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Is Adelaide a University City?

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Executive Director's Note

Welcome to the thirty fifth issue of *Economic Issues*, a series published by the South Australian Centre for Economic Studies as part of its Corporate Membership Program. The scope of Economic Issues is intended to be broad, limited only to topical, applied economic issues of relevance to South Australia and Australia. Within the scope, the intention is to focus on key issues – public policy issues, economic trends, economic events – and present an authoritative, expert analysis which contributes to both public understanding and public debate. Papers will be published on a continuing basis, as topics present themselves and as resources allow.

This paper examines the public policy that is intended to contribute to Adelaide becoming a university city. It does so through defining the characteristics of a university city and sets these characteristics as the benchmark to assess the direction of public policy. Attracting international students and international universities does make a contribution to "Adelaide as a Vibrant City", along with the existing campuses of our three universities. But the critical characteristics that lead to sustainable economic growth are research quality, internationally recognised researchers, the commercialisation of research and the start-up of high technology firms. A brief digression – to the case study of DSTO – illustrates these relationships. The number of high technology firms and associated employment are closely linked to world-leading research, the efforts of internationally recognised researchers, knowledge transfers and relational networks. These are the key indicators of a university city.

The authors of this paper are Assoc Professor Michael O'Neil, Executive Director and Mark Trevithick, Research Economist of the SA Centre for Economic Studies. The views expressed in the report are the views of the authors.

Michael O'Neil
Executive Director
SA Centre for Economic Studies
April 2013

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Is Adelaide a University City?

Overview

This Issues Paper identifies, defines and describes the characteristics of a university city, draws comparisons between Adelaide and overseas university cities and assesses the effectiveness of state government subsidies given to overseas universities to establish a presence in Adelaide.

The method of analysis involves characterising a university city in terms of employment, student enrolment, high-tech clustering, area occupied by the campus and supporting infrastructure. After defining these features comparisons between Adelaide and international University Cities of Cambridge England, Oxford England and Cambridge Massachusetts (USA) are drawn to determine if Adelaide shares their unique features. Policies that state government could use to further develop Adelaide as an international university city are then considered.

Results of the analysis show that Adelaide does not possess the characteristics of overseas university cities. In particular Adelaide is below the mark set by international university cities in terms of:

- per cent of total city employment accounted for by the university;
- number of teaching and research staff;
- student enrolment as a per cent of city population;
- per cent of high-tech firms and employment;
- city area occupied by the main university campus and level of supporting infrastructure, especially student accommodation.

The definitions of high-tech firms for each of the cities described in the analysis can be found in the Appendices to this report.

The Issues Paper finds that providing subsidies to attract overseas universities which offer niche courses is not the most effective means of transforming Adelaide into a university city. Investing in teaching, research and physical infrastructure of our existing universities would further develop their capabilities and represent more cost effective use of government financial support. The Issues Paper also highlights the importance of the reputation of a university above all other factors in determining the student mix and attraction of internationally recognised researchers. Suggestions in relation to a more effective allocation of government funding include providing funding to enhance the reputation of our existing universities by:

- further strengthening key research fields the state is strongest in;
- increasing the number of scholarships at our existing universities; and
- concerted effort to attract international research professors.

There are two notes to assist the reader. The most up-to-date data has been obtained where possible and student and employee numbers are provided in FTE's. When FTE's are unavailable student and employee numbers represent the aggregate number of students and staff. Second, a different definition of high-tech employment has been used for Massachusetts which is slightly more restrictive than the definition used for Cambridgeshire and Oxfordshire, while for South Australia estimating high-tech employment has required a degree of professional judgement.

1. Introduction

There has been rapid growth in the number of overseas students attending South Australian universities over the past ten years. To further capitalise on the growing education sector and transform Adelaide into a university city the South Australian government encouraged the establishment of a number of international universities offering subsidies to cover initial set up and running costs of their campuses. Three overseas institutions have been lured to Adelaide, including: Carnegie Mellon University (CMU) in 2006, the now closed Cranfield University in 2007 and University College London (UCL) in 2010. Adelaide now has five universities and is described by the state government as a university city. To determine if the label is valid, this paper defines characteristics of a university city and compares Adelaide with the internationally recognised University Cities of Oxford and Cambridge in England, and Cambridge, Massachusetts in the United States. If Adelaide is not a university city, discussion of alternate policies to transform Adelaide into one is provided.

Overseas University Cities have not attained their 'university city' status by virtue of having the most universities; rather they are University Cities through the footprint left by the university in the local community, in terms of employment in the university, attraction of students, creation of high-tech jobs, production of high calibre graduates, quality of research and community contribution. This paper does not argue that attracting foreign universities to Adelaide has not had a positive influence on the city, recognising that Adelaide's UCL and CMU campuses offer students a high quality education providing courses in a niche market, raising the international profile of Adelaide as an education destination. But these universities have a small cohort of students and research oriented academics which limits their overall impact in terms of contributing to Adelaide a university city.

The University of Adelaide, University of South Australia and Flinders University are highly regarded and significant contributors to the state's economy. The State's top institution, the University of Adelaide, is part of the prestigious Group of Eight universities; a coalition of leading Australian universities intensive in research and comprehensive in professional education. The University of Adelaide was ranked well above world average across a number of fields, especially medical research, which has traditionally been the universities key strength. It recently announced a $50 million investment in Roseworthy Campus and the intent to attract six world-class animal and crop researchers.[i]

This paper contains the following sections: Section 2 defines the characteristics of a university city using the examples of Oxford and Cambridge England and Cambridge Massachusetts; Section 3 considers whether Adelaide is a university city and potential policies that would help it to become one; while Section 4 provides concluding remarks.

2. Characteristics of a university city

Characteristics of University Cities that the SA Centre for Economic Studies (SACES) identifies as defining a university city:

- the university acting as the most significant employer in the town in terms of direct employment of research, teaching and administration staff at the university and associated research centres and institutes;
- a large student base as a proportion of the total population;
- regional employment in high-tech businesses; and

- significant presence in terms of the city area occupied by the university and on-campus supporting infrastructure such as student accommodation.

In addition strong linkages exist between the university, community and business sector promoting cooperation, collaboration and knowledge sharing. The next section of the report discusses each of these characteristics in detail, see Table 1 for a list of the universities designated by city which are discussed in this paper.

Table 1: Selected universities by city profiled in the report

City	Universities
Adelaide, South Australia	University of Adelaide University of South Australia Flinders University University College London Adelaide Carnegie Mellon University Adelaide
Oxford, United Kingdom	University of Oxford
Cambridge, United Kingdom	University of Cambridge
Cambridge, Massachusetts, United States	Harvard University Massachusetts Institute of Technology

2.1 Employment

The university is the principal and largest employer in a university city; employment is created directly within the university's departments and indirectly in organisations reliant on supplying the university with goods and services. Those employed directly are academic[ii] staff who are primarily involved in teaching and/or carrying out research and general university staff who work in university administration such as clerical and secretarial workers and IT support. University Cities are research intensive, attracting the most distinguished research staff domestically and from overseas.

In metropolitan Adelaide direct combined employment accounted for by the University of Adelaide, University of South Australia, Flinders University, UCL and CMU is 7,333 persons or 1.2 per cent of the city's total employment (see Table 2).[iii] Recent input-output tables for South Australia identify that for every single person employed in higher education in South Australia, including, tertiary, pre-school, primary and high school education, additional employment of 0.62 persons was supported on a full-time equivalent basis (FTE). When these flow-on employment impacts are included total employment accounted for by universities in metropolitan Adelaide increases to 11,879 persons, or 2 per cent of total persons employed.

Table 2: University employment as a per cent of city employment

Region	Total employment	Employment in universities[1]	Per cent of total	Sources
Metropolitan Adelaide (2011)	599,000	7,333[2]	1.2	ABS, 2011; DEEWR
Cambridge, England (2010)	90,000	9,110[3]	10.1	ONS, 2010; Annual Report, 2011
Oxford (2010)	107,600	9,443	8.8	ONS, 2010; University of Oxford
Cambridge, Massachusetts (2011)	106,400	18,322	17.2	Annual report, 2011, City of Cambridge

Note:
1 Totals are in FTE's where available.
2 Employment in universities for metropolitan Adelaide includes a small number of employees at the regional University of South Australia Whyalla, Mount Gambier campuses, CMU and UCL Adelaide campuses. Employment of 97 FTE persons at University of Adelaide's Roseworthy campus are excluded.
3 Employment at Anglia Ruskin's Cambridge, England, campus is excluded.

By comparison Harvard University and Massachusetts Institute of Technology (MIT) in Cambridge Massachusetts directly employs 18,322 persons accounting for 17.2 per cent of the city's employment. According to the City of Cambridge Massachusetts 2011 Annual Report, the city's two single largest employers were Harvard University (10,718 employees) and MIT (7,604 employees), while the next largest employers were the City of Cambridge (2,922 employees) and the biomedical research institute Novartis (2,095 employees). When compared with universities in metropolitan Adelaide, MIT and Harvard University employ a much larger proportion of the city's workforce and are the principal employer in Cambridge Massachusetts.

In England the University of Cambridge and University of Oxford directly employ 9,110 persons and 9,443 FTE persons in their respective cities or 10.1 per cent and 8.8 per cent of employment in each city respectively. The University of Oxford including its colleges and Oxford University Press is the largest employer in the city and second largest employer in the Oxfordshire County. In terms of direct and indirect employment the university supports more than 18,000 jobs (University of Oxford, 2012). Similarly, the University of Cambridge employs approximately one in every ten employees in Cambridge; while supporting many more indirect jobs. Both the University of Cambridge and University of Oxford are the principal employer in their respective cities.

A caveat readers should keep in mind when interpreting results in Table 2 is the different pattern of urban development in the United Kingdom and Australia. The capital cities of Australia's states all share common characteristics of high levels of urbanisation, metropolitan primacy and residential suburbs supported by transport-led development. This makes it harder for Australia to have a natural university city as the population is low density and spread over a much larger geographical distance. Therefore the total employment accounted for by universities in metropolitan Adelaide is significantly smaller in comparison to Cambridge and Oxford which have a denser population profile and more centralised communities spread over a smaller geographical area.

Another distinguishing feature of a university city is employment of academic staff involved in teaching and research and the employment of academic staff involved only in research. At the University of Adelaide, South Australia's most intensive research university, there is 1,754 FTE academic staff involved in teaching and research, compared with 1,097 FTE academic staff at the University of South Australia and 812 FTE academic staff at Flinders University for a total of 3,663 persons across all three universities (see Table 3). FTE academic staff conducting research only was 888 persons at the University of Adelaide, 313 persons at the University of South Australia and 257 persons at Flinders University.

By comparison MIT employs 5,123 teaching and research staff of which 3,385 persons are categorised as dedicated researchers, while Harvard employs 4,387 FTE teaching and research staff.[iv] In world university rankings MIT and Harvard rank first and third respectively (QS University Rankings, 2012) scoring 5/5 for producing internationally renowned research.[v]

Similarly, the University of Oxford across its 70 departments and colleges has 5,056 FTE academic staff of which 3,089 (in FTE's) are dedicated research staff (University of Oxford, 2012). According to the 2008 National Research Assessment Exercise the University of Oxford employs more world leading academics in terms of the originality, significance and rigour of their research than any other UK university. Its academic community includes more than 80 Fellows from the Royal Society and 100 Fellows of the British Academy (University of Oxford, 2012). The University of Cambridge has 5,998 teaching and research staff, of which 3,009 persons are categorised as contract research staff (Cambridge facts and figures, 2012) and ranks similarly to the University of Oxford in terms of the quality of research produced.

Table 3: Teaching and research staff

Institution	Teaching and research	Research only[1]	Teaching only	Total teaching and research staff[2]	Research only (per cent)
University of Adelaide (2011)[(a)]	856	888	10	1,754	50.6
University of South Australia (2011)[(a)]	735	313	49	1,097	28.5
Flinders University (2011)[(a)]	555	257	0	812	31.7
University of Cambridge (2011)[(b)]	-	3,009	-	5,998	50.2
University of Oxford (2011)[(c)]	-	3,089	-	5,056	61.1
MIT (2011)[(d)]	-	3,385	-	5,123	66.1
Harvard (2011)[(e)]	-	na	-	4,387	na

Note: [1] For the University of Cambridge, staff counted as doing 'research only' are contract researchers, therefore the percentage of "research only" staff is probably lower.
[2] Totals are in FTEs where available. Total staff engaged in teaching and research at the University of Cambridge includes academic related staff, while for the University of Oxford total teaching and research staff includes staff in a research support role.
Source: [(a)] DIISRTE; [(b)] Cambridge facts and figures January 2012; [(c)] University of Oxford 2012; [(d)] MIT 2012; [(e)] Harvard University Fact Book 2010-11.

2.2 Student presence

The student body as a proportion of the population of a university city is significant such that the body of students is a noticeable presence in the city centre. This section considers the student presence in the CBD of Adelaide created by the University of Adelaide's main North Terrace Campus and University of South Australia's City East and City West Campuses.

South Australia had 79,058[vi] university students enrolled at the University of Adelaide, University of South Australia and Flinders University in 2011 (DIISRTE, 2011). This represents 7.0 per cent of the population of metropolitan Adelaide (see Table 4) if all of these students lived within close proximity of the CBD and all actually attended courses in Adelaide and were not simply enrolled in off-shore courses delivered in, for example, Singapore.

By comparison in Cambridge England and Oxford England students are 15.1 per cent and 14.0 per cent respectively of the city's population, while in Cambridge Massachusetts students are 30.2 per cent of the city's population.

Table 4: Student enrolment as a per cent of city population

Region	Population	Total students	Per cent of total population	Sources
Metropolitan Adelaide (2011)	1,125,196	79,058	7.0	ABS, 2011; DEEWR
Cambridge, England (2010)	125,700	18,994	15.1	ONS, 2010; Cambridge facts, 2012
Oxford (2010)	153,700	21,535	14.0	ONS, 2010; Oxford Gazette
Cambridge, Massachusetts (2011)	106,038	32,053[1]	30.2	US Census Bureau; Harvard University and MIT

Note: [1] Total university students for Harvard are for the year 2010-11, for MIT total university students are for the year 2011-12.

In Adelaide, students are a visible presence in the Central Business District (CBD) with a large number of students attending University of Adelaide's main North Terrace Campus and a significant number of students attending University of South Australia's City West and City East campuses. Notwithstanding, compared to Cambridge England, Oxford England and Cambridge Massachusetts which have a far larger student/population ratio and many students living on campus

within walking distance of the city centre, the student presence in the CBD of Adelaide is less significant. At Oxford nearly all first year students live on campus at halls such as the Oxford Brookes Hall while second and third year students can elect to reside in purpose built accommodation within walking distance of the city centre and university campus. Similarly, the University of Cambridge, MIT and Harvard offer a variety of on-campus accommodation permitting students to live on campus for the duration of their study.

With the urban layout of Adelaide spread-out across a wide metropolitan area, combined with the university of Adelaide's North Terrace campus and University of South Australia's City East and City West campuses not offering on-campus student accommodation and the expensive cost of staying in student accommodation in the CBD, the majority of students choose to live further out from the city or reside in the family home. Many international students prefer to live in suburban Adelaide in share houses which are cheaper and more spacious than city apartments.

2.3 Employment in High-Tech businesses

University Cities experience formation of regional high technology business clusters, occurring through two mechanisms. Firstly, through the commercialisation of world leading research and technologies produced within the university, its research centres and institutes and secondly, through a stream of high quality graduates some of whom stay in the region and form small start-up companies after graduating. Cambridgeshire, Oxfordshire and Route 128[vii] surrounding Boston Massachusetts have experienced this phenomenon and consequentially regional high-tech employment is significantly above the national average in their respective countries.

According to Glasson et al's definition of a high-tech industry, high-tech **employment** in Cambridgeshire and Oxfordshire accounts for 13.6 per cent and 11.2 per cent of total employment respectively compared with the national rate of 7.5 per cent.[viii] In the state of Massachusetts, high-tech employment accounts for 8.7 per cent of total employment which is higher than the United States national average (see Table 4).[ix] In South Australia high tech employment accounts for 6.8 per cent of total employment which is lower than university city regions and slightly lower than Cambridge Massachusetts. [x] It is important to recognise that although South Australia has lower employment in high-tech industries relative to Cambridgeshire, Oxfordshire and Massachusetts, the state has developed a number of innovative high tech companies in defence and electronics. For example, Technology Park (Mawson Lakes) located 12 km north of Adelaide is home to over 85 high tech companies such as Optus, BAE Systems Australia and Saab Technologies and is an important contributor to the state's economic growth and overseas exports. While in southern Adelaide Bedford Park houses a Science Park located adjacent to Flinders University. In more recent times South Australia has sought to shift its emphasis from traditional manufacturing and assembly, to high-value knowledge based activities, which is likely to increase the profile of the state and continue to encourage start-ups of new high-tech firms as well as the establishment of overseas high-tech firms.

Based on Glasson et al's definition of a **high-tech firm** 13.6 per cent of firms in Cambridgeshire and 12.3 per cent of firms in Oxfordshire are high-tech, compared with an average of 10.2 per cent for Great Britain. Although no single figure on the number of high-tech firms in Massachusetts is provided, it is likely the proportion of high-tech firms is above the United States average given the cluster of firms along Route 128 (notably, the history of defence establishments). In South Australia, 4.2 per cent of firms are categorised as being high-tech which is significantly below that of the university city regions. Most South Australian high-tech firms are either international off-shoots of their parent company or are small scale and fall under engineering design and engineering consulting services and computer system design and related services. The success of high tech businesses in Oxfordshire, Cambridgeshire and along Route 128 can in large part be attributed to

research and discoveries made at their respective universities, the provision of support to high-tech start-ups and strong linkages formed between the education and business sectors permitting knowledge transfer between the university and business sector.

Table 5: High technology firms and employment by region

High technology firms	Firms		Employment		Source
	No.	Per cent	No.	Per cent	
Cambridgeshire (2007)	3,657	13.6	32,278	13.6	Lawton Smith and Romeo (2010)
Oxfordshire (2007)	3,866	12.3	35,523	11.2	Lawton Smith and Romeo (2010)
Great Britain (2007)	243,240	10.2	1,984,733	7.5	Lawton Smith and Romeo (2010)
Massachusetts United States (2009)	-	-	272,695	8.7	Regional Report, BLS, Nov (2011)
South Australia (2010)	**6,280**	**4.2**	**55,237[1]**	**6.8**	ABS (2010-11)

Note: [1] High-tech employment has been estimated using the number of firms listed in Counts of Australian Businesses. Counts are provided in terms of employee ranges, therefore non-employing high-tech businesses are assumed to have "one employee", businesses employing 1-19 staff are assumed to have "ten employees", businesses employing 20-199 staff are assumed to have "110 employees and businesses employing 200+ are assumed to have 200 employees.

Assistance establishing high-tech firms is provided by Oxford University through its wholly owned subsidiary Isis Innovation founded in 1988, which is the most successful university technology transfer company in the UK. Isis Innovation manages the universities intellectual property by working with university researchers on identifying and protecting market technologies, funding patent applications and legal costs, negotiating spin-off company agreements and managing consultancy opportunities. Since 1997 more than 60 spin-out companies have been created by the University of Oxford, with Isis Innovation providing seed funding to help establish many of these firms (University of Oxford, 2012). Linkages with the Oxfordshire business community combined with its highly skilled labour market (in large part due to the University of Oxford) are primary drivers of high-tech industrial development in the Oxfordshire region.

Cambridgeshire's high-tech cluster, known locally as the "Cambridge Cluster" or "Silicon-Fen", had given rise to more than 250 companies by 2005 through the process of knowledge transfer from the university (The Cambridge Cluster at 50, 2011). As with Oxford University, Cambridge University owns and operates its own technology transfer company "Cambridge Enterprise Limited", to facilitate commercialisation of intellectual property, provide seed funding and consultancy services for disseminating university knowledge and expertise to governments, industry and the public sector (University of Cambridge, 2012). Currently, Cambridge Enterprise is providing support to approximately 1,000 university researchers at various stages of the commercialisation process, providing assistance to commercialise their research.

In Massachusetts there is high-tech clustering of firms along Route 128, also known as the "Massachusetts Miracle", supported by technology transfers from MIT and Harvard University. In addition to a high-tech cluster along Route 128, the city of Cambridge Massachusetts is home to a number of the region's largest high-tech firms involved in the areas of biomedical research, the pharmaceutical industry and biotechnology These companies include: Novartis, Vertex Pharmaceuticals, Pfizer (Wyeth), Genzyme Corporation and Biogen Idec (City of Cambridge Massachusetts Annual Report, 2011).

MIT places great value on the social and/or industrial commitment of education and research, and on carrying out contract research for local businesses and forging close links with industry and large businesses (Hulsink et al, 2008), an attitude which has strongly contributed to the growth of Route 128. MIT directly supports the commercialisation of research through the Technology Licensing Office (TLO) established to patent MIT inventions, and to copyright the software and license access

to intellectual property to companies for commercial production. Similarly, Harvard University's Office of Technological Development (OTD) enables the development, transfer and adoption of innovations originating at Harvard, granting licenses to start up companies, providing technical small business know-how, while working in collaboration to develop and deploy the new technology.

South Australia's three established universities have also established successful organisations to commercialise research, and form new business ventures based on each University's innovative ideas and technologies. These include Adelaide Research and Innovation (ARI) at the University of Adelaide, ITEK at the University of South Australia and Flinders Partners at the Flinders University of South Australia. But in terms of the footprint left on the business sector the impact of universities in Cambridge England, Oxford England and Cambridge Massachusetts is larger, where the universities have given rise to such multinational high-tech companies as Raytheon, EG&G and Polaroid in the United States. While in Cambridge and Oxford a significant number of spin-out companies have been created along with a number of multi-national companies and numerous smaller scale companies established by alumni.

2.4 City area occupied by universities

In a university city campus buildings occupy a significant portion of the city centre including a number of prominent city buildings. In Oxford early prominent buildings include University College, Balliol College and Merton College which radically changed the architecture of the city, dominating the skyline and forming an integral part of the city centre. Today Oxford is comprised of 38 colleges of various sizes spread throughout the city and its surrounds. Similarly, the University of Cambridge occupies a significant portion of Cambridge, with most colleges located near to the city centre or along the River Cam. Today Cambridge University is comprised of 31 colleges the largest being Churchill College which covers 16 hectares of grounds located in outer Cambridge.

MIT Campus comprises 67 hectares extending approximately 1.5 km along the Cambridge side of the Charles River Basin, consisting of classrooms, education related buildings, 12 Institute Houses and 39 MIT-affiliated fraternities, sororities and living groups providing on-campus accommodation (MIT, 2012). Harvard's main campus comprises 84 hectares in the centre of Cambridge Massachusetts; its Medical and Dental Schools and School of Public Health in Boston covers 8 hectares, while its Business School, University Publisher, Athletics facilities and 'other' buildings in Boston cover 145 hectares. Harvard has significant additional land holdings throughout Massachusetts including, inter alia, Harvard Forest, Concord Field Station, Arnold Arboretum and Marlborough Animal Research Centre. Overall Harvard owns and operates more than 600 buildings of varying sizes, providing accommodation for students, research facilities, class rooms, administrative buildings and library space.

The University of Adelaide and the University of South Australia (City East and City West campuses) also occupy prominent parts of the City of Adelaide along North Terrace. The University of Adelaide lies adjacent the CBD and encompasses the area from the Torrens River along Victoria Drive to North Terrace. The University of South Australia's City East campus is situated proximate to the University of Adelaide grounds while its City West campus occupies its own separate campus on North Terrace. Since its inception in 1874, the University of Adelaide's North Terrace campus has expanded to cover an area of 14 hectares comprising 49 buildings, including medical facilities and dental hospital on Frome Road plus several buildings located on North Terrace opposite the main campus (University of Adelaide, 2012).

Flinders University has a small presence in the CBD leasing the former Reserve Bank building on Flinders Street while Flinders University's main campus is located in Bedford Park in the south of Adelaide. Although the University of Adelaide's North Terrace campus and the University of South Australia City West and City East campus occupy prominent positions adjacent to and within the CBD, their respective campuses are of smaller scale compared with campuses of international University Cities. MIT's main campus is approximately five times larger than Adelaide's North Terrace campus while Harvard's main campus is more than six times larger and both campuses are located close to the city centre of Cambridge Massachusetts (the Harvard campus is in the city centre).

2.5 Supporting infrastructure

Infrastructure supporting the Universities of Cambridge, Oxford, Harvard and MIT includes on campus infrastructure such as: student accommodation, libraries, students' rooms, students' unions, student societies, sports facilities, gymnasiums and dining halls which allows students the opportunity to involve themselves in campus life. Off campus infrastructure includes, inter alia, late night book stores, coffee shops, theatres, museums, restaurants, cafes and cinemas allowing students to immerse themselves in city culture and interact with local residents. The university also plays a key role in bringing students together because generally when it comes to social, cultural and sporting events in a university city it is the university rather than the town that is the main organiser.

One of the most important forms of supporting infrastructure are the availability of student accommodation whether on-campus or off-campus. For students attending Cambridge and Oxford Universities most live on campus in private halls within walking distance of university facilities, while students choosing to live in the city find houses and flats close by. Cycling or walking is the preferred mode of transport because most university infrastructure is centralised in the city centre. Recent research found one in five journeys in Cambridge are made by bike (The Guardian, 2011); with marked cycle lanes common across much of Cambridge and Oxford. To reduce traffic in Cambridge it is a regulation of the university, agreed with the City Council, that students are not to keep a car or motorcycle in Cambridge unless they have been granted a permit. This regulation makes the city pedestrian friendly and more easy to navigate.

Similarly, Harvard and MIT also have on-campus accommodation with 3,381 undergraduates living on campus at MIT (MIT, 2012), while at Harvard approximately 97 per cent of undergraduates choose to live on campus for the duration of their studies (University of Harvard, 2012). Therefore, riding or walking to and from campus is the preferred option for students.

The University of Adelaide and University of South Australia do not provide on-campus accommodation at their city campuses, leaving students with the responsibility to find rental accommodation in the city if they wish to live within walking distance of the campus. However, students can stay in one of the University of Adelaide's five residential colleges which are within 15 to 20 mins walking distance from the University of Adelaide. These colleges offer students fully furnished and catered accommodation.[xi] New purpose-built student accommodation has been constructed over recent years providing additional housing for students but existing accommodation is often small and expensive. The alternative is to rent a house in the suburbs and commute to campus by public transport. This results in a fracturing of the student community: those who don't live within walking distance of their campus are far less likely to participate in university-based clubs and events, and so are less likely to involve themselves in campus life (Can Adelaide be a University Town?, *The Advertiser*, 2010). Flinders University offers some on-campus catered accommodation in University Hall, with facilities to house 240 students and self-catered accommodation in Deirdre Jordan Village which comprises 80 fully equipped self-contained units

and townhouses for 310 residents. Both sets of residential facilities are of high quality offering students the opportunity to socialise and interact with each other (Flinders University, 2012). However, most students at Flinders choose to live off-campus and commute. While Adelaide's established universities offer a range of supporting infrastructure for students to involve themselves in the university and city, on-campus accommodation is not an option in Adelaide compared to international University Cities. They have only the very beginnings of "close to university campus" accommodation in the CBD. The current Royal Adelaide Hospital site and Frome Road could potentially provide much more significant on-campus accommodation.

3. Is Adelaide a university city?

The city of Adelaide has made significant steps towards attaining some of the characteristics of a university city in terms of improving supporting infrastructure such as student accommodation, modernising university facilities, attracting overseas students and academics and providing quality education.

Several new and purpose built student accommodation facilities in the city include: "The Village" opened in 2006 in the west end which houses 400 students, "Unilodge" opened in 2012 in the east end with 78 two bedroom apartments and "City West Apartments". These provide students the opportunity to live within walking distance of the University of Adelaide's North Terrace Campus and University of South Australia's City East and City West campuses, creating a stronger student presence in the city centre providing greater ease of access to the campus and encouraging greater involvement in campus activities and events.

Significant investment in new infrastructure projects on the University of Adelaide's North Terrace campus have provided state of the art facilities and improved student experiences. Recent building upgrades at the University of Adelaide's North Terrace campus include six major projects:

- Iluminat8 − redevelopment of Union Hall incorporating the new institute for Photonics and Advanced Sensing, a 420 seat lecture theatre and additional teaching and research facilities ($77 million);
- Hub Central − a state of the art study facility ($42 million);
- Ingkarni Wardli (formerly Innova21) − comprising a new building housing the School of Engineering, Mathematical and Computer Sciences ($100 million);
- Nexus 10 − involving a refurbishment of 10 Pulteney Street housing the Faculty of the Professions ($49 million);
- Scott Theatre Upgrade − involving a refurbishment to a multipurpose lecture theatre or performance theatre ($2.5 million); and
- Mawson Building upgrade − involving an upgrade to provide teaching laboratories and a learning area for science students ($3.7 million).

South Australia was also successful in securing federal funding for the construction of the purpose built South Australian Health and Medical Institute (SAHMRI) on North Terrace which will provide state of the art laboratories and equipment creating a world class precinct for medical research. SAHMRI will employ more than 600 researchers and will further enhance the reputation of Adelaide as a "centre of excellence" when it comes to medical research.

Notwithstanding these developments, Adelaide lacks a number of key university city characteristics in terms of: total city employment accounted for by its universities, number of teaching and research staff employed, student/population ratio, high-tech employment/ clustering and area

occupied by the main university campus. Based on these indicators Adelaide does not meet the definition of a true international university city. However, this does not imply that Adelaide cannot strive to encourage the development of these characteristics in the future through strategic state government policies.

3.1 Background information to overseas universities in Adelaide

The section below provides a profile of the degree programs offered by CMU and UCL, their student mix in terms of international and domestic students and subsidies provided by the State Government and private businesses to support their establishment.

Carnegie Mellon University (CMU) Adelaide

CMU's Adelaide campus teaches two internationally-ranked master degree programs, including a Master of Science in Public Policy Management (MSPPM) and Master of Science in Information Technology (MSIT). CMU (Heinz) is ranked 1st in the specialty area of Information and Technology Management and 7th in Public Policy Analysis according to the United States News and World Report 2013, Graduate School Rankings for Schools of Public Affairs. Both programs are available over a one-year or two-year track, dependent on applicants' work and professional experience and can be undertaken part-time or full-time. CMU Adelaide also offers a Global Master of Information Systems Management (MISM) and Global Master of Science in Public Policy and Management (MSPPM). Both programs are offered over a 21-month track over which time students will study in both Adelaide and Pittsburgh.

The campus of CMU Adelaide is located on Victoria Square. Faculty are located on-site or off-site rotating between Adelaide, Pittsburgh and Washington DC, with students having the opportunity to video conference with academics overseas. According to the QS University rankings CMU in the United States is ranked 49th in the 2012 global rankings in terms of its overall quality of education and research.

CMU Adelaide has achieved success in attracting overseas students to study in Adelaide. As of October 2012 approximately 82 per cent of the total student enrolment were international students (CMU Adelaide, 2012) with 21 counties, being represented, including:

- Africa (Ghana, Nigeria, Zambia, Kenya);
- South America (Argentina, Colombia, Mexico);
- Asia (India, China, Japan, Indonesia, Singapore, South Korea, Hong Kong, Vietnam, Philippines, Cambodia, Taiwan);
- Middle East (Iran, Pakistan); and
- North America (United States)

The South Australian Government provided CMU Heinz College with $19.5 million in funding in 2005 to assist with establishment costs over its first four years and scholarships for international and domestic students (CMU Adelaide, 2012). A further $3.8 million was provided as part of a scholarship program which will run for four years from 2010 until 2014 (CMU Adelaide, 2012), taking the total contribution from the State Government to CMU Adelaide to $23.3 million.

University College London (UCL) Adelaide

UCL's Adelaide campus specialises in the fields of energy and resources offering a Master of Science in Energy and Resources Management over two years. Year 1 comprises eight courses, while in year 2 students elect one of two options: a research stream where students undertake a research project in industry or a coursework stream comprising a combination of taught courses and

research. A Graduate Diploma in Energy and Resources: Policy and Practice is awarded to students completing year 1 only, while a Graduate Certificate in Energy and Resources: Policy and Practice is awarded to students completing four first year modules only. UCL also offers a research PhD program. According to the QS University rankings UCL in the United Kingdom is ranked 4th in global rankings for 2012 in terms of its overall quality of education and research.

UCL Adelaide has also attracted a number of international students to study at its Victoria Square campus. The mix of international and domestic students attending UCL Adelaide is 50:50.

The South Australian Government provided UCL with $3.5 million to establish a campus in South Australia as well as some part-support for rent at their site in Victoria Square (UCL Adelaide, 2012). Santos has provided some initial funding to establish the campus through the provision of scholarships, research funds and a professional chair and will support the school's setup and operations over its first eight years (University College London news, 2008). A number of private businesses have also provided funds towards scholarships including, BHP Billiton, KOGAS and several other private energy companies.

Cranfield University

Cranfield University was launched in 2007 specialising in defence related fields offering long and short courses in areas including electronic warfare, integrated logistics and explosives. In July 2008 Cranfield offered three two day courses involving 60 students and a ten day course for which student numbers are not available (Cranfield University Shuts up Shop in Adelaide, 2010, The Australian). The State government allocated $1 million as part of the initial start up cost before the closure of the campus in 2010 ('Lauded' UK-based Cranfield University closes Adelaide base, *The Advertiser*, 2010).
In total, the South Australian Government has provided $27.8 million in funding to support the development of three new universities in South Australia in an attempt to achieve a University City.

There are several advantages of attracting private universities such as CMU and UCL to Adelaide. They bring with them an established and internationally renowned reputation for the high quality teaching and research which is important to attract students. In addition their campuses are kept small and fill niche markets in the local education sector. Michael Worton, the Vice Provost at UCL, notes that *"the overseas campuses are deliberately kept small so that they can experiment with their teaching and operational practices...the major advantage of a niche campus is that, by definition, it has a strong and sharp academic focus, in terms of both its disciplines and the nature of the education and training it will offer"*(University College London – Big Visions, small overseas campuses, 2012). On the other hand, despite these advantages, given the specialised courses on offer, relatively small numbers of students and academic staff at their Adelaide campuses and limited space for campus expansion within the CBD, CMU and UCL are more limited in their capacity to transform Adelaide into a University City according to the definition of a University City outlined in Section 2.

3.2 Strengths of South Australian Universities

Excellence in Research Australia (ERA) assesses the strength of South Australian universities by using measures relating to researchers, research outputs, research income, and reputation as well as other measures. [xii] Traditionally South Australia has been strongest in the fields of health and medical research, with other key strengths in agricultural science, veterinarian sciences, performing arts and creative writing and environmental sciences (particularly environmental science and management). The University of Adelaide achieved a ranking which was "at or above" world standard across 90 per cent of assessed research fields and of research fields which were given the

highest possible score of 5, approximately half could be categorised under Medical and Health Sciences. All fields of research at the University of Adelaide scoring 5 included:

- Astronomical and Space Sciences;
- Optical Physics;
- Geology;
- Soil Sciences;
- Evolutionary Biology;
- Horticultural Production;
- Cardiovascular Medicine and Haematology;
- Medical Microbiology;
- Oncology and Carcinogenesis;
- Paediatrics and Reproductive Medicine;
- Medical Physiology;
- Nursing;
- Nutrition and Dietetics;
- Performing Arts and Creative Writing;
- Dentistry;
- Inorganic Chemistry;
- Geochemistry;
- Artificial Intelligence and Image Processing.

The University of South Australia and Flinders University also rated strongly, both at or above world standards (scoring 3 or higher) across 86 per cent and 74 per cent of the assessed research fields respectively (see Table 6).

Given these results and South Australia's strength in medical research through the University of Adelaide, it is asserted that government subsidies may be more effectively allocated to support research fields that South Australia is strongest in, such as medical science, agriculture and veterinary sciences, environmental sciences, earth sciences and physical sciences. These research fields offer the strongest links to, and prospects of, generating discoveries and the formation of commercialisation opportunities and start-up ventures. This is a critical medium to longer-term economic development strategy.

For example, the University of Adelaide has a number of leading medical research institutions with strong linkages to the Royal Adelaide Hospital, SA Pathology, The Queen Elizabeth Hospital, Women's and Children's Hospital, Children Youth and Women's Health Service and Women's and Children's Health Research Institute. By funding medical research, in prospect there would be flow-on benefits to these institutions enhancing the reputation of the University in academic research excellence. A supportive strategy would be to support the highest quality international students and academics to the State to further build the research and commercialisation reputation in medical science and technology.

3.3 The importance of reputation in attracting international students

Education quality in terms of teaching and research is an important consideration for international students in choosing an international study destination. The University Cities of Cambridge and Oxford are among top destinations in terms of teaching and research quality. In 2011 Cambridge

Table 6: Rating of research fields at the four digit level (5 being the highest standard, 1 the lowest)

	Ratings											
	5 - Well above world standard		4 - Above world standard		3 - At world standard		> 3 - Either at world standard or above		<3 - Below or well below world standard		Total	
Institution	**No.**	**Per cent**	**No.**	**Per cent**	**No.**	**Per cent**	**No.**	**Per cent**	**No.**	**Per cent**	**No.**	**Per cent**
University of Adelaide	18	27	21	31	21	31	60	90	7	10	67	100
University of South Australia	2	5	9	24	21	57	32	86	5	14	37	100
Flinders University	3	8	5	13	21	54	29	74	10	26	39	100
South Australia[1]	**23**	**16**	**35**	**24**	**63**	**44**	**121**	**85**	**22**	**15**	**143**	**100**

Note: [1] South Australia represents the combined total for the University of Adelaide, University of South Australia and Flinders University. Totals may not add to 100% due to rounding.
Source: ERA 2012 Outcomes – South Australian Overview.

was ranked 2nd and Oxford 5th (QS University Rankings, 2012) based on factors of research quality, graduate employability, teaching quality and international outlook. In the 2008 Research and Assessment Exercise Oxford and Cambridge consistently rank in the top two universities in the United Kingdom in terms of producing research which is world leading (or close to world leading) in terms of its originality, significance and rigour. For this reason the most talented students and academics are attracted because they have a reputation for excellence in education. Importantly, as the Australian Minister for Reconstruction in 1946 John Dedman noted,

> *"The reputation of a university depends not on the number of students or the splendour of buildings, but on the quality of its members and the nature of its contribution to learning".* John Dedman.

Universities that build upon their reputation for producing quality research and delivering the highest quality teaching will attract more students and produce innovations and technology with applications in the business community which can set the foundation for a city to develop the characteristics of a university city.

Over the last decade Adelaide has experienced strong growth in international student numbers. Between 2001 and 2010 international students attending South Australia's three largest universities approximately doubled from 10,810 students to 22,418 students (DIISRTE, 2012). As part of the elite Group of Eight Universities the University of Adelaide is highly regarded and is the most research intensive university in South Australia. In 2009 the University of Adelaide was ranked 6th out of the Group of Eight Universities in total research income per academic staff (in FTE) with a research function, making it one of the most research intensive universities in Australia.

In a recent government report by Australian Education International (AEI) education agents, prospective international students, students who had previously studied in Australia and parents of prospective students from China, Indonesia, Korea, Vietnam, Thailand and India were asked to rank a number of different factors in importance when choosing an international education destination. Students from China, Indonesia, Korea and Vietnam all ranked quality of education as most important (see Table 7) while education agents ranked quality second most important after cost of tuition. This is an important finding, with implications for state government, namely that attracting more overseas students to the state is not dependent on the number universities in the state but the quality of education offered with the quality of education being dependent upon the quality of schools departments, faculties and their academic staff.

The Vice-Chancellor of the University of Adelaide recently announced as part of the University's 10 year plan, a policy to attract "at least 10 high-impact international research professors in an effort to move the University up in global rankings". A similar proposal was successfully followed by the Victorian Government through their Science, Technology, Innovation (STI) initiative.

3.4 Providing scholarships

Another alternative aspect of South Australian universities which could be funded is that of scholarships. Offering scholarships help to attract and support the best students including those from rural and disadvantaged backgrounds and potential Ph.D. researchers. The University of Adelaide, University of South Australia and Flinders University offer a range of undergraduate and postgraduate scholarships providing financial support to assist with education and living costs for part or the whole of a student's duration of study. The Australia in the Asian Century White Paper outlines the key challenges and opportunities facing Australia. Education is one key area in which Australia can benefit from growth in Asia. As part of the Australian Government's commitment to the region 12,000 scholarships will be offered over the next five years to Australians wishing to study in the region and students from regional countries to undertake study or professional

Table 7: Ranked importance of factors when choosing an international study destination (1 is most important, 9 least important)

	Education agent						Students					
	China	**Indonesia**	**Korea**	**Vietnam**	**Thailand**	**India**	**China**	**Indonesia**	**Korea**	**Vietnam**	**Thailand**	**India**
Cost of living	5	3	3	3	2	3	3	2	3	3	1	3
Cost of travelling	8	9	9	8	7	9	8	7	8	6	5	9
Cost of tuition	2	1	1	1	1	2	2	3	2	2	2	1
Cost of visa	9	8	8	9	6	8	9	8	9	8	7	8
Funds needed to show	6	7	7	4	8	7	7	9	7	5	8	7
Opportunities to work	7	4	4	5	5	6	6	4	4	7	6	4
Quality of education	**1**	**2**	**2**	**2**	**3**	**1**	**1**	**1**	**1**	**1**	**4**	**2**
Prospects for PR	3	6	5	7	9	4	5	6	6	9	9	6
Safety	4	5	6	6	4	5	4	5	5	4	3	5

Note: PR = Permanent Residency
Source: Studying in Australia, views from six key countries, Australian Education International, 2011.

development in Australia. This provides universities in South Australia further opportunity to attract the highest quality students from Asia.

In 2012, 180 scholarships to the value of $2.6 million were awarded to students starting at the University of Adelaide (University of Adelaide Media Release, 2012). This included 35 Adelaide Undergraduate Scholarships awarded to students receiving an ATAR of 99.95 (with no bonuses), the Andy Thomas Scholarship providing $6,000 per year for four years and all HECS fees covered and 138 Principal's scholarships providing $5,000 in the first year of study to cover education and living costs.

3.5 Illustrating key principles: the case of the DSTO

The Defence Science and Technology Organisation (DSTO) located in Salisbury South Australia and the high-tech firms which surround it can be cited as a local example of high-tech clustering of firms around a research and development institution, similar in many respects to the pattern experienced in a University City. DSTO employs, scientists, engineers, IT specialists and technicians specialising in defence related electronics and surveillance and firms locate in the region to gain access to their knowledge and expertise. In addition, a number of high-tech firms have been spun-out directly from DSTO as a result of the organisations applied research and development.

A study conducted by the South Australian Centre for Economic Studies (SACES, 1994) which analysed aspects of the electronics industry in South Australia, found significant concentration of employment in electronics and defence research and manufacture was located in the north of Adelaide including Salisbury and at Technology Park at Mawson Lakes. It was also noted that electronic industries with the highest turnover tended to be in fields DSTO specialises, including: command and control systems, communication systems and surveillance and security equipment which highlights the interdependency between firms and DSTO.

Grouping of human capital within DSTO creates an organisation that is similar in effect to a small research based university with a rich array of linkages to industry, research institutions and eight Cooperative Research Centres (CRC's). DSTO has its own business office and technology transfer and commercialisation office which manages commercial relationships and intellectual property (IP), while DSTO's record of creating patents and spin-out companies matches international performance benchmarks based on the national survey of research commercialisation (Trenberth, 2004).

Although high-tech clustering is smaller compared with clusters around the University Cities of Cambridge England, Oxford England and Cambridge Massachusetts, the development of DSTO and the resulting formation of a technology cluster, can be used to illustrate the principles underlying the formation of a University City. Key principles include high levels of human capital, world leading research, knowledge transfer and relational networks that result in the sharing of knowledge and facilities which is supportive of venture capital investment.

South Australia's universities are traditionally strongest in the medical and health sciences fields of teaching and research especially at the University of Adelaide, which is well above world standards in these fields of study and research. The quality of medical research in South Australia has led to the development of new technologies which have been patented for commercial application; similarly, DSTO generates IP in defence electronics which is also being commercialised. But South Australia is hindered by the loss of graduates to the eastern states and needs to work to reverse the pattern. One possible solution is to open up more places available for recently graduated students, for example, medical and health sciences students, to do research at the University of Adelaide,

while funding could be provided to open more positions for engineers and scientists involved in research at institutions such as DSTO in Salisbury to keep graduates in the state and provide a base for them to develop their skills.

3.6 Conclusions

In a university city the University pervades all public life and forms the most important part of the city, not just physically in terms of the campus buildings but culturally and economically. It can be seen that the universities of Cambridge, Oxford, Harvard and MIT are the most important institutions in their respective cities, acting as the principal employer. These institutions form an integral part of their respective cities and the campus site, located in the city centre, is large with a range of supporting infrastructure for students which are ever present in the city centre forming a substantial portion of the total population. The research intensity of these universities combined with drawing the best and brightest academic staff and students from across the world results in research which is world leading in terms of its significance, originality and rigour with commercial applications, which has been shown to lead to technology transfer from the university to the business community. This is evidenced by high tech clustering of firms and employment in Cambridgeshire, Oxfordshire and along Route 128 in Massachusetts.

Attracting CMU and UCL has provided positive benefits to the state in terms of providing high quality education in niche fields and offering courses which are flexible in their teaching and operational practices. However, these institutions would appear to have limited capacity to contribute to Adelaide becoming a university city given the small scale and teaching focused nature of their operations. In terms of government subsidies provided, the government would arguably more effectively support the concept of a university city by more strongly supporting our existing universities. Transforming Adelaide so the city moves towards developing more of the characteristics of a university city requires strategic government policies aimed at improving the reputations and quality of our existing universities. Some recommendations to help Adelaide achieve some of the characteristics of a university city include: funding scholarships, funding areas of research South Australia is strongest in and continuing to enhance the reputations of each university by attracting the best internationally respected researchers and students and conducting the highest quality research. Although Adelaide has five world class universities this will not by virtue create a university city − Adelaide has made a number of positive steps but still requires further development to achieve the characteristics of a university city.

Attracting overseas universities or further support to our three local universities is a **means to an end** – but government has not been explicit about "the end". It must be more than subsidising international universities to locate in South Australia in an endeavour to increase the number of international students. Student numbers can be readily impacted by movement in the exchange rate or conditions for student visas. As we have noted, the factors important in the student destination decision are firstly, the quality of education which includes opportunities for research and second, those factors related to cost of living/tuition.

But the "**real end**" is the sustainable economic growth that flows from research quality that then leads to the commercialisation of research, the start-up of high technology firms with associated employment and incomes generated. This brings forth the venture capitalists as well. As the example of the DSTO illustrates, world-leading research, internationally recognised researchers, knowledge transfers and relational networks are critical factors to support business growth and they are the key indicators of a University City.

References

Adelaide Now (2010), "'Lauded' UK-based Cranfield University closes Adelaide base", www.adelaidenow.com.au, 23rd November 2010.

Advertiser, The (2010), "Can Adelaide be a University Town?" 27th December.

Australian Bureau of Statistics (ABS) (2012), "Labour Force Australia Detailed", September, (Cat. No. 6291.0.55.001).

_____ (2012), "Counts of Australian Businesses, including Entries and Exits", June 2007 to June 2011, (Cat No. 8165.0).

_____ (2011), "Regional Population Growth Australia", (Cat. No. 3218.0).

Carnegie Mellon University Australia (2012), Carnegie Mellon University Australia, viewed 23rd October 2012, < http://www.heinz.cmu.edu/australia/index.aspx>

City of Cambridge Massachusetts, Comprehensive Annual Financial Report Fiscal Year July 1, 2010 through June 30, 2011, prepared by Finance Department City of Cambridge, Massachusetts.

Department of Industry, Innovation, Science, Research and Tertiary Education (DIISRTE), Selected Higher Education Statistics – Staff 2011, Table 1.8 FTE for Full-time and fractional Full-time Staff by State, Higher Education Provider, Function and Gender, 2011.

_____ Selected Higher Education Statistics, 2011 First Half Year Student Summary, Table (i) (c): Summary of student numbers – List of Higher Education Providers, first half year 2011.

_____ Selected Higher Education Statistics, Higher Education Data Cube (uCube), 2012.

Edwards, V. (2010), "Cranfield University shuts up shop in Adelaide", *The Australian*, 1 December.

Flinders University (2012), Flinders University, Adelaide, South Australia, viewed 10th September 2012, < http://www.flinders.edu.au/>

Glasson, J., Chadwick, A. and Lawton-Smith., H. (2007), "Defining and managing high-tech: growth the case of Oxfordshire", *European Planning Studies*, vol 14, no. 4, pp 503-524.

Harvard University (2012), Harvard University, Cambridge, Massachusetts, viewed 24th September 2012, < http://www.harvard.edu/>

_____ (2011), Fact Book 2010-11, The Office of Institutional Research, Cambridge, Massachusetts.

Hong Kong Planning Department, "Initial Assessment of the Development of a University Town in Hong Kong", (2003), Working Paper No. 36.

Hood, L. (2010), Carnegie Mellon Campus faces closure with poor enrolments, *The Advertiser*, 23rd October 2010.

Hulsink, W and Dons, H., (2008), *Pathways to High-Tech Valleys and Research Triangles*, Springer, The Netherlands.

Laker, L. (2011), "What makes Cambridge a model cycling city?" *The Guardian*, 17th August 2011.

Lawson, C. (2011), *Studying in Australia: views from six key countries*, Australian Education International, Commonwealth Government.

Lawton Smith, H. and Romeo, S. (2010), "Entrepreneurship and Innovation: Oxfordshire's High-Tech Economy – Firm Survival, Growth and Innovation", Paper prepared for the Uddevalla Symposium.

Massachusetts Institute of Technology (2012), Massachusetts Institute of Technology, Cambridge, Massachusetts, viewed 24th September 2012, < http://web.mit.edu/>

Moscaritolo, M. (2012), "UCL's Adelaide Offering Expands", Adelaide Now, 21st May 2012

Office of National Statistics (ONS), Annual Employment Statistics (BRES) 2010, Table 8: Local Authority District (Provisional).

_____ Local profiles, April 2012 update.

Oxford University (2011), Gazette Supplement, Student Numbers 2010-2011, Supplement (2) to No. 4945, Vol 141.

Research Assessment Exercise (2008), *'Research Assessment Exercise 2008: the Outcome'*, United Kingdom.

South Australian Centre for Economic Studies (SACES) (2010), "The Contribution of the University of Adelaide to the South Australian Economy", report commissioned by University of Adelaide.

_____ (1994), "An analysis of selected aspects of the electronics industry in South Australia" report commissioned by the Strategy Task Force for the Development of the Electronics Industry of South Australia to the Year 2000. Cliff Walsh, Michael O'Neil and Eduardo Pol.

SQW Consulting (2011), "The Cambridge Cluster at 50, The Cambridge economy: retrospect and prospect", Final report to EEDA and Partners, United Kingdom

Trenberth, R. (2004), "Review of DSTO's External Engagement and Contribution to Australia's Wealth", Defence Science Technology Organisation, Australia.

University of Adelaide (2013), Excellence in Research Australia 2012 Results, University of Adelaide, viewed 15th April 2013,
URL <http://www.adelaide.edu.au/research/about/ERA/ranking/>

_____ (2012), Outstanding students win $2.6 million in scholarships, University of Adelaide, viewed 23rd of January 2013, URL
< http://www.adelaide.edu.au/news/news50961.html>

_____ (2012), The University of Adelaide, Adelaide, South Australia, viewed 10th September 2012, < http://www.adelaide.edu.au/>

United States Bureau of Labour Statistics, Regional Report (2011), 'High-tech industries in Massachusetts: Employment and Wage Trends during the 2001-2009 Period', United States Government

United States Census Bureau, Population Estimates (2011), Annual Estimates of the Resident Population for Incorporated Places over 50,000, Ranked by 1st July, 2011 Population: 1st April, 2010 to 1st July, 2011, United States Government

University College London (2012), University College London, School of Energy and Resources, Australia, viewed 23rd October, 2012, < http://www.ucl.ac.uk/australia/>

_____ (2008), UCL campus in Adelaide: final agreement signed, viewed 22nd October, 2012 < http://www.ucl.ac.uk/news/news-articles/0812/08120107>

University of Cambridge (2012), University of Cambridge, Cambridge, United Kingdom, viewed 10th September 2012, < http://www.cam.ac.uk/>

_____ (2012), Cambridge facts and figures, January.

_____ (2011) *Annual Report*, Cambridge University Press, Cambridge.

University of Oxford (2012), University of Oxford, Oxford, United Kingdom, viewed 10th September 2012, < http://www.ox.ac.uk/>.

_____ University of Oxford, Staffing figures 2011.

University of South Australia (2012), University of South Australia, Adelaide, South Australia, viewed 10th September 2012, < http://www.unisa.edu.au/>

_____ (2011), Annual Report.

Appendix A

Definition of high-tech industries used for Cambridgeshire, Oxfordshire and the United Kingdom according to Glasson, J., Chadwick, A. and Lawton Smith, H., (2006) using 1992 SIC codes.

High-tech manufacturing	**1992 SIC Category**
Electronic publishing, (Part of 22.1, all other publishing activity is excluded)	Part of 1992 SIC category 22.1
Pharmaceuticals and medical diagnostics	24.4
Biotechnology	no SIC category
Composites and other advance materials (no specific SIC category)	Included in SIC categories 25.24, 26.15, 26.82
Precision Engineering and precision components (no specific category)	Included in SIC category 28.52
Automated machinery and robotics (no specific category)	Included in SIC categories 29.56 and other 29 codes
Computer equipment and office machinery	30.01, 30.02
Electrical equipment - selected	31.1, 31.2, 31.62
Electronic equipment and components, communications equipment and household TV, radio and audio equipment	32.1, 32.2, 32.3
Medical and surgical equipment, precision instruments, process control equipment, optical instruments, and photographic equipment	33.1, 33.2, 33.3, 33.4
Motorsport and automotive engineering/design activities	no SIC category
Aerospace and related activities (e.g. aircraft maintenance)	35.3
High-tech services	
Telecommunications	64.2
Software development, consultancy and supply	72.2
Web/internet services (no specific SIC category)	no specific SIC category but included in 72.6
Other computer services	72.1, 72.3, 72.4, 72.5, 72.6
R&D natural sciences and engineering	73.1
Architectural and engineering activities and related technical consultancy	74.2
Technical testing and analysis	74.3

Source: Glasson, J., Chadwick, A. and Lawton-Smith., H. (2007), 'Defining, explaining and managing high-tech growth: The case of Oxfordshire', *European Planning Studies*, vol 14, no. 4, pp 503-524.

Appendix B

Definition of high-tech industries for Massachusetts, using 2007 NAICS codes.

High-tech industry	2007 NAICS category
Pharmaceuticals	3254
Computer equipment manufacturing	3341
Communications equipment manufacturing	3342
Semiconductor manufacturing	3344
Electronic instrument manufacturing	3345
Aerospace	3364
Software publishers	5112
Architecture	5413
Computer systems design	5415
Scientific research	5417
Internet, telecommunications and data processing	(a)

Note: Due to minor definitional changes in the conversion to NAICS 2007, employees in telecommunications have been aggregated under one industrial classification called "Internet telecommunications, and data processing". The aggregated industry includes data for NAICS codes 516, 5173 and 5175 from the previous classification system and 51913 from the 2007 classification system. These codes were affected by the NAICS update. The aggregate high-tech industry category also includes data from NAICS codes 5171, 5179, and 518 which were not affected.

Source: Regional Report, November 2011, High-tech Industries in Massachusetts: Employment and Wage Trends during the 2001-2009 Period, U.S Bureau of Labour Statistics.

Appendix C

Definition of high-tech industries in South Australia according to Glasson., J, Chadwick., A, Lawton Smith., H, (2006) using 2006 ANZSIC codes.

High-tech industry	2006 ANZSIC Category
Reproduction of Recorded Media	1620
Human Pharmaceutical and Medicinal Product Manufacturing	1841
Veterinary Pharmaceutical and Medicinal Product Manufacturing	1842
Aircraft Manufacturing and Repair Services	2394
Photographic, Optical and Ophthalmic Equipment Manufacturing	2411
Medical and Surgical Equipment Manufacturing	2412
Other Professional and Scientific Equipment Manufacturing	2419
Computer and Electronic Office Equipment Manufacturing	2421
Communication Equipment Manufacturing	2422
Other Electronic Equipment Manufacturing	2429
Other Electrical Equipment Manufacturing	2439
Software Publishing	5420
Music Publishing	5521
Music and Other Sound Recording Activities	5522
Wired Telecommunications Network Operation	5801
Other Telecommunications Network Operation	5802
Other Telecommunications Services	5809
Internet Service Providers and Web Search Portals	5910
Data Processing and Web Hosting Services	5921
Electronic Information Storage Services	5922
Scientific Research Services	6910
Architectural Services	6921
Surveying and Mapping Services	6922
Engineering Design and Engineering Consulting Services	6923
Scientific Testing and Analysis Services	6925
Computer System Design and Related Services	7000
Electronic (except Domestic Appliance) and Precision Equipment Repair and Maintenance	9422

Source: ABS, Counts of Australian Businesses, Including Entries and Exits, Jun 2007 to Jun 2011, Cat. No. 8165.0.

End Notes

[i] "University finally unwraps $50m gift", *The Advertiser*, p. 6, 6 March 2013.

[ii] According to the (International Standard Classification of Education (ISCED) 5-6) academic staff includes personnel whose primary assignment is instruction, research, or public service. This includes staff personnel who hold an academic rank with titles such as professor, associate professor, assistant professor, instructor, lecturer, or the equivalent of any of these academic ranks. The category includes personnel with other titles, (e.g. dean, director, associate dean, assistant dean, chair or head of department), if their principal activity is instruction or research. It does not include student teachers or teacher aides.

[iii] Census data indicates there were 9,971 persons employed in education in Greater Adelaide at the time of the 2011 Census. We would expect this number to be greater because it covers the full scope of employees at South Australian universities.

[iv] The number of FTE staff involved in research only at Harvard is not available.

[v] For more information on QS University Star Ranking system see http://www.topuniversities.com/qsstars/qs-stars-introduction

[vi] Total students in South Australian universities includes a small number of students at the regional University of South Australia Whyalla and Mount Gambier campuses, while the Roseworthy campus in the North of Adelaide and at Adelaide's CMU at UCL campuses is excluded. Total is for full year 2011.

[vii] Route 128 refers to the region along the Yankee Division Highway (Route 128, Interstate 95) to the west of Boston Massachusetts.

[viii] See Glasson, J., Chadwick, A., Lawton-Smith., H. (2007), Defining, explaining and managing high-tech growth: The case of Oxfordshire, *European Planning Studies*, vol 14, no. 4, pp 503-524. For a list of high-tech industries by 1992 SIC category using Glasson et al's definition, see Appendix A.

[ix] An employer is considered high-tech if "technology oriented workers" within an industry as identified by occupational staffing patterns, account for approximately 25 per cent or more of total jobs within the selected industry. For a list of high-tech industries according to 2007 NAICS categories using the above definition see Appendix B.

[x] Based on Glasson et al's definition of a high-tech firm using 2006 ANZSIC codes. High-tech industry categories have been attained by matching 2006 ANZSIC codes with their corresponding 1992 SIC high-tech industry categories as according to the definition of high-tech industries by Glasson et al. This has required a degree of judgement as there is not an exact correspondence between ANZSIC industry categories and SIC industry categories. For a list of high-tech industries according to 2006 ANZSIC categories using Glasson et al's definition see Appendix C.

[xi] For more information on Adelaide's five residential colleges see www.adelaide.edu.au/accommodation/colleges/

[xii] Excellence in Research Australia is an initiative of the Federal Government and a system for measuring and assessing research quality within Australia's higher education institutions using a combination of indicators and expert review committees. For more information see http://www.arc.gov.au/era/