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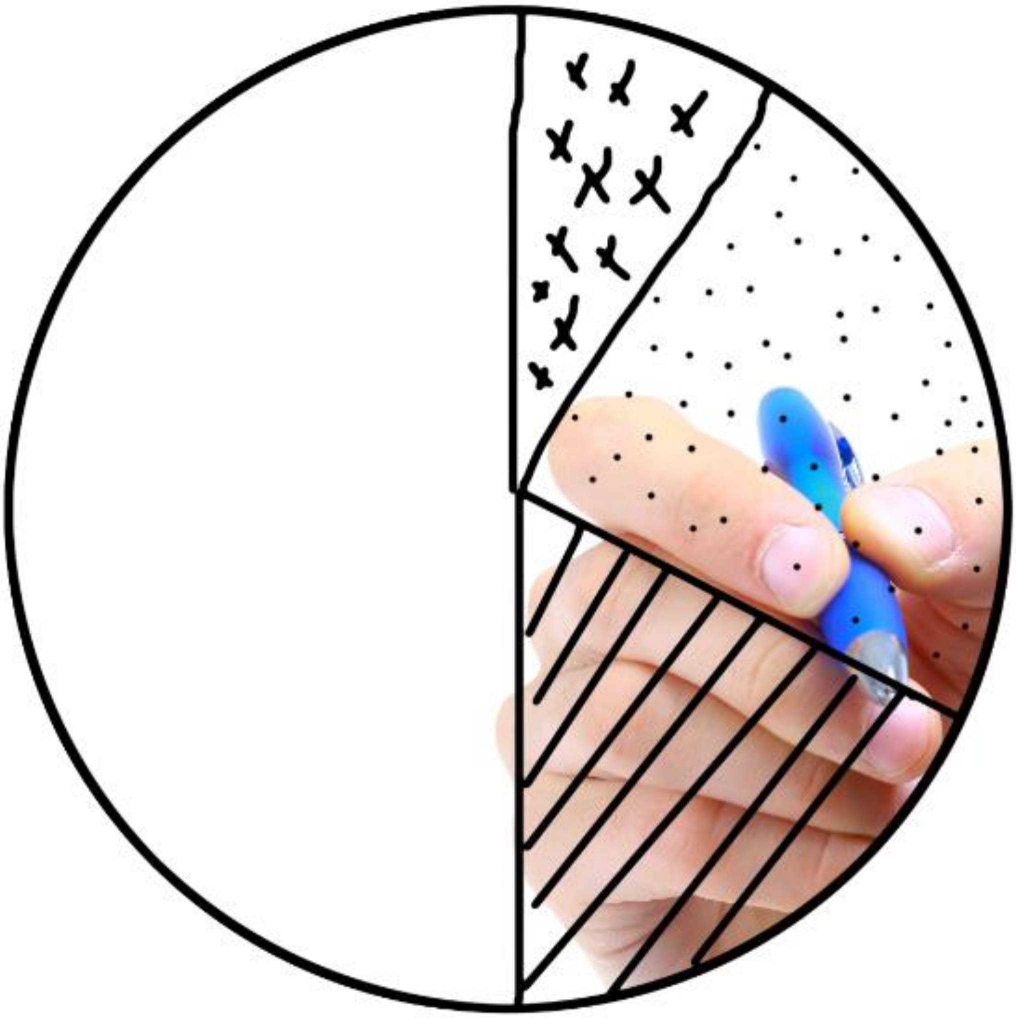

The importance of universities to Australia's prosperity

Universities Australia

April 2020

Deloitte
Access Economics

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Acronyms

Acronym	Full name
ABS	Australian Bureau of Statistics
ANZSIC	Australian and New Zealand Standard Industrial Classification
ASNA	Australian System of National Accounts
ATAP	Australian Transport Assessment and Planning
CGE	Computable general equilibrium
DAE-RIO-M	Deloitte Access Economics' Regional Input-Output Model
DWL	Dead weight loss
EBITDA	Earnings before interest, taxes, depreciation and amortisation
EFTSL	Effective full time student load
FTE	Full-time equivalent
GDP	Gross Domestic Product
GOS	Gross operating surplus
GTAP	Global trade analysis project
IO	Input-output
IVS	International visitor survey
NPV	Net present value
OECD	Organisation for Economic Co-operation and Development
PPH	Potentially preventable hospitalisations
SA	Statistical Area
TRA	Tourism Research Australia
UA	Universities Australia

Executive summary

Australia's universities are, by any measure, major economic entities. In 2018, they collectively employed 131,200 full time equivalent (FTE) employees and their operations directly contributed $23.2 billion to Australia's gross domestic product (GDP). When the economic activity that universities spur in upstream industries is taken into account, the sector's total contribution to the Australian economy increases to $31 billion and 186,500 FTE employees.

Universities are also instrumental to the facilitation of the nation's largest service export: international education. Indeed, the expenditure of international students who come to Australia and study at the nation's universities contributes $19 billion to the nation's GDP, with associated FTE employment of 125,000 in 2018. Not all of this is additional to the contribution of university operations described above, as international student tuition fees form part of the revenues from which the contribution of university operations is derived. The additional component is estimated at $10 billion to value added, with associated FTE employment of 70,400 in 2018.

International students also drive tourism activity, by virtue of friends and relatives travelling to Australia to visit them. The value of this activity contributed a further $369 million in value added and FTE employment of 2,200 in 2018.

Of course, the importance of universities to Australia's prosperity lies not in the economic activity associated with their operations, as sizeable as it is. Rather, their greatest importance lies in the role that universities play in driving growth in productivity and living standards – through the research they produce and the graduates they furnish the labour market with.

University graduates achieve a lifetime earnings dividend as a result of their university education. Earnings are higher not just *if* an individual has obtained a university qualification but *because* they have. In fact, the greatest contribution to the observed differential between the earnings of university graduates and others is indeed their university education (with innate ability, prior education and other factors accounting for around two fifths). In present value terms, the average bachelor level graduate accrues an additional $142,000 in post-tax earnings over their lifetime ($674,000 when undiscounted). Relative to the average person with no post-school qualification, this represents a discounted earnings premium of 31% (37% when undiscounted).

These gains, referred to as private benefits, in turn drive benefits across the wider economy – gains to government, to businesses and to other workers. These broader benefits, referred to as public benefits, are estimated at $172,000 in present value terms ($891,000 when undiscounted) for the average worker with a bachelor level qualification (relative to the average person with no-post-school qualification). That is, lifetime public benefits generated by the average worker with a bachelor qualification – *as a result of their bachelor qualification* – are expected to be $172,000 in present value terms.

When these per-worker gains are considered at an aggregate level, the modelling indicates that each percentage point increase in higher education attainment – equivalent to around 50,000 more higher education qualified workers – is associated with a 0.09% increase in GDP per annum. This represents $1.8 billion in additional economic activity annually, when compared to GDP in 2018. The fact that tertiary education attainment generates social and economic benefits that manifest outside the economic relationships readily simulated in models such as the one adopted here means that the actual impacts may be greater than what these estimates suggest. Previous modelling by Deloitte Access Economics indicates the total impact could be more than twice the size implied by these figures.

An analysis of these benefits alongside the costs of university education – measured here as the cost of the associated teaching and scholarship as well as the opportunity cost of individuals' time out of the workforce while studying – demonstrates that there is a considerable return to investments in university education. Analysis presented in this report suggests that every dollar invested by students and society in university education yields a lifetime benefit of around $4.

Considering government investment alone, this represents a return of around $3 to government (through higher income tax revenue), for each dollar of public expenditure.

Of course, the benefits that university graduates bring to Australia's economy and society transcend those that manifest in the labour market. There are a myriad of other ways in which the transformative impacts of university education on individuals' lives increase their value to society.

Universities' role in creating and disseminating new knowledge and ideas is among their greatest sources of value to society. Countries which spend a higher percentage of their GDP on higher education research and development have, on average, higher levels of GDP per capita.

This report finds that university research and development is a significant driver of Australia's productivity and economic growth. Indeed, through its impact on productivity, a 1% permanent increase investment in university research and development is estimated to generate an additional 0.13 percentage points of economic growth for Australia over the long-term. This is equivalent to a $2.4 billion annual GDP increase over the long-term. Noting that these effects can take many years to be fully realised, this evidence suggests that each dollar of expenditure on university research and development over the past 30 years grew GDP by around $5 in present value terms.

The contribution of universities to Australian economic and social prosperity has increased materially over the past five years, as the size and impact of the sector has grown. Universities continue to be significant contributors to economic activity, including as major employers that operate across both major cities and regional towns and through their role in facilitating Australia's international education export industry.

The value of universities also extends to their contribution to our national productivity and economic growth. The human capital and technological and social innovation generated by our universities have been critical to our economic success over the past 30 years. Deloitte Access Economics' 2015 report emphasised the importance of supporting Australia's transition towards a knowledge-based economy, and the productivity imperative which sits alongside this structural change. This report noted that over the coming decades creative and innovative embodied human capital will become central to the strength of the Australian economy while, at the same time, university research will continue to be an indispensable driver of technological progress.

This reality is as true now as it was five years ago, particularly as our economy and society is challenged by increasing international economic instability and uncertainty about the drivers of prosperity into the future. In this context, investments in universities are ultimately an investment in the nation's future; should Australian universities realise the enormous potential presented by our changing economy and society, and adapt to meet its changing needs and demands, the value of their economic contribution to society can only be expected to grow.

Deloitte Access Economics

Introduction

Universities Australia has commissioned Deloitte Access Economics to analyse the contribution that universities make to Australia's economic and social prosperity.

This report seeks to present a comprehensive and coherent framework of benefits generated by Australia's universities. This includes examination of the conceptual role of universities in Australian society and how they contribute to the success of the nation, as well as a more detailed analysis of the benefits directly attributable to universities. The scope of the analysis includes a detailed examination of the economic activity generated by university operations, while also examining the contribution made to the productive capacity of the economy through universities' teaching and learning, and research discovery and adoption.

This report builds on Deloitte Access Economics' 2015 study – which informed the development of Universities Australia's *Keep it Clever: Policy Statement 2016* – to provide an update of the economic contribution of Australian universities. This report updates the key analysis and findings from the 2015 report and extends on it to consider the private and public benefits of higher education and the returns generated from investment in Australia's university sector.

Approach

In undertaking the original and updated analysis for Universities Australia, this project has focussed on establishing a comprehensive framework of the benefits attributable to higher education. In doing this, the project has synthesised existing literature from Australia and internationally on the benefits of universities, as well as undertaken original analysis to establish estimates of some of the current benefits generated by universities in Australia. To achieve this, the work has involved:

1. a literature review to support the development of a conceptual framework which captures the many ways in which universities generate benefits for society
2. data collection, analysis and modelling, drawing on Universities Australia and publicly available sources and previously published Deloitte Access Economics research to identify quantitative and qualitative evidence of the benefits
3. synthesis of the evidence and reflections for funding
4. reporting and presenting the findings of the analysis.

This report

This report presents a summary of the analysis and is structured as follows:

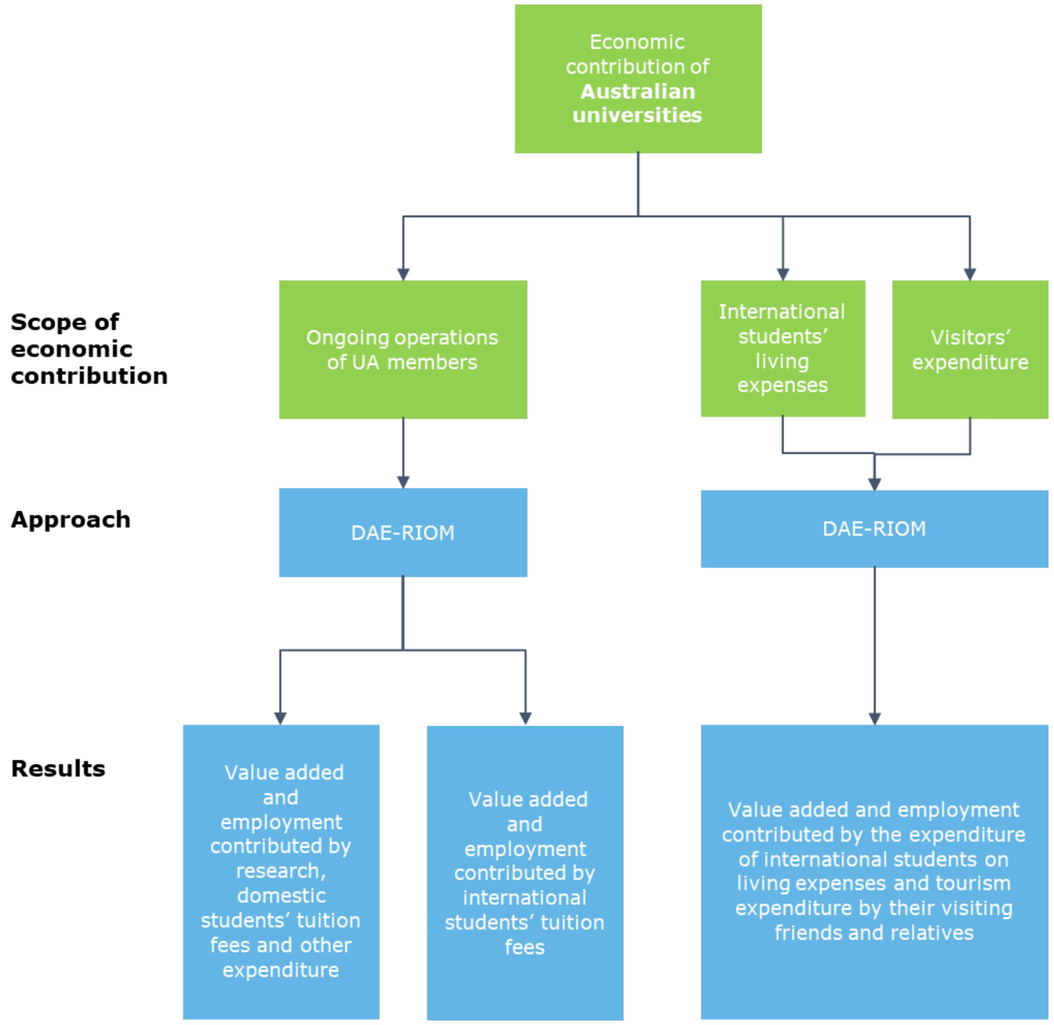
- Section 1 outlines **Australian universities' contribution to economic activity and jobs**
- Section 2 summaries the **public and private benefits of university higher education**
- Section 3 discussed the **returns on investment in Australian universities**, including through the **contribution of university research and teaching to long-term productivity growth in Australia**.

1 Australian universities' contribution to economic activity and jobs

The first part of this section examines the contribution of Australian universities' operations to the Australian economy in 2018. The analysis focusses on the tangible and quantifiable contribution of Universities Australia member universities' operations to economic measures such as value added and employment. The total economic contribution of the universities modelled in this report represents the sum of the entities' direct and indirect contribution to the Australian economy.

The second part of this section presents the value of international students in Australian universities in 2018. This includes the value added generated through the tuition fees of international students enrolled in a Universities Australia member university and the economic contribution associated with the tourism expenditure of visiting friends and relatives (VFR).

Figure 1.1: Overview of Australian Universities' economic contribution and how it has been measured



Source: Deloitte Access Economics

1.1 Economic contribution of university operations

Measures of economic contribution gauge the economic footprint of a given industry or firm in a historical reference year. In the case of universities, economic contribution analysis allows the estimation of the value of economic activity associated with (i) university operations; and (ii) the international student expenditure. The reason for pairing these two elements is simply that both are best analysed using an economic contribution modelling framework (as distinct from some of the other economic frameworks utilised throughout this report).

Economic contribution analysis does not analyse or demonstrate the value that universities create through their teaching, research and other activities. They simply measure the economic activity associated with universities' operations. The broader value created is estimated through other aspects of the economic modelling presented in this report.

The primary measure of a firm or industry's contribution to economic production is value added. The notion of *direct* economic contribution considers the value added generated by labour and capital inputs utilised directly by universities. In contrast, the *indirect* contribution is a measure of the flow-on activity derived from universities' demand for intermediate goods and services in other sectors of the economy (e.g. cleaning services, financial services, and so on).

The estimates of the direct and indirect economic contribution presented in this report are based on input-output (IO) modelling techniques. The Deloitte Access Economics Regional Input Output Model (DAE-RIOM) is an in-house modelling tool that derives state and regional level input-output matrices from the national input-output tables published by the Australian Bureau of Statistics (most recently for 2016-17).

1.1.1 Direct economic contribution

The direct economic contribution of Australian universities is the value added to the Australian economy as a direct result of their operating activities. In 2018, Universities Australia's members contributed $23.2 billion in direct value added and directly employed 131,200 full time equivalent (FTE) employees (see Table 1.1). Labour income and payroll taxes accounted for nearly 77% of the direct value added, with gross operating surplus representing a relatively minor share of Australian universities' direct economic contribution. It is estimated that labour income per FTE job equates to $130,000, reflecting the comparatively highly skilled workforce in the sector. To put this in perspective, the estimated median annual wage for a full-time employee in Australia in 2017-18 was $82,436.[1]

Table 1.1: Direct contribution of Australian universities' ongoing operations to Australia, 2018

Direct economic contribution	2018
Value added ($b)	23.2
Gross operating surplus ($b)	5.2
Labour income including net taxes on production (payroll tax) ($b)	17.9
Employment (FTE jobs)	131,200

Source: Deloitte Access Economics. Discrepancies may occur in total due to rounding.

Value added figures are rounded to the nearest 100 million, employment counts are rounded to the nearest 100 FTE jobs.

1.1.2 Indirect economic contribution

Australian universities indirectly contribute to value added and employment in the economy through their purchases of intermediate inputs from Australian suppliers.[2]

[1] Assuming 52 working weeks per year, with average weekly earnings extracted from the Australian Bureau of Statistics, Category no 6302.0.3, May 2018.

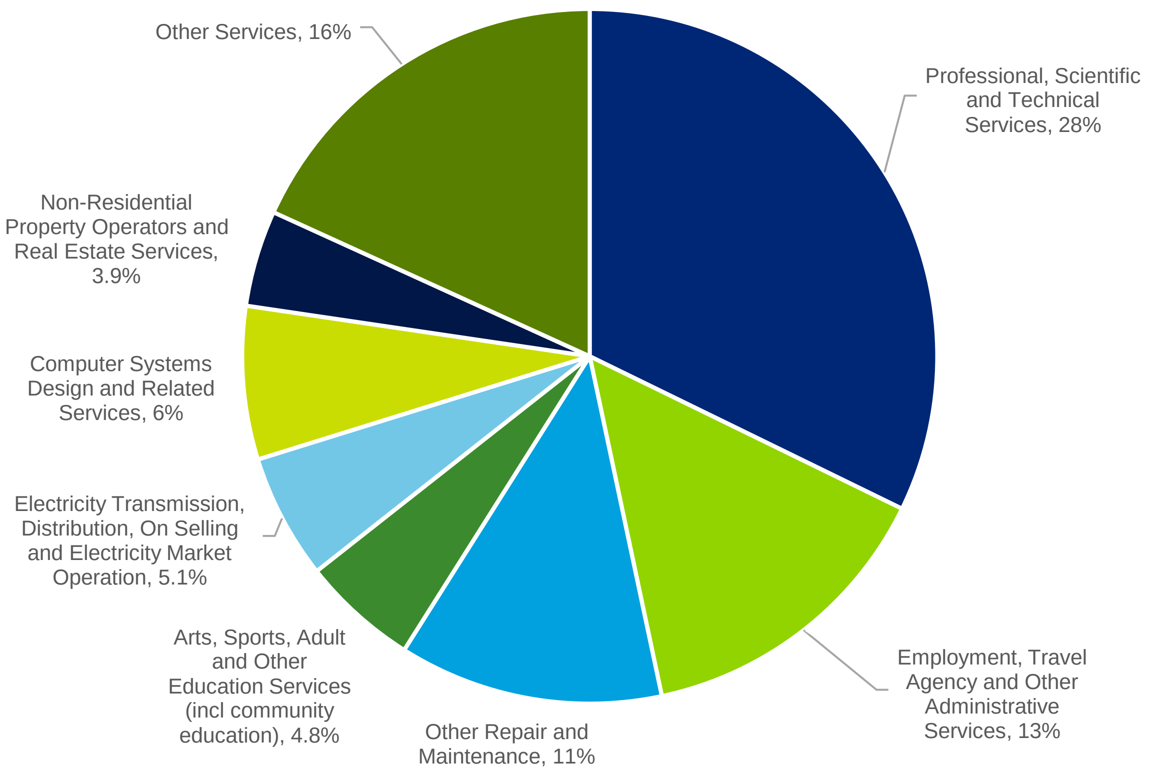
[2] This study excludes any estimated intermediate expenditure on offshore entities in order to isolate the economic activity captured by the Australian economy.

Based on the financial information obtained from universities, the industries that benefit most from universities ongoing operations include:

- *Professional, scientific and technical services*, through Universities Australia's expenditure on consumables, research and training materials.
- *Employment, travel agency and other administrative services*, through the universities' expenditure on travel, conferences and fieldworks for academics, as well as advertising and staff development.
- *Other repair and maintenance services,* through the universities' expenditure on repairs and maintenance, such as grounds maintenance or site management and servicing expenses.

These three industries captured approximately 52% of intermediate expenditure for the members of UA universities in 2018 (Chart 1.1).

Chart 1.1: Breakdown of Australian universities' intermediate expenditure by industry, 2018



Source: Deloitte Access Economics

It is estimated that in 2018, Australian universities' ongoing operations contributed $7.7 billion in indirect value added to the Australian economy. They also indirectly supported 55,300 FTE jobs throughout the Australian economy.

Table 1.2: Indirect contribution of Australian universities' ongoing operations to Australia, 2018

Indirect economic contribution	2018
Value added ($b)	7.7
Gross operating surplus ($b)	2.9
Labour income including net taxes on production (payroll tax) ($b)	4.9
Employment (FTE)	55,300

Source: Deloitte Access Economics. Due to rounding, individual items may not sum up to totals.

Value added figures are rounded to the nearest 100 million, employment counts are rounded to the nearest 100 FTE jobs.

1.1.3 Total economic contribution

Table 1.3 indicates that UA's member universities contributed a total of almost $31 billion to Australia's GDP in 2018 up from $25 billion in 2013, an increase of 26% over this period. Over this period, student load in EFTSL terms for Table A providers has risen by 15.6%, implying that there has also been an increase in nominal economic contribution per student, which has been broadly in line with inflation.

Table 1.3: Total economic contribution of Australian universities' ongoing operations to Australia, 2018

Total contribution of Australian universities	2018
Value added ($b)	30.9
Gross operating surplus ($b)	8.1
Labour income and net taxes on production (payroll taxes) ($b)	22.8
Employment (FTE)	186,500

Source: Deloitte Access Economics. Discrepancies may occur in total due to rounding.

Value added figures are rounded to the nearest 100 million, employment counts are rounded to the nearest 100 FTE jobs.

The total contribution to employment has grown from the 2013 estimate of 155,000 to an estimated 187,000 in 2018, an increase of 20% over this period. The growth has been partly driven by a change in the way direct employment is estimated.

In the 2015 report – where economic contribution figures for the 2013 base year were reported – estimates of direct employment were derived from ratios of value added per FTE job for a sample of universities. However, inconsistencies in the reporting of casual employees in universities' annual reports – which are utilised for the purposes of generating sector-wide estimates – have led to the adoption of an alternative approach in the current analysis. The approach used in the 2015 report would have underestimated the direct employment associated with universities.

The 2018 data is based on standardised estimates of direct employment provided to the Department of Education which include casual employment. This change in data source has increased estimates of direct employment by approximately 9% with the remaining increase reflecting an increase in actual employment in the sector. The difference between the growth of value added relative to employment is in part driven by the fact that value added is measured in nominal terms.

Approximately 75% of total value added is direct value added, with the remainder being indirect. Over two-thirds of total value added consists of labour income or payroll tax, reflecting the relatively labour-intensive nature of the sector. Indeed, over 55% of total value added constitutes direct labour income alone. This ratio is relatively high and reflects that much of the value added contributed by universities flows directly through to employee wages. A further 15% of value added flows through to labour income indirectly for those who work for upstream suppliers to the university sector.

The estimate of value added is lower than total income from continuing operations of the university sector which was estimated to be approximately $33.6 billion in 2018 based on information from UA member annual reports. This is due to two key aspects of the way economic contribution is calculated. Firstly, certain types of returns on capital are excluded from the calculation of gross operating surplus. This includes investment income and losses, gains and losses on the disposal of property, plant and equipment, foreign exchange gains and losses and impairment of assets. Secondly, since an economic contribution study assesses value added in Australia, the analysis excludes both direct and indirect international imports used by universities. Thus, total value added is lower than the sector's total revenue.

This study does not include consumption induced effects (commonly referred to as Type II multipliers) in the estimate of the economic contribution of Australian universities as inclusion of these effects in not convention in Australia. This inclusion of Type II multipliers is more common in economic contribution studies overseas and was used in a study by London Economics on 'The economic impact of Group of Eight universities'[3]. As a result, the figures presented here are not directly comparable to those in that report.

1.2 Value of education provision to onshore international students in universities

The economic contribution estimates outlined above include economic activity associated with international student tuition fees (and the services delivered by universities for these students) but exclude the economic footprint of international students more broadly (i.e., through the additional expenditure of international students and their families in Australia). Instead, the following section outlines the contribution of international students in Australian universities in 2018.

There are three components that make up the contribution of international students studying at UA member universities:

1. The value added and employment supported by international students' expenditure on tuition fees.
2. The value added and employment supported as a result of expenditure on non-tuition goods and services consumed by international students.
3. The value added and employment supported as a result of expenditure by friends and relatives who travel to Australia to visit international students (VFR).

The tuition fees component is previously captured here but also as part of the value added and employment estimates produced above, in Table 1.3. This is because tuition fees of international students are captured in universities' operating revenue, which is reflected in their annual reports. Estimating the other two components requires the additional use of the Tourism Satellite Account approach to measuring the economic contribution of tourism-related expenditure. This approach utilises the expenditure data recorded via the International Visitor Survey (IVS) by Tourism Research Australia (TRA) to estimate the expenditure associated with both international university students and their associated visitors in Australia and the application of multipliers derived from the TRA State Tourism Satellite Accounts.

1.2.1 Overview of international university students in Australia

In 2018, there were 398,100 onshore international student enrolments in the higher education sector in Australia.[4] In total, 86% of these students were enrolled in a higher education provider that was a Universities Australia member.[5] Higher education students in Australia come from an array of source markets, with China being the largest market, accounting for 38% of the total enrolments, followed by India and Nepal at 18% and 7% of total enrolments respectively.

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[3] Available from: https://go8.edu.au/research/economic-impact-group-of-eight-universities

[4] Department of Education, Skills and Employment, 2019, available from: https://internationaleducation.gov.au/research/International-Student-Data/Pages/InternationalStudentData2019.aspx

[5] Source: Table 7.5. Commencing Overseas Students by State, Higher Education Institution and Onshore/Offshore Status(a), Full year 2018. Available from: https://internationaleducation.gov.au/research/otherinternationaldata/pages/international-education-data-sources.aspx

International students often host visiting friends and relatives. In this study, in order to determine the economic contribution of tourism expenditure attributable to international education, it is necessary to isolate visitors whose decision to come to Australia was motivated by an intent to visit an international student studying here.

To estimate the economic contribution, the analysis focuses on the subset of visitors who have come to Australia to visit an international student or to have a holiday but who noted that a reason for their trip was to visit an international student. These purposes of visit are identified through visitors' responses to the International Visitor Survey. It is assumed that those whose main reason for coming to Australia was business, employment or other are less likely to have been driven to come to Australia specifically to visit an international student. This is likely a conservative approach, given that this is only a small share of the total number of travellers who visit an international student as part of their trip.

In total, international students studying at Australian higher education providers spent an estimated $11.5 billion on tuition fees and $13.3 billion[6] in living expenses in 2018, while their VFRs spent an additional $545 million in tourism consumption. It is assumed that 86% of this expenditure was undertaken by students studying at UA members (in line with their share of the sector's enrolments).

1.2.2 Economic contribution of international university students to Australia

In 2018, expenditure of international students in Australian universities contributed a total of $19.0 billion in value added and supported 125,100 FTE jobs across Australia. This includes $11.7 billion in direct value added and 83,000 FTE jobs in industries that directly interact with these students through either their expenditure on tuition fees or the goods and services these students consumed.

Again, this estimate of total value added is lower than the total export revenue of the sector, which is approximately $24.8 billion, or $21.3 billion for higher education enrolments among Universities Australia members. As noted above, this difference is due to the fact that value added estimates income accruing to factors of production in Australia. This excludes any imports acquired directly by international students or imports used an as inputs to produce goods and services for international students.

The indirect economic contribution of international university students measures the upstream effects of the expenditure made by these students. For example, the additional demand generated when international students buy coffee from local stores increases the demand for milk. The flow-on impacts to suppliers of intermediate goods and services to universities are counted in the indirect contribution.

Chart 1.2 shows the top tourism expenditure items for international onshore university students in 2018. It is estimated that the top five categories made up 59% of total consumption for these international students. The three downstream industries that benefited most from this expenditure were *Professional, Scientific and Technical Services*, *Non-residential property operators, Employment and Travel Agency Services, Finance* and *Transport Support services and storage.*

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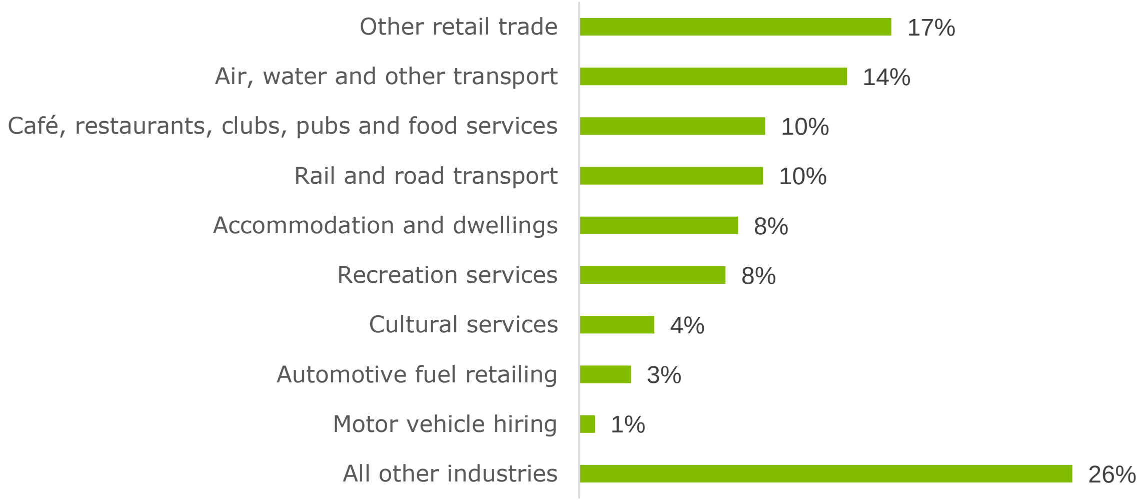
[6] After inclusion of airfares and adjusting for imputed consumption this figure rises to $17.1 billion, which is then used in the economic contribution analysis. This approach aligns with the framework in Tourism Satellite Account (TSA).

Chart 1.2: Share of tourism industries in international students' expenditure on goods and services



Source: Deloitte Access Economics

Across all downstream industries, it is estimated that international university students indirectly contributed $7.3 billion in value added and supported 42,100 FTE jobs across the Australian economy in 2018 (Table 1.4).

Table 1.4: Economic contribution of international university students to the Australian economy, 2018

		Direct	Indirect	Total
Value added ($b)				
	Tuition fees	6.8	2.3	9.1
	Goods and services	4.9	5.0	10.0
	Total	**11.7**	**7.3**	**19.0**
Employment (FTE jobs)				
	Tuition fees	38,500	16,200	54,700
	Goods and services	44,500	25,900	70,400
	Total	**83,000**	**42,100**	**125,100**

Source: Deloitte Access Economics. Discrepancies may occur in total due to rounding.
Value added figures are rounded to the nearest 100 million, employment counts are rounded to the nearest 100 FTE jobs.

1.2.3 Economic contribution of visiting friends and relatives to Australia

It is estimated that the tourism expenditure of visiting friends and relatives to international students in Australian universities contributed $369 million in total value added to Australia in 2018, consisting of $182 million in industries directly interacting with these visitors, and $187 million in downstream sectors.

The expenditure of those visiting friends and relatives also supports employment in industries providing goods and services to tourists. In 2018, this expenditure directly supported 1,300 FTE jobs and indirectly supported approximately 1,000 FTE jobs through downstream impacts (Table 1.5).

Table 1.5: Economic contribution of visitors to international students in Australian universities, 2018

	Direct	Indirect	Total
Value added ($m)	182	187	369
Employment (FTE jobs)	1,270	970	2,240

Source: Deloitte Access Economics. Discrepancies may occur in total due to rounding.

Note: Value added figures are rounded to the nearest million, employment counts are rounded to the nearest 10 FTE jobs.

1.2.4 Total economic contribution of international students

The total contribution of international students studying in Australia at UA member universities and the friends and relatives that visit them during their study is estimated to be $19.4 billion in total value added, with associated employment of 127,300 FTE jobs across Australia (Table 1.6).

Table 1.6: Total economic contribution of international students in Australian universities, 2018

	Direct	Indirect	Total
Value added ($b)	11.9	7.5	19.4
Employment (FTE jobs)	84,200	43,100	127,300

Source: Deloitte Access Economics. Discrepancies may occur in totals due to rounding.

Note: Value added figures are rounded to the nearest 100 million, employment counts are rounded to the nearest 100 FTE jobs.

Focusing purely on the activity that is not captured in university operations (which is included in section 1.1) and just on international students' expenditure on goods and services and the tourism expenditure of their visiting friends and relatives, this activity contributed $10.3 billion to value added and supported 72,600 FTE jobs. To put these figures into perspective, in terms of Australia's tourism industry, international university students studying in Australia in 2018 contributed an equivalent of 9.8% of total value added by the tourism sector and supported total employment equivalent to 9.4% of total employment in the tourism sector.[7]

1.2.5 Growth in the sector over time

A previous study by Deloitte Access Economics estimated the economic contribution of international students to the Australian economy in 2013 on behalf of the Department of Education.[8] This found that the international onshore students studying higher education contributed $11.1 billion to the Australian economy and supported 76,700 FTE jobs.

This study estimates that the corresponding figures for UA members[9] was $19.0 billion and 125,100 FTE jobs respectively. This represents growth in value added of 72% (in line with growth of corresponding or like-for-like higher education exports of 71% over this period). The number of

[7] These calculations were done in headcount terms in line with the way tourism is reported in the Tourism Satellite Accounts.

[8] Deloitte Access Economics (2015), *The Value of International Education to Australia*. Available from: https://internationaleducation.gov.au/research/research-papers/Documents/ValueInternationalEd.pdf

[9] UA members represent approximately 86% of higher education enrolments.

FTE jobs supported by UA members was also 63% higher than estimated for the higher education sector as a whole in 2013.

It is important to note that UA members do not cover all higher education enrolments. Indeed, export revenue associated with international students studying higher education (at any institution) almost doubled over the period from 2013 to 2018. While this study only estimates value added for UA members it is likely that value added for all higher education would have grown to a broadly similar extent to the increase in the sector's export revenue between 2013 and 2018.[10]

[10] The methodology used to capture the sector's economic contribution has changed slightly since the 2013 report with a Tourism Satellite Account framework being used in this study to estimate the contribution of international student living expenses, whereas a student economic contribution approach (similar to that used for tuition fees) was used for living expenses in 2013.

2 The benefits of university teaching and learning

The analysis in this section examines the long-term benefits that university graduates derive from their study and the wider economic impact associated with this. It considers the benefits accruing to graduates themselves (the private benefits) and the broader economic and social benefits (the public benefits) – on both a per-student basis and in aggregate. To gain an understanding of the return to the investment that the public and students themselves make in university education, the discussion concludes with an assessment of how the benefits generated relate to the costs incurred.

2.1 The public and private benefits of university higher education

Participation in university higher education can have a range of consequences on an individual's opportunities, productivity and decision-making over the course of their life, both in and outside the workforce. The benefits that directly accrue to individuals who participate in university higher education are referred to as private benefits.

University higher education also brings broader benefits to the economy and society through, for example, productivity spill-overs, increased tax revenue and/or impacts on social and civic outcomes. The benefits that accrue to third parties who are external to the production (supply) or consumption (demand) of university higher education are known as public benefits.

The public and private benefits generated by higher education attainment can be categorised as either market or non-market.

- Market-based benefits are measured in terms of economic output generally captured by income measures that result from increased levels of labour productivity.
- Non-market benefits—which may be measured in pecuniary or non-pecuniary terms—are broader in nature and capture benefits to individuals and society that manifest, often indirectly, from higher levels of educational attainment and human capital.

Table 2.1: Benefits of higher education

	Private	Public
Market	Labour market outcomes (where the qualification increases likelihood of employment, or attracts a wage premium)	Labour productivity spill-overs, increased tax receipts associated with productivity gains and wage premiums
Non-Market	Positive family, health outcomes associated with higher levels of education	Positive social outcomes associated with a higher level of educational attainment among the population

Source: Deloitte Access Economics (2020).

This report estimates the market benefits associated with university higher education, as these are most amendable to reliable quantification using the data and modelling instruments currently available. However, the analysis also highlights the range of non-market public and private benefits that are likely to manifest.

2.1.1 Public and private market benefits

The report draws extensively on past Deloitte Access Economics analysis for the Australian Government that estimates the private and public market benefits associated with a higher education qualification (Deloitte Access Economics, 2016). Deloitte Access Economics' original research built on an existing base of research in this field and employed new empirical methods to: (1) more comprehensively estimate the extent of private and public benefits from higher education; and (2) do so by field of education. A description of the full methodology is included in Appendix C.1.

The analysis presented in this report incorporates the following key updates to Deloitte Access Economics' original modelling:

- This analysis is based on the Australian Bureau of Statistics (ABS) 2016 Census of Population and Housing, whereas the previous analysis was based on 2011 Census data.
  - This is a key modelling input that informs the composition of the workforce by qualification level, the gross earnings premiums associated with higher education relative to those with no post-school qualifications (high school leavers up to and including Year 12 completers), and the mapping between qualifications, industries and occupations.
- The analysis is based on the Global Trade Analysis Project (GTAP) 10 database (based on the 2014 data), whereas the previous analysis was based on the GTAP 9 database (based on 2011 data).
  - The GTAP database informs the production structure of the Australian economy and underlies the computable general equilibrium (CGE) modelling.
- Updated income tax schedule for 2019-20 (Australian Taxation Office, 2019) from the 2015-16 schedule.
  - This informs the additional taxation revenue associated with more qualified workers.

Where the 2016 analysis focused on public and private benefits by **field of education** (and across qualification levels), this report instead focuses on the 'average' undergraduate qualification. This is modelled by increasing the supply of students with undergraduate qualifications (based on the typical fields of education in the economy as given by the 2016 Census) while decreasing the supply of students with no post-school qualifications. The benefits for undergraduate students are illustrative of the nature of benefits for all university students.

2.1.1.1 Private market benefits

University higher education attainment leads to private labour market benefits, in the form of higher lifetime post-tax earnings, through the following three sources:

- **Higher average wages** compared to a typical individual with no post-school qualification.
- **Increased likelihood of employment** compared to a typical individual with no post-school qualification.
- **Increased labour force participation levels** compared to a typical individual with no post-school qualification.

It is possible to compare observed earning differences between individuals with different qualification levels using the Census data. However, it is recognised that these observed differences in earnings for individuals with bachelor level qualifications relative to those without post-school qualifications also reflect other factors, such as a person's cognitive ability and demographic characteristics. As such, qualification effects[11] are separated from these other factors using regression analysis of the Household Income, Labour Dynamics in Australia (HILDA) Survey. The model adopted in the analysis presented in this report controls for:

- Demographic characteristics including age, gender, born in Australia, indigenous status, State of residence, ABS Remoteness Area, disability, English language proficiency, hours worked (earnings model), employment status (employment model), family type (employment model), and age of youngest child (employment model).
- Cognitive ability, which was proxied by the following tests in HILDA – Backward digits span, Symbol digits modalities and Shortened version of the National Adult Reading Test (NART-25).

[11] The qualification effect refers to the proportion of the wage premium that can be attributed to the attainment of the 'qualification', in this case a tertiary qualification.

Further details are given in Appendix C.1.

Chart 2.1 shows a disaggregation of annual earnings for individuals with a bachelor level qualification, compared to those individuals with no post-school qualifications. This represents the average earnings per individual, rather than per *employed* individual, and is consequently lower than estimates of average full-time earnings.

It shows that the average individual with a higher education bachelor qualification earns $39,000 more per annum compared to an individual with no post-school qualifications.

Approximately 58% of the earnings premium for those with higher education bachelor qualifications is attributable to the effects of their higher education qualification. The remaining 42% is attributable to a combination of demographic and cognitive factors.

Chart 2.1: Disaggregation of average annual earnings for higher education bachelor qualifications

Source: Australian Bureau of Statistics (2016), Deloitte Access Economics (2020). Average annual earnings are calculated as *average wages x average employment rate x average participation rate*. It does not represent the average earnings for an employed person. Averages are volume-weighted, based on 2016 Census counts of qualification holders by field of education.

Utilising these earnings premium results (for the average undergraduate graduate), and data from the 2016 ABS Census, it is possible to estimate the expected additional lifetime earnings for the average Australian university graduate. This analysis:

- accounts for time spent out of the labour force while studying
- accounts for differences in earnings over the working life cycle
- is measured in terms of net additional earnings (i.e., accounts for the tax paid)
- measures total earnings in Net Present Value (NPV) terms for the average graduate, using a discount rate of 7% (consistent with the 2016 report).[12]

[12] To measure the return on this stream of benefits and the associated investment costs it is necessary to convert this stream into present value terms. This is achieved by applying a social discount rate to the stream of benefits and costs. Harrison, (2010) notes that the Commonwealth's Office of Best Practice Regulation

These total earnings estimates represent the *net private market benefits* of university education.[13]

For the average bachelor level student, their **lifetime net private market benefits** in the form of additional lifetime post-tax earnings is expected to be $142,000 in NPV terms ($674,000 when undiscounted). Relative to other workers, this represents a discounted earnings premium of 31% (37% undiscounted) associated with the average bachelor level qualification over an individual's lifetime.[14]

This gain can be attributed to attainment of the qualification, which leads to higher average wages, likelihood of employment and participation in the workforce relative to individuals holding no post-school qualification.

2.1.1.2 Public market benefits

To estimate the *public market benefits* associated with a university education – which include increased returns to other factors of production and tax revenues – Deloitte Access Economics' in-house computable-general equilibrium model (DAE-RGEM) is utilised. The utilisation of a CGE model in this context allows the broader economic impacts of higher education to be simulated. Earnings premiums can be utilised as a basis for examining how the economy responds to a more productive workforce. The effects of labour productivity work their way through the economy, spurring investment and economic activity in ways that ultimately increase the economy's overall productivity capacity and its output.

An introduction to Economy-wide modelling using DAE-RGEM

The DAE-RGEM is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium (CGE) model of the world economy with bottom-up modelling of Australian regions. The model allows policy analysis in a single, robust, integrated economic framework. The model projects changes in macroeconomic aggregates such as Gross National Product (GNP), employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment are also produced.

The DAE-RGEM is used here to model the impacts of a more skilled workforce on the Australian economy.

The CGE model framework is best suited to modelling the impact of policies on the national economy. The framework accounts for resourcing constraints and opportunity costs, and is used to model changes in prices and the behaviour of economic agents in response to changes in economic and policy conditions. That is, a key feature of CGE models is that they link the supply and demand in each sector to other sectors in the economy, such that a shock to one sector flows through to all other sectors.

Further, goods in each sector are produced by factors of production (such as labour and capital). An increase in the quantity or quality (i.e. productivity) of these factors increases the productive potential of the economy, with different effects on different sectors depending on their relative reliance on each factor. As a result of these features, the CGE model is the most appropriate model for capturing the total market benefits associated with a more skilled labour force.

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recommends a real discount rate of around 7%, justified as being approximately the before-tax rate of return on private investment in the economy. It should be noted that a 7% discount rate may be considered high for analysis in the education sector, and some guidelines suggest the use of a rate closer to 3.5% (for example, the UK Green Book or Victorian DTF guidelines). As such, the discounted benefits presented here may be considered as a conservative estimate.

[13] These are considered the *net* benefits as time spent out of the labour force during studies have been captured. The *gross* benefits are higher.

[14] In the 2016 Deloitte Access Economics report, it was reported that the average undergraduate qualification was associated with a 41% discounted lifetime earnings premium (49% undiscounted). This represented the premium of the average *employed* person with an undergraduate qualification, compared to the average *employed* person with no post-school qualifications. In this study, the earnings premium is reported for the *average person*, and the results are not directly comparable.

While labour is typically produced by a representative agent, the underlying database of DAE-RGEM has been modified to accommodate workers of different occupation and qualification types. This modification employed allows the modelling to account for a shift in the composition of the workforce from individuals with no post-school qualifications to individuals with bachelor level qualifications.

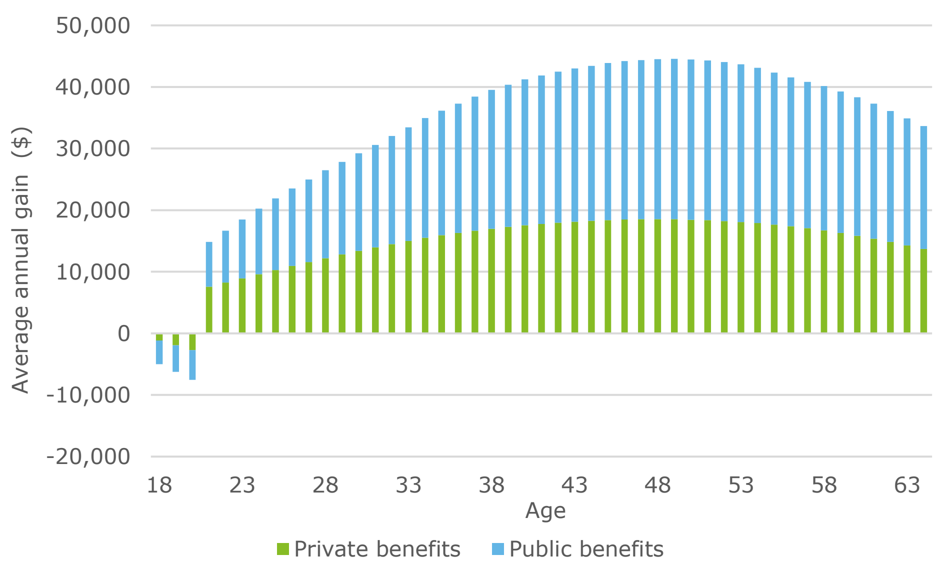
Refer to Appendix C.2 for further details on the CGE model.

The **lifetime public benefits** generated by the average worker with a bachelor qualification—as a result of their bachelor qualification—is expected to be $172,000 in present value terms ($891,000 when undiscounted). This includes $77,000 in additional income taxation associated with their higher lifetime earnings. Other flow-on public benefits include:

- Higher earnings for other workers. As workers with bachelor level qualifications become relatively more abundant, average earnings for workers holding no post-school qualifications are expected to increase as they become relatively scarcer.
- Induced investment and capital accumulation. As workers with Bachelor level qualifications join a range of sectors across the economy, additional investment is required to support sector expansion.

The annual year-on-year benefits are shown in Chart 2.2. The market benefits are expected to increase over an individual's lifetime as average earnings increase. The modelling assumes that the proportional earnings premiums associated with their university qualification is expected to remain constant through their working lives.[15]

Chart 2.2: Lifetime public and private benefits profile for average Bachelor level student



Source: Deloitte Access Economics (2020).

These results should be interpreted as the average public and private market benefits associated with university higher education based on historic relationships. While the CGE model does capture diminishing returns as the supply of bachelor qualified workers expands, it does not consider any trends in enrolment growth over time. Classic economic theory suggests that as labour supply of one skill type becomes less scarce, the market wages for those skills will fall. However, Moretti

[15] This assumption is examined further on page 44 of Deloitte Access Economics (2016).

(2004) found that the productivity spill-overs between individuals with high skill types (that is, graduates) overcomes the negative scarcity effects.[16]

Comparison to other studies

The market benefits associated with university higher education is lower than those presented in other publicly available studies. As explored below, this arises from differences in the approach or scope. When the other factors are accounted for, the results are broadly in line with the results presented in this analysis.

The Organisation for Economic Co-operation and Development (OECD) found that the total (public and private) lifetime benefits associated with a man attaining a bachelor's, master's and doctoral or equivalent level education was USD$585,900 compared to upper secondary education. For a woman, the equivalent figure was USD$493,000 (OECD, 2019a). Approximately a third of the benefits were estimated to be public benefits.

The total benefits estimated by the OECD are higher than the results reported in this analysis. This arises from the following differences in methodology and scope:

- The OECD study has a narrower definition of public benefits, and limit public benefits to additional personal taxation income. They do not account for flow-on benefits for other factors of production. Consequently, public benefits are a lower share of total benefits.
- The OECD study does not account for private benefits attributable to the qualification effect. They capture the full earnings differential between individuals with higher education qualifications and individuals without post-school qualifications. This will lead to higher estimates of private benefits.
- The OECD study estimated the gross benefits associated with university education. It does not consider costs associated with foregone earnings (and the impact on the broader economy) during further studies.
- The OECD study applied a lower discount rate of 2% per annum compared to the 7% per annum used in this report. Given that the benefits accrue over a working life, the discount rate will have a significant impact on lifting the results. When a 2% discount rate is used, the total market benefits estimated in this analysis increases to $923,000.

The Grattan Institute (2018) found that lifetime earnings for women with bachelor level qualifications was $2.0 million, or approximately $585,000 higher compared to the earning for women with Year 12 qualifications. For men, the private lifetime earnings were $2.7 million, representing a $789,000 private market benefit. Earnings are net of income tax, Medicare levy and Higher Education Loan Program (HELP) debt.

The private benefits estimated by Grattan Institute are higher than the results reported in this analysis. The Grattan Institute results are *undiscounted*, and do not account for the contribution of demographic or cognitive factors to earning differences. When the Deloitte Access Economics estimates are undiscounted, the gross private market benefits associated with a bachelor level qualification relative to no post-school qualification is $680,000.

Despite limiting the analysis to the qualification effect, the Deloitte Access Economics results are of a similar order of magnitude compared to Grattan Institute estimates. This results from: (1) the use of gains for the average – rather than median – individual, which would skew results; and (2) comparing to all individuals with no post-school qualifications, rather than Year 12 completers specifically.

[16] See page 17 of Deloitte Access Economics (2016) for a further discussion of this literature.

2.1.2 Non-market benefits

While many students are likely to be aware of the market benefits they derive from their time at university, few generally consider the benefits enjoyed beyond their enhanced employment and income prospects.

There have been a number of studies which have sought to examine these effects.[17] In broad terms, the **non-market private benefits** may be categorised as those relating to:

- **Health and longevity:** studies have found a positive correlation between levels of educational attainment and the health levels of individuals. The health benefits experienced by graduates are broad and generally relate to the choices made by graduates compared to those who have not attended university.
- **Happiness and wellbeing:** a number of studies have found a link between further education and happiness and wellbeing. This is likely to be through a combination of the income, health and employment effects that arise from education.
- **Knowledge and productivity:** the knowledge gained at university allows graduates to enhance their productivity not just within the workplace but within their personal lives as well. A number of studies have found that university graduates are able to make more efficient choices, saving money over the long run.
- **Children and education:** Higher education has a range of effects on the future family of a university graduate. Studies have shown that children with educated parents are healthier overall.

Other identified **non-market public benefits** from higher education that accrue include more stable, cohesive and secure environments, more efficient labour markets, faster and wider diffusion of new knowledge, viable social networks and civic institutions, greater cultural tolerance and enhanced democracy.

While these non-market benefits have not been quantified, studies suggest that they are likely to be greater than the market benefits (Grattan Institute, 2012).

2.2 The impact of university teaching and learning on national productivity and economic growth

The findings presented above demonstrate the benefits that university teaching and learning generates on a per student basis. While this is instructive, it provides limited insight regarding the overall importance of university teaching and learning to the Australian economy. To this end, the modelling presented in this section demonstrates how, in aggregate, university teaching and learning impacts the size and growth of the economy.

This analysis utilises the same CGE modelling framework described above to examine how increases in the level of educational attainment (measured as a share of the population aged 20 to 64) affect the macroeconomy. The modelling finds that each percentage point increase in higher education attainment—equivalent to around 50,000 more higher education qualified workers—is associated with a 0.09% increase in GDP per annum. This represents $1.8 billion in additional economic activity annually, when compared to GDP in 2018. Approximately half of this increase is associated with a more productive population, as reflected in the wage and employment premiums associated with additional human capital derived from graduates' undergraduate qualifications. The remainder arises from the economy's response to this productivity uplift, in the form higher returns on capital, which drives increased investment that supports increased economic output and employment.

To put these figures into context, in the decade to 2019, the proportion of the Australian population aged 20 to 64 years with a bachelor level or above qualification increased by seven percentage points – from 26% to 33% (Australian Bureau of Statistics, 2019). In line with the

[17] Grattan Institute (2012) provides a summary of the literature on the non-market benefits of higher education

results presented above, this would have resulted in a 0.7% increase in GDP ($13.3 billion), with 0.3% ($5.6 billion) resulting from productivity benefits.

While this modelling illustrates how the labour productivity gains that university attainment drives impact the macroeconomy, it does so in a somewhat limited way. Certainly, a CGE model is a very suitable tool for an exercise of this nature. However, the impacts and benefits it captures are limited to those that manifest through the economic relationships evident in the national accounts and the transaction equations (production structure and consumption function) that the model overlays.

There is evidence to suggest the economic benefits of higher education attainment transcend the impacts captured in a CGE framework. Indeed, higher levels of human capital can support improved economic and social outcomes beyond what is readily captured in the form of higher earners. For example, improved levels of educational attainment can support intergenerational improvements in the learning outcomes of children and young people, which drive future economic growth as well as enhancements to social outcomes, such as political engagement and civic leadership. Deloitte Access Economics' 2015 report for Universities Australia sought to explore this broader construct of benefits through the application of a cross-country macro-econometric model (the same model used in Section 3 where the impacts of university research are examined).

The analysis found that Australia's GDP was 8.5% higher because of the impact that university education has had on the productivity of the (then) 28% of the workforce with a university qualification. This represents an average GDP benefit of 0.3% for each one percentage point increase in attainment – a figure higher than the 0.09% presented above. Based on the previous estimates, this suggests that each one percentage point increase in university attainment could be associated with up to a $5.7 billion increase in GDP.

By applying the previously estimated 8.5% to GDP in 2018, the Australian economy would be $161 billion larger due to the stock of university qualified workers. Conceivably, therefore, the benefits accruing from channels beyond the economic relationships that the CGE model characterises may in fact be greater than those which a CGE model captures.

In estimating the economic benefits of university research (per the findings presented in Section 3), Deloitte Access Economics' original results with respect to the impacts of higher education attainment on GDP have also been revisited. The original modelling has been updated in light of the availability of additional cross-country data and where scope was identified to improve the specification of the model. This process has not given rise to a case to revise Deloitte Access Economics' 2015 estimates of the economic impacts of the labour productivity improvements that higher education attainment drives (as reported in the paragraph immediately above). However, it has reiterated that this modelling should be periodically reviewed and updated – especially given its time-series nature mean increases in the duration of data available have the potential to lead to improvements in the accuracy and reliability of the results.

2.3 Costs and benefits of university teaching and learning

The modelling results presented above demonstrate the public and private benefits of higher education attainment and the overall impact of improvements in attainment levels on the Australian economy. However, in order to understand the degree to which these benefits represent a return to the investment that students and taxpayers make, it is necessary to appraise them alongside the costs associated with their production.

To this end, this section compares the average market benefits associated with a bachelor qualification (based on the analysis presented above) with the average costs required to support the teaching and learning completed under the average bachelor qualification. The analysis:

- Is limited to the costs and benefits associated with domestic undergraduate students. It does not consider the benefits and costs that may accrue from international students.
- Only captures those benefits and costs associated with individuals who complete their qualifications. This is due to limited research available on the benefits for those who partially complete degrees. It may be sensible to assume that their costs and benefits are proportional to that of the average completer.

- Is agnostic to whether the benefits and costs are borne by the private individual or the government.

2.3.1 The costs of university teaching

Deloitte Access Economics draws on the following publicly available sources to provide an estimate of the costs associated with higher education teaching:

- Teaching and scholarship costs in universities
- Resource/administrative costs associated with supporting university teaching
- Opportunity costs from individuals undertaking university study. This includes both foregone income for the individual, as well as broader losses in economic activity as a result of the reduced labour supply.

This measure predominantly focuses on the financial costs associated with university teaching and learning. However, recognising that financial costs may underestimate the cost to the broader economy, some economic costs (i.e. the reduction in economic activity during studies) have been captured. However, this is likely to be an underestimate of the full economic costs associated with university teaching. For instance, any deadweight loss from government funding of university teaching, and the opportunity cost of the land and buildings provided by the state government, have not been captured.

Teaching and scholarship costs

Deloitte Access Economics (2019) collected and analysed data on the cost of delivering higher education – the costs of teaching and scholarship – at Australia's public university based on a sample of 25 universities. This was intended to build and develop the evidence-base on the cost of providing higher education for the Department of Education. It was estimated that the average cost of bachelor teaching and scholarship per Equivalent Full-Time Student Load (EFTSL) was $17,300 in 2017, across the sampled universities.

This captures costs associated with: lecturing, tutoring, demonstrating, reading and preparation for classes (lecture and tutorial content, handouts, workbooks, placing material on the Web, laboratories), all forms of marking and assessment, discussion and feedback to students (both face-to-face and electronically), administration of subjects, course advice and enrolment, organisation and supervision of practicum (including work experience and excursions), supervision of Honours students and committee work related to teaching.

Beyond these costs explicitly related to teaching and scholarship, it is possible that some research activity (and costs) indirectly support the co-production of teaching. While they have not been attributed as a part of this analysis, any allocation would increase the total costs associated with university teaching.

Based on the annual estimates, this represents **an average teaching cost of approximately $57,000 per undergraduate completion** (in 2019 dollars, discounted at 7% per annum).[18]

The analysis assumes that any student contribution to higher education funding (which is covered under HECS-HELP) is directed towards teaching and learning. Based on the 'maximum student contribution' weighted by undergraduate commencements in 2018, this represents $9,000 per annum, or $28,000 for a qualification (Department of Education, Skills and Employment, 2019d). **The remaining $29,000 is funded directly by the government** though the Commonwealth Grant Scheme.

Associated resource and administrative costs

In the strictest sense, the HECS-HELP system represents a transfer between the government and students, which does not affect the total costs of higher education teaching estimated above.

[18] It is assumed that the student has the average EFTSL load for domestic students and completes his or her course at average completion rates based on 2018 statistics (Department of Education, Skills and Employment, 2019a; 2019b). When not discounted, this represents a total cost of $71,320 per completion, or four years of EFSTL study.

However, the HECS-HELP system does generate additional financial costs that otherwise would not exist in a system where students (or the government) fully paid for university education upfront.

As no real interest is charged on HECS-HELP debt (it is indexed to the Consumer Price Index), there is a cost to the government from holding HECS-HELP debts as individuals repay them. Grattan Institute (2016) estimates that this represents an annual cost of 0.4% compared to the outstanding HECS-HELP debt. This figure has been adopted for the purposes of the analysis presented in this report. These interest subsidy costs are lower than historical levels (approximately 2.0% per annum), and any increases would increase total costs.

After accounting for the public teaching costs (which does not require additional resource costs), it is estimated that the HECS-HELP debt for each bachelor qualification completer will average $27,600 per completion (2019 dollars, discounted at 7% per annum).

Approximately 10% of students making contributions up front and do not incur interest subsidies (Universities Australia, 2018). The Australian Government estimates that 17% of total debt will not be repaid (Department of Education and Training, 2018).[19] It is assumed that the remaining students pay off their debt over nine years on average (Department of Education, Skills and Employment, 2019c). Consequently, **there is an interest subsidy of approximately $600 per undergraduate completion**, which is borne by the government. Further details on the assumptions are given in Appendix C

For those students who never repay their debt, the debt will ultimately be transferred to the government and become a public cost. This represents, on average, a transfer of $4,800 from the government to private individuals for each undergraduate completion.

Opportunity cost of further study

University students are likely to forego some income during their studies. The typical full-time student works 12 hours per week, while the typical part-time student works 30 hours per week during study periods (Universities Australia, 2018).

As a result of supplying less labour, earnings are expected to be on average $6,000 lower per student (in NPV terms) over their study period. This difference is relatively modest as this is based on *total earnings*, rather than the earnings for full-time workers, and the labour participation and employment of youths with no post-school qualifications tend to be relatively low, and comparable to the part-time labour provided by undergraduate students.

As on the benefits side, there are flow-on public costs resulting from a lower labour supply. Overall, GDP is expected to be on average **$18,000 lower per student during their studies** in NPV terms. The public cost is high relative to the private costs during a student's time in further studies. This is as high school graduates tend to be concentrated in capital intensive industries (such as manufacturing and construction), and fewer workers leads to less investment.

The financial and economic costs associated with university teaching are summarised in Table 2.2. **Each undergraduate completion is associated with a financial cost of $65,000, and an economic cost of $76,000.** Of this, $37,000 are public financial costs, and $47,000 are public economic costs.

This may be considered an underestimation of the true economic costs associated with the provision of higher education, as the deadweight loss (DWL) associated with the financing of public higher education contributions have not been considered.

[19] The analysis assumes that for students not repaying their debts, their loan sizes are similar to the average student.

Table 2.2: Average costs of domestic undergraduate teaching per completion (2019 dollars, NPV terms)

	Financial costs	Economic costs
Teaching and scholarship	$57,000	$57,000
Private costs	$28,000	$28,000
Public costs	$29,000	$29,000
Additional resource and administration	$600	$600
Private costs	-$4,800*	-$4,800
Public costs	$5,400	$5,400
Opportunity costs of further studies	$8,000	$18,000
Private costs	$6,000	$6,000
Public costs	$2,000	$12,000
Total	**$65,000**	**$76,000**
Private costs	$28,000	$28,000
Public costs	$37,000	$47,000

Source: Deloitte Access Economics (2020). A discount rate of 7% per annum has been used. Discrepancies may occur in totals due to rounding. *Private costs are negative due to doubtful HECS

Comparisons to other studies

The average cost of teaching and scholarship per EFTSL provided above are broadly consistent with other publicly available estimates.

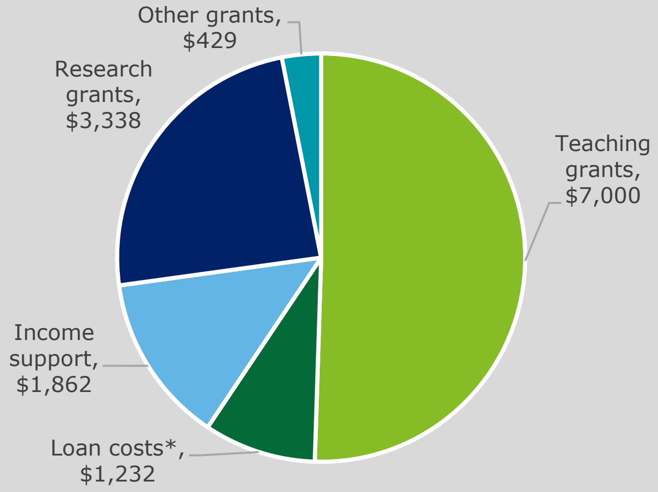
The Australian Council for Educational Research (2019) estimated that annual expenditure on bachelor and above education per full-time equivalent student was $29,595 (2015 dollars) in 2015. This includes:

- $17,262 in core educational services, which includes expenditure on teachers' salaries, teaching materials, books, construction and maintenance of school buildings and administration of schools.
- $11,237 in research and development, irrespective of whether the research is funded from general institutional funds or through separate grants or contracts from public or private funders.
- $1,097 in ancillary services, which refers to services provided by educational institutions to support the welfare of students, their families and their households, but which are peripheral to educational institutions' main educational mission (e.g. the provision of meals, health care, transportation, and housing).

These figures are inputs into the OECD publication *Education at a Glance*, which is referred to elsewhere in this report.

Grattan Institute (2018) estimated that public higher education subsidies in higher education equalled $13.9 billion in 2017-18. This included teaching grants through the Commonwealth Grant Scheme (CGS), loan costs, income support for students, research grants, and other grants (Chart 2.3). They additionally estimated that domestic student private higher education spending reached $6.7 billion in 2016. Together, this represents a total of $20.6 billion per annum in public higher education.

Chart 2.3: Public higher education subsidies, 2017-2018 ($m)



Source: Grattan Institute, (2018). *Loan costs only includes interest subsidies and debt not expected to be repaid.

While the report did not provide a per-student estimate associated with higher education, the costs represent approximately $27,600 per domestic EFTSL student (in 2018). When focusing on the costs directly associated with teaching (the private contributions and 85% of CGS funding), this represents an annual teaching cost of $17,000 per EFTSL. This is broadly consistent with the average cost of bachelor teaching and scholarship per EFTSL reported above.

2.3.2 Comparing the benefits and costs of university teaching

Based on the analysis outlined above, this study estimates there is an average economic cost of $76,000 per domestic undergraduate student in NPV terms. Based on the analysis in Section 2.1.1, an undergraduate qualification generates a gross market benefit of $330,000 in NPV terms over a domestic undergraduate student's working life.[20]

This represents a total market benefit of approximately $4 for each dollar of costs associated with undergraduate teaching and scholarship.

There is a degree of contention over the choice of discount rates when evaluating costs and benefits. While a discount rate of 7% has been recommended by the Office of Best Practice Regulation in Australia as it reflects the social opportunity cost of capital, it may not be appropriate in this case given that global interest rates are relatively low, and the benefits associated with higher education accrue over a long time horizon. Consequently, sensitivity analysis using a real discount rate of 3.5% per was completed.[21] Total market benefits would increase to $8 for each dollar of costs associated with undergraduate teaching and scholarship when using a 3.5% discount rate.

While this captures the full market economic benefits, not all economic costs have been captured. While a more skilled workforce will increase the size of the Australian economy, this benefit is not costless as the additional economic production requires the use of additional resources, such as

[20] In section 2.2, a net market benefit of $314,000 has been reported. However, this includes the costs from students spending time out of the labour force while studying. As this is now captured on the cost side (under opportunity costs of further studies), it is consequently removed.

[21] A discount rate of 3.5% reflects the social rate of time preference, which estimates the rate at which society is willing to trade present for future consumption. The social rate of time preference is generally estimated to be between 3.0% and 4.0%.

labour and capital. As they are used, they can no longer be used elsewhere in the economy. These foregone 'opportunity costs' are not captured in the direct production of university teaching.

Consequently, were the full costs captured, the returns to university teaching are likely to be lower. Recognising the uncertainty over cost estimates (both the range of teaching cost estimates provided above, and the underestimation of economic costs), results are shown to the closest integer.

Comparing the *public* financial benefits and costs, **each government dollar invested in university teaching is associated with a financial public benefit of $3.** The public financial benefits result from additional taxation from skilled graduates. Using a discount rate of 7%, each government dollar invested in university teaching is associated with a financial public benefit of $4.

Table 2.3: Costs and benefits associated with domestic undergraduate teaching (2019 dollars, NPV terms)

	Financial	Economic	Financial	Economic
	7% discount rate		3.5% discount rate	
Total costs and benefits				
Gross benefits of university teaching	$244,000	$330,000	$462,000	$663,000
Private benefits	$147,000	$147,000	$290,000	$290,000
Public benefits	$96,000	$183,000	$173,000	$373,000
Costs of university teaching	$65,000	$76,000	$72,000	$82,000
Private costs	$28,000	$29,000	$31,000	$35,000
Public costs	$37,000	$47,000	$41,000	$47,000

Source: Deloitte Access Economics (2020).

Comparisons to other studies

The OECD found that for a man attaining a bachelor's, master's and doctoral or equivalent level education, each dollar invested was associated with $4.89 in benefits. For a woman, it was $4.84.

These figures are conceptually closer to the financial costs and benefits presented by this report. On the costs side, they account for direct costs on education per student during the time spent in school, as well as the foregone earnings and taxes that result from the individual pursuing further studies. On the benefits side, they account for additional post-tax earnings and additional income taxation.

Focusing on public costs and benefits, the OECD found a public benefit of $5.37 for each public dollar invested in tertiary education for men; the public benefit was $4.48 for women.

However, the following conceptual differences make results incomparable:

- The OECD study includes the total costs associated with higher education, regardless of whether it is on research or teaching. Including research costs would increase annual expenditure on bachelor and above education per full-time equivalent student by 65%.
- Similar to the description of benefits in Section 2, the OECD figure uses a discount rate of 2% per annum and does not only capture the qualification effects. Consequently, this is likely to produce higher estimates compared to those reported in the present analysis, as while the costs are concentrated in the short term, the benefits accrue over a longer period.

3 Understanding the returns to university research

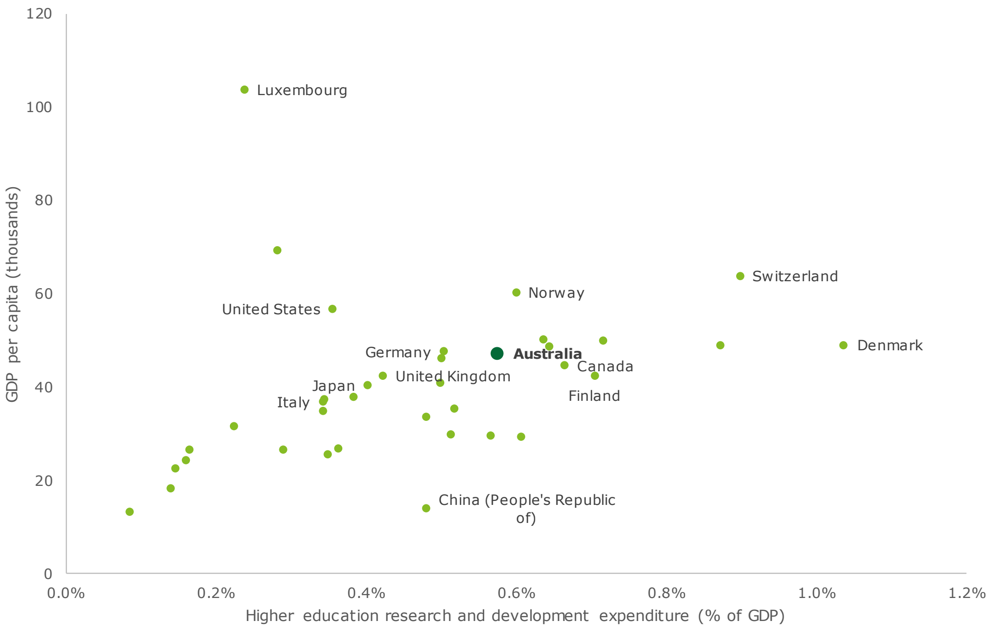
The other major channel through which universities impact economic growth and contribute to improvements in living standards is through their research. Accordingly, this section examines the contribution of Australian universities' research to the nation's productivity and economic growth. The results provided here comprise an update on analysis previously undertaken by Deloitte Access Economics and presented in its 2015 study for Universities Australia. The update benefits from both additional data and refinements to the underlying model and modelling methodology.

3.1 The contribution of research to national productivity and economic growth

Universities are leaders in research and development in our society. Through their investment and innovation in research and development, universities contribute to technological progress, creating knowledge spill-overs into the public and private sectors and driving productivity growth (Acs et al 1992; Bloom et al 2013; Jaffe, 1989).

As shown in Chart 3.1, there is a strong positive relationship between productivity and expenditure on university research and development. Countries that spend a higher percentage of their GDP on higher education research and development have, on average, higher levels of GDP per capita. Compared to other countries, Australia spends a relatively high percentage of GDP on higher education research and development.

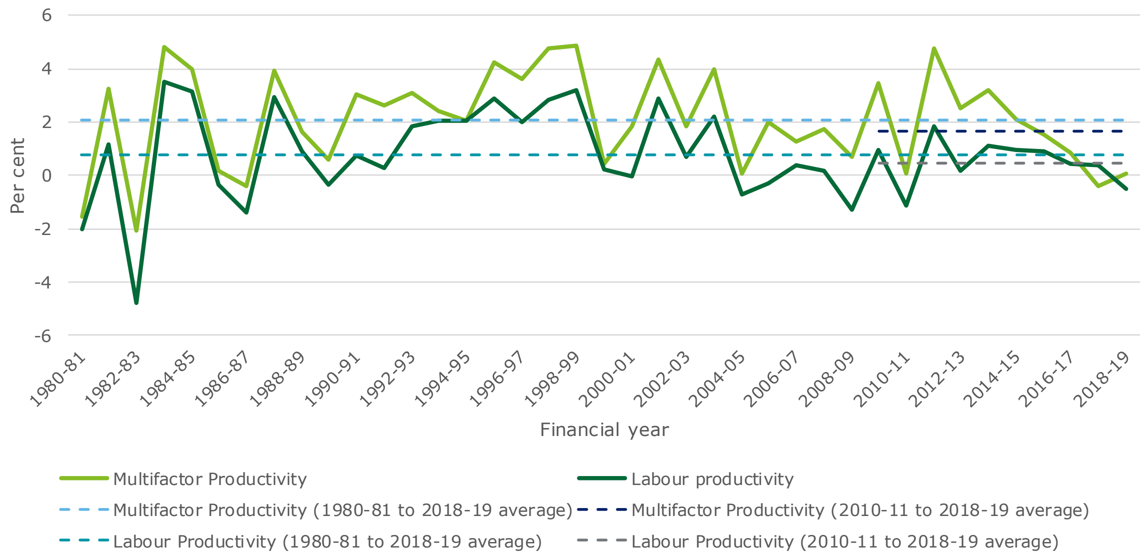
Chart 3.1: University research and per capita income across countries ($US 2015 PPP '000s), 2015



Source: Deloitte Access Economics (2020), OECD (2020).

It is well documented that Australia is in a period with low productivity growth (Birrell and McCloskey, 2019; Productivity Commission, 2019). Since recovering from the downturn of the Global Financial Crisis and end of the mining boom in 2011-12, measures of multifactor and labour productivity in Australia have been declining (see Chart 3.2). Universities can contribute significantly to productivity through their research and development activity, driving technological innovation for physical capital and increased human capital accumulation for labour productivity. Human capital is developed through improved skills, knowledge and intellectual resources from university research and development.

Chart 3.2: Multifactor and labour productivity growth in Australia



Source: Australian Bureau of Statistics (2019).

It is generally very difficult to reliably measure the exact returns from investments in university research and development. This arises from the fact that research can take a wide variety of forms, ranging from pure basic research to applied research and experimental development. University research also takes place across a broad range of fields, which generate a range of market and non-market benefits across different aspects of the economy and society (O'Mahony et al., 2019).

It can also be difficult to fully account for the attributable benefits of research, particularly when it is more foundational in nature. Foundational research can be a catalyst for further research and development that can have significant effects on technological innovation, often in unintended or unforeseen ways. In this context, the impacts of research and development can also take a long time to be fully realised, which can further complicate attempts to provide reliable measures of impact.

While the full spectrum of basic and applied research undertaken by universities can have positive impacts on the economy, research that is strategic and explicitly focused on achieving goals or impacts is most likely to generate observable economic contributions in the nearer term.[22]

There is a body of literature on the private and public returns to research and development that indicate a wide range of returns achieved from research investment, with varied levels of spill-over benefits to society.

For example, Bloom, Schankerman, and Van Reenen (2013) estimate a private rate of return to research and development of 21% and a social rate of return to research and development of 55%. The Productivity Commission has also produced a range of estimates. In one of its most statistically robust models, the Commission found the spill-over returns to domestic research and development averaging 50% (Productivity Commission, 2006). In other models, the Productivity Commission found higher returns of between 85-180%, although these models had wide

[22] See: Deloitte Access Economics (2015b), *The economic contributions of Australia's research universities – the UNSW example*, report prepared for UNSW. Available at: http://www.smartinvestment.unsw.edu.au/sites/default/files/documents/Economic%20contributions%20of%20UNSW%20-%20Final%20report%20-%20Deloitte%20Access%20Economic....pdf

confidence intervals and high levels of sensitivity to key assumptions (Productivity Commission, 2008). In a survey of the rates of return in the research and development literature, Dowrick (2003) surmised that the private return to firms is in the range of 20-30%; when spill-overs are accounted for in microeconomic studies, these gross returns are in the range of 30-40%; and in macroeconomic studies which cover the entire economy estimates range from 50% to over 100%.

Evidence from cross-country analysis

Consistent with the previous Deloitte Access Economics report, this study has used a cross-country macro-econometric model to estimate the contributions of higher education research and development to productivity growth. This approach utilises evidence of economic growth across countries and over time to identify the potential contribution that investments in university research and development make towards long-term economic growth.

This study's approach was based on the method used by Bassanini and Scarpetta (2001) in their OECD paper, and includes evidence from 37 countries over the period 1980 to 2015. The list of countries that are included in the model are provided in Table 3.1.

Table 3.1: List of countries included in the model

Country list					
Australia	Austria	Belgium	Canada	Chile	China
Czech Republic	Denmark	Estonia	Finland	France	Germany
Greece	Hungary	Iceland	Ireland	Israel	Italy
Japan	Korea	Luxembourg	Mexico	Netherlands	New Zealand
Norway	Poland	Portugal	Russia	Slovak Republic	Slovenia
South Africa	Spain	Sweden	Switzerland	Turkey	United Kingdom
United States					

Source: Deloitte Access Economics (2020).

In this model, the key dependent variable is GDP per capita. To account for other factors that explain changes in economic growth over time, key explanatory variables include:

- gross capital formation as a share of GDP
- tertiary education attainment as a proportion of those who are aged 15 and above
- expenditure on higher education research and development per capita
- expenditure on other research and development per capita – *this study's key variable of interest*
- total exports and imports as a percentage of GDP.

This is consistent with Bassanini and Scarpetta's (2001) approach and accounts for other factors to allow a more accurate estimate of the effect of higher education research and development on productivity growth. However, this model is limited by the lack of the data as not all countries report capital formation and research and development spending on a yearly basis. A full description of this model and methodology is provided in Appendix A.

The results from this study suggest that a permanent 1% increase in the level of investment in higher education research and development per capita in Australia will lead to a 0.13 percentage point increase in multifactor productivity (MFP) growth in the long-term. This is equivalent to a

$2.4 billion annual increase in Australia's GDP over the long-term, due to an additional 1% permanent increase in higher education research and development expenditure. As a comparison, Australia's MFP has been growing at an average of 2.1% per annum over the last 40 years (see Chart 3.2). This illustrates the importance of investment in university research and its potential role in helping lift Australia's productivity growth back towards the long-term average.

The effect of investment in higher education research and development on MFP is relatively similar to previously reported results from Deloitte Access Economics (2015a) (0.15 to 0.2 percentage point increase in MFP growth). Changes are largely driven by the increased data availability from an updated data set and an extra five years included in the analysis. However, the results from this study are consistent with findings from the Productivity Commission (2007) for Australia but slightly lower than the elasticity estimate previously reported for OECD countries (Guellec and van Pottelsberghe, 2001), as outlined in Table 3.2 below.

Table 3.2: Previous findings in the literature

Study	Estimated results
Deloitte Access Economics (2015a)	A 1% increase in higher education research and investment spending will increase productivity by 0.15 to 0.2 percentage points.
Productivity Commission (2007)	Estimates of the responsiveness of GDP or MFP to a 1% change in research and development typically fall between 0.05% and 0.45%.
Guellec and van Pottelsberghe (2001)	A 1% increase in government and university-performed research spending will increase MFP by around 0.17 percentage points.

Source: Deloitte Access Economics (2020).

3.2 Costs and benefits of university research

This section presents the benefits of investment in Australian university research and development to the Australian economy alongside the historical costs of this investment. These benefits are based on the contribution of university research and development to national productivity growth outlined above.

The benefits from university research and development are realised in many ways. One of the most measurable ways that the benefits accruing to the economy are captured is through increases to Australia's GDP. Of course, as discussed above, these benefits are not realised immediately. Indeed, they may take many years—even decades—to fully materialise. So, any attempts to analyse the benefits of university research must take a sufficiently long-time horizon.

In calculating the return on investment, the effects of additional investments in university research and development over the past 30 years are simulated using the estimated elasticity outlined above, with transitional dynamics simulated using the estimated economic convergence term from the model. This convergence term provides an estimate of how quickly the economy reacts to changes in the underlying fundamentals, such as productivity associated with university research and development. Further detail on these calculations are provided in Appendix B of this report.

To calculate the return on investment from Australian university research and development activity, benefits must be calculated and translated into dollar figures. The NPV of the total benefit is divided by the NPV of the total cost—measured as the sum of yearly spend on university research and development—to calculate the return on investment figure.[23] This is calculated for the period from 1985 to 2015.[24]

As outlined above, the results of the estimated cross-country model indicate that a permanent 1% increase in the level of higher education research in Australia can increase multifactor productivity growth by 0.13 percentage points. On this basis, the effects of historical investment in university research and development suggest that for each dollar of expenditure over the past 30 years, economic output (GDP) grew by around $5 in present value terms.[25]

The estimated elasticity of university research with respect to economic output applies to the average level of R&D expenditure per capita across the countries included in the growth model. To the extent that elasticity effects diminish as per capita spending on university R&D increases this elasticity may be an overestimate when applied to marginal estimates in Australia.

Expenditure on R&D represents a proxy for the stock of knowledge attributed to university research that exists in the economy. As such, marginal effects of ongoing expenditure on R&D may also represent the ongoing contributions of this stock of knowledge, and therefore overestimate the effects of marginal increases in R&D expenditure that occur in the short run.

Nevertheless, these estimates of the long-term macroeconomic impact of university research output clearly demonstrate a strong relationship between university research and economic growth. However, they reveal little of the mechanisms by which the impacts occur, or the pre-conditions necessary to ensure that such benefits are realised. As such, these effect sizes cannot be reliably applied generally to individual research activities for the purposes of estimating economic impacts.

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[23] The net present value is used to discount the value of the research in future years back to when the investment first occurs.

[24] A discount rate of 7% was used in the NPV calculations.

[25] This is consistent with the findings from a previous Deloitte Access Economics (2015), *The economic contributions of Australia's research universities – the UNSW example*, falling within the range of a 5 to 10 dollars increase in GDP per capita for every dollar invested in higher education research and development, utilising a similar methodology.

4 Concluding observations

- Classic measures of economic contribution illustrate the footprint of universities as major employers in the Australian economy. However, they do not capture the primary value that universities bring to our economic and social prosperity.
- The primary measures of value reaffirm higher education as transformative for individuals and a major contributor to growth in living standards
    - They show that high quality university education delivers sizeable benefits and handsome investment returns for both individuals and society.
    - These returns are maximised where universities optimise their operations and where enrolment patterns align closely with the ever-evolving needs of the economy and society.
        - Continued pursuit of both operating efficiency and optimal curriculum design is important to returns being sustained and, where possible, enhanced.
- The findings also reaffirm the major influence university research has on productivity and economic growth.
    - They show that investments in university research and development continue to be fundamental to driving productivity and economic growth.
    - At the same time, they reiterate that, in a climate where recent prosperity drivers like the mining boom continue to wane and productivity growth remains sluggish, investment in research and development has a critical role to play in driving growth in living standards.
        - Owing to its very nature, the returns to university research—like all research—are variable. They are maximised where research endeavour is connected with business, industry and society – and where transmission mechanisms are clear and effective. Orientation toward the drivers that maximise return remains important.
- Recognising that change is a constant, the environment in which Australian universities operate is on the cusp of – perhaps even amidst – a period of much change.
    - There has been continued and sustained change to the composition of Australia's economy, the role of labour therein and the requisite skills and capability of workers.[26]
    - But, perhaps most significantly, considerable change is occurring to the policy and regulatory environment in which universities operate.
        - Reviews like the review of the Australian Qualification Framework, the review of the Higher Education Provider Category Standards, the *Joyce Review* of the VET system and the *Shergold Review* of Senior Secondary Pathways are impacting what is permissible, what is enabled and what is encouraged.
- By any measure, the university sector plays a major role in driving living standards – not just among those who interact with it directly, but across society more widely. The pace at which is economic contribution and significance increases will be determined by its success in adapting in ways aligned with the drivers of its value as the environment in which it operates evolves.

[26] See, for example: https://www2.deloitte.com/au/en/pages/building-lucky-country/topics/building-lucky-country.html

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Appendix A: Economic contribution analysis

Economic contribution studies are intended to quantify measures such as value added, exports, imports and employment associated with a given industry or firm, in a historical reference year. The economic contribution is a measure of the value of production by a firm or industry.

All direct, indirect and total contributions are reported as gross operating surplus (GOS), labour income, value added and employment (with these terms defined in Table A.1).

Table A.1 Definitions of economic contribution estimates

Estimate	Definition
Gross operating surplus (GOS)	GOS represents the value of income generated by the entity's direct capital inputs, generally measured as the earnings before interest, tax, depreciation, and amortisation (EBITDA).
Labour income	Labour income is a subcomponent of value add. It represents the value of output generated by the entity's direct labour inputs, as measured by the income to labour.
Value added	Value added measures the value of output (i.e. goods and services) generated by the entity's factors of production (i.e. labour and capital) as measured in the income to those factors of production. The sum of value added across all entities in the economy equals gross domestic product. Given the relationship to GDP, the value added measure can be thought of as the increased contribution to welfare.
Employment (FTE)	Employment is a fundamentally different measure of activity to those above. It measures the number of workers (measured in full-time equivalent terms) that are employed by the entity, rather than the value of the workers' output.
Direct economic contribution	The direct economic contribution is a representation of the flow from labour and capital committed in the economic activity.
Indirect economic contribution	The indirect contribution is a measure of the demand for goods and services produced in other sectors as a result of demand generated by economic activity.
Total economic contribution	The total economic contribution to the economy is the sum of the direct and indirect economic contributions.

Source: Deloitte Access Economics

Definitional notes

When calculating the GOS for a typical for-profit firm or industry, income streams from government (such as transfers or production subsidies) are excluded as they are a transfer of public funds, not reflective of income generated by the activities of the firm or industry. However, for non-profit organisations providing a service that generates external, non-use benefits that are not reflected in market prices, government transfers are included in the GOS calculation as they are fundamental to ongoing operations. Similarly, value added is typically calculated as GOS plus labour income net of subsidies; under the ABS Australian System of National Accounts (ASNA) (ABS 2013):

A subsidy on a product is a subsidy payable per unit of a good or service. An enterprise may regard a subsidy as little different from sales proceeds. However, in the national accounts, subsidies are regarded as transfer payments from general government, enabling enterprises to sell their output for less than would otherwise be the case.

It is important to distinguish non-profit organisations from the national accounting definition of a subsidy. As above, a non-profit organisation provides a service that generates external, non-use benefits that are not reflected in market prices; as such government funding is essentially a payment for a service (not a transfer). This funding mechanism is distinctly different from the ASNA definition of a subsidy, which focusses on subsidies per unit of production or sales. This type of 'subsidy' is, therefore, not considered an offsetting factor in the value added calculation.

Value added

The measures of economic activity provided by this contribution study are consistent with those provided by the Australian Bureau of Statistics. For example, value added is the contribution the sector makes to total factor income and gross domestic product (GDP).

There are a number of ways to measure GDP, including:

- expenditure approach – measures expenditure: of households, on investment, government and net exports; and
- income approach – measures the income in an economy by measuring the payments of wages and profits to workers and owners.

Below is a discussion measuring the value added by an industry using the income approach.

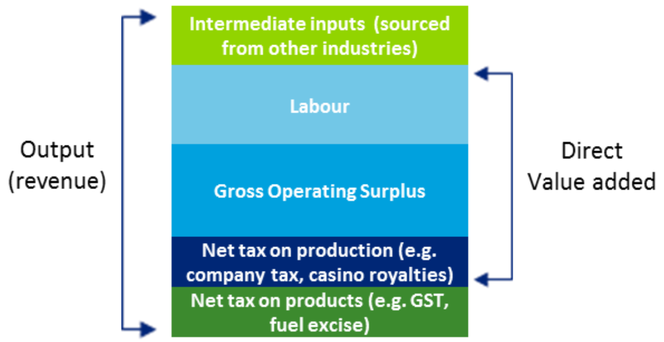
Measuring the economic contribution – income approach

There are several commonly used measures of economic activity, each of which describes a different aspect of an industry's economic contribution:

- **Value added** measures the value of output (i.e. goods and services) generated by the entity's factors of production (i.e. labour and capital) as measured in the income to those factors of production. The sum of value added across all entities in the economy equals gross domestic product. Given the relationship to GDP, the value added measure can be thought of as the increased contribution to welfare.
  Value added is the sum of:
  - Gross operating surplus (GOS) represents the value of income generated by the entity's capital inputs, generally measured as the earnings before interest, tax, depreciation and amortisation (EBITDA).
  - Tax on production less subsidy provided for production. Note: given the manner in which returns to capital before tax are calculated, company tax is not included or this would double-count that tax. In addition, it excludes goods and services tax, which is a tax on consumption (i.e. levied on households).
  - Labour income is a subcomponent of value added. It represents the value of output generated by the entity's direct labour inputs, as measured by the income to labour.

Figure A.1 shows the accounting framework used to evaluate economic activity, along with the components that make up *output*. Output is the sum of value added and the value of intermediate inputs used by the firm or industry.

Figure A.1 Economic activity accounting framework



Source: Deloitte Access Economics

Contribution studies generally outline employment generated by a sector. Employment is a fundamentally different measure of activity to those above. It measures the number of workers that are employed by the entity, rather than the value of the workers' output.

Direct and indirect contributions

The **direct** economic contribution is a representation of the flow of labour and capital in the economic entity.

The **indirect** contribution is a measure of the demand for goods and services produced in other sectors as a result of demand generated by the direct economic activity of the economic entity. Estimation of the indirect economic contribution is undertaken in an input-output (IO) framework using Australian Bureau of Statistics IO tables which report the inputs and outputs of specific sectors of the economy (ABS 2018).

The total economic contribution to the economy is the sum of the direct and indirect economic contributions.

Other measures, such as total revenue or total exports are useful measures of economic activity, but these measures alone cannot account for the contribution made to GDP. Such measures overstate the contribution to value added because they include activity by external firms supplying inputs. In addition, they do not discount the inputs supplied from outside Australia.

Limitations of economic contribution studies

While describing the geographic origin of production inputs may be a guide to a firm or industry's linkages with the local economy, it should be recognised that these are the type of normal industry linkages that characterise all economic activities.

Unless there is unused capacity in the economy (such as unemployed labour) there may not be a strong relationship between a firm's economic contribution as measured by value added (or other static aggregates) and the welfare or living standard of the community. The use of labour and capital by demand created from the industry comes at an opportunity cost as it may reduce the amount of resources available to spend on other economic activities. This is not to say that the economic contribution, including employment, is not important. As stated by the Productivity Commission in the context of Australia's gambling industries: (Productivity Commission 1999):

> *Value added trade and job creation arguments need to be considered in the context of the economy as a whole … income from trade uses real resources, which could have been employed to generate benefits elsewhere. These arguments do not mean that jobs, trade and activity are unimportant in an economy. To the contrary they are critical to people's well-being. However, any particular industry's contribution to these benefits is much smaller than might at first be thought, because substitute industries could produce similar, though not equal gains.*

In a fundamental sense, economic contribution studies are simply historical accounting exercises. No 'what-if', or counterfactual inferences – such as 'what would happen to living standards if the firm or industry disappeared?' – should be drawn from them.

The analysis – as discussed in the report – relies on a national IO table modelling framework and there are some limitations to this modelling framework. The analysis assumes that goods and services provided to the sector are produced by factors of production that are located completely within the state or region defined and that income flows do not leak to other states.

The IO framework and the derivation of the multipliers also assume that the relevant economic activity takes place within an unconstrained environment. That is, an increase in economic activity in one area of the economy does not increase prices and subsequently crowd out economic activity in another area of the economy. As a result, the modelled total and indirect contribution can be regarded as an upper-bound estimate of the contribution made by the supply of intermediate inputs.

Similarly, the IO framework does not account for further flow-on benefits as captured in a more dynamic modelling environment like a Computerised General Equilibrium (CGE) model.

Input-output analysis

Input-output tables are required to account for the intermediate flows between sectors. These tables measure the direct economic activity of every sector in the economy at the national level. Importantly, these tables allow intermediate inputs to be further broken down by source. These detailed intermediate flows can be used to derive the total change in economic activity associated with a given direct change in activity for a given sector.

A widely used measure of the spill-over of activity from one sector to another is captured by the ratio of the total to direct change in economic activity. The resulting estimate is typically referred to as 'the multiplier'. A multiplier greater than one implies some indirect activity, with higher multipliers indicating relatively larger indirect and total activity flowing from a given level of direct activity.

The IO matrix used for Australia is derived from the ABS 2017-18 IO tables, the latest available IO data at the time of the analysis. The industry classification used for IO tables is based on the Australian and New Zealand Standard Industrial Classification (ANZSIC), with 114 sectors in the modelling framework.

Appendix B: Estimating the return on research

B.1. Estimating the effect of higher education research and development on productivity

In line with a large body of economic development literature, this report seeks to estimate the effects of higher education research and development (R&D) on economic growth using a neo-classical production function. The formal framework is first set out by Mankiw et al (1992) with an augmented-form implemented by Bassanini and Scarpetta (2001). The models used in this report adhere closely to this literature, with modifications provided to accommodate the focus on higher education R&D. The standard neo-classical growth model is derived from a constant returns to scale production function with three inputs (capital, labour and human capital) that are paid their marginal products. Production (output) at time t is given by:

$$Y(t) = K(t)^{\alpha}H(t)^{\beta}\big(A(t)L(t)\big)^{1-\alpha-\beta}$$

Where Y, K, H and L are respectively output, physical capital, human capital and labour, α is the partial elasticity of output with respect to physical capital, β is the partial elasticity of output with respect to human capital and $A(t)$ is a measure of technological progress, $\Omega(t)$ and economic efficiency, $I(t)$.

$$A(t) = I(t)\Omega(t)$$

This research incorporates higher education R&D along with other R&D activities and exposure to international trade as key determinants of economic efficiency $I(t)$ embodied in $V_j(t)$.

$$\ln I(t) = p_0 + \sum_j p_j \ln V_j(t)$$

Technological progress is assumed to be exogenous and grows at rate $g(t)$.

$$\dot{\Omega(t)} = g(t)\Omega(t)$$

Substituting the steady-state values of physical capital and human capital yields the intensive form of steady-state output as a function of h^*.[27]

$$\ln(y^*) = \ln\Omega(t) + p_0\sum_j p_j \ln V_j(t) + \frac{\alpha}{1-\alpha}\ln s_k(t) + \frac{\beta}{1-\alpha}\ln h^*(t) - \alpha(1-\alpha)\ln(g(t)+n(t)+d)$$ [28]

The above is valid in empirical cross-country analysis only if countries are in their steady states or if deviations from steady state are independent and identically distributed. If observed growth rates include out-of-steady-state dynamics, then the transitional dynamics have to be modelled explicitly (Bassanini and Scarpetta, 2001). A linear approximation of the transitional dynamics can be expressed as follows (Mankiw et al, 1992):

[27] The steady-state stock of human capital h^* is not observed, it can be expressed as a function of actual human capital: $\ln h^*(t) = \ln h(t) + \frac{1-\psi}{\psi}\Delta\ln\left(\frac{h(t)}{A(t)}\right)$

[28] Where y^* is the steady-state output per capita, s_k is the investment rate in physical capital, $n(t)$ is the population growth rate, and d is the rate of depreciation.

$$\Delta \ln y(t) = -\phi(\lambda) \ln y(t-1) + \phi(\lambda)\left(\frac{\alpha}{1-\alpha}\right) \ln s_k(t) + \phi(\lambda)\left(\frac{\beta}{1-\alpha}\right) \ln h(t) + \sum_j p_j \phi(\lambda) \ln V_j(t) + \frac{1-\psi}{\psi}\left(\frac{\beta}{1-\alpha}\right) \Delta \ln h(t) - \phi(\lambda)\left(\frac{\alpha}{1-\alpha}\right) \ln(g(t) + n(t) + d) + \left(1 - \frac{\phi(\lambda)}{\psi}\right) g(t) + \phi(\lambda)(p_0 + \ln \Omega(0)) + \phi(\lambda) g(t) t$$

This equation represents the generic functional form that has been empirically estimated in this research. Further, the coefficient $\phi(\lambda)$ represents the convergence parameter. The convergence parameter captures the speed in which countries converge to their steady-state output.

In addition to estimating the steady state solutions, the analysis also estimate another functional form, adding short-term dynamics to the model. This augmentation is advantageous as it relaxes the assumption that countries are in their steady states and that deviations from the steady state are independent and identically distributed. Its functional form can be expressed as follows:

$$\Delta \ln y(t) = \alpha_0 - \phi \ln y(t-1) + \alpha_1 \ln s_k(t) + \alpha_2 \ln h(t) - \alpha_3 n(t) + \alpha_4 t + \sum_{j=1}^{3} a_{j+4} \ln V_j + b_1 \Delta \ln s_k(t) + b_2 \Delta \ln h(t) + b_3 \Delta \ln n(t) + \sum_{j=1}^{3} b_{j+3} \Delta \ln V_j$$

Similar to specifications used in Bassanini and Scarpetta (2001), this analysis uses a sample of 37 countries between 1980 and 2015 (Table B.1). Where appropriate, data is converted to constant 2015 US dollars using constant Purchasing Power Parity to allow for better comparability across countries.

Table B.1: List of countries included in the sample

Country list					
Australia	Austria	Belgium	Canada	Chile	China
Czech Republic	Denmark	Estonia	Finland	France	Germany
Greece	Hungary	Iceland	Ireland	Israel	Italy
Japan	Korea	Luxembourg	Mexico	Netherlands	New Zealand
Norway	Poland	Portugal	Russia	Slovak Republic	Slovenia
South Africa	Spain	Sweden	Switzerland	Turkey	United Kingdom
United States					

Source: Deloitte Access Economics (2020)

Table B.2 provides the variables included in the estimated model and the source for those variables. In the model, not all countries provide data for tertiary education attainment, higher education and other research and development expenditure on a yearly basis. The data points for the missing years of the relevant countries are interpolated using cubic splines. The model has also been updated to contain two dummy variables for 2008 and 2009 instead of a trend term as the coefficients for these variables are statistically significant.[29]

[29] Previously, the coefficient reported on the trend term was not statistically significant.

Table B.2: List of variables included in the model

Variable	Source
Gross domestic product	OECD
Tertiary education attainment (% of 15+ population)	Barro-Lee (2010)
Total population growth	OECD
Gross capital formation (% of GDP)	World Bank
Expenditure on higher education R&D per capita	OECD
Expenditure on other R&D per capita	OECD
Exports and imports of goods and services (% of GDP)	World Bank
2008 dummy variable	
2009 dummy variable	

Source: Deloitte Access Economics (2020).

Table B.3 presents the results from the model.

Table B.3: Modelling results from model including short term dynamics

Parameter	Coefficient value
$\ln y(t-1)$	-0.0426***
$\ln s_k(t)$	1.273***
$\ln h(t)$	0.0167
$n(t)$	-27.48***
$V_1(H\ R\&D)$	0.126*
$V_2(O\ R\&D)$	0.0900
$V_3(Trade)$	0.600***
$\Delta \ln s_k(t)$	0.142***
$\Delta \ln h(t)$	-0.0125
$\Delta\, n(t)$	0.354
$\Delta\, V_1(H\ R\&D)$	0.00227

$\Delta V_2(O\ R\&D)$	0.0359***
$\Delta V_3(Trade)$	-0.00222

Note: *p<0.10, **p<0.05, ***p<0.01. Reported coefficients are transformed to exclude the convergence term per their functional form. Dummy variables for 2008 and 2009 were also included as controls but are not reported here.

Source: Deloitte Access Economics (2020).

B.1.2. Elasticities

The model coefficients can be interpreted as an elasticity on steady-state GDP. For example, the effect of higher education research and development on steady-state GDP has the functional form of ϕp_j where the convergence parameter, ϕ, is the estimated coefficient for $\ln y(t-1)$. p_j then represents the elasticity of higher education research and development on steady-state output, which is estimated to be 0.126 in our model. This implies that a 1% increase in higher education research and development expenditure per capita will increase steady-state output by 0.126 percentage points.

B.1.3. Convergence parameter

The convergence parameter ϕ plays an important role in explaining the results. The statistical significance of the convergence parameter, which is the estimated coefficient for $\ln y(t-1)$, suggests a conditional process of convergence and the rate of which countries move towards their steady-state output levels. The convergence term is estimated to be -0.0426, which indicates that the economies will close 4.26% of the gap between their current and steady-state levels of output. The convergence process is asymptotic, meaning that countries will never truly reach their steady-state levels but rather move very close to it.

B.1.4. Model limitations

All models are limited by the quality of the data inputs available and the cross-country econometric model is no exception. As mentioned previously, higher education and other research and development data is not available on a yearly basis for all countries included in the model. For example, between 2000 and 2010, Australia only provided higher education research and development expenditure data to the OECD for every second year, skipping the odd-numbered years. Barro-Lee data on tertiary education attainment (which is used to estimate the human capital term) provides observations on five-year intervals (i.e. data points are only given for 1980, 1985, 1990 etc.). For these datasets, a cubic spline was used to interpolate the values for the years with missing data. As a result, the estimates provided in the model are an approximation and would have wider confidence intervals than the true estimate.

Another data quality issue is the revision of historical datasets. The OECD data used in the estimation draws on national account numbers provided by OECD countries themselves. As governments can change the methodology for the calculation of national account numbers, historical data can be revised, and the new series will be provided to the OECD. Some of the underlying GDP data for the cross-country model have been revised since the 2015 report, driving some of the differences in the results here relative to the 2015 report.

Further, there is an additional five years of data included in all datasets in our updated cross-country model compared results in the 2015 report. This has driven most of the differences in the coefficients when compared to the 2015 report, indicating that the relationships estimated by the model have changed with the inclusion of additional years of data.

The tertiary human capital attainment coefficient in the cross-country model is not statistically significant, which is different when compared to the 2015 report. However, the data underlying this variable is only available to 2010 and thus estimates to 2015 are imputed. This is likely to create a degree of measurement which creates attenuation, that is, the measurement error may bias the coefficient towards zero. Thus limited conclusions can be drawn in respect of the change in the coefficient on human capital. The size and statistical significance of the coefficient is also sensitive to the inclusion of other explanatory variables and the updated dataset used in the model. For example, the inclusion of the short run physical capital term captures some of the effects of the human capital, as does the inclusion of tertiary education research and development. This suggests that the contribution of human capital accumulation to GDP may be captured by other mechanisms such as accumulation of physical capital or research and development by the university sector. Further research is needed to untangle the nature of these relationships and potential independencies which was not the primary focus of the modelling here.

B.2. Estimating the return on investment of higher education research and development

To estimate the return on investment of higher education research and development, its costs and benefits are estimated over a 30 year period between 1985 and 2015. The calculation draws on the results from the cross-country econometric model.

Total costs are calculated using annual higher education research and development expenditure data from the OECD. This is the same expenditure data which is used in the cross-country model. Similar to the cross-country model, the years with missing expenditure data was interpolated using cubic splines. The net present value of the additional cost of higher education research and development funding for each year is calculated and summed over all years to derive the total cost.[30]

To calculate the benefits, the higher education research and development expenditure on steady-state GDP elasticity and the convergence term from the econometric model is used to derive the percentage increase in steady-state GDP per year from university research.[31] The model assumes that not all the benefits are realised in the year that the expenditure occurs and accounts for this by gradually phasing in the percentage increase in steady-state GDP over the 30 years. The annual increase is then multiplied by the annual GDP figure to obtain the level of growth due to higher education research and expenditure. Similar to the costs approach, the net present value of the additional benefit of higher education research and development expenditure for each year is calculated. This is done to discount the value of the benefits of research in later years as the benefits of the research will have a more significant impact closer to release than in later years. The sum of the net present values for all years is calculated to obtain the total benefits figure.

The final return on investment figure is obtained by dividing the discounted benefits of higher education research and development by the costs.

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[30] All calculations use a discount rate of 7%. The first year discounted is the year in which the expenditure was incurred.
[31] This is done by multiplying the percentage change in research funding per capita by the elasticity of higher education research and development.

Appendix C: Benefits of university teaching modelling approach

This appendix provides further detail on the empirical approaches, data transformations, and intermediate findings of the econometric analysis undertaken in this study to determine the private and public benefits associated with university qualifications.

C.1. Estimating the private benefits of university teaching

C.1.1. Overview of the modelling approach

Following the approach used in Deloitte Access Economics (2016), micro-econometric modelling was conducted to separate the contribution of a university qualification to an individual's outcomes from that of other factors. The three models include:

- Earnings (conditional on employment)
- Employment (conditional on being in the labour force)
- Participation in the labour force.

This was conducted using the Household, Income and Labour Dynamics in Australia (HILDA) Survey (pooled from wave 1 to wave 16), which is a longitudinal survey that examines broad social and economic factors, with a particular focus on family, household formation, income and work.

The dataset was used as it includes a rich set of information on individuals' employment and wage outcomes over time, and includes information on their qualification levels, and other factors that may affect their labour market outcomes.

In addition to the key dependent variables of interest highlighted above, the following controls were included in each of the models:

- Education variables - including qualification level, field of education; and provider type.
- Controls for demographic characteristics - including age, gender, born in Australia, indigenous status, State of residence, ABS Remoteness Area, disability, English language proficiency, hours worked (earnings model), employment status (employment model), family type (employment model), and age of youngest child (employment model)
- Controls for cognitive ability (tested in Wave 12 of the HILDA survey) – including Backward Digits Span (BDS), Symbol Digits Modalities (SDM), and a shortened (25-item) version of the National Adult Reading Test (NART-25).

Consistent with other studies of this nature, the analysis was limited to those:

- Aged 25 to 64 years
- Had zero business income
- Reported details about their educational attainment and, if applicable, field of education; and
- Did not hold a doctorate (to exclude higher degree research degrees, noting that masters degrees by research are unable to be distinguished from masters degrees by coursework, and are hence included in the sample).

Any observations with any missing data were excluded.

C.1.2. Model specifications

Earnings model

The earnings model is specified as an 'augmented Mincer equation', based on Mincer's (1974) seminal work on the effects of education on wages and taking into account the key variables detailed above. The estimated equation is given by:

$$\log_e w_{it} = \beta_0 + \beta_1 E_{it} + \beta_2 X_{it} + \beta_3 \theta\theta_{it} \ + \gamma_t + \epsilon_{it}$$

where:

- w_{it} is the wage of individual i at time t and $\log_e$ means natural logarithm
- E_{it} is a vector of educational characteristics (qualification level, field of education)
- X_{it} is a vector of individual characteristics (including demographic characteristics and cognitive ability)
- θ_{tit} is a vector including the natural logarithm of hours worked and a dummy for whether the individual was employed full-time
- γ_t is a year fixed effect
- ϵ_{it} is a random error.

Employment model

The second part of this modelling examines the effect of higher education (including qualification level and field of education) on the likelihood of an individual participating in the labour force to be employed.

This propensity is estimated using a linear probability model, which isolates the effect of higher education and controls for other explanatory characteristics. The functional form of this equation is shown below:

$$\Pr(Employed_{it} = 1 \mid Participation_{it} = 1) = \alpha_0 + \alpha_1 E_{it} + \alpha_2 X_{it} + \gamma_t$$

where:

- $Employed$ is a dummy variable that equals one if individual i at time t is employed and equals zero if they are not employed
- $Participation$ is a dummy variable that equals one if individual i at time t is participating in the labour force and equals zero if they are not
- E_{it} is a vector of educational characteristics (qualification level, field of education)
- X_{it} is a vector of individual characteristics (including demographic characteristics and cognitive ability)
- γ_t is a year fixed effect.

Participation model

The participation model similarly uses a linear probability model to isolate the effect of higher education (and other explanatory variables) on the likelihood of an individual participating in the labour force. The functional form of the equation is shown below:

$$\Pr(Participation_{it} = 1\ ) = \alpha\gamma_0 + \gamma_1 E_{it} + \gamma_2 X_{it} + \gamma_t$$

where:

- $Participation$ is a dummy variable that equals one if individual i at time t is participating in the labour force and equals zero if they are not
- E_{it} is a vector of educational characteristics (qualification level, field of education)
- X_{it} is a vector of individual characteristics (including demographic characteristics and cognitive ability)
- γ_t is a year fixed effect.

The γ's are parameters to be estimated and the data is obtained by pooling across the waves of HILDA data. Standard errors are clustered at the individual level, to account for the likelihood that the outcomes of each individual (and hence error terms) are highly correlated over time.

C.1.3. Results

Table C.1 summarises the results of the earnings model.

Table C.1: Coefficient estimates on log weekly wages of employed graduates

Dependent variable: Log weekly wages	Education and labour force controls only (1)	Adding demographic controls (2)	Full model, adding cognitive ability controls (3)
Qualification level			
Postgraduate	0.368***	0.336***	0.248***
Bachelor	0.281***	0.253***	0.170***
Sub-bachelor	0.117***	0.101***	0.067*
Certificate III/IV	-0.005	-0.013	-0.048
Field of Education			
Science	0.024	0.030	0.010
IT	0.125*	0.096	0.076
Engineering	0.070	0.064	0.085*
Medicine	0.176	0.176	0.118
Nursing	0.243***	0.281***	0.309***
Other Health	0.044	0.061	0.082
Education	0.098***	0.118***	0.119***
Management and Commerce	0.093***	0.079**	0.080**
Law	0.241***	0.221***	0.215***
Food and Hospitality	-0.139**	-0.150**	-0.133*
Labour force characteristics			
Employed full-time	0.301***	0.279***	0.260***
Log hours worked	0.749***	0.731***	0.757***
Demographics			
Aged 30-34		0.031**	0.041**
Aged 35-39		0.045**	0.048**
Aged 40-44		0.035*	0.021
Aged 45-49		0.036*	0.017
Aged 50-54		-0.005	-0.008
Aged 55-59		-0.080***	-0.100***
Aged 60-64		-0.114***	-0.148***
Male		0.054***	0.073***
Not born in Australia		0.069***	0.047*
Indigenous		0.077*	0.150***
Has long-term health condition		-0.114***	-0.073***
Low English language proficiency		-0.243***	-0.169
Cognitive ability			
Backward Digits Span (BDS)			0.005
Symbol Digits Modalities (SDM)			0.002*
National Adult Reading Test (NART-25)			0.016***

Source: Deloitte Access Economics. Note: *** represents significance at the 1% level; ** at the 5% level; and * at the 10% level. Base categories are: no post-school qualification, FoE Arts, and Aged 25-29. Coefficient estimates for: year fixed effects, state and remoteness area are not reported for brevity.

Table C.2 summarises the results of the employment and participation models.

Table C.2: Coefficient estimates on likelihood of employment (given participation), and likelihood of labour force participation of graduates

Explanatory variable	Employed, conditional on participation (1)	Labour force participation (2)
Qualification level		
Postgraduate	0.000	0.057***
Bachelor	0.002	0.038***
Sub-bachelor	-0.001	0.016
Certificate III/IV	-0.003	0.038***
Field of Education		
Science	0.011*	0.036**
IT	0.003	0.035**
Engineering	0.022***	0.037***
Medicine	-0.002	0.053*
Nursing	0.027***	0.105***
Other Health	0.020***	0.108***
Education	0.022***	0.063***
Management and Commerce	0.011**	0.047***
Law	0.012	0.034
Food and Hospitality	0.008	0.033
Demographics		
Aged 30-34	0.003	-0.001
Aged 35-39	0.010**	0.008
Aged 40-44	0.019***	0.001
Aged 45-49	0.024***	-0.011
Aged 50-54	0.028***	-0.040***
Aged 55-59	0.030***	-0.147***
Aged 60-64	0.030***	-0.348***
Male	0.004	0.095***
Indigenous	-0.077***	-0.056**
Has long-term health condition	-0.034***	-0.198***
Youngest child aged 0-4		-0.332***
Youngest child aged 5-14		-0.061***
Youngest child aged 0-4 x Male		0.310***
Youngest child aged 5-14 x Male		0.070***
Cognitive ability		
Backward Digits Span (BDS)	0.000	-0.001
Symbol Digits Modalities (SDM)	0.001***	0.004***
National Adult Reading Test (NART-25)	0.001***	0.003***

Source: Deloitte Access Economics. Note: *** represents significance at the 1% level; ** at the 5% level; and * at the 10% level. Base categories are: no post-school qualification, FoE Arts, and Aged 25-29. Coefficient estimates for: year fixed effects, state, remoteness area, household family structure are not reported for brevity.

C.1.4. Application to this report

Using the estimates from the regression analysis, it is estimated that approximately 58% of the earnings premiums associated with the average bachelor qualification[32] is attributable to the effects of their higher education qualification. The remaining 42% is attributable to a combination of demographic and cognitive factors.

These shares were applied to the average employment outcomes by qualification level (based on the 2016 ABS Census) to provide the most up-to-date view on the expected additional lifetime earnings for the average Australian university graduate that is attributable to the qualification.

C.2. Estimating the public benefits of university teaching

To estimate the *public market benefits* associated with a university education – which include increased returns to other factors of production and tax revenues – Deloitte Access Economics' in-house computable-general equilibrium model (DAE-RGEM) is utilised. The utilisation of a CGE model in this context allows the broader economic impacts of higher education to be simulated.

This section describes the method used to simulate the economy-wide impacts for a given increase in the supply of higher education graduates (alongside a given decrease in individuals without post-school qualifications), and a description of DAE-RGEM.

C.2.1. Simulating a shock

Deloitte Access Economics simulated an illustrative scenario where 10,000 individuals with no post-school qualifications ended up with 'average' bachelor level qualifications (as given by the composition of the existing labour force by field of education).

However, recognising that the total difference in labour market outcomes between bachelor holders and high school leavers can be attributed to the qualification, a series of adjustments were made to only capture the labour market benefits associated with the qualification.

For instance, for an illustrative example of providing 1,000 typical individuals with no post-school qualification a bachelor level engineering degree, the following steps would need to be taken (Figure C.1):

- Calculate the wage premium associated with an average engineering graduate over a high school leaver. The average engineering graduate earns 120% more than their high school leaver counterpart.
  - Use econometric results on the proportion of the wage premium attributable to the qualification. It is 38% for the case of engineering. Consequently, the qualification-specific wage premium over high school leavers is 45% (120% x 38%).
  - Use the qualification-specific wage premium to adjust for the number of additional 'average' individuals to be added to engineering. The part attributable to the qualification is equal to 659 individuals.
- From the 659 average engineering graduates and 1,000 high school leavers, determine the resultant labour supply based on the skill-specific participation rates. The average participation rate for engineering graduates between the ages of 25-64 is 90%, compared to 70% for high school graduates. This gives a participation rate premium of 29%.
  - Similar to the method used for the wage premium, attribute a proportion to the qualification. In this case, it is 38%. The qualification-specific participation rate premium is 11% (38% x 29%).
  - Consequently, 700 high school leavers will be taken from the labour supply (1,000 x 70%), while 512 engineering graduates will be added (111% x 70% x 659).
- While employment is determined within the model, an out of model adjustment to the labour supply is required to account for the qualification premium associated with lower unemployment rates for the engineering graduates.

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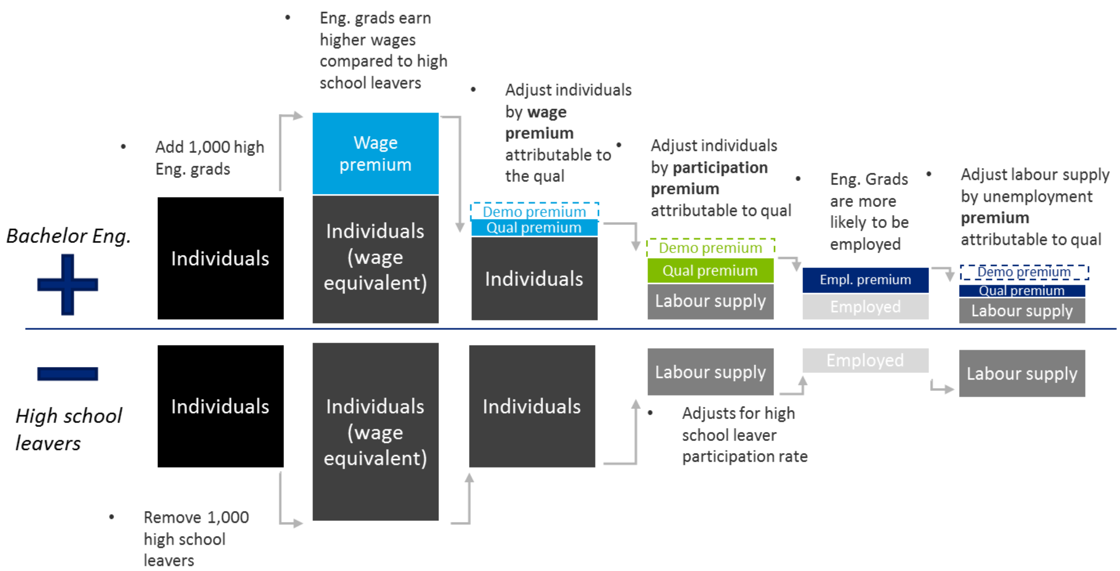
[32] The individual results for the different fields of education were weighted based on the composition of the 2016 working age population with bachelor degrees as their highest qualification level (ABS census).

  - Using the skill-specific unemployment rates from the DAE-RGEM baseline results, determine the number of employed persons out-of-model for the two skill categories. For instance, bachelor engineering graduates face an average unemployment rate of 3.4% compared to 8.1% for high school leavers. This represents a premium (in employment) of 5 percentage points.
  - Attributing a share of the employment premium to the degree (71%), the qualification adjusted premium is 3.5 percentage points.
  - Consequently, to mimic a qualification-adjusted unemployment rate of 4.9%, and employment of 487 individuals, the labour supply for engineering needs to be shocked by an additional 503 units to account for the full unemployment rate of 3.5%.
- The adjusted labour supply is then inputted as a simulation the model. To represent a movement of 1,000 individuals from high school leavers into bachelor graduate, 700 individuals will be taken out of the labour supply for high school leavers, and 503 individuals will be added to the labour supply of bachelor engineering graduates.

Figure C.1: Premium adjustment framework for labour supply shock generation



In addition to adjusting the shock to only capture the qualification effect, the following adjustments were also made:

- **Accounting for foregone labour supply during students' studies.** It is assumed that for the three years that students take to complete their undergraduate studies, they supply less labour.[33] The typical full-time student works 12 hours per week, while the typical part-time student works 30 hours per week during study periods (Universities Australia, 2018). It is assumed that they earn the same per hour wage as their high school leaver counterparts.
- **Accounting for earnings premiums over individuals' working lives.** ABS census data on average wages, unemployment rate and participation by qualification level was used to capture the differing earning premiums over an individual's working life. As seen in Chart 2.2, the premium tends to peak when individuals are in their 40s before decreasing.

C.2.2. Out-of-model adjustments

Based on the time-dynamic shocks, the DAE-RGEM produces on a variety of outputs comparing a 'baseline' path of the economy where the skills mix of the economy does not change, with a 'policy' path of the economy where the skills mix has been shocked exogenously.

[33] Note that this is illustrative, and undergraduate students in some fields of education, such as enginerring, may study for longer than three years.

The Gross National Product (GNP) deviation resultant from the change in the skills mix is defined as the **total benefits**. GNP is the most appropriate measure of benefits as it discounts for foreign ownership of capital, where the returns will flow out of the economy.

The **private benefit** is defined as the additional post-tax income received by the marginal individuals who are moved into a higher skill category:

$$Private\ benefit\ = policy\ post\ tax\ wages\ for\ marginal\ graduates -$$

$$baseline\ post\ tax\ wage\ for\ marginal\ school\ leavers$$

The *policy* wage for the marginal higher education graduates is compared to the *baseline* wage for the high school leavers to account for the price effect of wages lowering as additional workers join a particular skill category.

Using the pre-tax income (model output), the post-tax income is calculated out of model. This is because income taxes in the CGE model are based on average tax rates, and cannot account for the higher marginal taxes paid as worker income increases. Without adjustment, this could potentially underestimate the share of public benefit.

The broad methodology is as follows:

- Work out average tax rates from the 2018-19 tax rates, including income tax and the Medicare rebate for the tax brackets
- Adjust the average baseline and policy pre-tax incomes received by high school leavers and higher education graduates by the tax rates derived above
- Calculate the marginal tax rate paid on the additional income by the average worker
- Apply the marginal tax rate to the total additional pre-tax income received by the marginal individuals who are moved into a higher skill category.

The **public benefits** are then defined as the difference between the total and private benefits. In addition to the additional taxation paid by the marginal movers into the higher skill category, other public benefits and costs include:

- Net payment to other factors, including other workers, and to capital
- Direct taxes paid by other factors of production and indirect taxes paid on goods and services production.
- Net transfer income overseas from additional foreign investment in Australia.

C.2.3. Overview of the CGE model

A change in any one part of the economy will have impacts that reverberate throughout the entire economy. For example, the building of a new mine will involve increased economic activity in the mining industry but it will also have a range of impacts in other parts of the economy:

- There will be effects up and down **the supply chain**. As a sector expands it will draw in an increased volume of intermediate inputs from related sectors resulting in an increased demand for their output and an expansion in production. If the expansion in the sector is demand driven (especially foreign demand) then the price of its output will increase putting pressure on those who use it as an intermediate input meaning their production may contract.
- The expansion in both the sector directly affected and those which supply it will result in an increased competition in **factor markets** (like those for labour and capital). Factors will move between industries in response to changes in demand and the price (wage) they can earn. This will result in the 'crowding out' of some activity in competing sectors as they lose workers and capital.
- At an aggregate level (across the whole economy) there may be an increase in demand for labour such that it induces increased labour supply (the encouraged worker effect) or an inflow of capital as relative rates of return shift. This **induced factor supply** enables an expansion of

the economy, meaning more income and consumption which can stimulate sectors oriented toward this.
- If the expanding sector is export-oriented, then the expansion of its production which resulted in increased export income could be associated with a positive shift in the terms of trade. However, this positive effect – in conjunction with an inflow of investment – would increase demand for local currency, causing **real exchange rate** appreciation with consequences for other exporting industries.

CGE models, are the best-practice method available for examining the impacts of a change in one part of the economy on the broader economy as they can capture the multitude of impacts highlighted above. Not only can CGE models account for these effects, the results from the models can be used to build a narrative which stakeholders respect – because it is based on accepted economic theory and the latest data – and one which is easily understood.

DAE-RGEM

The Deloitte Access Economics regional general equilibrium model (DAE-RGEM) belongs to the class of models known as recursive dynamic regional CGE models.[34] Other examples of models in this class are the Global Trade and Analysis Project Dynamic (GDyn) model, the Victoria University Regional Model (VURM) and The Enormous Regional Model (TERM).

Like GDyn, DAE-RGEM is a global model, able to simulate the impact of changes in any of the 140 countries in the GTAP database (including Australia) onto each of the 140 countries. The ability to incorporate the flow-on impacts of changes that may occur in rest of the world is a key feature of global models that is not available in single-country models, such as the VURM Model or TERM.

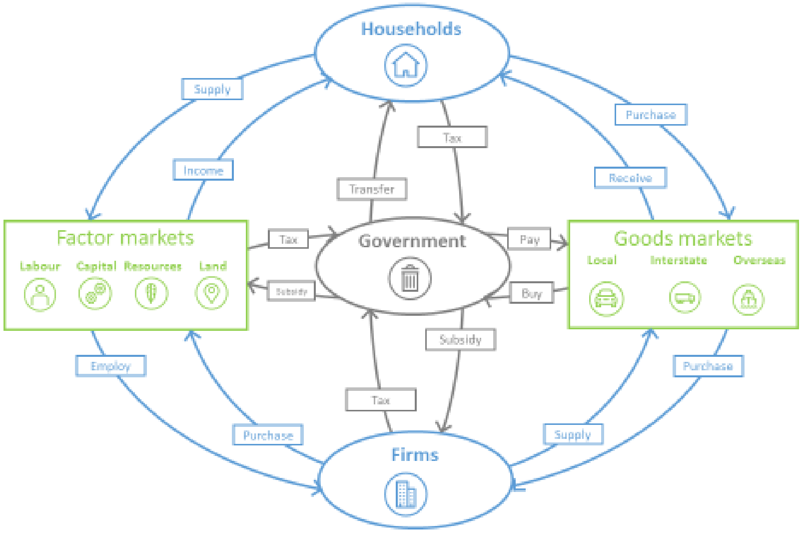
However, like those models, DAE-RGEM is a bottom-up model of regional Australia. So DAE-RGEM is able to project the impacts on different States and sub-State regions of Australia of changes occurring in any region of Australia or in rest of the world within a single, robust, integrated economic framework.

This model projects changes in macroeconomic aggregates such as GDP, employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports by commodity and employment by industry are also produced.

The following diagram gives a stylised representation of DAE-RGEM, specifically a system of interconnected markets with appropriate specifications of demand, supply and the market clearing conditions determine the equilibrium prices and quantity produced, consumed and traded.

[34] In North America the term Applied General Equilibrium (AGE) is also used.

Figure C.2: A stylised representation of DAE-RGEM



The model rests on the following key assumptions:

- All markets are competitive and all agents are price takers
- All markets clear, regardless of the size of the shock, within the year.
- It takes one year to build the capital stock from investment and investors take future prices to be the same as present ones as they cannot see the future perfectly
- Supply of land and skills are exogenous. In the business as usual case, supply of natural resource adjusts to keep its price unchanged; productivity of land adjusts to keep the land rental constant at the base year level.
- All factors sluggishly move across sectors. Land moves within agricultural sectors; natural resource is specific to the resource using sector. Labour and capital move imperfectly across sectors in response to the differences in factor returns. Inter-sectoral factor movement is controlled by overall return maximizing behaviour subject to a CET function. By raising the size of the elasticity of transformation to a large number we can mimic the perfect mobility of a factor across sectors and by setting the number close to zero we can make the factor sector specific. This formulation allows the model to acknowledge the sector specificity of part of the capital stock used by each sector and also the sector specific skills acquired by labour while remaining in the industry for a long time. Any movement of such labour to another sector will mean a reduction in the efficiency of labour as a part of the skills embodied will not be used in the new industry of employment.

DAE-RGEM is based on a substantial body of accepted microeconomic theory. Key features of the model are:

- The model contains a 'regional household' that receives all income from factor ownerships (labour, capital, land and natural resources), tax revenues and net income from foreign asset holdings. In other words, the regional household receives the gross national income (GNI) as its income.
- The regional household allocates its income across private consumption, government consumption and savings so as to maximise a Cobb-Douglas utility function. This optimisation process determines national savings, private and government consumption expenditure levels.
- Given the budget levels, household demand for a source-generic composite goods are determined by minimising a CDE (Constant Differences of Elasticities) expenditure function. For most regions, households can source consumption goods only from domestic and foreign sources. In the Australian regions, however, households can also source goods from interstate. In all cases, the choice of sources of each commodity is determined by minimising

the cost using a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function defined over the sources of the commodity (using the Armington assumption).
- Government demand for source-generic composite goods, and goods from different sources (domestic, imported and interstate), is determined by maximising utility via Cobb-Douglas utility functions in two stages.
- All savings generated in each region are used to purchase bonds from the global market whose price movements reflect movements in the price of creating capital across all regions.
- Financial investments across the world follow higher rates of return with some allowance for country specific risk differences, captured by the differences in rates of return in the base year data. A conceptual global financial market (or a global bank) facilitates the sale of the bond and finance investments in all countries/regions. The global saving-investment market is cleared by a flexible interest rate.
- Once aggregate investment level is determined in each region, the demand for the capital good is met by a dedicated regional capital goods sector that constructs capital goods by combining intermediate inputs in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these intermediate inputs subject to a CRESH aggregation function.
- Producers supply goods by combining aggregate intermediate inputs and primary factors in fixed proportions (the Leontief assumption). Source-generic composite intermediate inputs are also combined in fixed proportions (or with a very small elasticity of substitution under a CES function), whereas individual primary factors are chosen to minimise the total primary factor input costs subject to a CES (production) aggregating function.

C.3. Estimating the interest costs associated with teaching and learning

The study estimates that there is an interest subsidy of approximately $600 per undergraduate completion. This is calculated as:

- For those individuals that pay their HECS-HELP debt upfront, there is expected to be no additional interest subsidy costs. They represent approximately 10% of students of domestic undergraduate students (Universities Australia, 2018).
- For those individuals who are expected to not repay their debts, the interest costs will accrue over their life. This represents 17% of all debt (Department of Education and Training, 2018). This share could potentially decrease as a result of the reduction to the compulsory repayment income threshold.
- For the average individual who pays off their debt, the interest will apply over the period of repayment. As of 2017-18, individuals make their first compulsory repayment 5.3 years after they first incur any debt, with the debt repaid in full after 9.08 years (Department of Education, Skills and Employment, 2019c). They represent the remaining 73% of students.

Limitation of our work

General use restriction

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