THE KNOWLEDGE CITY INDEX:
A TALE OF 25 CITIES IN AUSTRALIA
2017

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“It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of light, it was the season of darkness, it was the spring of hope, it was the winter of despair...”

Charles Dickens, *A Tale of Two Cities* (1859)
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The nature of work is changing. For some workers, it is the best of times, as their knowledge, skills and creativity become increasingly valuable and combine to make them more prosperous. For others, however, it is the worst of times, as their hard-won skills and occupational practice become increasingly irrelevant or obsolete. In many sectors of our economy, automation, artificial intelligence (AI), big data, and machine learning will make more and more jobs redundant, or at least change them fundamentally (Frey & Osborne, 2013). Moreover, it is not just unskilled or semi-skilled workers who face these threats from new technologies and the changing nature of work. Increasingly, many skilled and professional occupations are being affected by these same technologies and their associated economic and social transformations, leading some to question the very future of many professions (Susskind & Susskind, 2015). It is predicted that roughly half of the jobs that currently exist in developed economies could be automated or otherwise made redundant by 2030 (Frey & Osborne, 2015).

But the future of work is not necessarily bleak. As some occupations are replaced by technologies, others are likely to emerge in the new economies that open up. However, the new occupations will require different sets of skills from the past, and will be focused around new forms of industry and production. In short, those occupations that will advance in the near future will be in the information and knowledge areas. They require human creativity and interpretation rather than the repeated application of rules, and require the more nuanced interpersonal skills that technologies are still not capable, and seem unlikely ever, of replicating.

How will the changing nature of work and the transformation enabled by new technologies and the knowledge economy play out in Australia? We know which types of jobs are most likely to decline and we have some sense of what types of jobs, or at least which sectors, are likely to be most resilient. But this dichotomy of decline and resilience is not equally distributed across the geography of Australian cities. Some Australian cities are well positioned to grow and advance in the emerging technology-driven and knowledge-based economy, but others lack the infrastructure and capacity to resist and survive the impacts of technological redundancy. Just like for individual workers, for some Australian cities it promises to be ‘the best of times’, but for many others it would appear to be ‘the worst of times’.

To better understand these impacts on our cities and inform our policy and planning responses, this report builds a knowledge cities index (KCI) for Australian cities. We examine a total of 25 cities in the country and analyse each of them according to its knowledge capital (the underlying knowledge infrastructure of a city) and knowledge economy (the knowledge activation within a city). We combine six different measures through a data standardisation process, in order to give a comparative overview of all 25 cities. In doing so, we employ an innovative approach to Australian cities that provides a unique understanding of how the changing nature of work is impacting different urban areas in different ways. This framework is both extendable to comparative analysis of cities in other countries and repeatable over time in order to understand how cities are changing over time.
The KCI results provide the most comprehensive understanding of the knowledge strengths and weaknesses of Australian cities, and insights into which cities are most likely to be resilient in the transition to a knowledge economy. Among them, three key findings are worth our attention:

- In our tale of 25 cities, five cities in Australia appear to be well prepared for the technological revolution and knowledge transition that are already taking place and can be qualified as ‘a knowledge city’ (Sydney, Melbourne, Canberra, Brisbane and Perth). The remaining 20 cities have knowledge limitations to various degrees.

- Canberra stands out as one of Australia’s leading knowledge cities, despite its comparatively small population and employment bases. It has higher proportions of its population with both knowledge capacity and who are actually working in the knowledge economy than any other city.

- Cities that have traditionally relied on the manufacturing and mining industries for employment base lack sufficient knowledge capital and have not developed the knowledge economy to respond successfully to the impact of new technologies on their economies.

For the top five cities, the current shift to a knowledge economy promises to be ‘the best of times’. For the other 20 cities, however, it could well be ‘the worst of times’ as the knowledge economy becomes the dominant focus for local prosperity. Understanding the underlying components of these changes and exploring the social, political and economic implications that stem from them requires a nuanced approach. This report provides an analysis which both quantifies the knowledge economies of the various cities and compares them. In so doing, it provides the basis of such an approach.

This report is structured as follows. Following this introductory chapter, chapter 2 conceptualises knowledge, knowledge economy and knowledge cities that underpin the theoretical and methodological approaches of this report. Chapter 3 outlines the 25 Australian cities studied in this report, and the framework and methodology for measuring their knowledge capability by constructing the KCI. Chapter 4 presents the KCI results in different versions to illustrate the different aspects of a city’s knowledge performance. Chapter 5 provides each of the 25 cities’ knowledge portraits to illustrate its strength and weakness as measured by the indicators of the KCI. Chapter 6 concludes the report by linking the KCI findings with existing policy initiatives to point out a policy and planning outlook for future Australian knowledge cities.
The downturn in the mining boom which, until recently, has driven Australia’s economic growth and stability, and the expectation that such a boom is unlikely to return, emphasises the need for a transition to a more knowledge-based economy. In fact, knowledge is already an important part of Australia’s economy. In 2016, Australia’s third biggest export sector was not a physical commodity, but was education in the form of international students who came to study in an educational institution within the country. After iron ore and coal, Australia’s key export industry is knowledge-based, contributing $20.3 billion to the national economy in 2016 (Universities Australia, 2016). Australia’s geography makes the study of the knowledge economy and the cities where it is emerging particularly important. As Judith Brett (2011) notes, after the White settlement began, cities in Australia needed the country to feed them, earn their exports and provide the narrative for Australia’s cultural mythology. But with Australia’s increasing urbanisation, the role of cities as the centre of national development accelerated (Brett, 2011). This trend is especially so in the transition towards a knowledge economy.

A few broad contexts underpin our study. The first is the debate around the future of work that forecasts large-scale displacement of jobs in the coming decades. The second is the knowledge economy and what constitutes knowledge and its value to economic growth. The third is the growing importance of knowledge cities and the factors that make them successful.
2.1 The Future of Work
People have made various predictions about technological transformations and profound impacts that automation, machine learning, AI and other related inventions are having or will soon have on every sector of the economy. These predictions vary in precision, but have in common one overarching message: many of the jobs that currently exist will be made redundant in the next few decades. For computer scientist Moshe Vardi (2016), we are at a tipping point or ‘phase transition’ as the inexorable rise of automation leads to mass replacement of workers with machines: he predicts a net 50 per cent loss of employment within 30 years. A different approach by McKinsey argues that in many areas of work it is not so much whole jobs that are at threat, but significant proportions of individual jobs; they argue that as much as 45 per cent of current work is likely to be automated within individual jobs, affecting every sector of the economy, although the pace of change may vary (Chui, et al, 2015).

Arguably the most detailed and rigorous approach to understanding the future of work is Frey and Osborne’s (2013) study of the USA. Their work draws upon sophisticated classification and ranking of occupations to examine the susceptibility of over 700 categories of jobs to automation. Their initial research suggested that 47 per cent of all extant jobs in the USA were susceptible to automation or could otherwise be made redundant by the advance of various technologies.

The central claim of all of these predictions is that technologies are advancing at such a rate that they are impacting all sectors of the economy. As Frey and Osborne (2017, p. 258) put it:

> Historically, computerisation has largely been confined to manual and cognitive routine tasks involving explicit rule-based activities… Following recent technological advances, however, computerisation is now spreading to domains commonly defined as non-routine.

Their conclusion is that, as technology advances, it is getting better and better at replacing non-routine labour – both cognitive and manual. Non-routine cognitive activities, such as analysing financial performance of companies or the stock market to make investment decisions, are now greatly augmented for better or worse by computerisation (Arnoldi, 2016; Karppi & Crawford, 2016). Equally, non-routine manual tasks, especially in logistics, are rapidly using automation to replace human labour, most notably in Rio Tinto’s mines.

There is also a second claim central to these predictions: a set of creative, social and developmental skills remain the preserve of human intelligence and cannot easily be automated. As McKinsey’s report (Chui, et al, 2016) puts it:

> The hardest activities to automate with currently available technologies are those that involve managing and developing people (9 per cent automation potential) or that apply expertise to decision-making, planning, or creative work (18 per cent). These activities, often characterised as knowledge work, can be as varied as coding software, creating menus, or writing promotional materials. For now, computers do an excellent job with very well-defined activities, such as optimising trucking routes, but humans still need to determine the proper goals, interpret results, or provide common-sense checks for solutions.

Consequently, ‘perception and manipulation tasks, creative intelligence tasks and social intelligence tasks’ (Frey & Osborne, 2017, p. 261) are the least easy to automate and are likely to be in the highest demand as more routine activities in the workplace are automated.

It is important not to be too drawn in by the deterministic nature of many of these accounts. It is true that technologies are advancing at an accelerating and inexorable rate and that many jobs will be susceptible to their impacts. However,
we also need to recognise that technological innovations have complex and unpredictable interactions with social and political institutions. The impact of technologies in the workplace will be mediated by the ways in which organisations, professions and individuals adopt them, and by the way in which governments, and society more broadly, regulate and domesticate their adoption. There will be change but it will not be linear and certainly not completely predictable.

The key task for this report, therefore, is not about forecasting the future. We do not seek to add another set of predictions or prognostications about the jobs that are most likely to survive the latest technological transformations and to embrace the knowledge economy. While we contextualise our findings with the predictions of others, it is the changing nature of work that is our central interest. Our focus, therefore, is on understanding the extent to which Australia and its cities have the capacity to respond to the complex challenges to which technological change is giving rise. At the very heart of such an understanding are the issue of knowledge and the growth of the knowledge economy.

2.2 Knowledge and the Knowledge Economy

‘Knowledge’ is a complex and nebulous concept, and is subject to a myriad of definitions. It can take many forms, be acquired through many different approaches, involve formal and informal elements, have both explicit and tacit components, and be constituted from both scientific and intuitive processes. Although we acknowledge the definitional opacity of knowledge, for the purposes of this report we must start with an operationalisable definition of knowledge and, in particular, how different types of knowledge might have economic value.

One way of thinking about knowledge is to draw a distinction between the material and the immaterial, and the types of labour that are associated with the production of material and immaterial artefacts (Hardt & Negri, 2005). In the industrial era, economic productivity was largely focused around the production of material commodities: physical artefacts that had a clear material purpose within our society (cars, televisions, fridges, ovens, and so on). Economic growth then depended upon innovations in the production of such material goods and in the growing demand for their consumption. In the post-industrial era, the focus is much more on the development of intangible goods or knowledge artefacts. These immaterial products depend less on the exploitation and enhancement of physical assets, but more on the application of cognition: they are the product of education and ingenuity.

The labour associated with the production of knowledge, and knowledge artefacts, is cognitive rather than physical. Such knowledge draws on the intuitive capacity of humans to deal with uncertainty and ambiguity, and to build patterns and narratives that are not just rule based, but are creatively constructed. It is the knowledge associated with the immaterial that is related to the types of jobs that are least susceptible to automation and are likely to drive growth in the knowledge economy.

Another important aspect is the communicative value of knowledge. For knowledge to have an economic value, it is not only necessary for individuals to have the cognitive capacity to develop ideas, to be creative and innovative, but also for there to be an exchange of knowledge. Knowledge, therefore, needs to be seen as a resource to be utilised, developed, transferred, and transacted. Moreover, it needs to have a value attached to it. For example, the knowledge possessed by an individual has economic value only if it is drawn upon to deliver an artefact used by others. Such artefacts can range from the reports or advice of a consultant or the representation of a lawyer, through to a stock market trade. The important point is that the original knowledge leads to an artefact that is exchanged, and this exchange has an economic value. Such economic value can be measured through the price attached to the transfer, the salary attached to the labour that produces it.
Defining knowledge in these economic terms means that we are essentially discounting other forms of knowledge that are valuable to society. But we are being deliberately reductionist here to make a point. Our focus here is exclusively on that knowledge which underpins directly our approach to knowledge economy and knowledge cities. Consequently, knowledge in this context is that which is used to make a clear and measurable economic impact. Therefore, we consider knowledge that contributes directly to economic activity; that is, which contributes to a country’s GDP. More specifically, our focus is on knowledge that contributes to the economic base and growth of cities, and hence our focus on knowledge cities.

2.3 The Knowledge City

The concept of the knowledge city is not new; its emergence has been discussed for several decades. However, theorists differ in what constitutes a knowledge city. Their focus ranges from the diversity of knowledge occupations and the existence of key knowledge producing infrastructure (such as the presence of universities, and science parks), through to the quality of life that attracts the creative classes, and enhances the social and cultural milieu of a place. However, few of them go beyond such definitions to create effective measures for comparing knowledge cities. Indeed, while many espouse the achievements of specific cities and reflect on the factors that may have contributed to their success, few have offered a systematic analysis of the factors that might drive the success for a knowledge city, or developed a methodology for comparing them (see, for example, Agtamel and Bakker, 2016). One of our goals, therefore, is to address this methodological poverty by developing a framework for comparing knowledge cities. We apply this framework to Australia but we contend that the framework has wider applicability.

Our understanding of knowledge cities flows from the conceptualisation we developed above regarding what constitutes knowledge and its relationship with knowledge economies. If knowledge economies are based on the development and exchange of high value knowledge artefacts, then it follows that knowledge cities are those significant urban areas that are rich in such exchanges and have the capacity to build on their knowledge resources. Fundamentally, knowledge cities are those areas that have both the human capital to underpin the knowledge economy – knowledge workers – and the infrastructure to utilise that human capital to create economic value.

Our focus on cities may, at first glance, appear unusual in an increasingly globalised knowledge world but it is well justified. There is an argument that, in a digital age, knowledge exchange is not geographically bounded, except by constructed barriers that are derived from linguistic and cultural differences or by legal constraints imposed by nation states, corporations and the like. In principle, knowledge can be produced or acquired anywhere and, equally, can be transmitted and shared globally, prompting the argument that knowledge is no longer geographically constrained. Though some may proclaim geography irrelevant, we do not share this viewpoint. We contend propinquity and the corporeal nature of knowledge cities become increasing important in a digital era and cannot so simply be dismissed. One of the fundamental features of knowledge cities and precincts, such as knowledge parks, innovation hubs and the like, is the proximity of individuals in the generation and exchange of knowledge, ideas and innovations. Such proximity and propinquity generates a culture and conviviality of enquiry, and allows for the chance acquaintances that supplement the formal structures of cooperation. This capacity to generate incidental enhancement of knowledge delivers on the expectation that cities are the places where knowledge can best be developed and exchanged (Florida, 2005; Turkle, 2015).

Our conclusion, therefore, is that knowledge cities are the fundamental drivers of innovation and creativity for the prosperity of a nation’s economy. Knowledge cities are also those geographic areas that are likely to be least susceptible to the impacts of technological advancement highlighted above.
Despite the importance of knowledge cities as the future drivers of prosperity, there is a surprising absence of tools with which to measure and compare different cities. In this section we develop the basis of our Knowledge Cities Index (KCI) and set out the core measures that we incorporate into the index. Our purpose is to provide not only a snapshot of where Australian cities are at present but also to provide a tool that can be used in different countries and at different times. In the long term, therefore, we aim to provide both international comparison and time series data to compare the evolution of knowledge cities. As a starting point, however, we focus on developing the index for comparing the present state of knowledge cities in Australia.
3.1 Australian Cities
This report covers 25 major cities in Australia. Their boundaries are delimited by the Significant Urban Areas (SUAs), which are used by the Australian Bureau of Statistics (ABS) to represent cities and towns with a population over 10,000 and contains their likely growth in the next 15 years (Figure 1). Unlike the conventional use of administrative boundaries to define cities, using SUAs focuses on the urban functions and labour markets that evolve across administrative boundaries. Encompassing an area of less than 5 per cent of Australia’s total land, these 25 cities accommodate 76 per cent of Australia’s national population, and 72 per cent of all jobs (Table 1). With just a few exceptions, these 25 cities are based on Australia’s coastline and are separated by significant distances. In this respect, they are more geographically isolated than cities in more densely populated continents.

Figure 1. 25 Significant Urban Areas in Australia
### Table 1. Population, Employment and Land Areas of 25 Australian Cities

<table>
<thead>
<tr>
<th>Cities</th>
<th>Population</th>
<th>Employment</th>
<th>Land Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adelaide</td>
<td>1,198,467</td>
<td>510,682</td>
<td>2024.4</td>
</tr>
<tr>
<td>Albury – Wodonga</td>
<td>82,083</td>
<td>36,749</td>
<td>628.2</td>
</tr>
<tr>
<td>Ballarat</td>
<td>91,800</td>
<td>39,167</td>
<td>343.6</td>
</tr>
<tr>
<td>Bendigo</td>
<td>86,078</td>
<td>36,295</td>
<td>287.4</td>
</tr>
<tr>
<td>Brisbane</td>
<td>1,977,316</td>
<td>886,345</td>
<td>5,056.1</td>
</tr>
<tr>
<td>Bunbury</td>
<td>65,608</td>
<td>22,756</td>
<td>22.5</td>
</tr>
<tr>
<td>Bundaberg</td>
<td>67,341</td>
<td>23,709</td>
<td>305.7</td>
</tr>
<tr>
<td>Cairns</td>
<td>133,912</td>
<td>55,145</td>
<td>254.3</td>
</tr>
<tr>
<td>Canberra - Queanbeyan</td>
<td>391,643</td>
<td>205,352</td>
<td>482.3</td>
</tr>
<tr>
<td>Central Coast</td>
<td>304,755</td>
<td>85,643</td>
<td>566.2</td>
</tr>
<tr>
<td>Darwin</td>
<td>106,257</td>
<td>52,672</td>
<td>294.7</td>
</tr>
<tr>
<td>Geelong</td>
<td>173,450</td>
<td>73,203</td>
<td>918.8</td>
</tr>
<tr>
<td>Gold Coast - Tweed Heads</td>
<td>557,823</td>
<td>202,143</td>
<td>1,402.8</td>
</tr>
<tr>
<td>Hobart</td>
<td>200,498</td>
<td>89,875</td>
<td>1,212.6</td>
</tr>
<tr>
<td>Launceston</td>
<td>82,222</td>
<td>35,525</td>
<td>435.4</td>
</tr>
<tr>
<td>Mackay</td>
<td>77,293</td>
<td>36,936</td>
<td>208.2</td>
</tr>
<tr>
<td>Melbourne</td>
<td>3,847,567</td>
<td>1,668,358</td>
<td>5,679.3</td>
</tr>
<tr>
<td>Newcastle - Maitland</td>
<td>398,770</td>
<td>165,994</td>
<td>1,018.9</td>
</tr>
<tr>
<td>Perth</td>
<td>1,670,952</td>
<td>733,832</td>
<td>3,367.1</td>
</tr>
<tr>
<td>Rockhampton</td>
<td>73,680</td>
<td>32,432</td>
<td>580</td>
</tr>
<tr>
<td>Sunshine Coast</td>
<td>270,771</td>
<td>97,670</td>
<td>1633</td>
</tr>
<tr>
<td>Sydney</td>
<td>4,028,525</td>
<td>1,735,438</td>
<td>4,046.7</td>
</tr>
<tr>
<td>Toowoomba</td>
<td>105,984</td>
<td>46,980</td>
<td>498.1</td>
</tr>
<tr>
<td>Townsville</td>
<td>162,291</td>
<td>69,888</td>
<td>696.2</td>
</tr>
<tr>
<td>Wollongong</td>
<td>268,944</td>
<td>89,275</td>
<td>572.2</td>
</tr>
<tr>
<td>Total of 25 cities</td>
<td>16,424,030</td>
<td>7,032,064</td>
<td>32,535</td>
</tr>
<tr>
<td>Australia</td>
<td>21,507,719</td>
<td>9,807,530</td>
<td>7,692,000</td>
</tr>
<tr>
<td>Share of 25 cities in Australia</td>
<td>76%</td>
<td>72%</td>
<td>0.42%</td>
</tr>
</tbody>
</table>

Data source: ABS, 2011.
3.2 The Basis of the Knowledge City Index
Our Knowledge City Index has been developed to allow a comparison of these 25 SUAs. It is premised on two core domains:

• Knowledge capital – that is, measures of the extant knowledge infrastructure of the city and the resources which a knowledge economy can draw upon.
• Knowledge economy – that is, measures of the knowledge activity of the city and its related prosperity.

We contend that there is a relationship between these two domains, especially over time. To build and sustain a knowledge economy, there needs to be the underlying resources and infrastructure to draw upon. At the same time, there needs to be evidence that there is knowledge generation. The successful knowledge city will prosper in a virtuous cycle that will enhance the capacity through successful economic activity. Our model brings these two domains together to measure both the capacity to generate knowledge and the economic value of such knowledge generation (see Figure 2).

We operationalise the measurement of each domain by focusing on six indicators (summarised in Table 2); three in each domain.

For Knowledge Capital we focus on:

• Knowledge Capacity – this indicator is the first of two to measure aspects of human capital. For this indicator we focus on the educational qualifications of residents; namely, the proportion of residents in the SUA who have a tertiary level qualification (bachelor degree or higher). Tertiary education is a widely recognised measure of strong human capital.
• Knowledge Mobility – this indicator is the second measure of human capital. It focuses on the number of migrant workers in knowledge intensive industries. Migrants, in this sense, are defined as people from outside of the SUA who have moved to it within the last five years, and can include both Australians from other areas and workers from overseas. This measure is important because it emphasises the extent to which a city can attract talent from outside of its own pool of resources.
• Digital Access – this indicator measures the physical infrastructure that underpins the knowledge economy. In this instance we use the number of households with an internet connection but we also recognise that more nuanced measures (such as speed of connection, etc) may become more appropriate as census data is enhanced.

For Knowledge Economy we focus on:

• Knowledge Industries – this indicator focuses on the importance of a knowledge base to the local economy by measuring the number of people employed in knowledge industries within the area.
• Income – this indicator is used as a proxy for the value-add that knowledge work contributes to the local economy by measuring the number of workers earning in the top income bracket (i.e. more than $104,000, pa).
• Smart Work – this indicator measures the number of workers who do not commute but work from home. We see this final measure as an important contributor to the knowledge economy because it reflects the changing work practices that are a major feature of the emerging knowledge economy.

By combining knowledge capital (KC) and knowledge economy (KE) the index integrates both the inputs and outputs of a city’s ‘knowledgeness’ to create the Knowledge City Index (KCI).

Figure 2. The KCI Model
<table>
<thead>
<tr>
<th>Knowledge Capital (KC)</th>
<th>Indicators</th>
<th>Measures</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>KCI: Knowledge Capacity</td>
<td>Residents with tertiary qualifications</td>
<td>This measures a city’s locally based human capital.</td>
<td></td>
</tr>
<tr>
<td>KCII: Knowledge Mobility</td>
<td>Migrant residents working in knowledge intensive industries</td>
<td>This measures a city’s attraction to knowledge workers from elsewhere in Australia and overseas who newly moved into the city.</td>
<td></td>
</tr>
<tr>
<td>KCIII: Digital Access</td>
<td>Dwellings with internet connection</td>
<td>This measures the accessibility to digital infrastructure.</td>
<td></td>
</tr>
<tr>
<td>Knowledge Economy (KE)</td>
<td>KEI: Knowledge Industries</td>
<td>Workers for knowledge intensive industries</td>
<td>This measures the knowledge base in the local economy.</td>
</tr>
<tr>
<td>KEII: Income</td>
<td>Workers earning the highest bracket of income</td>
<td>This measures the high-value-added part in the local knowledge base.</td>
<td></td>
</tr>
<tr>
<td>KEIII: Smart Work</td>
<td>Non-commuting workers</td>
<td>This measures the practice of non-commuting work facilitated by digital technology and the knowledge economy.</td>
<td></td>
</tr>
</tbody>
</table>
Next, we turn to the data sources that we have used to create the index. For all six indicators, we used the Australian Census 2011 data, which provides the most pertinent data sets for these measures at the designated geographical level. For the Knowledge Capital measures, the Place of Usual Residence data was used to reflect the people who ‘live’ in the specific city. For the Knowledge Economy measures, the Place of Work data was used to reflect the people who ‘work’ in the given city. The two census categories have important differences in that people may reside in one area but work in another. Our decision to use Place of Usual Residence for knowledge capital measures reflects our desire to measure the potential knowledge base of the city. Equally, our decision to use Place of Work data for Knowledge Economy measures reflects our desire to focus on the ways in which cities are exploiting knowledge capital, regardless of whether the human capital resides within the area or commutes.

The advantages of using census data for this purpose is threefold. First, because every household (technically) completes the census it is much more comprehensive than surveys that sample only a proportion of the population. As a consequence, we are able to drill down into, and compare, geographic areas across Australia; a feature that is not normally possible with national surveys. Second, as the Australian census is quinquennial, it will be possible to build a time series analysis of these same areas to explore how they develop and compare over time. Third, as census data has a degree of harmonisation across OECD countries in terms of the data definitions that are used, it may be possible to take our tool and compare across countries as well as within. While we recognise that the 2011 data that we are currently applying to the KCI has aged, we balance this recognition with the clear advantages that it offers our current and subsequent analyses. Moreover, as the analysis in the next two chapters will show, even the 2011 census data reveals some significant divergences between cities in Australia.

Finally, we turn our attention to the ways in which we have classified knowledge industries. For the measures of Knowledge Mobility and Knowledge Industries, we constructed a category of ‘knowledge intensive industries’ to specifically capture the ‘knowledge intensiveness’ in a city’s KC and KE. These knowledge intensive industries were defined on the basis that their major output is knowledge or that they are instruments for the reception, processing or transmission of knowledge. Their selection was informed by a wide range of literature on knowledge production, knowledge employment, and knowledge workers (Brint, 2001; Florida, 2002; Florida, 2003; Frey & Osborne, 2015; Hu, 2014, 2016; Machlup, 2014; Mellander, 2009).

For this report, the knowledge intensive industries were selected from 126 sub industries from the following eight broad industry groups in the Australian and New Zealand Standard Industrial Classification (ANZSIC), based on a previous study by Tuli and Hu (2015):

- Information Media and Telecommunications
- Financial and Insurance
- Professional, Scientific and Technical
- Manufacturing
- Public Administration and Safety
- Education and Training
- Health Care and Social Assistance
- Arts and Recreation

In this way, we have constructed the foundations for measuring and comparing cities in the form of a knowledge city index. The next step is to derive a method for combining the different measures and computing the index.

### 3.3 Computing the KCI

In order to create our index we start from the premise that we need to attribute a similar value to each of the six indicators that we are using. For each of the six measures, therefore, we calculated values for both numbers and proportions in each city. We then standardised the values of numbers and proportions respectively for the 25 cities with the maximum designated as 10 and the minimum designated as 1, through the following steps:

1. **Step 1:** We designate 10 to the maximum value, and 1 to the minimum value;
2. **Step 2:** We then recalculate the values between the minimum and maximum using the following equation:
   \[ \text{NewValue} = \frac{(\text{OldValue} - \text{OldMin}) \times (\text{NewMax} - \text{NewMin})}{\text{OldMax} - \text{OldMin}} + \text{NewMin} \]
   Where \(\text{NewMax}=10\), \(\text{NewMin}=1\)
3. **Step 3:** All the original values were then standardised into a set of values ranging from 1 to 10.

The above standardisation of measures was informed by the Human Development Index by the United Nations Development Programme (UNDP, 2015). A worked example of this process is shown in Box 1.
In order to be able to rank the cities, the standardised scores for each indicator were added together to create an overall score for the city, in which the maximum possible score would be 60, if any city was the highest performer in all six indicators.

This process was repeated for both the absolute numbers and the proportions for each city. As a consequence, two separate standardised scores were created for each city in relation to all six of our indicators, allowing us to understand cities in terms of both the absolute numbers in relation to each indicator, and the relative importance of that indicator in each city.

As Chapter 4 will show, the very different scale of cities means that the very big cities will inevitably have larger numbers in many of the indicators than smaller cities. Equally, however, it is also plausible that smaller cities may have a much greater proportion of knowledge capital and a proportionately stronger knowledge economy than some of Australia’s larger cities. Our full KCI factors in both scale and proportion by adding the standardised measures for each of them together and then dividing by two to produce a final measure. This approach ensures that the index accounts for both the relative size and the concentration of the ‘knowledgeness’ within a given city. By standardising our index we do not ignore the scale of a city when comparing it to others. This calculation therefore factors in the differences in the scale of cities as well as the knowledge intensive nature of cities.

**Box 1 – Calculating the KCI: A worked example**

This box works through a calculation for the KCI for one city (Wollongong) for one indicator (people working in knowledge industries). It calculates a standardised position for the first the proportion and second the size, before computing the final index by aggregating the two standardised positions.

**PROPORTION – % of people working in knowledge industries**

**Step 1 – Assigning high and low values**

- Highest value: 53% (Canberra) – allocated 10
- Lowest value: 17% (Mackay) – allocated 1

**Step 2 – Recalculating values (see formula)**

- *(Example for Wollongong)*
  - Wollongong: 24%
  - \[ \text{Wollongong} = \frac{(24-17) \times (10-1)}{53-17} + 1 \]
  - \[ \text{Wollongong} = \frac{7 \times 9}{36} + 1 \]
  - \[ \text{Wollongong} = 2.75 \]

**SIZE – number of people working in knowledge industries**

**Step 1 – Assigning high and low values**

- Highest value: 570,000 (Sydney) – allocated 10
- Lowest value: 4,100 (Bunbury) – allocated 1

**Step 2 – Recalculating values (see formula)**

- *(Example for Wollongong)*
  - Wollongong: 21,500
  - \[ \text{Wollongong} = \frac{(21,500 - 4,100) \times (10-1)}{570,000 - 4,100} + 1 \]
  - \[ \text{Wollongong} = \frac{17,400 \times 9}{565,500} + 1 \]
  - \[ \text{Wollongong} = 1.28 \]

**Step 3 - KCI - Standardisation**

- \[ \text{KCI indicator} = \frac{(\text{Proportion} + \text{Size})}{2} \]
- \[ \text{KCI indicator} = \frac{(2.75 + 1.28)}{2} \]
- \[ \text{KCI indicator} = 2.015 \]

Wollongong’s aggregated indicator for people employed in knowledge industries, therefore, is 2.015. This indicator is then added to the other five indicators for Wollongong to establish its overall total. The scores for each city can then be ranked.
We now turn to the Knowledge City Index for Australian cities and present the index in three ways. First, we focus on the analysis by proportion, in order to establish which cities are the most knowledge intensive. Second, we focus on the analysis by size, in order to understand which cities are the largest in terms of their contribution to the knowledge economy. Third, we present the aggregated Knowledge City Index which balances both proportion and size to offer a relative measure of the knowledge city. This third table is our key finding; it is the KCI for Australia. Finally, we also test the relationship between our two domains of Knowledge Capital and Knowledge Economy by presenting a linear regression of the standardised scores for each city.

In each of the three main tables we provide the aggregated scores for each city; that is, an aggregation of the standardised scores for each city. The table is then presented in rank order, from the highest ranked city to the lowest. Importantly, we have not ranked each indicator; it is possible for a city on a lower rank to have higher standardised scores on some indicators. However, we have retained the breakdown between each indicator so that the different contributions of each, and the way in which they contribute to the indexed measure of each city, can be seen.

In reading the tables it is important to remember that each of the indicators is a standardised measure rather than an absolute one, based on a scale of 1 -10, where 1 is the lowest scoring city and 10 the highest (see the previous chapter for details). This standardisation approach enables us to weight the data, thereby minimising the impact of extremes and outliers.
4.1 Analysis by Proportion

Figure 3. The KCI for Australian Cities by Proportion

- **KCI**: knowledge capacity
- **KCII**: knowledge mobility
- **KCIII**: digital access
- **KEI**: knowledge industries
- **KEII**: income
- **KEIII**: smart work
An analysis by proportion gives a good indication of the relative importance of knowledge based work to the local economy. Of course, it does not take into account the scale of each city but, in some respects, that absence of scale makes the analysis even more pertinent. Reading through the different indicators, it is possible to see which cities have, for example, the greatest knowledge capacity (i.e. residents with tertiary qualifications), or the most people working in knowledge industries, as a proportion of their overall population.

The most striking feature of Figure 3 is that Canberra-Queanbeyan (the SUA that encompasses the ACT and the adjoining New South Wales city of Queanbeyan) not only ranks at the top of the list of cities but also ranks top in five out of the six indicators; only in relation to smart work, the measure of people working from home, does Canberra-Queanbeyan fall behind other cities in proportionate terms. In some respects, Canberra-Queanbeyan’s high ranking is not surprising. As Australia’s capital city and home to a large proportion of the Commonwealth public service, there is inevitably a high knowledge focus in its employment patterns. However, we are nonetheless surprised at just how much Canberra-Queanbeyan stands above the others, especially as the measures are standardised rather than absolute, thereby reducing the impact of extremes and outliers.

The existence of the other state and territory capitals in the high end of the bar chart is not surprising. Each of these cities have the infrastructure of state or territory government underpinning their economies, as well as other knowledge industries. Perhaps of greater interest is the conjunct positions of the Sunshine Coast and the Gold Coast – Tweed Heads urban areas, both of which are ahead of the state capitals of South Australia (Adelaide) and Tasmania (Hobart), as well as the industrial cities of Newcastle and Wollongong. Their position in the proportion table appears to be driven especially by two related indicators. First, both of them have relatively high standardised levels of digital access. Second, both of them have high proportions of smart work; indeed, the Sunshine Coast has the highest smart work of all 25 cities in our study, as a proportion of the overall workforce. These two factors appear to indicate a high level of knowledge workers active from home, although the relatively low standardised income levels in these two areas would also imply that this knowledge work is not of high economic value.

Our conclusion from Figure 3 is that Canberra-Queanbeyan is fundamentally and exceptionally Australia’s knowledge city. As a proportion of its overall activity, it has both the underlying knowledge capital and the activated knowledge economy that sets it apart from all other cities in Australia. While other state and territory capitals can also boast similar profiles, the extent to which Canberra-Queanbeyan has proportionately more than these other cities across almost all indicators emphasises its unique position as not only Australia’s political capital but also its knowledge capital. While its current position may be a result of the public services focus of its employment it nonetheless positions Canberra-Queanbeyan well for the future knowledge economy as well.
4.2 Analysis by Size

Figure 4. The KCI for Australian Cities by Size

- **KCI**: knowledge capacity
- **KCII**: knowledge mobility
- **KCIII**: digital access
- **KEI**: knowledge industries
- **KEII**: income
- **KEIII**: smart work
A focus just on size creates an immediate change to our analysis. Not surprisingly, the cities with the largest populations also have the largest absolute numbers in the different indicators. Most notably, Australia’s most populous urban area, Sydney (population in 2011 was just over 4 million), also has the most residents with tertiary qualifications, the highest number of migrant workers, and the most number of workers employed in knowledge industries. Indeed, it scores a perfect 10 for all six of our indicators, when measured by size. Melbourne, Australia’s second largest city (population in 2011 was 3.8 million) comes a close second.

What is more surprising, at first glance at least, is the speed at which the curve in Figure 4 accelerates down after these first two cities. Brisbane and Perth are half the size (in terms of our indicators) of Sydney, and Adelaide less than a third. The remaining cities barely show on the bar chart beyond the first five or six. The reason for this outcome is quite simply to do with population. The significant urban areas that constitute Sydney and Melbourne, when combined, are home to over a third (36 per cent) of Australia’s population. Moreover, the first five cities in bar chart accommodate 12.7 million inhabitants, or 59 per cent of the population. It is no surprise, then, that these cities are also home to significant knowledge industries, workers and so on.

Our conclusion from Figure 4 is that the largest urban areas will inevitably have a role to play in advancing Australia’s knowledge economy. The question is whether they can balance the focus on knowledge with the other industries that are also jostling for space.
4.3 The Knowledge City Index

Figure 5. The KCI for Australian Cities

- KCI: knowledge capacity
- KCII: knowledge mobility
- KCIII: digital access
- KEI: knowledge industries
- KEII: income
- KEIII: smart work
In building our Knowledge City Index, we have been conscious not only of the insights that each approach offers but also of the limitations of a focus on either proportion or size. While proportion gives us a good understanding of how knowledge intensive a city is, when mapped against size, a very different picture has emerged. Our challenge has been to find a way of taking into account both proportion and size to develop a more nuanced tool that effectively measures knowledge cities. Our solution has been to combine both measures through a standardisation process that gives equal weight to measures of both proportion and size.

To develop an effective measure of the knowledge intensive nature of cities, this final version of the index incorporates the proportion and the overall size of knowledge activities within a city. Integrating both proportion and size of a knowledge city is methodologically different from conventional measures of absolute numbers. For this version of the index we used a data standardisation process that ensures the KCI accounts for these different elements of scale and proportion. This approach ensures that we acknowledge the considerably different variation of living and working populations across these cities, and capture their knowledge core.

Figure 5 presents a very different picture of Australia’s knowledge cities. While the two major urban centres of Sydney and Melbourne are still the strongest in the index, the return of Canberra-Queanbeyan in third place emphasises the importance of this city as a leading centre for knowledge industries both now and in the future. The other striking feature is the extent to which some cities with relatively large populations, most notably Perth (population 1.7 million) and Adelaide (population 1.2 million) still score quite weakly on the overall index, highlighting the different industrial economies of these areas.

Overall, there appear to be three discrete categories of cities that are emerging from the aggregated and standardised Knowledge City Index:

- First, there are the high ranking five cities at the left of the chart (Sydney, Melbourne, Canberra-Queanbeyan, Brisbane and Perth), all of which appear to have a good combination of size and proportion of knowledge intensiveness. Canberra-Queanbeyan is the exception here in so far as it makes up for a relatively small population (390,000) with a much higher proportion of knowledge intensity.
- Second, there are four middle ranking cities (Adelaide, Darwin, Sunshine Coast and Gold Coast – Tweed Heads) which feature sufficiently on the index to be recognised as having some knowledge intensiveness. However, for these cities there are noticeable issues that may prevent them from developing stronger profiles, most notably the limited number of knowledge workers in Adelaide and the significant dependence on smart work opportunities in the Sunshine Coast and Gold Coast –Tweed Heads.
- Third, the long tail of 16 weak cities stands out. A combination of port, industrial and mining cities, these 16 appear to have significant weaknesses and limitations in their ability to adapt to the future knowledge economy.

Our conclusion from Figure 5, therefore, is both optimistic and pessimistic. The optimistic story focuses on the high ranking five and their knowledge intensity. The pessimistic story expresses concern for the long tail of 16 cities that appear to lack the knowledge capacity and knowledge economy. The good news is that the five high-ranking cities are also home to 55 per cent of the nation’s population.
4.4 Knowledge Input and Output

One assumption for designing the KCI is that the Knowledge Capacity and Knowledge Economy form an input-output relationship, which integrate and interact to constitute a city’s knowledge capability. As we argued earlier strong Knowledge Capacity in the form of human capital and other resources are an important underpinning of a knowledge economy. However, there is also a need to activate these resources to create a healthy knowledge economy that is exploiting them effectively.

To test the validity of this assumption, we selected the indicators of Knowledge Capacity and Knowledge Industries and applied measures by proportion only to plotting the 25 Australian cities (Figure 6). In effect, this correlation tests the extent to which highly qualified people (i.e. those with a tertiary education) are being employed in knowledge intensive occupations. The strong correlation between the two indicators reveals a consistent balance between knowledge input and output, or knowledge supply and demand, among Australian cities. Among them, Canberra-Queanbeyan stands out as an outlier given its very high proportion of knowledge capacity and knowledge industries in its local knowledge base.

This correlation confirms the validity of our model, as well as highlighting the dynamic relationship between knowledge capacity and knowledge economy. We do not argue that there is causality between one factor and another or, indeed, that one factor necessarily precedes another. Rather, we suggest that it is the interaction between knowledge capacity and knowledge economy that drives or inhibits growth.

Figure 6. Knowledge Capacity vs. Knowledge Industries in Australian Cities
The KCI presents a portrait for each of the 25 Australian cities in terms of knowledge capability. Each portrait provides measures across two domains – Knowledge Capital (KC) and Knowledge Economy (KE) – in order to differentiate the input and output of a city’s knowledge base. Together with other localised information and data on industries of employment and occupation structure, educational institutions, and natural endowments, they inform policy makers, city planners and the public of where their cities stand in the national context.

The lessons learned from these vignettes are distinct for each city and therefore are not aimed at providing a single or overarching policy response for all Australian cities. However, the city portraits provide a potential starting point in developing customised policy for each individual city and informing policy making and planning for the opportunities and challenges identified. They reveal a city’s strength, potential to improve and also areas of weakness. They are presented in order of their positions according to the KCI.

At the top of each city portrait are two sets of numbers. The first row of numbers adds together the three standardised scores for each of the two domains; knowledge capital and knowledge economy. The second row shows the percentage that the standardised score represents as a proportion of the city’s overall score.
• Sydney is Australia’s gateway global city and a financial capital of global importance.

• Sydney is positioned as the number one knowledge city in Australia according to the KCI. It has the highest KC (24.16) and KE (23.68) among the 25 Australian cities. Sydney is already saturated in its knowledge capability compared to other cities in Australia.

• There are still some areas for Sydney to make improvements in terms of Knowledge Industries, Knowledge Mobility and Smart Work.

• The major industries of employment in Sydney include: Cafes, Restaurants and Takeaway Food Services (4.0%), School Education (4.0%), Hospitals (3.2%), Legal and Accounting Services (2.9%), and Depository Financial Intermediation (2.5%).

• The occupational distribution of Sydney includes the following breakdown: Professionals at 26.2%, Clerical and Administrative Workers at 16.3%, Managers at 13.4%, Technicians and Trades Workers at 11.9%, and Sales Workers at 8.9%.

• There are six public universities in the Greater Sydney region: the University of Sydney, the University of New South Wales, the University of Technology Sydney, Macquarie University, the Western Sydney University, and the Australian Catholic University. Four public universities maintain secondary campuses in the city: the University of Notre Dame Australia, the University of Wollongong, Curtin University of Technology, and the University of Newcastle.

• 24.7% of Sydney’s population attended a tertiary or technical institution.
MELBOURNE

- Melbourne is the 2nd largest global city in Australia and enjoys a global fame for knowledge, design, and liveability.
- Melbourne is the 2nd strongest performer on the KCI. However, there remain a number of areas where further improvements are required. It is behind Sydney in all of the six KCI indicators especially in Knowledge Industries, Knowledge Mobility, Income and Smart Work.
- The major industries of employment include: Cafes Restaurants and Takeaway Food Services (4.3%), School Education (4.1%), Hospitals (3.7%), Legal and Accounting Services (2.5%), and Tertiary Education (2.3%).
- Occupational distribution in Melbourne is as follows: Professionals were 24.4%, Clerical and Administrative Workers were 15.3%, Technicians and Trades Workers were 13.2%, Managers 12.5%, and Sales Workers were at 9.7%.
- The Greater Melbourne region is the home to seven public universities: the University of Melbourne, Monash University, La Trobe University, RMIT University, Deakin University, Swinburne University of Technology, and Victoria University.
- 25% of Melbourne’s population attended a tertiary or technical institution.
• Although by population Canberra-Queanbeyan is the 8th in Australia, it stands out as the 3rd in the KCI.

• The Canberra-Queanbeyan region performs well and holds in balance in five indicators of the KCI except for Smart Work. The existence of the public service and ‘30 minutes’ city’ (commuting to work in 30 minutes or less) are possible explanations for this underperformance.

• Canberra-Queanbeyan shows a strong performance in Knowledge Industries and Knowledge Mobility. The city remains attractive to global and local talents to provide human capital for its knowledge economy.

• In Canberra – Queanbeyan, 19.3% people worked for the Commonwealth Government. Other major industries of employment include: Defence at 6.0%, Cafes, Restaurants and Takeaway Food Services at 3.8%, School Education at 3.6%, and Tertiary Education at 3.5%.

• Canberra - Queanbeyan has the highest proportion of Professionals (28.7%) in Australia, followed by Clerical and Administrative Workers (19.3%), Managers (15.6%), Technicians and Trades Workers (10.5%), and Community and Personal Service Workers (9.3%).

• The two main tertiary institutions are the Australian National University and the University of Canberra. Other tertiary educational institutions include: the Australian Catholic University, St Mark’s Theological College (part of the Charles Sturt University), UNSW at Canberra, and the Royal Military College, Duntroon. Tertiary level vocational education is available through the multi-campus of Canberra Institute of Technology.

• 31.8% of the population attended a tertiary or technical institution, which is the highest level of all Australian cities.
BRISBANE

- Brisbane is the 3rd most populous city in Australia.
- Brisbane performs well in Digital Access and considerably well in all other measures according to the KCI.
- Architectural, Engineering and Technical Services employ 2.6% of the population in Brisbane, making it one of the major industries of employment. Other major industries of employment include: School Education (4.6%), Hospitals (4.5%), Cafes, Restaurants and Takeaway Food Services (4.2%), and State Government Administration (2.7%).
- Occupational distribution in Brisbane is divided as follows: Professionals at 22.7%, Clerical and Administrative Workers at 16.3%, Technicians and Trades Workers at 13.4%, Managers at 11.5%, and Community and Personal Service Workers at 9.6%.
- Brisbane has multi-campus universities and colleges, including the University of Queensland, Queensland University of Technology, and Griffith University. Other universities which have campuses in Brisbane include the Australian Catholic University, Central Queensland University, James Cook University, University of Southern Queensland, and the University of the Sunshine Coast. Brisbane is also home to the Aboriginal Centre for the Performing Arts. There are also three major TAFE colleges in Brisbane.
- 24.4% of the population in Brisbane attended a tertiary or technical institution.
PERTH

- Perth, capital of Western Australia (WA), is the only capital city on Australia’s west coast.
- According to the KCI, Perth’s performance is comparatively strong in Income and Digital Access compared to the other four measures.
- Architectural, Engineering and Technical Services are one of the major industries of employment (5.2%) in Perth. Other major industries include: School Education (4.9%), Cafes, Restaurants and Takeaway Food Services (4.4%), Hospitals (3.5%), and Supermarket and Grocery Stores (2.3%).
- Occupational distribution in Perth is divided as follows: Professionals were 22.0%, Technicians and Trades Workers were 16.0%, Clerical and Administrative Workers were 15.2%, Managers were 11.4%, and Community and Personal Service Workers came in at 9.7%.
- Perth is home to four public universities: the University of Western Australia, Curtin University, Murdoch University, and Edith Cowan University. There is also one private university, the University of Notre Dame. Four TAFE exist in the metropolitan Perth area.
- 23.9% of the population in Perth attended a tertiary or technical institution.
Among the state capital cities, Adelaide performed moderately ahead of Darwin and Hobart only, both of which contain much smaller populations.

Adelaide’s performance is comparatively strong in Knowledge Industries, Digital Access and Knowledge Capacity; and moderately in the other three measures.

Major industries of employment in Adelaide include: School Education (4.4%), Restaurants and Takeaway Food Services (4.2%), Hospitals (4.2%), Supermarket and Grocery Stores (2.8%), and Residential Care Services (2.7%).

Occupations in Adelaide are distributed as follows: Professionals at 21.8%, Clerical and Administrative Workers at 15.5%, Technicians and Trades Workers at 13.9%, Managers at 11.0%, and Community and Personal Service Workers at 10.7%.

Adelaide hosts three public universities: Flinders University, University of Adelaide, and University of South Australia, and one private university, Torrens University Australia.

In addition to the universities, Adelaide is home to a number of research institutes, including the Royal Institution of Australia.

25% of the population in Adelaide attended a tertiary or technical institution.
Darwin, the capital city of the Northern Territory, is situated on the Timor Sea and represents the Top End’s regional centre. Darwin’s proximity to Southeast Asia positions it as a strong link between Australia and countries to the immediate north, such as Indonesia and East Timor.

According to the KCI, Darwin’s performance in Knowledge Mobility is comparatively strong and relatively limited in Smart Work. It is fairly good in Knowledge Industries and Income, and moderate in Digital Access and Knowledge Mobility.

Darwin’s strategic location has considerable potential to be an international knowledge capital in the East Timor area.

Like Canberra, State Government Administration is the primary industry of employment in Darwin (8.1%), followed by Defence (7.8%), School Education (4.7%), Cafes, Restaurants and Takeaway Food Services (3.7%), and Public Order and Safety Services (3.2%).

Occupational distribution in Darwin is divided as follows: Professionals are 20.3%, Clerical and Administrative Workers are 16.3%, Technicians and Trades Workers are 15.5%, Community and Personal Service Workers are 13.4%, and Managers are 12.5%.

Darwin is home to the Charles Darwin University.

16.2% of the population in Darwin attended a tertiary or technical institution.
SUNSHINE COAST

- Sunshine Coast is a regional centre, tourism base, and the 3rd most populous city in Queensland. Its urban area spans in approximately 60 km along the coastline.
- In the KCI, Sunshine Coast ranks less on KC measures and more on KE measures. It is worth noting that it has the 3rd highest score in Smart Work among the 25 cities.
- The predominant industries of employment include: School education (5.4%), followed by Cafes, Restaurants and Takeaway Food Services (5.1%), and Hospitals (3.7%).
- The most common occupations in Sunshine Coast include: Professionals at 18.3%, Technicians and Trades Workers at 16%, Clerical and Administrative Workers at 13.7%, Managers at 12.1%, and Sales Workers at 12%.
- The city has one main university, the University of the Sunshine Coast. TAFE Queensland has four campuses at Mooloolaba, Maroochydore, Nambour, and Noosa.
- 17.3% of population in Sunshine Coast attended a tertiary or technical institution.
GOLD COAST – TWEED HEADS

- Gold Coast is a major tourist destination in Australia, the 6th largest non-capital city and the 2nd largest city in Queensland. The city and its surrounds are well known for theme parks, nightlife, a high-rise skyline and film production.
- Tourism remains fundamental to Gold Coast’s economy, with almost 10 million visitors a year coming to the area. Gold Coast will host the 2018 Commonwealth Games.
- According to the KCI, the Gold Coast – Tweed Heads area has comparatively high scores in Smart Work, the 4th among the 25 Australian cities, and Digital Access.
- Gold Coast – Tweed scores fairly low in Knowledge Industries and Income, and moderately in Knowledge Mobility and Knowledge Capacity.
- Main industries of employment are Cafes, Restaurants and Takeaway Food Services (5.3%), School Education (4.3%), Hospital services (3.3%), and Accommodation (2.9%).
- Its occupational structure is as follows: 17.3% are Professionals, 15.4% are Technicians and Trades Workers, 14.4% are Clerical and Administrative Workers, 12.7% are Sales Workers, and 12.2% are Managers.
- Two major university campuses are situated on the Gold Coast; Bond University and Griffith University. Southern Cross University and Central Queensland University also operate smaller campuses there. TAFE has five campuses in Southport, Ridgeway (Ashmore), Benowa, Coomera and Coolangatta.
- 20.4% of the population in Gold Coast – Tweed Heads attended a tertiary or technical institution.
HOBART

• The capital city of the island state Tasmania, Hobart, is the 2nd oldest capital city, after Sydney, in Australia. It is the least populated state capital in Australia.
• Hobart has a large and growing tourist industry. Its economy is heavily reliant on the sea. It is a busy seaport, a hub for cruise ships during the summer months. Hobart is an Antarctic gateway city, with geographical proximity to East Antarctica and the Southern Ocean.
• According to the KCI, Hobart has relatively good scores in Knowledge Capacity and Knowledge Industries. Hobart scores moderately in Knowledge Mobility and Digital Access, but fairly low in Income and Smart Work.
• The main industries of employment in Hobart include: School Education (5.9%), State Government Administration (5.6%), Cafes, Restaurants and Takeaway Food Services (4.7%), Hospitals (3.3%), and Central Government Administration (2.7%).
• Occupational distribution is as follows: Professionals at 22.7%, Clerical and Administrative Workers at 16.1%, Technicians and Trades Workers at 13.6%, Community and Personal Service Workers at 11.5%, and Managers at 11.4%.
• Hobart is home to the main campus of the University of Tasmania.
• Hobart has the potential to grow as a specialised knowledge city that harnesses its unique location in terms of marine and Antarctic studies.
• 24.6% of Hobart’s population attended a tertiary or technical institution.
NEWCASTLE - MAITLAND

- Newcastle is a harbour city in New South Wales and traditionally was an area of heavy industry. Many of those ‘old economy’ industries moved out of the city over the recent decades, which has led to economic diversification of the city.
- At present, the two largest employers in the city are the Hunter New England Area Health Service and the University of Newcastle. The National Stock Exchange of Australia (formerly Newcastle Stock Exchange) is based in the city.
- According to the KCI, the city performs comparatively well in Digital Access and Income; moderately in Knowledge Mobility, Knowledge Capacity and Knowledge Industries; but underperforms in Smart Work.
- Major industries of employment include: School Education (4.7%), Cafes, Restaurants and Takeaway Food Services (4.6%), Hospitals (4.4%), Supermarket and Grocery Stores (2.7%), and Residential Care Services (2.5%).
- Occupation distribution in Newcastle – Maitland are as follows: Professionals at 21%, Technicians and Trades Workers at 15.8%, Clerical and Administrative Workers at 14.6%, Sales Workers at 10.3%, and Community and Personal Service Workers at 10.1%.
- With economic diversification well underway, the Newcastle – Maitland region has potential to be a knowledge city that further excels in the health and education sectors.
- The city is home to the University of Newcastle.
- 23.8% of its population attended a tertiary or technical institution.
TOWNSVILLE

- Townsville is on the north-eastern coast of Queensland, adjacent to the central section of the Great Barrier Reef.
- In the KCI, the city rates very low in Smart Work, but positively in Digital Access. The city also performs relatively well in Knowledge Industries, Income and Knowledge Mobility.
- Defence is the main industry of employment in Townsville (5.3%). Other major industries of employment include: Hospitals (5.2%), School Education (5.0%), and Cafes, Restaurants and Takeaway Food Services (4.5%).
- The occupation distribution of Townsville is as follows: Professionals at 17.6%, Technicians and Trades Workers at 16.6%, Clerical and Administrative Workers at 14.4%, Community and Personal Service Workers at 12.4%.
- Townsville is home to James Cook University, Barrier Reef Institute of TAFE, a campus of Central Queensland University, the Australian Agricultural College Corporation, and a new Australian Technical College, North Queensland campus.
- Townsville can grow more knowledge-based industries related to defence force, as defence is the main industry of employment in the city.
- 22% of the population in Townsville attended a tertiary or technical institution.
WOLLONGONG

• Wollongong is a coastal city in New South Wales, 80 kilometres south of Sydney along the Grand Pacific Drive. Wollongong has a long history of coalmining and old industry. It is a regional centre for the fishing industry in South Coast.
• The city performs moderately in Knowledge Industries, Income, Digital Access, and Knowledge Capacity. Unlike other coastal regional centres, Wollongong measures relatively low in Smart Work and even lower in Knowledge Mobility.
• Major industries of employment in Wollongong include: School Education (5.4%), Cafes, Restaurants and Takeaway Food Services (4.6%), Basic Ferrous Metal Manufacturing (4.2%), Hospitals (3.6%), and Tertiary Education (3.3%).
• Occupational distribution in Wollongong is as follows: Professionals at 20.5%, Technicians and Trades Workers at 15.9%, Clerical and Administrative Workers at 14.2%, Community and Personal Service Workers at 11.5%, and Managers at 9.8%.
• Wollongong has one university, the University of Wollongong with two main campuses: the primary campus and the innovation campus. In addition, there are two campuses of the Illawarra Institute of TAFE.
• 24.5% of the population in Wollongong attended a tertiary or technical institution.
CAIRNS

- Cairns, the gateway to Australia’s Great Barrier Reef, is a main city of tropical Far North Queensland. Tourism plays a major part in the local economy. According to Tourism Australia, the Cairns region is the 4th most popular destination for international tourists in Australia after Sydney, Melbourne, and Brisbane.
- According to the KCI, Cairns has comparatively low scores in Knowledge Industries, Income, and Knowledge Capacity; but it performs moderately in Smart Work, Digital Access, and Knowledge Mobility.
- Major industries of employment include: School Education (5.2%), Cafes, Restaurants and Takeaway Food Services (4.9%), Hospitals (4.7%), Accommodation (3.8%), and Supermarket and Grocery Stores (2.8%)
- Occupational distribution is as follows: Professionals at 18.1%, Technicians and Trades Workers at 15.7%, Clerical and Administrative Workers at 14.6%, Community and Personal Service Workers at 12.3%, and Sales Workers at 11.1%.
- Tertiary education institutions include: the Cairns Campus of James Cook University, Central Queensland University centre in Cairns, and the TAFE college.
- 15.8% of the population in Cairns attended a tertiary or technical institution.
Central Coast is a regional coastal centre in New South Wales, to the north of Sydney.

According to the KCI, KE measures are greater than KC in Central Coast. Low scores are registered in Knowledge Industries, Income, Knowledge Capacity, and Knowledge Mobility. Central Coast stands out in Smart Work and performs moderately in Digital Access.

Major industries of employment include: School Education (4.5%), Cafes, Restaurants and Takeaway Food Services (4.5%), Hospitals (3.7%), Residential Care Services (3.2%), and Supermarket and Grocery Stores (3.1%).

Occupational distribution is as follows: Professionals at 17.9%, Technicians and Trades Workers at 15.8%, Clerical and Administrative Workers at 14.7%, Community and Personal Service Workers at 11.6%, and Sales Workers at 11.4%.

The University of Newcastle has a campus in Central Coast and there are three campuses of TAFE in Gosford, Wyong and Ourimbah.

17.3% of the population in Central Coast attended a tertiary or technical institution.
TOOWOOMBA

- Toowoomba is located in the Darling Downs region in Queensland, to the west of Brisbane.
- According to the KCI, the city performs fairly low in Knowledge Industries, Income, Smart Work, and Knowledge Mobility. However, it rates moderately in Digital Access and Knowledge Capacity.
- Major industries of employment include: School Education (6.7%), Hospitals (5.2%), Cafes, Restaurants and Takeaway Food Services (4.3%), Tertiary Education (3.0%), and Residential Care Services (2.3%).
- Occupational distribution is as follows: Professionals at 19.5%, Technicians and Trades Workers at 15.4%, Clerical and Administrative Workers at 14.6%, Labourers at 12.1%, and Community and Personal Service Workers at 10.5%.
- Toowoomba has the following educational intuitions: The University of Southern Queensland, TAFE Queensland, a small campus of University of Queensland, and a health training facility of Griffith University.
- 20.7% of Toowoomba’s population attended a tertiary or technical institution.
MACKAY

- Located in Queensland, Mackay is nicknamed the ‘sugar capital’ of Australia because of the region’s production of Australia’s cane sugar.
- The city rates reasonably well in Income and Digital Access. However, the city’s ratings are very limited across all the other measures of the KCI.
- Mackay is the only city with a main industry of employment of Coal Mining (7.2%). Other major industries of employment include: School Education (4.6%), Cafes, Restaurants and Takeaway Food Services (3.4%), Hospitals (3.1%), and Architectural, Engineering and Technical Services (2.5%).
- Occupational distribution is as follows: Technicians and Trades Workers at 21.3%, Professionals at 14.5%, Clerical and Administrative Workers at 13.4%, Machinery Operators and Drivers at 12.2%, and Labourers at 10.8%.
- Mackay has two university campuses: The Mackay campus of Central Queensland University and a local campus of James Cook University in South Mackay. The city has one TAFE college.
- 13.4% of Mackay’s population attended a tertiary or technical institution.
GEELONG

- Geelong, a port city located on Corio Bay and the Barwon River in Victoria, is located 75 kilometres southwest of Melbourne. It is the 2nd largest Victorian city after Melbourne.
- Historically the city was a manufacturing centre in Victoria.
- The city scores moderately in Income, Digital Access, and Knowledge Capacity. Its scores are quite limited in the remaining indicators.
- Major industries of employment include: School Education (5.1%), Hospitals (5.0%), Cafes, Restaurants and Takeaway Food Services (4.9%), Supermarket and Grocery Stores (2.6%), and Tertiary Education (2.6%).
- Occupational distribution is as follows: Professionals at 19.1%, Technicians and Trades Workers at 16.0%, Clerical and Administrative Workers at 12.8%, Community and Personal Service Workers at 11.2%, and Labourers at 11.0%.
- Deakin University is primarily based in Geelong.
- 21.3% of Geelong’s population attended a tertiary or technical institution.
ALBURY-WODONGA

- Albury-Wodonga is the twin cities of Albury and Wodonga situated on the boarder of Victoria and New South Wales.
- According to the KCI, Albury–Wodonga performs fairly low in Income, Smart Work, and Knowledge Capacity. However, its performance is moderate in the other three indicators.
- Major industries of employment include: School Education (4.6%), Restaurants and Takeaway Food Services (4.2%), Hospitals (3.5%), Defence (3.4%), and Supermarket and Grocery Stores (3.2%).
- The occupation distribution is as follows: Professionals at 17.6%, Technicians and Trades Workers at 16.0%, Clerical and Administrative Workers at 13.7%, Labourers at 11.0%, and Community and Personal Service Workers at 10.9%.
- It contains campuses of two universities: La Trobe University and Charles Sturt University.
- 22.7% of its population attended a tertiary or technical institution.
Ballarat is located in Victoria and has the 3rd largest population for an inland city in Australia. Historically, it was a major centre for gold mining; emerging industries in this century include information technology service and renewable energy.

The city scores comparatively high in Knowledge Capacity, which is the highest of the last 15 cities in the KCI. For a small city, it therefore performs well in this regard. However, its performance in Income is very limited.

In terms of industries of employment, 6.9% of its population worked in Hospitals, 5.9% in School Education, and 4.8% in Cafes, Restaurants and Takeaway Food Services.

Occupation distribution is as follows: Professionals at 21.0%, Technicians and Trades Workers at 15.3%, Clerical and Administrative Workers at 13.4%.

Ballarat has two universities: Federation University and a campus of the Australian Catholic University.

22.9% of Ballarat’s population attended a tertiary or technical institution.
BENDIGO

- The city of Bendigo is located in Victoria and is the 4th largest inland city in Australia.
- Among the six KCI indicators, Bendigo has the highest score in Digital Access and Knowledge Economy (just above 2), and scores fairly low in all other measures, especially low in Income and Knowledge Mobility.
- Bendigo has a large and growing service economy and its largest industry of employment is the Hospital (6.5%), followed by School Education (5.5%), Cafes, Restaurants and Takeaway Food Services (4.4%), Supermarket and Grocery Stores (3.2%), and lastly Depository Financial Intermediation (2.8%).
- The occupation distribution is as follows: Professionals at 20.0%, Technicians and Trades Workers at 14.8%, Clerical and Administrative Workers at 13.2%, Labourers at 11.7%, and Sales Workers at 11.3%.
- The Bendigo campus of La Trobe University is a large and growing educational hub.
- 21.9% of its population attended a tertiary or technical institution.
BUNBURY

- Bunbury is a port city in Western Australia, to the south of Perth. Mining and mineral processing sector remain a main driver for the city’s economy.
- According to the KCI, the city’s performance is limited in Knowledge Industries, Income, Knowledge Mobility, and Knowledge Capacity. However, it performs comparatively high in Digital Access and Smart Work.
- In terms of industry of employment, the city has a sizable School Education (5.6%). Other major industries of employment include: Basic Non-Ferrous Metal Manufacturing (4.3%), Cafes, Restaurants and Takeaway Food Services (3.9%), Hospitals (2.8%), and Supermarket and Grocery Stores (2.6%).
- Unlike many other Australian cities, Technicians and Trades Workers represent a high proportion of occupations at 20.4%, followed by Professionals at 15.0%, Clerical and Administrative Workers at 12.9%, Labourers at 12.5%, and Machinery Operators and Drivers at 9.8%.
- South Regional TAFE has campuses in Bunbury, providing a range of vocational education.
- 13.5% of Bunbury’s population attended a tertiary or technical institution.
Launceston is one of Australia’s oldest cities, and is the 2nd largest city in Tasmania. It was also the first Australian city to be powered by hydroelectricity.

Among the six indicators of the KCI, it has the highest score in Knowledge Capacity and the lowest in Income.

School Education is the primary industry of employment (6.5%). Other major industries include: Cafes, Restaurants and Takeaway Food Services (5.2%), State Government Administration (3.3%), Hospitals (3.2%), and Supermarket and Grocery Stores (3.1%).

The occupational distribution is as follows: Professionals at 19.7%, Technicians and Trades Workers at 14.6%, Clerical and Administrative Workers at 13.8%, Community and Personal Service Workers at 11.6%, and Sales Workers at 11.4%.

The University of Tasmania, including the Australian Maritime College, is located in the city.

25.6% of Launceston’s population attended a tertiary or technical institution.
• Rockhampton is a regional centre outside of the South East Queensland and hosts a number of government and business administrative offices. It experiences 300 days of sunshine on average, making it an attractive tourist destination.
• Rockhampton’s performance in KC indicators is lower than KE indicators. The city performs very limitedly in all measures of the KCI, except for Income.
• 5.6% of its population worked in School Education. Other major industries of employment include: Hospitals (5.5%), Cafes, Restaurants and Takeaway Food Services (4.1%), Coal Mining (2.8%), and Meat and Meat Product Manufacturing (2.6%).
• Technicians and Trades Workers (17.5%) is the main occupation in Rockhampton, followed by Professionals at 16.1%, Clerical and Administrative Workers at 14.5%, Labourers at 12.5%, and Community and Personal Service Workers at 10.3%.
• Rockhampton is a major education centre for the region. Central Queensland University was founded in Rockhampton in 1967.
• 15.1% of its population attended a tertiary or technical institution.
BUNDABERG

- Bundaberg is located to the north of Brisbane, known as the ‘southern gateway to the Great Barrier Reef’. Its economy is mainly based on local sugarcane industries and commercial fruits and vegetable production.
- Siting in the final position on the KCI, the city has a number of areas where improvements are needed. The city shows limited performance across all measures except for Income. However, the city shows some potential in Smart Work, which could be a focus for future development.
- Similar to Sunshine coast, Rockhampton and Wollongong, Bundaberg has significantly lower score on KC measures than KE measures. This suggests these cities have some space to grow their knowledge capital.
- In Bundaberg, 6.8% of people worked in School Education. Other major industries of employment include: Hospitals (5.1%), Cafes, Restaurants and Takeaway Food Services (3.9%), Supermarket and Grocery Stores (3.4%), and Residential Care Services (2.7%).
- The occupational distribution is as follows: professionals at 15.6%, technicians and trades workers at 15.2%, labourers at 14.4%, clerical and administrative workers at 13.2%, and sales workers at 11.3%.
- Bundaberg has Wide Bay Institute of Technical and Further Education, and a campus of the Central Queensland University.
- 12.8% of Bundaberg’s population attended a tertiary or technical institution.
The KCI and the individual city portraits provide insights into the resilience and limitations of 25 Australian cities in the transition to a knowledge economy. There are a number of Australian cities that perform well and have increasingly bright futures, whereas others are struggling to find their place in the transition from a traditional economy to a knowledge-based economy. This report re-emphasises the importance of place and the particular nature of Australia as a highly urbanised society, and the geography of Australian cities that are vastly separated from each other.

The KCI is not just about comparing cities, or about identifying successful or unsuccessful cities. It is also about contributing to the debate about the structure and capacity of each city and how it can address shortcomings. When thinking about the implication of the findings we suggest that each Australian city be examined individually to identify their distinctiveness and develop their strength for innovation and knowledge-based urban development. We do not imply that a single solution will fit each city. Locally derived and implemented policies will be essential to the future of each and every city. It is for this reason that we have developed, in the previous chapter, a snapshot of 25 Australian cities to allow a brief insight into the knowledge capital and knowledge economy of these cities. The report therefore opens a new door for the investigation into Australian cities. It has investigated the existing knowledge capability through six indicators: knowledge capacity; knowledge mobility; digital access; knowledge industries; income; and smart work. The findings make a timely contribution to the discussion of the knowledge future of Australian cities and policy debates.
6.1 Building up Knowledge Capability

By building the KCI and the 25 city portraits, this report presents a starting point for considering areas that are worthy of taking advantage of and situations that are best avoided. Here we are able to show how the KCI relates to and reinforces three key policy agendas currently pursued by the Australian Government.

Smart Cities Plan and City Deals

The Smart Cities Plan is the Australian Government’s blueprint for the future of Australian cities. It has three key focuses – ‘smart investment’, ‘smart policy’ and ‘smart technology’ (Australian Government, 2016). This plan is a federal level framework for cities that will guide actions across various portfolios for better outcome of Australian cities. It aims to go beyond the capital cities and find opportunities for any Australian city, a focus of this report as well. The initiatives of ‘City Deals’ and ‘National Cities Performance Framework’ are part of the implementations of the plan.

The 25 city portraits complement the evidence that decision makers and planners can draw on while preparing City Deals, and much of the KCI is aligned with ‘National Cities Performance Framework’. The KCI is a useful tool to guide where the smart investment should go to improve knowledge capital and knowledge economy. The city portraits guide analysts and policy makers to be realistic about the potentials and capacities of each city. They also highlight cities that have less capacity or less potential to become fully-fledged knowledge cities and, therefore, improve the information used to make investment decisions. While preparing a series of City Deals in the near future, the Australian Government can more clearly identify the unique strengths of each city at an earlier stage for an improved implementation of the policy.

National Innovation and Science Agenda

Innovation and Science Australia has produced the Performance Review of the Australian Innovation, Science and Research System (Innovation and Science Australia, 2016). It measures the status of knowledge creation (9 out of 10), knowledge application (1 out of 10), and knowledge transfer (5 out 10) in Australia and compares this to other OECD countries. In the most recent review Australia performed relatively poorly in knowledge transfer and very low in knowledge application according to the report. Although Australia did perform relatively well in terms of knowledge creation, it should be noted that not one Australian university is situated within the global top 20. This ranking is explained partly by the comparatively low levels of the Australian Government’s R&D expenditure and a lack of focus on experimental development, pure basic, strategic basic and applied research (Innovation and Science Australia, 2016). There are areas of focus for future investment, specifically, innovation and knowledge creation as it relates directly to developing new business opportunities and economic growth.

The limitations associated with innovation were comprehensively and systematically examined and verified in the KCI. Only 5 Australian cities stand out as being placed in a reasonably strong position to face the future challenges of the changing nature of working practices in a transition to a knowledge economy, and the remaining cities face challenges to various degrees.

Future of Work

The Australian Department of Employment’s report ‘Tomorrow’s Digitally Enabled Workforce’ (Hajkowicz, et al, 2016) contributes to the debates of policy and practice. The report outlines the way in which technology is reshaping our lives and considers in particular the impacts on workforces through exploring the manner in which digital disruption and transformation is occurring. Key factors identified in the report echo much of our argument: many jobs will become automated and the traditional employment model that has served the Australian economy well for the much of the 20th century will become increasingly untenable.

The Department’s report also identifies six major job areas that will become increasingly significant as transforming into a fully-fledged knowledge economy: big data analysts, complex decision support analysts, remote controlled vehicle operators, customer experience experts, personalised preventative health helpers, and online chaperones. These job areas directly relate to the skills and tasks
identified by Frey and Osborne’s (2013) study of the labour markets as most vulnerable to the changing nature of work practices, with the areas least susceptible including perception and manipulation of tasks, creative intelligence tasks, and social intelligence tasks. It is clear, therefore, that while there are opportunities to be taken advantage of, especially from the perspective of Australia’s 25 cities, there are also hazards that can be avoided.

6.2 An Outlook for Urban Policy and Planning

The findings and approaches of the KCI provide several significant highlights for policy makers and planners to inform their understanding of, and responses to, the knowledge economy and the knowledge city. The 25 Australian cities are situated across Australian political and economic geographies and systems. As the KCI highlights, there are a number of cities that are experiencing ‘the best of times’ when it comes to the new prevailing conditions of technological advancement, changing work, and economic transition. Meanwhile, there are also cities that do not capture the opportunities to the same extent as the top runners. They are likely to experience ‘the worst of times’ if no immediate and effective action is undertaken. To survive an increasingly competitive and connected knowledge economy that is interlinked in national and international systems, no action should not be an option for cities, no matter whether they are experiencing ‘the best of times’ or ‘the worst of times’.

The knowledge economy presents opportunities and challenges for cities of different sizes, large and small. Further, it challenges the validity of our conventional perception of cities by sizes in a knowledge-based economy. The KCI points out localised competitive strength and weakness of cities in their performances of knowledge capability. It finds that it is not a matter of ‘the bigger the better’ any more for urban competitiveness. The knowledge economy provides new areas and directions for smaller cities to grow their prosperity, in certain niche areas at least. From a policy perspective, while it is important to adopt policy and planning approaches at the national and state scales, it is equally important to consider them at a city level, for small cities in particular. For a long time, the policy focus has been on large capital cities, which is potentially to the detriment/expense of regional or remote cities. A ‘one size fits all’ approach, or even an approach that assumes cities of a comparable size require similar policy responses would not result in leveraging benefits across the cities. Policy making should be tailored to different types of cities, on the basis of a deep understanding of the locality in question.

Unlike previous economic and social transformations of the twentieth century, we now have more finely tuned ways of anticipating the changes associated with economic transitions, as illustrated by the framework, approaches and tools used in developing the KCI. We are now in a stronger position to refine policy instruments that allow for a greater focus on localities and cities around Australia to support and enable their transitions into a more prosperous future.
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