified persons, 2006 and 2016 Census

	<i>NPS</i>	<i>IT</i>	<i>ERT</i>	<i>STEM</i>	<i>non-STEM</i>
2006 Census					
Participation rate					
Men	82.6%	93.4%	86.1%	86.9%	87.0%
Women	77.9%	83.6%	79.7%	79.4%	80.3%
Unemployment rate					
Men	3.04%	4.18%	2.63%	3.15%	2.66%
Women	3.38%	4.80%	4.91%	3.96%	2.53%
2016 Census					
Participation rate					
Men	80.2%	93.4%	85.8%	86.2%	82.9%
Women	76.4%	80.3%	78.5%	77.7%	78.6%
Unemployment rate					
Men	3.63%	3.92%	3.16%	3.49%	4.70%
Women	4.28%	6.22%	6.02%	5.06%	4.13%

4. STEM and women's labour market outcomes: evidence from HILDA

4.1 The data

HILDA is a panel survey of individuals from a representative sample of private households (see Watson and Wooden 2010). Within selected households all occupants aged 15 and over are surveyed annually. Around 13,000 individuals from over 7,000 households have responded in each year, with year-on-year attrition rates averaging below 10 per cent. In 2011 an additional top-up sample of 2,153 households encompassing 4,009 responding individuals was recruited to the survey sample (HILDA Survey Annual Report 2012). The HILDA survey collects extensive information about economic outcomes; labour market experience and history; family and household formation; subjective well-being and other attitudinal data.¹

In addition to core data items collected annually, the HILDA questionnaires have included a series of 'major modules' on wealth, retirement, fertility, health and education that are repeated roughly every four years on a rotating basis. The education module, first included in 2012 and repeated in 2016, collects more detailed information from individuals with post-school qualifications, including the field of study and the institution from which those qualifications were gained (see Wilkins 2015).

¹ See <http://melbourneinstitute.unimelb.edu.au/hilda> for further details on the HILDA survey.

For the purposes of this study we restrict the sample to persons who held a bachelor degree or higher qualification. In the first wave of HILDA, and for each new person who enters the survey, respondents are asked their highest level of qualification attained. In each survey in subsequent years they are asked about any courses they have successfully completed and the associated level of qualification obtained. As noted, more detailed information on qualifications obtained was collected in Waves 12 and 16. From this information a derived variable is generated for every year indicating the respondents' highest education level achieved.

Hence it is straightforward to identify, in each year, persons with a bachelor degree or higher qualification. For this study we also need to establish whether an individuals' highest qualification is in a STEM field. Field of highest post-school qualification is collected only in Wave 12 (2012) and Wave 16 (2016). Table 3, based on the Wave 16 data, shows population estimates for the number of persons and gender breakdown by the field of study categories available in HILDA. Within this classification, and consistent with studies cited above, we define STEM fields as including natural and physical sciences, information technology and engineering and related technologies. The HILDA estimates indicate that women make up more than half of the overall population with university and higher qualifications (54.3 per cent). Slightly more men have qualifications in the natural and physical sciences, but it is information technology and engineering and related qualifications that are most male dominated (with 32.0 per cent and just 14.4 per cent female representation respectively). These population estimates derived from the HILDA data and survey weights closely align with Census estimates.

Table 3: Persons with bachelor degree or higher: field of study by gender, 2016

<i>Field of study</i>	<i>Persons</i>	<i>Male (%)</i>	<i>Female (%)</i>
Natural and physical sciences	264,540	53.5	46.5
Information technology	260,011	68.0	32.0
Engineering and related technologies	401,248	85.6	14.4
Architecture and building	100,820	71.0	29.0
Agriculture, environment and related studies	105,459	62.9	37.1
Medicine	157,939	53.6	46.4
Nursing	350,809	8.7	91.3
Other health-related	317,485	28.6	71.4
Education	765,976	28.6	71.4
Management and commerce	1,029,647	55.7	44.3
Law	173,621	56.2	43.8
Society and culture	630,985	31.1	68.9
Creative arts	186,242	41.1	58.9
Food, hospitality and personal services	43,738	51.1	48.9
Other	70,400	38.7	61.3
Total	4,858,920	45.7	54.3

Notes: frequencies calculated using HILDA person weights.

The construction of the panel dataset is best described by way of an example. Persons with a bachelor degree or higher are classified into one of three levels of qualification: bachelor or honours; graduate diploma or graduate certificate; or post-graduate (masters or doctorate). Consider a respondent observed in Wave 12 to have a graduate diploma/certificate in a STEM field. If in Wave 11 their highest level of qualification is also graduate diploma/certificate *and* in Wave 12 they do not report having completed any course with a qualification at that level or above in the past year, then we can assume that the highest qualification held in Wave 11 is the same one as that reported in Wave 12. If they also report the same level of qualification in Wave 10 *and* in Wave 11 do not report having completed a course at the graduate diploma/certificate level or above in the past year, then we can infer that the same STEM qualification was held in Wave 10. Hence it is possible to work backwards from Wave 12 to identify the period in which the same qualification is held. Where there is any change in the level of qualification or an equivalent qualification is completed in the following year, that and all prior observations are dropped for that individual, since the field of that qualification is indeterminable. In this way, we can identify an interval leading up to 2012 during which the individual held the same highest qualification and whether it is in a STEM or non-STEM field.

STEM status is also known for Wave 2016. For Waves 13 to 15 it is possible to follow the same approach working forwards from Wave 12 or backwards from Wave 16 to define intervals with the individual's qualification unchanged. It is useful to draw on both checkpoints since some people leave the survey in Waves 14 and 15, meaning only the Wave 12 reference qualification can be used; while others enter the survey or gain university qualifications after Wave 12, so that the Wave 16 reference qualification must be used. This process yielded a panel with a total of 41,237 pooled observations on 4,993 individuals for which field of study is determined. Slightly fewer observations are available for much of the analysis conducted below due to missing observations on other variables included in the modelling, particularly given our focus on employed persons. Table 4 shows the (unweighted) number of persons in the sample in each wave by STEM status and gender. The sample numbers are much lower in the early waves due to the longer time between the survey and the reference point (2012) at which STEM status can be observed. In total there are 2,037 observations on 265 women with STEM qualifications and 5,348 observations on 634 men with their highest qualification in a STEM field.

Table 4: Graduates with field of study of highest qualifications determined, HILDA sample by Wave (unweighted)

Wave	Observations (persons)			Female share (%)		
	STEM	Non-STEM	Total	STEM	Non-STEM	Total
1 (2001)	218	952	1170	22.5	62.1	54.7
2 (2002)	233	1022	1255	24.0	61.8	54.8
3 (2003)	258	1104	1362	25.2	61.8	54.8
4 (2004)	284	1202	1486	24.3	61.9	54.7
5 (2005)	307	1331	1638	24.4	62.0	54.9
6 (2006)	319	1370	1689	25.4	62.4	55.4
7 (2007)	355	1550	1905	25.6	62.6	55.7
8 (2008)	379	1673	2052	26.4	61.9	55.4
9 (2009)	417	1829	2246	26.6	61.5	55.0
10 (2010)	444	2000	2444	27.7	62.3	56.0
11 (2011)	660	2899	3559	28.8	62.5	56.2
12 (2012)	715	3275	3990	28.7	62.5	56.4
13 (2013)	685	3238	3923	28.8	62.2	56.3
14 (2014)	669	3313	3982	28.8	62.4	56.8
15 (2015)	698	3438	4136	29.2	62.7	57.1
16 (2016)	744	3656	4400	30.6	63.0	57.5
Pooled	7385	33852	41237	27.6	62.3	56.1

4.2 Some descriptive statistics

To assess the benefits women derive from gaining STEM qualifications, relative to university qualifications in other fields, we use the HILDA data to look at labour force status and a range of subjective assessments relating to individuals' satisfaction with various aspects of their jobs. Table 5 presents averages for selected data from the HILDA data pooled from Waves 1 to 16. Of those observations on university qualified people for whom field of study could be determined, people with STEM qualifications had marginally lower participation rates and a smaller percentage of those employed worked on a part-time basis. This holds from both males and females. However, the unemployment rate for women with STEM qualifications was significantly higher than for other university qualified women, consistent with Census data presented above. This did not apply for men, for whom the unemployment rate was the same for both groups.

In terms of hourly wages, the average for STEM qualified women was slightly lower than that for other women, but the difference is not statistically significant. As expected, given the overall gender pay gap in Australia, women with STEM qualifications earned significantly less than males with STEM qualifications. For men, however, STEM qualifications are associated with higher hourly earnings compared to men with qualifications in non-STEM fields. Thus the gender wage gap is observed to be larger among workers with STEM qualifications. Wages of women with STEM qualifications were 79.1 per cent of those of their male counterparts, but among those with non-STEM qualifications women's hourly wages are 86.3 per cent of male wages.

Table 5: Labour market outcomes: means for graduates with and without STEM qualifications, by gender, HILDA 2001-2016.

	<i>Females</i>			<i>Males</i>		
	<i>STEM</i>	<i>non-STEM</i>	<i>All</i>	<i>STEM</i>	<i>Non-STEM</i>	<i>All</i>
Labour force status:						
Participation rate	76.8% ^{#†}	79.5%	79.2%	83.2%	85.7%	84.9%
% of workers part-time	36.7% ^{#†}	39.8%	39.5%	11.1%	14.3%	13.4%
Unemployment rate	3.0% [#]	1.9%	2.0%	2.5%	2.5%	2.5%
Real hourly wages (in \$2016)	\$39.08 [†]	\$39.70	\$39.65	\$49.42	\$46.00	\$47.00
Satisfaction with [0-10]						
Employment opportunities ^a	6.93 ^{#†}	7.50	7.45	7.39	7.52	7.52
Total pay ^b	7.20	7.15	7.16	7.27	7.20	7.20
Job security ^b	7.50 ^{#†}	7.96	7.92	7.72	7.90	7.90
The work itself (what you do) ^b	7.47 ^{#†}	7.70	7.68	7.61	7.66	7.66
The hours you work ^b	7.37 ^{#†}	7.21	7.22	7.19	7.17	7.17
Work/non-work flexibility ^b	7.83 ^{#†}	7.35	7.39	7.70	7.53	7.53
Overall job satisfaction ^b	7.51 [#]	7.63	7.62	7.57	7.60	7.60
I use many of my skills & abilities ^b [1-7]	5.38 ^{#†}	5.74	5.71	5.58	5.62	5.61

Note: a. assessed by all persons; b. assessed by employed persons only. # indicates the figure is significantly different to that for females with non-STEM qualifications at the 5% level by the standard t-test; † indicates the figure is significantly different to that for males with STEM qualifications.

In terms of subjective assessments, we report results for satisfaction assessed on an 11-point scale ranging from 0 (totally dissatisfied) to 10 (totally satisfied) and whether workers feel their skills and abilities are well utilised in their work on a 7-point scale (1=strongly disagree, 7= strongly agree). STEM qualified women are substantially less satisfied with their employment opportunities compared to other university qualified women. Among those who are in employment, they are also significantly less satisfied with their job security, and the nature of the work they do, and feel their skills and abilities are less well utilised. However, STEM qualified women are more satisfied with the hours they work and the flexibility their job provides to balance work and non-work commitments. All this contributes to STEM qualified women reporting lower overall job satisfaction than those with non-STEM qualifications. For men those same differences between STEM qualified and other workers apply in terms of their relative direction, but the gaps are far smaller in each case.

4.3 The pay-off to STEM qualifications: Multivariate analyses

To more rigorously control for differences in the characteristics of STEM and non-STEM qualified men and women, a series of multivariate models are estimated. Binary logit models are estimated for the probability of participating in the labour force, and for the probability of being unemployed, conditional upon participating. Wages are modelled using a standard Mincerian wages equation with the log of real hourly wages as the dependent variable. Ordered probit models are estimated for each of the satisfaction ratings reported in Table 5. Conditional upon the explanatory variables, these models estimate the probability of the individual reporting a higher rather than lower satisfaction rating of the job attribute (or stronger agreement in the case of use of skills and abilities). In each case the models are random-effect panel models, taking into account the fact that we have repeat observations on individuals.

The models for labour force participation are estimated separately by gender because of the well-known differential effects of family circumstances on men's and women's participation. In all other models we include dummy variables indicating whether the respondent is female and whether they have STEM qualifications, plus a *Female*STEM* interaction term. Under this specification, the coefficient on STEM approximates the independent effect of holding a STEM related qualification on the outcome for men, and the coefficient on the *Female*STEM* interaction term captures any additional effect of holding STEM qualifications for women. All models are estimated as random effects panel models which account for unobservable individual effects. Fixed effects models, which control more rigorously for unobservable individual effects, are not used in this instance because of the very limited variation in the key variable of interest at the individual level, namely the field of study of highest qualification.²

We include controls for basic demographic characteristics, including age³, marital status, presence of dependent children, the presence of a long-term health condition and migrant/English language background. Controlling for age is particularly important, because the push for more women to enter 'non-traditional' STEM fields is likely to mean that the female STEM workforce is made up of a disproportionate number of younger and more recent graduates. Indeed, in our pooled sample, the mean age of women with STEM qualifications is 41.9 years compared to 43.8 years for other university qualified women. The age difference between STEM and non-STEM qualified males is more marginal, at 45.8 years compared to 46.2 years. By definition all individuals included in the sample report having a university degree. We include additional dummy variables capturing highest level of qualification (graduate certificate/diploma or masters/doctorate).

² Estimation of the effect of STEM in the fixed effects models would be based only on those individuals for whom there is a change in the value of STEM, and thus a change in the field of their highest qualification.

³ Models for participation are restricted to persons aged 69 years and under. Models for unemployment relate only those participating in the labour market, who range in age from 18 to 89 years. With the exception of satisfaction with employment opportunities, all other 'satisfaction' variables are defined only for employed graduates, for whom ages range from 18 to 89 years.

An extremely rich set of potential covariates is available in HILDA relating to individuals' labour market history, characteristics of their job and of their workplaces. We opt for a reduced form approach because we are primarily interested in net outcomes for women who gained STEM qualifications. For example, it is possible to include previous time out of the workforce as an independent variable in the model of employment and wages; and to include wages, hours of work or contract status as independent variables in the various models of satisfaction. However, each of these covariates may themselves be influenced by STEM status. The addition of such covariates would be useful for exploring the source of differences in outcomes for women with and without STEM qualifications, but our concern here is to establish whether or not such differences exist in the first place. We leave more detailed decompositions of those differences - if identified - to future research. For models estimated on the sample of employed persons we add controls for sector (private, government business enterprise, public and not-for-profit), workplace size and the respondent's geographical location (major city, inner regional or outer regional).

Full regression results are included in the tables in the appendix, and here we summarise the results by presenting coefficients relating to gender and holding of STEM qualifications (see Table 6). As noted, the models of labour force participation are estimated separately for males and females. We also restrict the sample to persons aged 69 and under for these models. For both genders, holding STEM related qualifications is associated with a lower probability of participation in the labour force relative to persons holding non-STEM qualifications (see Appendix Table A1). For females the coefficient (β) is -0.367 and significant at the 10 per cent level ($p=0.08$). The estimated negative effect is larger for males and significant at the 5 per cent level ($\beta=-0.468$, $p=0.05$), however a formal test indicates that we cannot reject the null hypothesis that the true effect for women is equivalent to that for men (chi-square=0.63).

Results from the model for the probability of being unemployed, conditional upon participation in the labour market, indicate that women university graduates are significantly less likely than male graduates to be unemployed. Estimated odds ratios suggest women are around 25 per cent less likely to be in unemployment ($p=0.07$), presumably reflecting women being more likely to leave the labour force when out of work. Holding STEM qualifications has no significant effect on the chance of being unemployed for men. The result for the female*STEM interaction term implies a substantial 46 per cent increase in the probability of being unemployed associated with holding a STEM qualification for women, but we cannot reject the hypothesis of no effect ($p=0.30$).

Table 6: Summary of coefficients for female and STEM variables, panel models, HILDA Waves 1-16.

Independent var	Sample		Males and females				Females only	
	Female	P>z	STEM	P>z	Female*STEM	P>z	STEM	P>z
Model/Dep var.	β		β		β		β	
Binary logit								
Participation ^a	n.a.		n.a.		n.a.		-0.37*	0.08
Unemployment	-0.28*	0.07	-0.03	0.87	0.38	0.30	0.33	0.28
OLS								
Real hourly wages	-0.11***	0.00	0.09***	0.00	-0.09**	0.02	0.00	1.00
Ordered probit (Satisfaction with ...)								
Emp. opportunities	0.00	0.90	-0.04	0.48	-0.18*	0.06	-0.21***	0.00
Total pay	0.02	0.59	0.08*	0.10	0.09	0.32	0.18**	0.02
Job security	0.00	0.98	-0.05	0.39	-0.04	0.69	-0.10	0.23
The work itself	0.06*	0.07	0.03	0.60	-0.10	0.22	-0.09	0.19
Hours worked	0.05	0.17	0.09**	0.04	0.18**	0.04	0.24***	0.00
Flexibility	-0.02	0.62	0.12**	0.01	0.15	0.11	0.24***	0.00
Job overall	0.06	0.10	0.05	0.28	0.00	0.96	0.03	0.70
(disagree/agree...)								
Uses skills/abilities	0.16***	0.00	0.06	0.28	-0.34***	0.00	-0.27***	0.00

Note: *** ** and * indicate the estimated coefficient is significantly different from zero at the 1, 5 and 10 per cent levels, respectively; a. sample restricted to persons aged 69 and under.

In the wages equation the dependent variable is the log of real hourly wages⁴, so the coefficients approximate the percentage change in wages associated with a one unit change in the independent variable. In this sample of university qualified workers, women are observed to earn around 11 per cent lower hourly wages than men ($\beta=-0.11$, $p=0.00$). Having your highest qualification in a STEM related field is associated with 9 per cent higher earnings, but this is exactly offset by a 9 per cent wage penalty if those STEM qualifications are held by a women. Hence, after controlling for basic demographics and job characteristics, women with a STEM qualification face a gender wage gap of around 20 per cent. Restricting the sample to women only, there is no difference in hourly earnings between STEM qualified women and other female graduates: the STEM 'penalty' is a penalty relative to men with those qualifications, rather than relative to other women.

To further explore sources of differences in wages earned by STEM-qualified women relative to other female graduates and relative to STEM-qualified men, Blinder-Oaxaca decompositions were conducted. Consider a linear regression of the log of wages (Y) of the form: $Y_{\rho} = \beta_{\rho}X'_{\rho} + \varepsilon_{\rho}$ for two different groups (ρ =group A or group B), where X' is a vector of observed characteristics with associated vector of estimated coefficients β and ε a standard error term. The difference in mean (log) wages between

4 Hourly wages are calculated as weekly earnings in main job divided by hours usually worked per week, and indexed by the consumer price index to be expressed in 2016 dollars.

group A and group B can be decomposed into components associated with differences in observed characteristics (differences in the X 's) and differences in the returns to those characteristics (differences in the β 's).⁵ The wage equations above revealed no statistically significant difference between the hourly earnings of female graduates with STEM qualifications and female graduates with non-STEM qualifications. The Blinder-Oaxaca decomposition of differences in hourly earnings for women with STEM and non-STEM qualifications confirms that differences attributable both to characteristics and to estimated coefficients are insignificantly different from zero. Within the STEM qualified workforce, the decomposition analysis shows a 20 per cent wage penalty for women. The wage gap attributable to differences in observable characteristics, at 3.8 percentage points, is not significantly different to zero. In contrast, differences in coefficients account for 15.4 percentage points of that wage gap ($p=0.00$). Given the sample numbers the estimated contributions for individual variables are imprecise, but the results suggest that both differences in age profiles by gender and the return to age are important. For males with STEM qualifications, wages increase by an estimated 5.7 per cent per year, compared to just 4.1 per cent for women, suggesting lower returns to experience and more limited career progression for women.⁶ More career interruptions and greater time spent in part-time work for women may also contribute to this result.

Surprisingly, given the estimated gender wage gap within the STEM workforce, there is evidence from the model of workers' satisfaction with their pay that women with STEM qualifications are more satisfied with their pay than other female workers. Results from the models including the interaction term suggest this arises from a combination of higher pay satisfaction for STEM qualified workers overall, and higher satisfaction again for women with STEM qualifications.

Several other results stand out in the 'satisfaction' models. Each year respondents to the HILDA Person Questionnaire are asked their satisfaction with a range of aspects of their lives, of which one is 'Your employment opportunities'. STEM-qualified women are less satisfied with their employment opportunities than both STEM-qualified males and women with qualifications in other fields. The effect is only marginally significant in the model estimated across males and females ($p=0.06$), but highly significant and of some magnitude in the model estimated for females only.

The observations above that STEM qualified women are markedly less likely to feel their skills and abilities are well utilised in their jobs persists in the multivariate models. Typically women tend to agree more strongly than men with the statement 'I

5 To be complete, there is a further component associated with the interaction between the differences in X 's and differences in the β 's. The decompositions are conducted using STATA's 'oaxaca' command with standard errors clustered at the individual level to account for the panel dimension of the data. Details can be found in Jann (2008). In the two decompositions reported here we use the coefficients for females with non-STEM qualifications, and for males with STEM qualifications, as the base or 'non-discriminatory' coefficients, as those are the majority groups in the relevant comparisons.

6 These estimates are direct effects of age (in years) and do not take into account the second order (age-squared) effects. The total effect is contingent upon the point in the age distribution at which it is evaluated. The decomposition shows a very large contribution from the lower return to years of age for women, but the effect is not significantly different to zero ($p=0.36$).

use many of my skills and abilities in my current job'. However, the opposite applies for women with STEM qualifications. No such evidence of skill under-utilisation is evident for male workers with STEM qualifications.

Generally workers with STEM qualifications are more satisfied with their hours and flexibility to balance work and non-work commitments, and this reflects both a general association that applies to men and women, plus added satisfaction for STEM qualified women.

Given Li *et al.*'s (2017) findings of inferior outcomes for recent graduates from STEM courses, we re-estimated the models with the sample restricted to persons aged 40 and under. This reduced sample included just under half (48 per cent) of the observations on employed persons, and the lower sample size will reduce the power of the models for making statistical inferences, including with respect to the minority of women with STEM qualifications. As can be seen in Table 7, the results are very similar for the younger cohort as for the overall sample. The lower labour force participation for women with STEM degrees is less pronounced and becomes insignificant ($\beta=-0.29$; $p=0.21$), though this may reflect the smaller sample size. However, the wage penalty associated with the female*STEM interaction term is more pronounced for the younger cohort ($\beta=-0.15$; $p=0.00$). With a STEM wage premium estimated at 10 per cent ($p=0.00$), the implied gender wage gap widens to 25 per cent among younger STEM qualified workers. The result pertaining to perceptions of skill utilisation holds for the younger cohort.

Table 7: Summary of coefficients for female and STEM variables, persons aged 40 and under

Sample	Males and females						Females only	
	Female		STEM		Female*STEM		STEM	
Independent. var	β	P>z	β	P>z	β	P>z	β	P>z
Model/Dep var.								
Binary logit								
Participation ^a	n.a.		n.a.		n.a.		-0.29	0.21
Unemployment	-0.18	0.31	-0.22	0.38	0.44	0.29	0.21	0.54
OLS								
Real hourly wages	-0.07***	0.00	0.10***	0.00	-0.15***	0.00	-0.04	0.24
Ordered probit (Satisfaction with ...)								
Emp. opportunities	-0.01	0.82	-0.07	0.30	-0.15	0.18	-0.20**	0.02
Total pay	-0.03	0.43	0.03	0.58	0.16	0.12	0.20**	0.01
Job security	0.02	0.69	-0.09	0.17	0.08	0.45	-0.02	0.83
The work itself	0.04	0.32	0.03	0.59	-0.10	0.29	-0.08	0.27
Hours worked	0.56	0.57	1.70*	0.09	1.36	0.17	0.21**	0.01
Flexibility	-0.06	0.23	0.11*	0.10	0.18*	0.09	0.26***	0.00
Job overall	0.03	0.53	0.04	0.43	0.02	0.80	0.05	0.48
(disagree/agree...)								
Uses skills/abilities	0.12**	0.03	0.04	0.56	-0.29**	0.01	-0.23***	0.01

Note: ***, * and * indicate the estimated coefficient is significantly different from zero at the 1, 5 and 10 per cent levels, respectively; a. sample restricted to persons aged 69 and under.

Finally, we further differentiated qualifications between the three STEM fields of natural and physical sciences, information technology and engineering and related technologies. We stress that the numbers of observations available for estimating the effects of holding each qualification specifically for women are low, particularly for those models applicable only to employed persons. In total there are observations for 105 employed women with qualifications in NPS; 39 in IT; and 45 in ERT, although we have repeated observations on those individuals. With this caveat in mind, the results, as reported in Table 8, suggest:

- the lower participation of females with STEM qualifications applies primarily to those with qualifications in the natural and physical sciences ($\beta=-0.59$; $p=0.02$);
- the higher incidence of unemployment is driven by higher unemployment for women with information technology qualifications (interaction term $\beta=1.53$; $p=0.01$). The associated odds ratio implies females with IT related qualifications are around 4 times more likely than a male with IT qualifications to be unemployed;
- females' reduced satisfaction with their employment opportunities applies across the three fields, with the estimates for the interaction term largest for IT ($\beta=-0.37$; $p=0.02$);
- Women with engineering related qualifications earn 20 per cent higher hourly wages than women with non-STEM qualifications, and it is these women that mainly drive the result noted above of relatively high pay satisfaction among STEM qualified women;
- The perceptions of under-utilisation of skills and abilities is refined to women with qualifications in the natural and physical science and in IT; it does not apply to women in engineering fields.

Table 8: Summary of coefficients for individual STEM fields of study

Model/Dep var.	Males & Females: female*field Interaction term						Females only: STEM field of study							
	Nat & Phys science		IT		Engineer & related		Nat & Phys science		IT		Engineer & related			
	β	P>z	β	P>z	β	P>z	β	P>z	β	P>z	β	P>z		
Binary logit														
Participation ^a														
Unemployment	-0.22	0.67	1.53**	0.01	-0.35	0.68	-0.59**	0.02	-0.37	0.38	1.05**	0.04	-0.50	0.52
OLS														
Real hourly wages	-0.07	0.22	-0.06	0.40	0.07	0.21	-0.08**	0.05	0.06	0.31	0.20***	0.00		
Ordered probit (Satisfaction with ...)														
Emp. opportunities	-0.10	0.49	-0.37**	0.02	-0.14	0.39	-0.19*	0.06	-0.32**	0.01	-0.16	0.25		
Total pay	0.13	0.33	0.07	0.62	0.20	0.19	0.12	0.21	0.21*	0.10	0.33**	0.01		
Job security	-0.13	0.40	-0.09	0.59	0.18	0.21	-0.14	0.24	-0.12	0.37	0.05	0.67		
The work itself	-0.17	0.17	0.00	0.98	-0.06	0.65	-0.14	0.12	0.01	0.92	-0.05	0.68		
Hours worked	0.19	0.13	0.23	0.12	0.10	0.47	0.23**	0.01	0.38***	0.00	0.13	0.30		
Flexibility	0.12	0.39	-0.01	0.97	0.37***	0.01	0.18*	0.06	0.33***	0.00	0.31**	0.01		
Job overall	0.01	0.92	-0.09	0.56	0.05	0.73	0.02	0.80	0.03	0.81	0.04	0.76		
(disagree/agree...)														
Uses skills/abilities	-0.42***	0.00	-0.42**	0.02	-0.04	0.80	-0.35***	0.00	-0.26*	0.08	-0.03	0.83		

Note: ***, **, * indicate the estimated coefficient is significantly different from zero at the 1, 5 and 10 per cent levels, respectively; a. sample restricted to persons aged 69 and under.

5. Conclusion

Data from both the 2016 ABS Census of Population and Housing and from the HILDA survey provide little support for the received wisdom that STEM skills are in shortage relative to other skills gained at the tertiary level. In recent times unemployment rates have been higher among tertiary qualified persons whose highest qualification is in a STEM field. There is, however, some evidence of a positive wage premium for males only. More importantly, for the research question at hand, we find that women who gain STEM qualifications fare relatively poorly in the labour market in a number of respects. For women with STEM qualifications, labour force participation rates are lower and unemployment rates higher than for women qualified in other fields. While wages appear to be on par for women with STEM and non-STEM qualifications, women with STEM qualifications face higher wage inequality in the form of lower relative wages when compared to their male counterparts holding those same qualifications. The gender wage gap among STEM qualified workers appears to be more pronounced for younger women.

In addition to gender wage inequality, women who gain a university degree in a STEM related field are markedly less satisfied with their employment opportunities and, once employed, feel their skills and abilities are less well utilised. This is in comparison both to other women, and to men with STEM qualifications. The field of information technology, in particular, seems to be one in which women face substantial barriers, although this conclusion is based on a relatively small number of observations.

Overall, for women who enter university, the evidence suggests there is little labour market benefit to be gained from entering a STEM related field as opposed to other fields, and doing so presents a number of challenges. There is clearly a degree of disconnect between the evidence on labour market outcomes and the narrative of the need for more women to enter such fields and, to our knowledge, those advocating greater participation of women in STEM have not clearly articulated any market failure to support the argument that current levels of participation are sub-optimal. There has been a modest increase in the female representation in STEM fields in the past 10 years. If women are to be encouraged to enter such courses in what is seen to be in the best interests of the country and economy overall - by increasing Australia's capacity in strategic occupations and being the pioneers who tackle occupational gender segregation - but this comes at the cost of sacrificing their own labour market opportunity, then it seems reasonable that such policies should be backed by compensatory incentives for those women. This may be in the form of scholarships to meet the cost of studying in those courses, or tax breaks through the Higher Education Contribution Scheme and associated Higher Education Loans Program (HECS-HELP).

Positive action to change attitudes and behaviours at the workplace is also needed. It is difficult to conceive of reasons for why women in such fields do relatively worse in terms of employment opportunity, earnings and the matching of their skills to their jobs, other than the fact that they enter male dominated working environments that adversely affect their job opportunities, promotion prospects and earnings

growth. We note, however, that engineering and related technologies is the most male dominated field, but not necessarily the worst in terms of gender outcomes, in fact offering high wages for women. This is an encouraging sign that more pronounced gender segregation need not necessarily translate into poorer outcomes for women. Further research focussing on women's experiences in engineering and related careers, and accompanying workplace policies and practices, may be of benefit in identifying ways to address discrimination in other strongly gender-segregated sectors.

A limitation of the research is that it has been necessary to define STEM status on the basis of the field of a person's highest qualification, as recorded in HILDA or the Census. Hence persons who gained their first university degree in STEM, but who go on to gain qualifications in other fields, such as management, would not be included in our definition of the 'STEM workforce'. Healy *et al.* (2011) also note the example of those who gain an undergraduate degree in mathematics or science and become teachers. Typically their highest qualification is a graduate diploma or masters in education, and thus they would also be excluded from the definition of STEM. One might argue that it is returns by field of study of an individual's first degree that are of most relevance. As the number of HILDA waves increases, sample sizes will eventually become sufficient to support a similar analysis based on the field of study of individuals' first observed degree. Certainly research based on larger samples at the level of individual fields of study would be highly valuable for drawing policy implications. This could most readily be achieved via access to Australian Taxation Office's data, which in principle can readily match graduate data to employment and earnings outcomes through their administration of HECS-HELP scheme. This could provide confidentialised records on employment status and earnings for the high proportion of graduates that leave university with a HECS debt, matched to university data on field of study, level of qualification, institution and other aspects of their tertiary education. Unfortunately the ATO has been reluctant to date to provide such data to researchers, despite its obvious relevance to issues surrounding the economics of higher education in Australia.

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Appendix Table A1: Regression results, binary logit models for probability of participating in the labour market and probability of being unemployed (given participation), HILDA Waves 1-16

	<i>Labour force participation^a</i>				<i>Unemployment</i>	
	<i>Females</i>		<i>Males</i>		<i>(males & females)</i>	
	β	$P> z $	β	$P> z $	β	$P> z $
Constant	-4.33 ***	0.00	-5.77 ***	0.00	-4.24 ***	0.00
Age	0.53 ***	0.00	0.68 ***	0.00	-0.08 **	0.02
Age-squared/100	-0.73 ***	0.00	-0.90 ***	0.00	0.10 **	0.01
Family status:						
Married, no dep. children	—		—		—	
Married, kids aged 0-4	-3.54 ***	0.00	-0.27	0.34	-0.05	0.80
Married, kids aged 5-14	-0.84 ***	0.00	0.61 *	0.06	-0.50 **	0.02
Married, kids aged 15-24	0.29	0.22	1.00 ***	0.00	-0.56 **	0.02
Single, no dep. children	0.25	0.12	-0.33	0.16	0.81 ***	0.00
Single, kids aged 0-4	-2.59 ***	0.00	-1.40	0.40	1.04 *	0.06
Single, kids aged 5-14	-0.66 **	0.04	-1.32	0.41	0.40	0.26
Single, kids aged 15-24	0.45	0.26	0.59	0.52	0.12	0.81
Has long-term health condition	-0.61 ***	0.00	-0.68 ***	0.00	0.69 ***	0.00
Born in Australia	—		—		—	
Born overseas:						
English speaking background	-0.22	0.32	0.09	0.79	0.50 **	0.02
Non-English sp background	-1.27 ***	0.00	-0.54 **	0.05	1.43 ***	0.00
Highest level of qualification:						
Bachelor/honours degree	—		—		—	
Graduate cert/diploma	0.44 ***	0.01	0.00	0.99	-0.33 *	0.08
Masters or doctorate	0.96 ***	0.00	0.24	0.37	0.06	0.73
STEM (field of study)	-0.37 *	0.08	-0.47 **	0.05	-0.03	0.87
Female					-0.28 *	0.07
Female * STEM					0.38	0.30
Observations	21993		16790		33654	
Individuals	2800		2081		4646	
Obs/individual						
Minimum	1		1		1	
Average	7.9		8.1		7.2	
Maximum	16		16		16	
Wald chi-square	826.7 ***	0.00	415.66 ***	0.00	180.7 ***	0.00

Note: ***, * *and * indicate the estimated coefficient is significantly different from zero at the 1, 5 and 10 per cent levels, respectively; a. sample restricted to persons aged 69 and under.

Appendix Table A2: Regression results – wage equation, HILDA Waves 1-16
(dependent variable = log of real hourly wages in 2016 dollars)

	β	$P> z $
Constant	2.273 ***	0.00
Age	0.056 ***	0.00
Age-squared/100	-0.050 ***	0.00
Married	0.049 ***	0.00
Has long-term health condition	-0.010	0.28
Born in Australia	—	
Born overseas:		
English speaking background	-0.006	0.80
Non-English speaking background	-0.132 ***	0.00
Highest level of qualification:		
Bachelor/honours degree	—	
Graduate cert/diploma	-0.005	0.75
Masters or doctorate	0.073 ***	0.00
Sector of employment:		
Private, for profit	—	
Private, not for profit	-0.026 *	0.05
Government business enterprise	0.055 ***	0.00
Public sector	0.031 ***	0.01
Other	-0.080 ***	0.01
Workplace size:		
Small (1-19 workers)	-0.130 ***	0.00
Medium (20-99 workers)	-0.060 ***	0.00
Large (100+ workers)	—	
Region of residence:		
Major city	—	
Inner regional centre	-0.079 ***	0.00
Outer regional or remote	-0.053 ***	0.01
Employed part-time	0.117 ***	0.00
Female	-0.112 ***	0.00
STEM (field of study)	0.088 ***	0.00
Female * STEM	-0.089 **	0.02
Observations	29860	
Individuals	4448	
Obs/individual: Minimum	1	
Average	6.7	
Maximum	16	
Wald chi2	1986.8 ***	0.00
R-sq: within	0.08	
Between	0.16	
Overall	0.12	

Note: ***, * and * indicate the estimated coefficient is significantly different from zero at the 1, 5 and 10 per cent levels, respectively.

Appendix Table A3: Regression results, panel ordered probit models for employment opportunity/job satisfaction ratings, HILDA Waves 1-16.

Independent var	Satisfaction with ... [0 = totally dissatisfied to 10 = totally satisfied]										Use skills and abilities [1-7]					
	Emp. opport.		Pay		Job security		The work itself		Hours of work		Flexibility		Job overall		Use skills and abilities [1-7]	
	β	P>z	β	P>z	β	P>z	β	P>z	β	P>z	β	P>z	β	P>z	β	P>z
Age	-0.06	0.00	-0.01	0.16	-0.05	0.00	-0.02	0.00	-0.07	0.00	-0.05	0.00	-0.05	0.00	0.02	0.02
Age-squared/100	0.06	0.00	0.03	0.00	0.05	0.00	0.04	0.00	0.09	0.00	0.07	0.00	0.07	0.00	-0.01	0.20
Married	0.12	0.00	0.08	0.00	0.18	0.00	0.08	0.01	0.12	0.00	0.11	0.00	0.13	0.00	0.10	0.00
Has long-term health condition	-0.12	0.00	-0.10	0.00	-0.08	0.00	-0.03	0.28	0.03	0.18	0.04	0.14	-0.04	0.11	0.02	0.53
Born in Australia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Born overseas:																
English sp. background	-0.04	0.50	-0.05	0.38	-0.03	0.64	-0.05	0.35	-0.03	0.61	-0.02	0.73	-0.05	0.38	-0.11	0.07
Non-ESB	-0.56	0.00	-0.22	0.00	-0.29	0.00	-0.15	0.00	-0.02	0.70	-0.13	0.00	-0.19	0.00	-0.20	0.00
Highest level of qual.:																
Bachelor/honours	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Graduate cert/dip	0.12	0.01	-0.02	0.68	0.07	0.13	0.06	0.10	0.00	0.98	-0.10	0.01	-0.01	0.87	0.12	0.01
Masters/doctorate	0.09	0.03	0.04	0.28	-0.10	0.02	0.09	0.02	-0.06	0.14	-0.05	0.22	-0.03	0.50	0.14	0.00
Sector of employment:																
Private, for profit	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Private, not for profit	0.08	0.05	0.19	0.00	0.19	0.00	0.19	0.00	0.19	0.00	0.00	0.98	0.19	0.00	0.21	0.00
Government business	0.16	0.00	0.19	0.00	0.19	0.00	0.00	0.99	0.19	0.00	-0.01	0.85	0.11	0.01	0.16	0.00
Public sector	0.18	0.00	0.21	0.00	0.21	0.00	0.03	0.43	0.19	0.00	-0.06	0.09	0.13	0.00	0.27	0.00
Other	-0.04	0.64	0.21	0.02	0.21	0.02	0.32	0.00	0.06	0.48	0.04	0.64	0.11	0.22	0.09	0.41
Workplace size:																
Small (1-19 workers)	-0.20	0.00	-0.03	0.23	0.18	0.00	0.18	0.00	0.16	0.00	0.37	0.00	0.15	0.00	-0.06	0.07

Continued / ...

Appendix Table 3 (Cont'd)

Independent var	Satisfaction with ... [<i>0</i> =totally dissatisfied to <i>10</i> =totally satisfied]												Use skills and abilities [1-7]					
	Emp. opport.		Pay		Job security		The work itself		Hours of work		Flexibility		Job overall		β	<i>P</i> > <i>z</i>		
Medium (20-99 wrkrs)																		
Large (100+ workers)																		
Region of residence:																		
Major city																		
Inner regional	-0.01	0.84	-	0.04	0.33	0.03	-	0.48	0.09	0.03	-	0.07	0.08	0.02	0.66	0.10	0.01	0.09
Outer regional/remote	0.02	0.80	0.09	0.15	0.21	0.00	0.15	0.01	0.02	0.02	0.75	-0.07	0.27	0.11	0.05	0.16	0.02	0.02
Female	0.00	0.90	0.02	0.59	0.00	0.98	0.06	0.07	0.05	0.05	0.17	-0.02	0.62	0.06	0.10	0.16	0.00	0.00
STEM (field of study)	-0.04	0.48	0.08	0.10	-0.05	0.39	0.03	0.60	0.09	0.04	0.12	0.01	0.01	0.05	0.28	0.06	0.06	0.28
Female * STEM	-0.18	0.06	0.09	0.32	-0.04	0.69	-0.10	0.22	0.18	0.18	0.04	0.15	0.11	0.00	0.96	-0.34	0.00	0.00
Observations	36806		32656		32642		32671		32670		32664		32669		29360			
Individuals	4869		4568		4567		4569		4569		4569		4569		4388			
Obs/individual																		
Minimum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Average	7.6	7.1	7.1	7.1	7.1	7.2	7.2	7.2	7.2	7.2	7.1	7.1	7.2	7.2	6.7	6.7	6.7	6.7
Maximum	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Wald chi2	271.5	0.00	331.0	0.00	216.1	0.00	275.5	0.00	267.0	0.00	387.3	0.00	327.4	0.00	274.4	0.00	274.4	0.00

Note: Cut points from ordered probit models omitted. a. Sample for the model for employment opportunities includes all responding persons, while the remaining models apply to employed persons only; b. scale ranges from 1=strongly disagree to 7=strongly agree.

What Determines Coverage by Collective Agreements or Awards?

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JEL: J50, J52, J58

1. Introduction

Wage setting in Australia features a complex system of interdependencies between awards, collective agreements (CAs) and individual arrangements (IAs). How an employee comes to have their pay and conditions set has long been the subject of close study. In the context of recent declines in collective agreement coverage, the purpose of this article is to examine the influence of employee and employer characteristics on collective agreement coverage. The causes of that decline are not the topic of this paper, but the determinants of collective agreement coverage are, because of the substantial effects it has. Collective bargaining is commonly a way by which employees boost their power in order to obtain higher pay and better conditions and better treatment at work and is a mechanism by which wage inequality is reduced (Jackson, A and Schellenberg, 1999; Peetz, 2006; International Labour Office, 2016). Understanding the factors that encourage it can facilitate our understanding of the factors shaping those outcomes.

We use the latest Survey of Employee Earnings and Hours (EEH) by the Australian Bureau of Statistics (ABS) to examine a range of factors which affect the probability that an employee is covered by a collective agreement or alternative instrument at a point in time. This paper addresses the following questions:

1. How do employee characteristics affect their likelihood of being covered by a collective agreement?
2. How does union density at the industry and occupational level affect the likelihood of an employee being covered by a collective agreement?
3. How do these effects vary if we compare the likelihood of being covered by a collective agreement to being covered by awards or by individual arrangements?
4. How do these effects vary for employees in the private and public sectors?
5. How does this vary for employees in the retail and hospitality sectors, where wages in awards and collective agreements are similar?

This analysis takes advantage of cross-sectional, unit-record data to measure the impacts of factors including industry and occupation of employment, employer size, casual and part-time employment status, and junior employee status. Some of the complex interdependencies mentioned above are first outlined in the next section, after a discussion of some relevant literature.

2. Background

There is a long history of research into the determinants of union density, but much less into the determinants of collective agreement coverage, despite the close relationship between the two.

Usually, unions are a pre-requisite for collective bargaining. In most other countries, collective agreements in employment can only be made by unions, and there is no scope for non-union employees to directly bargain with employers to create agreements that override statutory conditions without union involvement in some way. So internationally, collective agreement coverage is closely linked to union coverage: amongst countries on Jelle Visser's ICTWSS database there was, in 2012, a correlation

of $r=0.45$ between these two variables ($n=38$), (based on calculations from Visser, Jelle, 2017)¹. In the US and Canada, union density and collective bargaining coverage are almost codeterminous, as most unionised workplaces have full membership coverage and a collective agreement, while in most workplaces where unions fail to secure majority support for unionism, membership soon falls to nearly zero. Elsewhere they are not the same thing, however, and in many countries unions use extension provisions of some type to expand the coverage of collective agreements beyond the workplaces for which negotiations immediately occur. In many countries it is possible for employees to be covered by a collective agreement without being a union member. Nonetheless, within most countries, there is a close relationship between union density and CA coverage density. In Australia in 2014, only 16 per cent of employees were in a trade union. However, a much higher proportion would have been in a workplace with a union delegate because of the bias of union members, and delegates, towards larger workplaces (Morehead, Steele, Alexander, Stephen and Duffin, 1997). In 2007 the figures had been 21 and 36 per cent respectively (Considine and Buchanan, 2007).

More importantly, in Australia there is the almost unique option for employers of having a ‘non-union’ collective agreement. In principle, this might weaken the relationship between union coverage and collective bargaining in Australia. In practice, non-union agreements only typically account for about one in ten employees under collective agreements, so we would still expect there to be a strong link between unionism and collective bargaining. More important might be the varying strength of unions at the workplace or enterprise level. Union density is not necessarily a good indicator of union strength. A union might have members in a particular workplace or organisation, but not the bargaining power to force an agreement onto an employer. If delegates are well organised or have higher density in certain types of workplaces (say in larger workplace or the public sector) then collective agreements may be more likely there. On the other hand, non-union agreements may have quite different determinants, though there is also reason to believe that employers will seek to use union substitution devices in those workplaces that are most susceptible to unionisation. If that is the case, then many of the statistical determinants of union and non-union agreements may be quite similar.

The existence of non-union agreements is perhaps one of the less unusual aspects of the Australian system. More noteworthy is the now unique system of ‘modern awards’ that sets minimum rates of pay and conditions of employment in each industry, minima that vary by occupation. These awards are made by industrial tribunals—mostly the federal industrial tribunal, now called the Fair Work Commission (FWC). Though currently an administrative instrument of the FWC, in earlier times awards were the mechanism by which industrial disputes between unions and employers were settled. Then, as now, employees benefited from awards regardless of whether they were union members. While awards for the lowest classifications of unskilled workers are identical to the national minimum wage, for more skilled employees the relevant minima are higher. Collective agreements in turn must satisfy a ‘better off *overall*’ test (BOOT), by which employees covered by them are meant to be, in net terms, better off than they would be under the relevant award. This test is assessed by the FWC but, for union agreements, it historically relied on assurances by unions that their

members would indeed be better off—something which, in most industries, was a fair assumption, as unions used collective bargaining to improve the pay and conditions of members. Indeed, union support for the move in Australia to ‘enterprise bargaining’ was predicated in part on the idea that this was needed to give employees the incentive to unionise, as employees were seen as giving little credit to unions for nationally determined award wage increases.

That approach by the FWC to approving agreements was revised, however, after some major CAs in retail trade were successfully challenged on the grounds that they had breached the BOOT—that is, there were a number of employees who were worse off under the CA than they would have been under the award. It seemed that CAs may have served a different function in that industry, with one journalist arguing ‘The [union]’s cosy relationship with employers might have been bad for its members, but it was advantageous for its leadership, providing it with the numbers that gave it greater say in union and party forums, greater clout in factional horsetrading and a bigger voice in parliament’ (Secombe, 2016). In the hospitality industry (‘food and accommodation services’) some similar issues arose, and there was high usage of non-union collective agreements at the end of the WorkChoices period (when there was no BOOT or comparable test for CAs) as employers sought to use CAs to keep unions out of their workplaces. So in Australian retail and hospitality, the determinants of collective bargaining coverage might be quite different to elsewhere.

For workers on individual agreements (IAs), pay and conditions should be no worse in any respect than under the relevant award. ‘Individual flexibility arrangements’ enable various working time restrictions to be circumvented in certain circumstances, but provide no leeway for cutting hourly wages below award minima. Within this constraint (or sometimes, ignoring it), IAs are typically determined unilaterally by the employer or negotiated between the employer and employee, without reference to any other party or regulator. While CAs and awards are finalised by the FWC, IAs are not. In that sense, they are the least regulated form of employment. For some highly paid employees (senior managers being an extreme example) awards might theoretically apply but in practice are irrelevant as the award pay rates are far below actual pay rates. As all employees on individual agreements must be paid at or above the award rate, then it is arithmetically inevitable that average pay under legal individual agreements will be higher than average pay under awards.

The literature identifies substantial variations in union density by industry and occupation (Visser, E J, 1991; Jackson, Andrew and Schetagne, 2004). In several countries, density is higher in blue-collar occupations than white-collar occupations (Visser, E J, 1991; Schnabel and Wagner, 2007). Density is almost everywhere higher in the public sector than the private sector (Grimes, 1994; Jackson, Andrew and Schetagne, 2004). It is lower amongst casual or temporary than among permanent workers (Australian Bureau of Statistics, 6333.0) and lower among part-time than full-time workers (Millward, 1990; Grimes, 1994). It is normally higher in large workplaces and organisations, mainly because unions find it easier to organise workers in such workplaces, but also because larger organisations tend to be more rules-based and unions may become part of the rule-making web (Visser, E J, 1991; Wooden and Balchin, 1993; Grimes, 1994; Morehead et al., 1997; Schnabel and Wagner, 2007;

Lucas, 2009). In most countries, women have been less likely to be union members than men, but the gap has been reducing in recent decades and in some countries (e.g. Sweden, the UK and Australia) union density is now higher amongst women than men (Visser, Jelle, 2006). Gender differences tended to be explained by structural factors (the types of jobs women were in, and the types of industries in which they worked) rather than attitudinal differences between men and women (Freeman and Medoff, 1984). An earlier study found that, after controlling for occupation and a range of personal and attitudinal characteristics, men were more likely to be unionised than women in Germany, Ireland and Italy, the reverse was true in Denmark, Sweden and Finland, and in more countries the gender effects lost significance (Schnabel and Wagner, 2007). Union density is also normally lowest among the youngest workers and highest in the oldest age groups (Lucas, 2009; Peetz, Price and Bailey, 2015).

As mentioned, there are few studies explicitly focused on the determinants of collective bargaining coverage. Coverage is usually higher in the public sector than in the private sector, illustrated by New Zealand's experience (Harbridge, May and Thickett, 2003). The paucity of studies on the determinants of collective agreement coverage contrasts with the considerably broader literature on the effects of collective bargaining in its various forms, with the OECD, for example, extensively reviewing the literature and investigating this issue in its 2018 *Employment Outlook* (Organisation for Economic Cooperation and Development, 2018).

3. Data and methods

This analysis uses the *Confidentialised Unit Record File* (CURF) from the 2016 EEH. The EEH is a survey of employers conducted every two years, collecting data on a nationally representative sample of their employees. The 2016 survey comprises data on around 53,000 employees, collected directly from their employers, and includes data on rate of pay, employment type, part-time status, occupation, hours paid, and method of pay-setting. A description of the variables used in the analysis is provided in the Appendix. The data was accessed using the ABS' *Remote Access Data Laboratory* (RADL). The RADL is a secure processing environment which allows access to the unit record data, while limiting the type and size of outputs to ensure that individuals and organisations are non-identifiable.

In addition to data from the EEH survey, we also use estimates of the average rate of unionisation from the ABS' *Characteristics of Employment* August 2016 catalogue. This dataset is drawn from a supplementary survey of respondents sampled as part of the ABS' monthly *Labour Force Survey*, and includes further questions on union membership and earnings. The LFS is a monthly survey of, for these purposes, employees aged 15 and over, contrasting with the EEH which is a survey of employers. The survey sample of the LFS is benchmarked to the five-yearly population census, and comprises around 26,000 households. Detailed data on labour force status, employment characteristics (including industry and occupation), and union membership status are collected by the LFS.

After excluding self-employed individuals, our main sample comprises 52,208 individuals. The unweighted data in Table 1 show that about one in five employees

observed in the sample are employed on a casual basis, while 37 per cent are employed part-time. Around 7 per cent are under 21 years old, while over 83 per cent work in organisations of at least 20 employees. One in five employees work in the public sector, while the largest industries of employment are healthcare, public administration, and education. These unweighted sample data are slightly different from the weighted population estimates generated by the ABS.

Table 1. Summary statistics

<i>Variable</i>	<i>Mean</i>	<i>Std. Dev</i>
Public sector	0.20	0.40
Industry		
Mining	0.03	0.17
Manufacturing	0.05	0.22
Electricity, Gas, Water and Waste Services	0.03	0.17
Construction	0.05	0.23
Wholesale Trade	0.05	0.22
Retail Trade	0.08	0.28
Accommodation and Food Services	0.05	0.21
Transport, Postal and Warehousing	0.05	0.23
Information Media and Telecommunications	0.03	0.18
Financial and Insurance Services	0.05	0.21
Rental, Hiring and Real Estate Services	0.03	0.17
Professional, Scientific and Technical Services	0.05	0.22
Administrative and Support Services	0.06	0.24
Public Administration and Safety	0.09	0.29
Education and Training	0.08	0.28
Health Care and Social Assistance	0.12	0.33
Arts and Recreation Services	0.04	0.19
Other Services	0.04	0.20
Occupation		
Manager	0.08	0.27
Professionals	0.22	0.41
Technicians and Trades Workers	0.11	0.32
Community and Personal Service Workers	0.13	0.34
Clerical and Administrative Workers	0.18	0.38
Sales Workers	0.12	0.32
Machinery Operators	0.08	0.27
Labourers	0.09	0.28
Casual employee	0.21	0.41
Part-time employee	0.37	0.48
Female employee	0.49	0.50
Junior employee	0.07	0.25
Medium/ large employer (At least 20 employees)	1.83	0.38
Industry union density	14.01	9.94
Occupational union density	12.37	4.71

We estimate the probability of CA coverage within a cross-sectional probit regression framework. It is assumed that CA coverage is related to a range of underlying demographic and employment characteristics. These variables include gender, sector of employment, industry of employment, occupation of employment, casual employment status, full-time vs part-time status, employer size, junior employee status, and union density at the industry and occupational levels. The model specification is:

$$P(Y = 1|X) = f(\alpha + \beta X)$$

There are three outcome variables of interest. The first $Y1$, takes a value of 1 if an employee is covered by a registered or unregistered collective agreement, and a value of 0 for all other forms of wage-setting. The second $Y2$, takes a value of 1 if an employee is covered by a registered or unregistered collective agreement, and a value of 0 if the employee's wage is set at exactly the award. The third $Y3$, takes a value of 1 if an employee is covered by a registered or unregistered collective agreement, and a value of 0 if the employee's wage is determined by a registered or unregistered individual arrangement.

Analysis of the three outcomes is undertaken for all employees, as well as for the following subsamples:

- Private sector employees in the retail and hospitality industries;
- Private sector employees outside the retail and hospitality industries;
- Public sector employees.

The rationale for this sub-sample analysis is because we anticipate the possibility of different relationships between those sectors and that indeed turns out to be the case. In retail and hospitality, for example, the gap between award and CA wages, in EEH data, is close to zero. Consequently, the factors driving the choice between CA-coverage and alternative mechanisms may be different in these industries. For example, a high CA wage premium in most industries could indicate that CAs there are often a means by which unions obtain better wages and conditions and so are driven by employee interest in higher pay, whereas in the absence of such a wage premium in retail and hospitality the motivations for CAs may be different there. The different uses of CAs across the sectors might in turn suggest different determining factors. Similarly, given the higher rates of CA coverage in the public sector, the factors driving variation in wage-setting in the public sector may be different to those in the private sector.

The function $f(.)$ is assumed to follow a normal distribution, and maximum likelihood estimators of the parameters β are calculated. As with all nonlinear regression models, the estimated coefficients β have no direct interpretation. In order to make sense of the model, the results present the average partial effects, which are defined as the change in the probability of CA coverage with respect to the variable of interest. For example, the results report the probability of CA coverage for part-time employees, relative to full-time employees.

The analysis is limited by the use of a single cross-section of data. In particular, our estimates may be biased where significant unobserved effects exist, such as the effect of employment classifications or seniority. Future research could consider the collection of longitudinal data, or quasi-experimental changes in wages policy.

One oddity that might strike readers is that the industry and occupation variables have two defaults, instead of the usual one. This is because of the interaction between union density at the industry level, and the dummy industry variables (and likewise, the interaction between union density at the occupational level, and the dummy occupational variables). That interaction requires an additional industry dummy variable be deleted. We have chosen default categories that are fairly small in size and fairly similar in terms of their effects. Hence in industry, 'Rental, Hiring and Real Estate Services' and 'Other services' are the default category, collectively representing less than 7 per cent of respondents, and we call this grouping 'Rental and other services'. On occupations, our default group is the two lower-skilled blue collar categories, 'Machinery Operators' and 'Labourers', and we label them 'Machinery Operators and labourers'. They represent just one sixth of respondents (being two of the three smallest occupational categories) and again are fairly similar in their effects.

4. Findings

Within each set of explanatory variables, we discuss the findings firstly by reference to the main outcome of interest (for example, model 1.1 in Table 2, which refers to CA coverage compared to non-CA coverage for all employees), and then we dig deeper into the findings by discussing the various other comparisons and sub-samples—i.e. models 1.2 to 3.4. Models 2.1 to 3.4 are shown in tables 3 and 4. Table 3 shows equations predicting the probability of CA coverage compared to award reliance while Table 4 shows equations predicting the probability of CA coverage compared to individual arrangements.

Table 2: Probability of CA coverage vs all other methods of wage setting

<i>Model</i>	<i>1.1</i>		<i>1.2</i>		<i>1.3</i>		<i>1.4</i>	
	<i>All employees</i>		<i>Private sector (retail and hospitality)</i>		<i>Private sector (outside retail and hospitality)</i>		<i>Public sector</i>	
	Est.	Std. Err	Est.	Std. Err	Est.	Std. Err	Est.	Std. Err
Average partial effect	29.8***	(0.8)	-	-	-	-	-	-
Public sector								
Industry								
Mining	-17.6***	(4.3)	-	-	-16.9***	(3.3)	-	-
Manufacturing	-10.4***	(3.6)	-	-	-10.7***	(3.1)	-	-
Electricity, Gas, Water and Waste Services	-36.7***	(3.5)	-	-	-30.1***	(1.8)	-5.5***	(2.1)
Construction	3.6	(2.5)	-	-	1.0	(2.4)	-	-
Wholesale Trade	-6.6***	(1.6)	-	-	-4.4***	(1.4)	-	-
Retail Trade	4.4**	(1.9)	-10.0***	(1.9)	-	-	-	-
Accommodation and Food Services	20.8***	(1.6)	-	-	-	-	-	-
Transport, Postal and Warehousing	-16.2***	(5.3)	-	-	-16.3***	(4.2)	-	-
Information Media and Telecommunications	2.8	(2.3)	-	-	3.7*	(2.2)	-	-
Financial and Insurance Services	35.0***	(1.2)	-	-	39.3***	(1.5)	-	-
Professional, Scientific and Technical Services	6.4***	(1.8)	-	-	-8.5***	(1.8)	-	-
Administrative and Support Services	3.3**	(1.6)	-	-	1.4	(1.6)	-	-
Public Administration and Safety	-33.8***	(6.1)	-	-	-28.2***	(2.8)	3.4***	(1.2)
Education and Training	-7.8	(8.0)	-	-	-7.6	(7.2)	13.7***	(1.1)
Health Care and Social Assistance	1.2	(4.2)	-	-	14.7***	(4.4)	-23.9***	(1.7)
Arts and Recreation Services	8.1***	(2.5)	-	-	8.8***	(2.5)	-	-
Occupation								
Manager	-24.3***	(2.0)	1.6	(9.4)	-28.0***	(1.1)	-2.7	(5.9)

Professionals	-21.1***	(1.1)	-23.7***	(5.4)	-24.9***	(0.9)	11.3***	(2.1)
Technicians and Trades Workers	-5.4***	(1.2)	-8.2**	(3.8)	-7.1***	(1.1)	8.8***	(1.8)
Community and Personal Service Workers	-23.9***	(1.4)	-36.3***	(3.8)	-20.2***	(1.2)	7.1**	(3.3)
Clerical and Administrative Workers	-16.4***	(1.3)	-3.5	(4.7)	-22.7***	(1.0)	13.2***	(2.1)
Sales Workers	15.8***	(2.6)	38.1***	(7.1)	-3.7	(2.6)	5.9	(5.4)
Casual employee	-13.7***	(0.7)	-28.8***	(1.7)	-11.7***	(0.8)	-1.2	(1.7)
Part-time employee	13.6***	(0.7)	38.6***	(1.5)	8.2***	(0.8)	1.1	(1.1)
Female employee	-1.9***	(0.6)	-5.1***	(1.5)	-1.0	(0.7)	-3.4***	(0.9)
Junior employee	7.6***	(1.1)	21.6***	(1.9)	-5.1***	(1.3)	-9.4**	(4.6)
Medium/ large employer (At least 20 employees)	43.2***	(0.4)	50.8***	(1.0)	37.1***	(0.4)	23.3***	(2.5)
Industry union density	2.8***	(0.4)	-	-	2.5***	(0.4)	-	-
Occupational union density	1.3***	(0.2)	3.0***	(0.9)	0.8***	(0.2)	-0.2	(0.6)
Number of observations	52,208		6,743		35,277		10,188	
Pseudo-R ²	0.2411		0.3229		0.2333		0.1037	

The estimates shown represent the average partial effects, which are defined as the change in the probability of CA coverage (relative to coverage by all other methods of wage setting), with respect to a change in each employee characteristic.

Default categories: Workers in rental, hiring and real estate services or 'other services', who are Machinery operators or labourers, who are male, permanent, full-time, adult employees in a small (under 20 employees) organisation.

***, ** and *: Significant at the 1%, 5% and 10% levels respectively

Table 3: Probability of CA coverage vs award reliant

<i>Model</i>	<i>2.1 All employees</i>		<i>2.2 Private sector (retail and hospitality)</i>		<i>2.3 Private sector (outside retail and hospitality)</i>		<i>2.4 Public sector</i>	
	<i>Est.</i>	<i>Std. Err</i>	<i>Est.</i>	<i>Std. Err</i>	<i>Est.</i>	<i>Std. Err</i>	<i>Est.</i>	<i>Std. Err</i>
<i>Average partial effect</i>								
Public sector	-0.2	(0.8)	-	-	-	-	-	-
Industry								
Mining	25.1***	(0.7)	-	-	26.3***	(1.1)	-	-
Manufacturing	4.9	(3.6)	-	-	3.8	(4.1)	-	-
Electricity, Gas, Water and Waste Services	-13.4	(11.2)	-	-	-25.4**	(12.8)	4.1**	(1.8)
Construction	15.0***	(1.6)	-	-	14.6***	(1.9)	-	-
Wholesale Trade	3.9**	(1.7)	-	-	4.7***	(1.7)	-	-
Retail Trade	-1.9	(2.0)	-9.8***	(2.0)	-	-	-	-
Accommodation and Food Services	9.3***	(1.3)	-	-	-	-	-	-
Transport, Postal and Warehousing	1.5	(6.3)	-	-	-1.3	(7.3)	-	-
Information Media and Telecommunications	13.5***	(1.6)	-	-	12.8***	(2.0)	-	-
Financial and Insurance Services	24.2***	(0.5)	-	-	26.3***	(0.6)	-	-
Professional, Scientific and Technical Services	19.7***	(0.9)	-	-	12.3***	(2.0)	-	-
Administrative and Support Services	-0.3	(1.6)	-	-	-1.0	(1.8)	-	-
Public Administration and Safety	-29.2**	(13.1)	-	-	-42.1***	(13.4)	-6.1***	(1.3)
Education and Training	0.1	(8.7)	-	-	-4.9	(10.3)	4.9***	(1.3)
Health Care and Social Assistance	-5.0	(4.6)	-	-	7.4*	(4.2)	-35.7***	(2.0)
Arts and Recreation Services	10.3***	(1.9)	-	-	12.5***	(1.9)	-	-
Occupation								
Manager	11.2***	(2.0)	32.2***	(5.6)	8.4***	(2.9)	6.8*	(3.6)

Professionals	6.9***	(1.1)	11.5	(12.6)	6.8***	(1.5)	12.3***	(1.8)
Technicians and Trades Workers	0.1	(1.2)	-7.0	(4.6)	0.2	(1.4)	6.9***	(1.6)
Community and Personal Service Workers	-8.6***	(2.1)	-44.9***	(6.0)	-10.0***	(2.4)	9.3***	(2.3)
Clerical and Administrative Workers	4.2***	(1.3)	7.4	(5.2)	-2.2	(1.8)	12.0***	(1.8)
Sales Workers	16.4***	(1.7)	44.7***	(7.9)	9.8***	(2.6)	7.7*	(4.0)
Casual employee	-17.8***	(0.8)	-33.3***	(1.9)	-18.0***	(1.0)	-1.4	(1.5)
Part-time employee	4.5***	(0.7)	29.0***	(2.1)	-1.3	(0.9)	1.1	(1.0)
Female employee	-5.6***	(0.6)	-7.4***	(1.6)	-6.4***	(0.9)	-4.6***	(0.8)
Junior employee	0.2	(1.0)	20.1***	(1.9)	-16.0***	(1.8)	-10.5**	(4.5)
Medium/ large employer (At least 20 employees)	51.9***	(0.9)	58.3***	(1.5)	53.9***	(1.2)	11.2***	(2.6)
Industry union density	1.8***	(0.4)	-	-	1.8***	(0.4)	-	-
Occupational union density	0.6**	(0.2)	3.3***	(1.1)	0.6**	(0.3)	-0.4	(0.5)
Number of observations		33,736		5,307		18,804		9,625
Pseudo-R ²		0.2112		0.2824		0.2610		0.1407

The estimates shown represent the average partial effects, which are defined as the change in the probability of CA coverage (relative to award reliance), with respect to a change in each employee characteristic.

Default categories: Workers in rental, hiring and real estate services or 'other services', who are Machinery operators or labourers, who are male, permanent, full-time, adult employees in a small (under 20 employees) organisation.

***, ** and *: Significant at the 1%, 5% and 10% levels respectively

Table 4: Probability of CA coverage vs individual arrangements

<i>Model</i>	3.1 <i>All employees</i>		3.2 <i>Private sector (retail and hospitality)</i>		3.3 <i>Private sector (outside retail and hospitality)</i>		3.4 <i>Public sector</i>	
	<i>Est.</i>	<i>Std. Err</i>	<i>Est.</i>	<i>Std. Err</i>	<i>Est.</i>	<i>Std. Err</i>	<i>Est.</i>	<i>Std. Err</i>
<i>Average partial effect</i>								
Public sector	46.7***	(0.6)	-	-	-	-	-	-
Industry								
Mining	-31.5***	(5.2)	-	-	-28.4***	(3.4)	-	-
Manufacturing	-18.2***	(4.4)	-	-	-18.3***	(3.6)	-	-
Electricity, Gas, Water and Waste Services	-55.1***	(3.8)	-	-	-39.7***	(1.8)	-4.6***	(1.1)
Construction	-3.1	(2.9)	-	-	-5.7**	(2.8)	-	-
Wholesale Trade	-9.1***	(1.9)	-	-	-8.0***	(1.7)	-	-
Retail Trade	12.2***	(1.9)	-4.5**	(2.1)	-	-	-	-
Accommodation and Food Services	23.8***	(1.4)	-	-	-	-	-	-
Transport, Postal and Warehousing	-28.8***	(6.6)	-	-	-25.8***	(4.7)	-	-
Information Media and Telecommunications	-3.4	(2.6)	-	-	-0.8	(2.6)	-	-
Financial and Insurance Services	28.6***	(1.0)	-	-	36.6***	(1.5)	-	-
Professional, Scientific and Technical Services	-2.6	(2.0)	-	-	-13.5***	(2.0)	-	-
Administrative and Support Services	6.4***	(1.7)	-	-	6.3***	(1.9)	-	-
Public Administration and Safety	-43.5***	(8.9)	-	-	-34.6***	(4.1)	5.5***	(0.5)
Education and Training	-16.3*	(9.6)	-	-	-14.5*	(8.4)	5.2***	(0.4)
Health Care and Social Assistance	14.9***	(4.1)	-	-	16.6***	(5.0)	4.4***	(0.4)
Arts and Recreation Services	2.7	(2.7)	-	-	3.4	(2.9)	-	-
Occupation								
Manager	-53.4***	(1.8)	-35.4***	(13.0)	-43.2***	(1.0)	-10.4	(6.9)

Professionals	-43.5***	(1.4)	-56.2***	(7.2)	-41.1***	(1.0)	0.7	(1.2)
Technicians and Trades Workers	-16.4***	(1.5)	-16.2***	(5.3)	-16.4***	(1.3)	2.1**	(0.8)
Community and Personal Service Workers	-23.3***	(2.1)	-29.4***	(10.8)	-17.7***	(1.9)	0.3	(2.0)
Clerical and Administrative Workers	-40.0***	(1.6)	-28.5***	(6.9)	-38.1***	(1.1)	2.1*	(1.2)
Sales Workers	-9.4***	(3.3)	7.8	(10.2)	-21.5***	(2.6)	-1.5	(4.2)
Casual employee	-7.4***	(1.0)	-0.1	(2.5)	-8.2***	(1.1)	-0.8	(1.0)
Part-time employee	18.4***	(0.8)	49.1***	(2.0)	14.4***	(1.0)	0.1	(0.7)
Female employee	1.5**	(0.7)	0.5	(1.7)	1.1	(0.8)	0.8*	(0.5)
Junior employee	15.4***	(1.3)	11.5***	(2.2)	6.0***	(2.1)	0.3	(2.1)
Medium/ large employer (At least 20 employees)	54.6***	(0.6)	77.6***	(1.8)	44.5***	(0.5)	16.4***	(2.2)
Industry union density	3.0***	(0.4)	-	-	3.0***	(0.4)	-	-
Occupational union density	0.1	(0.3)	0.9	(1.0)	-0.3	(0.3)	0.0	(0.3)
Number of observations	42,539		4,506		29,550		8,483	
Pseudo-R ²	0.3820		0.5031		0.2973		0.1942	

The estimates shown represent the average partial effects, which are defined as the change in the probability of CA coverage (relative to coverage by individual arrangements), with respect to a change in each employee characteristic.

Default categories: Workers in rental, hiring and real estate services or 'other services', who are Machinery operators or labourers, who are male, permanent, full-time, adult employees in a small (under 20 employees) organisation.

***, ** and *: Significant at the 1%, 5% and 10% levels respectively

Sector

One of the biggest single factors influencing collective agreement coverage is sector. Overall, public sector employees are 29.8 percentage points more likely than private sector employees to be covered by a collective agreement (CA), holding all else constant (model 1.1).

This was because public sector employees are less likely to be covered by an individual arrangement (IA). Public sector employees were 46.7 percentage points more likely to be covered by a CA, relative to IAs, than private sector employees (model 3.1). However, the relative probability of public sector employees to be covered by a CA relative to an award was no different to that for private sector employees (model 2.1).

In short, the pay and conditions of public sector employees is much more likely to be covered by a more regulated instrument than that of private sector employees. This is as we would expect. However, if pay and conditions are regulated, being in the public sector as opposed to the private sector does not, in itself, make it more likely that it would be a CA rather than an award that ruled.

Industry and occupational union density

Estimates of union density are derived from the ABS' *Labour Force Survey* (LFS).

There was a strong relationship between union density and collective agreement coverage. After controlling for other factors, a 1 percentage point increase in union density in an industry adds 2.8 percentage points to CA coverage amongst employees in that industry. A 1 percentage point increase in union density in an occupation leads to a 1.3 percentage point increase in CA coverage in that occupation (model 1.1).

A positive relationship between union density and CA coverage would be expected as, even in Australia, where it is possible for CAs to be negotiated without a union, the great majority of employees covered by federal CAs are covered by CAs to which unions are a party.

This is mostly a phenomenon in the private sector, where a 1 percentage point rise in occupational union density leads to a 0.8 percentage point increase in CA coverage (model 1.3), whereas in the public sector the effect of size is near zero and insignificant (model 1.4).

Union density particularly affects the choice between awards and CAs. The higher the union density in an industry or occupation, the higher is CA coverage relative to awards amongst employees in that industry or occupation (models 2.1 to 2.4). This pattern also happens at the industry level in the choice between CAs and IAs, but not at the occupation level, where results are found to be insignificant (models 3.1 to 3.4). That is, holding other things constant, a higher rate of union density in an occupation does not make it more likely that an employee will be on a CA relative to an IA.

This may be because *industry*, rather than occupation, reflects employer behaviour (it is the principal economic activity of the employer, whereas occupation is based upon the principal tasks undertaken by employees at work). Unions mostly organise along industry lines, especially since the amalgamations of the 1990s. In strongly organised industries, employers will negotiate CAs rather than IAs, either because they are forced to by collectively acting employees or as an alternative to union organisation in their particular firm (through a non-union CA). In weakly organised industries, employers will offer IAs when they choose to pay above the award.

Industry

Industries have many characteristics, not just the rate of unionisation, that may influence employer (and union) behaviour within them. So we included a series of industry dummy variables. As mentioned, the default or reference category was ‘Rental, Hiring and Real Estate Services’ and ‘Other services’, which we collectively call ‘Rental and other services’ (representing 6.8 per cent of unweighted respondents.)

Overall, after controlling for other factors (including sector and industry union density), the highest positive effects on CA coverage are found in financial and insurance services (where CA coverage is 35.0 percentage points higher than the reference category Rental and other services), and Accommodation and food services (where the effect is 20.8 percentage points) (model 1.1).). In the former, this probably reflects the tendency of the big banks and insurance companies to negotiate CAs with their large workforces, covering numbers of employees that are considerably greater than the numbers of union members. In the latter, it probably reflects the tendency of employers to negotiate non-union CAs as a means of union exclusion, rather than IAs. This is reflected in the high effect on that industry variable in model 3.1: in accommodation and food services, employees were 24 percentage points more likely to be covered by a CA when the alternative was an IA, compared to in the reference group rental and other services. Readers should be careful in interpreting these figures, particularly the large negative effects on public administration and safety, and electricity gas and water (both over 30 percentage points). Remember that these figures represent the effects after sector (which adds to CA coverage), size (see below) and industry union density, amongst other things, are controlled. So, public administration has a high rate of CA coverage (78 per cent in bivariate EEH data—in fact, the highest of any industry), but not as high as might be expected given that it is in the public sector, it is mostly large organisations and it has a high rate of union density. We suspect that there is specific employer behaviour at work here—the industry coefficients, in the end, are best interpreted as an indicator of employer agency, given that many of the key structural characteristics of an industry, such as employer size and industry union density, are controlled for in the regressions. Long delays in negotiating replacement CAs, and the frequent failure of employer-sponsored CA ballots in the Commonwealth public sector, are indicators of an employer strategy that objects to union ‘intransigence’ regarding trade-offs in pay or conditions in conflict with a workforce that wishes to maintain union representation to protect those conditions (Senate Education and Employment References Committee, 2016).

Most industries followed similar patterns in model 1.3 (in which the population was restricted to employees in the private sector, aside from retail and hospitality) and in model 1.1 (all employees). The exception was Health care and social assistance, where the probability of CA coverage was higher amongst private sector employees in that industry (model 1.3), and lower amongst public sector employees (model 1.4) when compared with employees in Rental and other services. Training, accreditation and registration of employees in the industry is highly regulated (eg by the Australian Health Practitioner Regulation Agency and the fifteen occupational National Boards), and public sector employers in that industry tended to set the pattern for CA coverage. Consequently, private sector CA coverage in Health care and social assistance tended to more closely mimic arrangements for public sector employers. On the other hand, in the public sector, some health care workers may be covered by state industrial relations jurisdictions in which some 'awards' perform the function that 'agreements' perform elsewhere. This would, in part, explain the very large negative effect on this industry in model 2.4 (comparing CA and award coverage amongst public sector employees). In turn, then, overall CA coverage in health and social assistance sector may be artificially low due to the role some state awards might play.

The largest negative industry effects on CA coverage are found in Electricity, gas and water (where compared with other method of setting pay, CA coverage is 36.7 percentage points lower than reference category Rental and other services), Public administration and safety (33.8 percentage points), followed by Mining (17.6 percentage points) and Transport, postal and warehousing (16.2 percentage points) (model 1.1). One factor that may be exaggerating the coefficient in public administration and safety is that, as result of an internal review by the ABS of its framework, a significant proportion of employees in the NSW public sector were recoded from CAs to awards between 2014 and 2016.

With the exception of Public administration and safety, there were even stronger negative effects found for these industries in model 3.1, reflecting higher probabilities of IA coverage, compared to CA coverage. That is, employers in those industries choose to pursue IAs in preference to CAs. Mining is well known for union avoidance strategies, and they use IAs wherever possible rather than CAs (McDonald and Timo, 1996; World Competitive Practices, 1999; Hearn Mackinnon, 2007). Due to high rates of pay, award incidence in mining is low (so, there is a significant positive effect on the mining dummy variable in model 2.1, which compares employees under CAs with employees under awards). This is not the case in either of the other two industries (electricity gas and water, and transport, postal and warehousing), as the effects in model 2.1 suggest no statistically significant difference between being covered by CAs or awards.

Occupation

Aside from the expected tendency, mentioned above, for occupations with higher union density to also have higher CA coverage, we see that CA coverage among sales workers was 15.8 percentage points higher, relative to machinery operators and labourers (model 1.1). This appeared to mainly or even exclusively occur in the retail and hospitality industries, where sales workers were naturally very common. There, CA coverage was 38.1 percentage points higher, relative to machine operators and labourers, given the levels of union density in those occupations and other factors (model 1.2). By contrast, there was no significant effect for this occupation across other private sector industries, or in the public sector.

The effect was particularly strong when determining whether sales workers in retail and hospitality were on a CA or on an award: model 2.2 implies that sales workers are 44.7 percentage points more likely to be CA covered than award-reliant. By contrast, in those industries the effect in determining whether sales workers in retail and hospitality were on a CA or on an IA was statistically insignificant (model 3.2). The effects here probably reflect employer behaviour: in retail, encouraging low-paid sales employees who would otherwise be on an award to negotiate union CAs that had average hourly wages fairly similar to awards; and in accommodation and food services to endorse non-union CAs that covered low-wage sales employees who again would be paid fairly similar hourly wages under the CAs as under the awards, but on this latter occasion for the purpose of union avoidance.

At the other end of the scale, the lowest rates of CA coverage, after controlling for all factors, were amongst several white-collar occupations: managers (– 24.3 percentage points, compared to the reference group machinery operators and labourers); community and personal service workers (also – 23.9 percentage points); and professionals (– 21.1 percentage points). But here there were important differences between sectors. In the private sector (excluding retail and hospitality), CA coverage of managers was 28.0 percentage points below the reference group even after controls (model 1.3). In the public sector, there was no significant effect (model 1.4). That is, quite a number of public sector managers were covered by collective agreements but few in the private sector were so covered.

Professionals also had higher CA coverage in the public sector (by 11.3 percentage points, compared to the reference category, even after controlling for all variables including occupational union density—model 1.4) but lower in the private sector (by 24.9 percentage points—model 1.3). This probably reflected the situation for health and education professionals, such as nurses and teachers, who had extremely high coverage by CAs in the public sector, even where quite a few workers were not union members, whereas in the private sector CA coverage was considerably less and required reasonable union density before it could be established.

Indeed, for several white-collar occupations signs were positive and significant in model 1.4 (public sector) but negative and significant in model 1.3 (private sector, excluding retail and hospitality)—at least, by comparison with the reference group of machinery operators and labourers. This probably reflected quite different interactions between occupation and CA coverage in the two sectors. That is, blue collar workers' rates of CA coverage were less determined by sector, and more determined by factors such as unionisation; whereas white collar workers' rates of CA coverage were more heavily influenced by sector—that is, the differences between the public and private sectors in terms of CA coverage was much greater for white than for blue collar occupations.

Another way of looking at the data is this: white collar unions in the public sector face much higher rates of 'free-riding'—people being covered by CAs without being union members—than either blue-collar unions or white-collar unions in the private sector.

Employer size

We used a dichotomous variable to measure employer size, distinguishing between employers with fewer than 20 employees (we call these 'small' employers) and those with 20 or more employees (we call these 'medium/large employers'). Results find that compared with other methods of setting pay, CA agreement coverage is greater among medium/large employers (models 1.1, 2.1 and 3.1).

Size has a major impact on CA coverage. Unions find it very hard to organise workers in small firms; and even if some join, they often do not have the numbers to force the employer to negotiate a CA. Amongst larger employers, however, particularly in retail and hospitality, employers may find benefit from negotiating a CA.

CA coverage is 43.2 percentage points higher in medium/large employers than in small employers (model 1.1). The size effect is much greater in the private sector (37.1 percentage points outside retail and hospitality, as per model 1.3; 50.8 percentage points in retail and hospitality, as per model 1.2) than in the public sector (23.3 percentage points, as per model 1.4).

In retail and hospitality in particular, there is a major difference: the probability of being CA-covered is 77.6 percentage points higher for employees in a medium/large organisation than those in a small one (model 3.2).

Casual employment

Casual employment was measured by the variable identifying whether employer respondents believed that relevant individuals were permanent/fixed term or casual employees. Most would have received casual loadings.

Casual employees were, after all other factors were controlled, 13.7 percentage points less likely to be covered by a CA than permanent or fixed term employees (model 1.1). This was especially the case in retail and hospitality (where the effect size was 28.8 percentage points—model 1.2) but was also the case in the rest of the private sector (where the effect size was 11.7 percentage points—model 1.3). In the public sector, the effect was very small and insignificant (model 1.4).

The use of casual employees is likely to be lower in firms with CAs. Even if the CAs themselves do not regulate the use of casual employees, where unions are strong enough they will tend to negotiate a CA and so the existence of a CA is an imperfect proxy for union power (imperfect because, for roughly one in ten employees covered by a CA, it is a non-union CA). Where unions are strong enough they will often attempt to discourage the use of casual employees, or employers will reduce their use of casual employees below what it might otherwise have been.

The difference in effect sizes between industry sectors may partly reflect that, in retail and hospitality, CA coverage tends to lead to more positions being permanent part-time or permanent full-time. It is partly also a size phenomenon (although we have a size variable, mentioned above, it is only dichotomous and fails to distinguish between, for example, medium and large employers), so perhaps large employers in this sector are both more likely to be covered by a CA and more likely to use a permanent workforce. These tendencies are apparent throughout much of the private sector but especially so in retail and hospitality, with, for example, large supermarket chains and department stores, with CA coverage, preferring permanent to casual workforces even when the majority of staff are employed part-time as a result of the negative effects of large casual workforces (Price, 2003).

In the public sector, the use of casual labour is governed more by public sector rules than by CAs, and so high or low use of casuals has no significant relationship with CA coverage.

Part-time employment

For part-time employment, the directions of effects are largely the opposite of what is seen with casual employment. That is, part-time employees were, after all other factors were controlled, 13.6 percentage points more likely to be covered by a CA than full-time employees (model 1.1). In retail and hospitality the size of the effect was large (38.6 percentage points—model 1.2), while in the rest of the private sector it was 8.2 percentage points (model 1.3). Again, in the public sector there was no effect.

This may at first seem counter-intuitive. But let's think about retail and hospitality for a moment. Many lower-grade employees are part-time employees. They are also, not unusually, covered by CAs. Higher-grade employees tend to be full-time and tend not to be covered by CAs. They are often covered by individual arrangements. Despite all the control variables we have in EEH, we do not have a variable that measures classification or seniority, so this pattern of employment will mean a strong relationship between CA or IA coverage, part-time employment and level. Hence in retail and hospitality, the effect size linked to part-time employment is much larger for the choice between CA and IA (49.1 percentage points—model 3.2) than for the choice between CA and award (29.0 percentage points—model 2.2). Moreover, models with a term interacting part time status with casual employment status further supported this interpretation – that is, higher grade employees (most likely to be full time and permanent) were significantly less likely to be covered by a CA than permanent part-time employees (more likely to be lower grade) These results are available on request.

This explains some, but not all, of the directions of the signs on part-time employment. It also appears to be the case that retail and hospitality firms with CAs make greater use of part-time work. Perhaps this is because of the restrictions placed on casual employment, either reluctantly via CAs or voluntarily in such firms anyway. With less 'flexibility' available through casual employment, they make greater use of (permanent) part-time employment. If so, it is the case only in retail and hospitality: the signs on the part-time variable in models comparing CAs and awards in the rest of the private sector, and the public sector, are near zero and non-significant.

As with casual labour, in the public sector, the use of part-time labour is governed more by public sector rules than by CAs, and so high or low use of part-timers has no significant relationship with CA coverage.

Junior employees

After controlling for other factors, on average junior employees were 7.6 percentage points more likely to be covered by a CA than adult employees (model 1.1). The effect was particularly large in the retail and hospitality sector (21.6 percentage points), and in fact the sign was reversed in the rest of the private sector, and the public sector. So quite different explanations are needed for the retail and hospitality sector, and the rest of the workforce.

Outside of retail and hospitality, junior employees appear very likely to be starting on award rates of pay. Hence in models 2.3 and 2.4, the effects are significant and negative, meaning that junior employees in some parts of the public sector, and the rest of the private sector, are more likely to be on awards relative to CAs. This is a reflection of the low starting pay and classifications of junior employees.

In retail and hospitality, however, CAs in large firms are often substitutes for awards (rather than paying well above them, as they do in other industries) and so new employees start on CAs instead of awards. That might explain why we do not see negative effects, but it does not in itself explain why there is a large positive effect of the junior variable in model 2.2, which compares employees on CAs and awards in retail and hospitality. For this, we may also need to look at labour supply aspects. New young entrants to the labour market, often wanting part-time or casual work, might be attracted not only to work in retail and hospitality, but also to work in large enterprises with CAs in that industry sector.

More accurately, it might be the case that large enterprises with CAs in retail and hospitality disproportionately offer junior rate jobs (compared to other firms in that industry sector). That would explain the size of the positive effect in model 2.2, but further research is needed to confirm or refute this hypothesis.

Female employees

Overall, after controlling for other factors, female employees were 1.9 percentage points less likely to be covered by a CA than men. The difference is small but statistically significant. The largest effect was in retail and hospitality (5.1 percentage points), while it was 3.4 percentage points in the public sector and insignificant in the rest of the private sector (models 1.1 to 1.4).

The overall pattern was driven by women's lower tendency to be covered by CAs rather than awards, evident in most sectors (models 2.1 to 2.4). Women were slightly but significantly more likely than men to be covered by a CA compared to an IA (model 3.1), also evident in the public sector but not elsewhere (models 3.2 to 3.4).

Summary EEH data showed much larger differences between men and women and, in some cases, the reverse pattern. Overall, 40 per cent of women, and 38 per cent of men, are covered by CAs, a similar difference found in the multivariate analysis. However, women's overall award coverage (29 per cent) was substantially higher than men's (20 per cent), and so in bivariate data, the share of CA employees amongst all 'pay-regulated' (CA plus award) employees was 58 per cent amongst women but 66 per cent amongst men, a difference of 8 percentage points—much higher than the 2 percentage point difference in multivariate analysis (model 2.1). It seems likely that the remaining difference is also due to structural factors not picked up by single-digit industry and occupational control variables. For example, amongst professionals, women are a high proportion of health and education professionals (such as nurses and teachers), with high unionisation and CA coverage, but a lower proportion of other professionals (such as engineers and economists) with low unionisation and low CA coverage. Amongst sales workers they are a high proportion of checkout operators and cashiers, with high award coverage, but a lower proportion of insurance and real estate salespeople, with high IA coverage. These structural effects, at the two or three-digit level of occupational analysis, would not be detected in the single digit analysis here.

Accordingly, it seems likely that gender differences in instrument coverage reflect differences in the sort of jobs women and men do and the industries in which they work, rather than any different behaviours by men and women in terms of collective negotiation or desires for representation. This would be consistent with earlier studies showing apparent gender differences in trends such as union propensity to reflect structural rather than behavioural factors. (Grimes, 1994; Peetz, 1998).

5. Conclusions

Three major factors stand out as shaping CA coverage in Australia: sector of employment, employer size, and union density. CA coverage is higher in industries and, to a lesser extent, occupations that have higher rates of union density, because unions seek to obtain collective agreement coverage as a means of consolidating decisions agreed to by managers. Yet knowing about unionism is not enough to know about CA coverage. CA coverage is substantially higher in the public sector than the private sector, even after controlling for these differences in industry union density, probably because collective agreements help implement and standardise rules of payment and behaviour that are important in bodies ultimately spending taxpayer money. It is higher in large and medium sized organisations than in smaller organisations, largely because larger organisations are easier to organise, tend to pay higher wages anyway, and face higher transaction costs through individual negotiations.

CA coverage also varies substantially between industries even after allowance is made for these factors. This in turn appears to reflect different employer strategies in those industries, That is, apart from the structural factors mentioned above and unionism

itself, employer agency plays a major role in explaining coverage by instruments. In some instances—and these tend to follow patterns within industries, so employers within an industry will adopt a ‘pattern’ demonstrated by other employers in the same industry—employers may choose to use individual contracts, or even non-union (or sometimes union) collective agreements as substitutes for unions, or at least for union militancy, or they may simply choose to adopt CAs because they have low transaction costs.

Coverage by CAs also varies substantially between individual occupations, probably reflecting different behavioural norms in those occupations. There are smaller differences in coverage between casual and permanent employees, between part-time and full-time employees, between junior and adult employees, that again mostly reflect different employer behaviours and norms. While gender had the appearance of an independent effect, that was probably simply because the industry and occupational control variables were not disaggregated enough to show their true effects.

Australia’s unique system of industrial regulation, at least in terms of its emphasis on awards, does not appear to have an immediately obvious impact on the determinants of collective bargaining—though we must be very careful here, because so few international studies have sought to study the determinants. At least in the public sector—where our results show that Australia, like other countries, has higher density in this sector—award regulation does not appear to have been a substitute for collective bargaining.

Overall, the results are consistent with the proposition that unions use collective bargaining to strengthen the power of workers, and that, in effect, joining a union is only the first stage for an employee in boosting their power—as to entrench it they need to be in a union that can negotiate a collective agreement, and the factors that enable unions to do this are, in many cases, also the factors that most enable workers to build strength by unionising in the first place. While that may seem obvious—isn’t collective bargaining what the Webbs told us unions existed for? (Webb and Webb, 1920)—it helps remind us that workers who join a union in circumstances that may otherwise be difficult are unlikely to secure the full benefits of unionism.

The flipside of this is as follows. Non-union agreement-making in Australia—another almost unique feature—is either too insignificant, or too similar to union bargaining in its coverage, to affect the results. If non-union agreement-making was fundamentally different to union collective bargaining in its coverage, the signs on the coefficients determining collective agreement coverage would be the opposite of those on the determinants of unionism after unionism was controlled in equations. We know that wage increases through non-union collective agreements are consistently lower than those achieved through union agreements (Department of Employment, 2016). There is nothing in here to suggest anything other than non-union agreement-making is simply a substitute for union collective bargaining. That is, it is used by employers as an alternative to union collective bargaining, but has the advantage of delivering more power to employers and less to employees. There is nothing here to suggest it fills a void created by the restricted coverage union collective bargaining. Overall, we can make sense of the patterns of collective agreement coverage by reference to unionism, factors that strengthen unions (size and sector), and known employer strategies regarding particular industries and occupations.

Appendix A

Table A1. Description of EEH variables

<i>Derived variable</i>	<i>Source</i>	<i>Description</i>
sectpub	SECTPUB variable in EEH microdata	Categorical variable denoting sector of employment 1 = Private sector employee; 2 = Public sector employee
anzsic1	ANZSIC1 variable in EEH microdata	Categorical variable denoting industry of employment, classified according to 1-digit ANZSIC classification
anzscol	ANZSCO1 variable in EEH microdata	Categorical variable denoting occupation of employment, classified according to 1-digit ANZSCO classification
casual	TYPEEMP variable in EEH microdata	Dummy variable where 1 = casual employee 0 = permanent or fixed term employee
pt	FTPT variable in EEH microdata	Dummy variable denoting part time status 1 = part time employee; 0 = full time employee
sex	SEX variable in EEH microdata	Gender variable where 1 = male; 2 = female
empstat	EMPSTAT variable in EEH microdata	Dummy variable for employee status. The analysis excludes all owner-managers of incorporated enterprises
empsize	EMPSIZE variable in EEH microdata	Categorical variable denoting employer size 1 = Employer of less than 20 employees 2 = Employer of 20 or more employees
mosp	MOSP variable in EEH microdata	Categorical variable denoting method of pay setting 1 = Award only 2 = Registered collective agreement 3 = Unregistered collective agreement 4 = Registered individual agreement 5 = Unregistered individual arrangement
junior	AGECE variable in EEH microdata	Dummy variable where 1 = individual aged 20 and under; 0 = individual aged 21 and over
idensity	ABS cat.no. 6333.0, Characteristics of employment	Derived continuous variable denoting industry level union density.
odensity	ABS cat.no. 6333.0, Characteristics of employment	Derived continuous variable denoting occupational level union density.

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Endnote

1 We have used density data from household surveys where available (n=15), otherwise union-based data (n=23) where survey data are not available.

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