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Abstract

The study analyses the impacts of selected regional universities on regional economies within Australia using a multi-regional CGE model, VU-TERM. Universities enhance a community's knowledge base through teaching and research, raising productivity within the region. To depict the regional economic contribution of universities, we simulate a hypothetical removal of regional campuses. We estimate demand-side shocks using expenditure patterns of university enrolees. Supply-side impacts use inputs from econometric studies estimating rates-of-return to levels of educational attainment. Armidale's local economy is hit hardest by a hypothetical removal of its university. Other regions suffering substantial losses include Ballarat, Toowoomba and Rockhampton.

JEL Classification Codes: C68, O18

Keywords: CGE Modelling, Regional Universities, Economic Contribution

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I Introduction

Regional universities can provide substantial positive contributions to regional economies. The presence of a university provides more career development opportunities within a region. Tertiary students from elsewhere, either within Australia or overseas, increase regional demands for local goods, services and housing. The presence of a local university may open up the possibility of local synergies between industries or essential services and the university (Uyarra, 2010).

However, recent cuts in the federal funding to Australian universities have impacted disproportionally on universities located in regional Australia. Nationally, a 2017 report by Universities Australia showed that "… students and universities have contributed around $3.9 billion in net savings between 2011–12 and 2016–17.[1] Details of the Commonwealth Government's December 2017 freeze to university funding, made available in June 2018, confirmed a further $2.3 billion of cuts to university funding over the period 2018-2021, equivalent to a 4.5 per cent decrease in funding. But as summarized in Table 0 below, a number of university members of the Regional Universities Network (RUN) face funding cuts over this period which are considerably higher than the national average. The sensitivity of regional universities to these funding cuts is exacerbated by the fact that regional universities do not have the endowment and reputation of leading Australian universities like the G8, making them more vulnerable to downturns in public funding.

TABLE 0 *Estimated funding cuts to RUN universities, 2018-21*

	Funding decrease	
RUN-member University	%	$m
Southern Cross University (SCU)	5.7	33
The University of New England (UNE)	3.2	25
Federation University Australia (FED)	5.9	29
Central Queensland University (CQU)	15	147
University of the Sunshine Coast (USC)	8.7	66
University of Southern Queensland (USQ)	3.1	29

Source: ABC News (2018)

The objective of this study is to simulate the economic contribution that these regional universities make to their respective regional economies. To do so, we adopt the approach of Madden (2017) to economic contribution, and conduct a simulation to answer the following question: "What would the regional economy where each RUN-member university has a campus look like if the campus had never existed?" We simulate the hypothetical removal of the regional campuses of universities that are members of the RUN using a Computable General Equilibrium (CGE) model of the Australian economy with sufficient regional detail to separately identify the SA3 regions which are home to a RUN-member university's regional campus. The losses that would result at the regional level from

[1] See "The Facts on University Funding" (April 2017), available from https://www.universitiesaustralia.edu.au/Media-and-Events/submissions-and-reports/The-facts-on-university-funding.

not having a local campus arise from several direct effects. First, regional universities are an important employer in regional communities. Absence of a campus would weaken the local job market. Adjustment at the local level is likely to result through a combination of lower real wages and inter-regional migration. Some university staff would have found jobs at other universities. Others would have remained in the community, in all probability with lower paid jobs. Others would have participated less in the labour force.

Absence of a university campus would mean lower demands for local services with a consequent drop in local income (approximated in the CGE model by total value added or GDP). This would mean lower demand for restaurants, health services, entertainment, community services, transport services and other local services. Lower demand would also see lower local prices relative to otherwise, notably in the housing market.

In addition to lower local demands, skill acquisition arising from the presence of a local university would diminish in the community. This is evident in data from the Graduate Outcomes Survey showing that a substantial proportion of graduates from a regional university remain to take on employment within that region. For example, health services are an important employer in regional communities. Without a university, health-related professions would rely increasingly on training from outside of the region.

In addition to skill acquisition associated with university attendance, universities provide pervasive but small productivity improvements across all industries. For example, research in agricultural science disciplines contributes to productivity improvements that extend beyond the local region. We have not modelled the local productivity benefits that may arise from synergies between a regional university and, for example, a regional teaching hospital. Such synergies may be possible within both the teaching program and the provision of some health services.

Table 1 summarizes the economic structure of the regions in which individual campuses of RUN-member universities are located. Clearly these vary widely. For example, Armidale has the largest university activity as a share of total regional economic activity. Consequently, Armidale's local economy is hit harder by a hypothetical removal of its university than other RUN regions. The final row of Table 1 reports regional Gross Domestic Product, providing an indication of the relative size of the economies of these different regions.

The paper proceeds as follows. In the next Section we describe the methodology used to determine the economic impact that RUN-member universities have on their regional economies. We describe the CGE model used for the study, and detail the data and process used to determine the impact that these regional universities have on local demand and supply in their respective regional economies. In Section III we describe the assumptions made to close the model so that we simulate the long-run economic impacts of RUN-member universities. Results reported in Section III highlight the range of impacts that RUN-member universities have on their regional economies, contributing 3.5 to 12.9 per cent to GDP and 1.9 to 9.6 per cent to employment in the region where the dominant campus is located. Section IV concludes.

TABLE 1

Economic structure of each region (industry share of total regional value added, %)

	CQU								FED			SCU			UNE	USQ		USC		
	RockhmptnQld	MackayQld	GladstoneQld	BundabergQld	CentHlndQld	TownsvillQld	CairnsSthQld	NoosaQld	BallaratVic	LatrobeVlVic	GrampiansVic	RichValHnNSW	Coolangatta	CoffsHrbrNSW	ArmidaleNSW	ToowoombaQld	IpsSprRdbQld	BuderimQld	GympiCoolQld	HerveyBayQld
Primary	14.1	26.1	14.0	14.0	51.9	5.7	4.5	4.5	4.1	8.5	29.9	5.3	3.2	3.6	9.0	7.7	3.0	6.3	12.5	8.4
FoodProds	2.7	3.2	0.3	4.7	0.2	1.3	1.2	0.9	3.8	1.5	3.2	9.4	0.7	1.3	0.9	2.8	3.9	1.4	3.8	1.0
AlcoSmokes	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.2	0.1	0.5	0.1	0.3	0.0	0.3	0.0	0.1	0.0	0.1	0.0
HholdGoods	2.5	3.3	23.0	3.0	1.9	3.4	2.5	1.8	4.1	6.1	2.6	4.6	3.4	3.7	1.7	4.1	7.1	3.2	9.7	4.0
ClothingFtwr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0
CarCosts	1.1	1.2	0.8	2.0	0.9	1.1	1.5	1.1	2.3	1.3	1.2	2.2	1.0	1.8	1.3	1.6	1.8	1.5	2.0	1.8
Utilities	5.9	1.6	5.4	1.8	1.3	2.8	2.2	1.3	1.7	17.6	2.2	1.7	1.6	1.5	1.6	2.1	1.8	1.5	1.8	2.3
OthService	38.0	35.3	31.5	45.3	26.0	51.2	53.2	63.6	48.8	38.3	33.5	44.8	60.0	56.0	46.9	48.3	52.1	58.1	44.9	52.0
Transport	11.0	10.4	10.9	3.5	5.1	5.6	5.9	1.8	3.1	2.0	4.1	2.7	2.3	3.0	2.1	4.6	7.2	1.9	3.8	3.4
AirTransport	0.3	0.5	0.4	0.1	0.2	0.3	1.2	0.2	0.0	0.0	0.0	0.0	1.3	0.5	0.0	0.1	0.2	0.3	0.0	0.0
OwnerDwellng	8.4	7.9	7.1	9.3	6.9	8.4	9.9	10.9	9.4	7.6	7.8	10.6	10.2	10.9	11.4	9.1	9.0	10.4	9.6	10.5
OthEducation	4.5	3.1	2.5	5.3	2.2	5.0	5.1	4.6	5.8	4.8	4.1	5.6	4.8	6.0	5.0	5.3	3.9	4.0	4.3	5.2
TertiaryEdu	1.7	0.4	0.3	0.4	0.2	1.8	0.5	0.9	3.0	1.0	0.3	2.5	1.1	0.8	12.1	2.4	0.9	2.2	0.4	0.4
Health	5.3	3.8	2.1	6.4	1.7	6.8	6.7	5.3	8.0	5.6	6.2	6.4	6.0	6.5	4.5	6.4	4.9	6.2	4.0	7.1
ChildComCare	4.1	2.7	1.6	3.2	1.3	6.0	4.5	2.0	4.4	5.0	3.6	2.9	2.3	3.2	2.4	4.9	3.5	2.1	2.6	3.3
RecreatEnttn	0.3	0.2	0.2	0.4	0.2	0.5	1.0	1.0	1.2	0.5	0.7	1.1	1.4	1.1	0.7	0.4	0.4	0.8	0.4	0.5
ExpEdu	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
GDP ($ bn)	8.1	9.1	6.1	4.0	2.9	14.2	5.9	2.1	5.6	4.9	3.5	3.3	3.1	4.4	1.9	9.6	11.8	3.2	2.2	2.1

Source: CoPS VU_TERM database

II Study method

Universities have a range of effects on the regional economies in which they are located.[2] A university's operations increase demands for local goods, services and housing. Potential impacts are greater than local demand increases.[3] Due to the nature of their output – primarily teaching and research – universities have an effect on the community's knowledge base, and thus act to raise productivity, both in the university's own region and in other regions to which the new knowledge spills over.

There have been numerous regional economic impact studies of particular universities, mainly using input-output models which capture the multiplier effects of university expenditure in the region -- see Florax (1992) and Giesecke and Madden (2006). The literature on the knowledge effects of universities has been largely by way of econometric studies (see Florax (1992) and Henderson (2007)). The present study follows the general approach of Giesecke and Madden (2006) and Madden (2014 and 2017) in modelling both local expenditure impacts and knowledge impacts.

In the remainder of this section, we discuss our approach to modelling the contribution made by the regional campuses of the six universities that are members of the Regional Universities Network (RUN) to their local economy. The major innovations in the present study relate to the local area under examination. Giesecke and Madden (2006) analysed the economic effects of the University of Tasmania that is the only university within its state. Subsequent regional CGE studies of higher education by Hermannsson *et al*. (2014) and Madden (2014) model all universities in aggregate in regions (Scotland and Queensland respectively) where cross-border commuting is limited, while Madden models local effects of a university located in a district of a large metropolis.[4] Here we examine the economic effects of RUN-member regional campuses, which are typically located at a distance from state capitals.

(i) The Economic Model: VU-TERM

In the master database of VU-TERM, there are 192 industry sectors in 334 SA3 regions. In the version of VU-TERM used for the study, the model has been aggregated to 17 industry sectors (see Table A1 in Appendix) in 24 regions. The 24 regions correspond to the SA3 region in which each regional campus of the RUN-member Universities is located: CQU (8 campuses); Federation University (3 campuses); Southern Cross University (3 campuses);

[2] There is an extensive literature on the benefits of universities to their local economies (see, for instance, Florax, 1992, Feldman and Desrochers, 2003, Drucker and Goldstein, 2007, Fritsch and Slavtchev, 2007, Dalziel et al., 2009, and Harris *et al*., 2011). We confine ourselves to only economic effects. Universities can also have non-market benefits, both of a private and public nature, but we do not deal with those in this study. See McMahon (2009) for a discussion of non-market benefits.

[3] Different industries can have varying regional economic impacts due to the composition and geographical sourcing of their inputs. A characteristic of the education industry is that, like certain other service industries (e.g. those operating tourist attractions, and sports and other events), it attracts out-of-region visitors who increase local demand. This attribute is dealt with in items (ii) and (iii) below.

[4] Giesecke and Madden (2006), Madden (2014) and Hermannsson *et al.* (2014) all model changes in the sizes of universities, while Madden (2017) examines the local economic contribution of a university.

University of New England (1 campus); University of Southern Queensland (2 campuses); University of the Sunshine Coast (3 campuses); one rest-of-state region for each of New South Wales, Queensland, and Victoria, and an aggregate rest-of-Australia region. The RUN-member University regional campuses and the postcodes contained in each campus' SA3 region are detailed in the Appendix in Table A2.

In VU-TERM, each industry produces a single commodity. Investment is allocated across industries to maximise rates of returns to investors (households, firms). Capital creators assemble, in a cost-minimizing manner, units of industry-specific capital for each industry. Each region has a single representative household and a single government agency. Finally, there are foreigners, whose behaviour is summarised by export demand curves for the products of each region and by supply curves for international imports to each region.

As is standard in CGE models, VU-TERM determines the supply and demand for each regionally-produced commodity as the outcome of optimising behaviour of economic agents. Regional industries are assumed to choose labour, capital and land so as to maximize their profits while operating in a competitive market. In each region a representative household purchases a particular bundle of goods in accordance with the household's preferences, relative prices and its amount of disposable income. Regions are linked via interregional trade, interregional migration and capital movements. For a detailed description of the theoretical structure of the VU-TERM model, see Wittwer (2012).

(ii) Treatment of foreign students with VU-TERM

Of particular relevance to this study is VU-TERM's specific treatment of overseas students, captured by a separate exports-of-education ("ExpEdu") sector. This sector takes account of education export fees plus the living expenses of overseas students. Household demands in the original CGE database that reflect living expenses of students become intermediate inputs into "ExpEdu". There were 645,185 international enrolments in 2015 in Australia, equal to about 2.5% of the national population. Of these, 363,421 were enrolled in the tertiary sector, of which 8,552 were accounted for by international students attending a RUN-member University regional campus. Expenditure shares for international students are lower than the population share for some commodities, but not air transport.

We identify two separate effects that universities have on their regional economies (Giesecke and Madden, 2006). First, a "demand-side effect" reflects the impacts that a university's presence has on local expenditures. Second, universities contribute a "supply-side effect" through their teaching and research activities, raising the productivity of graduates who gain a tertiary qualification (a positive effect on labour productivity) and improving the productivity of industrial activities overall by producing research (a positive effect on all-factor productivity). The demand-side effects as they relate to RUN-member Universities are described in greater detail in *(iii),* while the two supply-side effects, labour-productivity and research productivity are described in *(iv)*.

(iii) Demand-side effects

To determine the effect of RUN-member University enrolments on demand in each region, we begin with the information about student expenditure patterns from Western *et al.* (2005), who report estimates of weekly spending for international higher education students in Australia. The expenditure data in Western *et al.* (2005) are used directly to determine an estimate of the expenditures of overseas students at RUN-member University regional campuses. We assume an international full-time student spends 40 weeks each year in the region in which they are enrolled, and exclude all out-of-region expenditure. The data in Table 12 of Western *et al.* (2005) are for 2004. These data are converted to 2016 values using the ratio of consumer price indices of 2016 and 2004 for the state in which the campus is located (ABS cat. 6401.0, Table 5).

These updated data from Western *et al.* (2005) allow us to model the expenditure patterns of international students at RUN-member regional campuses. But to determine the expenditure patterns of domestic students, we need to recognize that these will vary depending on the student's mode of study and the location of their home residence relative to the campus they attend. Students whose permanent residence is within commuting distance of their campus will spend only a fraction of their total expenditures on campus, and students who study via external mode typically attend lectures remotely and spend almost no time on campus.

To proceed, we use data on 2016 campus enrolments reported in Table 2[5] that decompose total enrolments into the following categories:

- overseas: students whose reported home residence is overseas;
- intra-region – internal: students whose reported home residence is in a postcode which is within the SA3 region in which the campus is located and whose mode of study is internal;
- intra-region – external and multi-mode: students whose reported home residence is in a postcode which is within the SA3 region in which the campus is located and whose mode of study is external or multi-modal;
- intra-state – internal: students whose reported home residence is in the state but not the SA3 region in which the campus is located and whose mode of study is internal;
- intra-state – external and multi-mode: students whose reported home residence is in the state but not the SA3 region in which the campus is located and whose mode of study is external or multi-modal;
- interstate - internal: students whose reported home residence is in a state other than that in which the campus is located and whose mode of study is internal; and
- interstate – external and multi-mode: students whose reported home residence is in a state other than that in which the campus is located and whose mode of study is external or multi-modal.

Following Giesecke and Madden (2006), we assume that the living costs of inter-state and intra-state students who study via internal mode are 80 and 60 per cent of those for overseas

[5] The enrolment data in Table 2 include full-time and part-time commencing and continuing students by campus. These data are converted to equivalent full-time student load (EFTSL) figures using EFTSL-to-enrolment ratios for domestic and international students at each RUN-member university.

students, respectively. This reflects the likelihood that a proportion of these students may have permanent residences within weekly or daily commuting distance of their campus.[6] Intra-state and inter-state students studying via external mode are assumed to behave like intra-region students, with expenditures that are 10 per cent of those for overseas students. Intra-region students will live in their region whether or not they were studying on campus, so their expenditure multipliers are 0.1, except for those on housing, utilities and entertainment/recreation expenditures, whose multipliers are 0. This methodology allows us to calculate estimates of expenditures for all students attending RUN-member University campuses in 2016.

[6] Giesecke and Madden (2006) assumed that this intra-state student multiplier was 0.5, but their study looked at students in Tasmania. Since RUN-member campuses are located in much larger states, the proportion of students with permanent residences within a reasonable commute of campus will be smaller, so we use a multiplier of 0.6 instead of 0.5 for these students.

TABLE 2

Campus enrolment by origin of student

		postcode	SA3	Overseas	Domest	Intra-region		Intra-state		Inter-state	
						Internal	Extern.	Internal	Extern.	Internal	Extern.
CQU	Rockhampton	4702	30803	160	12416	1520	1110	667	6949	61	2109
	Mackay	4740; 4741	31202	6	633	541	18	61	1	11	1
	Gladstone	4680	30802	4	151	149	1	1	0	0	0
	Bundaberg	4670	31901	24	793	680	41	61	6	5	0
	Emerald	4720	30801	0	16	1	0	14	0	1	0
	Townsville	4810	31802	0	63	49	8	5	0	1	0
	Cairns	4870	30602	2	89	64	6	19	0	0	0
	Noosa	4566	31605	1	182	66	4	103	6	3	0
Federation Uni	Ballarat	3350	20101	599	5980	2347	77	2736	374	306	140
	Churchill	3842	20504	46	1552	725	3	802	9	12	1
	Horsham	3400	21501	0	21	20	1	0	0	0	0
Southern Cross	Lismore	2480	11202	174	8419	1081	472	1193	3180	236	2257
	Gold Coast	4225	30902	716	2996	462	45	1029	137	1173	150
	Coffs Harbour	2450	10402	25	1264	715	90	348	78	27	6
U New England	Armidale	2351	11001	1100	20689	621	647	2204	11116	372	5729
U Sth. Queenslnd	Toowoomba	4350	31701	3645	20717	2499	1889	1587	10700	205	3837
	Springfield/Ipswich	4300; 4305	31003; 31004	168	2548	1261	0	1260	0	27	0
U Sunshine Coast	Sippy Downs	4556	31601	1568	11284	2573	13	8445	78	163	12
	Gympie	4570	31903	0	238	222	0	16	0	0	0
	Fraser Coast	4655	31904	4	496	351	0	145	0	0	0

Source: Student enrolments across all RUN campuses from 2014-2016, mapped using ABS ASGS Correspondences.

(iv) Supply-side effects

The supply side effects capture the two principal contributions that are made by universities on the supply-side of the economy: teaching and research. The former results in a labour force that is more skilled, evidenced by the tertiary qualifications held by RUN-member University graduates. These translate into improved labour productivity, the quantification of which is outlined in subsection (v). Productivity improvements derived from RUN-member University research activities are detailed in subsection (vi).

(v) Labour productivity

The primary data source for labour productivity shocks is the file "DS_GOS_RUN2013-16.xlsx" [This file is the institute-specific outputs of the Graduate Outcome Survey from 2013-2016, supplied by RUN Strategic Information & Analysis Unit. The Graduate Outcomes Survey (GOS) is a national survey of recent higher education graduates being conducted for the Australian Government Department of Education and Training by the Social Research Centre, see https://www.srcentre.com.au/our-research/graduate-outcomes-survey] that reports the location of workplace by postcode of RUN-member University graduates over the period 2013-2016. For example, data reported in this file tell us that in 2016, 218 CQU Bachelor degree graduates were working in a postcode that is within the SA3 region of a CQU campus. A further 200 CQU Bachelor graduates were working in Queensland but in a postcode which is not within the SA3 region of a CQU campus. Table 3 reports the number of students working intra-region or intra-state for all RUN-member Universities by award category (Diploma, Bachelor, GradDip, MAPhD).[7] Clearly there are large differences between RUN-member Universities in the share of graduates who work in a region in which the same RUN-member University has a campus. University of New England has only one campus, and far more UNE graduates work intra-state (ie: in New South Wales but not in Armidale) than intra-region.

CQU graduates are the exception. For qualifications other than Masters and PhD degrees, more graduates from CQU are employed in CQU postcodes than elsewhere intra-state. A number of possible reasons may explain this. In Table 2, we see that less than 2% of enrollees at CQU are from overseas, whereas the proportion for all universities shown in Table 2 exceeds 9%. This alone might push up the proportion of graduates employed locally. It could be that differences in course offerings between CQU and elsewhere, perhaps based on the relative isolation of CQU campuses, influence the different proportions of graduates employed locally. An explanation of differences in graduate patterns is beyond the scope of the present study.

To translate these employment figures into labour productivity effects, we need to resolve the following issues:

[7] More specifically, "Diploma" includes the award categories Advanced Diploma (AQF), Associate Degree, Diploma (AQF), and Enabling; "Bachelor" includes Bachelor's Graduate Entry, Bachelor's Pass, Bachelor's Graduate Honours, Postgrad. Qual. Prelim and Non-award courses; "GradDip" includes Graduate certificate, Graduate (post) dip. (ext. area) and Graduate (post) dip. (new area); "MAPhD" includes Master's by coursework, Master's by research, PhD by coursework and PhD by research.

1. employment figures in Table 3 are based off the Graduate Student Survey, which only samples a fraction of total graduates, a smaller proportion of whom respond (n≈6,500 surveyed, while N≈20,000 population of graduates from RUN);
2. results from the Graduate Student Survey are at the University level - we need results at the campus level;
3. university graduates should be modelled as receiving a wage premium, the major component of which represents increased skills acquired through their university studies.

To deal with (1), we assume that the Graduate Student Survey is representative, and apply a multiplier of 20/6.5 to the data in Table 3 to arrive on total graduates employed. To deal with (2), we allocate RUN-member graduates by University in Table 3 across RUN-member regional campuses using enrolment shares by award category calculated from the enrolment data in the file "RUN enrol data 2014 – 2016.xlsx" [This data contains information on student enrolments across all RUN campuses from 2014-2016, supplied by RUN Strategic Information and Analysis Unit, and is consistent with Higher Education uCube data, see: http://highereducationstatistics.education.gov.au/. Mapping between postcode (POA) to SA3 used the ABS Australian Statistical Geography Standard (ASGS) Correspondences, see: http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Correspondences] To resolve item (3), we follow Madden (2017) and multiply the number of intra-region employees by a wage premium earned according to award type. We use the wage premia from the "log hourly wage" regressions that assume 10 per cent upwards ability bias reported in Table 4 in Leigh (2008:244).[8] In particular, Diploma graduates are assumed to receive a wage premium of 13 percent, Bachelor graduates a premium of 32 per cent, Graduate Diploma students a premium of 35 per cent, and PhD graduates a premium of 41 per cent.

TABLE 3

RUN-member graduates employed by region and award

	Diploma	Bachelors	GradDip	MAPhD	Diploma	Bachelors	GradDip	MAPhD
	Central Queensland U – intra-region				Central Queensland U – intra-state			
2013	29	297	106	21	16	171	91	64
2014	28	327	94	25	27	174	98	49
2015	23	336	84	22	19	200	77	56
2016	21	218	55	16	17	200	35	21
	Federation U – intra-region				Federation U – intra-state			
2013	6	131	71	13	26	257	106	51
2014	1	185	29	21	1	336	57	86
2015		183	23	33	2	285	117	106
2016	1	18		18	3	45	4	27
	Southern Cross U – intra-region				Southern Cross U – intra-state			
2013	12	204	26	18	35	284	38	55
2014	8	175	25	16	21	270	41	47
2015	6	168	21	14	22	245	51	61
2016	7	107	16	24	16	171	24	34
	U of New England – intra-region				U of New England – intra-state			
2013	3	73	8	20	12	371	129	148

[8] We assume that the wage premia by award category are the same for each year over 2013-2016.

2014	1	72	14	35	28	458	185	167
2015	1	86	11	36	23	460	184	178
2016	1	69	7	20	31	437	121	179
	U of South Queensland – intra-region				U of Southern Queensland – intra-state			
2013	16	203	28	59	62	411	122	157
2014	12	243	41	59	71	354	141	181
2015	16	205	41	49	56	368	148	144
2016	15	203	33	68	73	359	166	166
	U of Sunshine Coast – intra-region				U of Sunshine Coast – intra-state			
2013	0	128	18	19	2	456	44	52
2014	0	133	13	19	2	508	54	64
2015	0	145	13	30	0	582	37	39
2016	0	77	10	13	6	444	55	64

Source: Graduate Outcome Survey from 2013-2016

These adjustments to the data in Table 3 allow us to estimate the number of graduates working in each region in which a RUN-member campus is located, reported in Table 4.

TABLE 4
RUN graduates employed in region

CQU	Rockhampton	1521	SCU	Lismore	535
	Mackay	53		Gold Coast	213
	Gladstone	9		Coffs Harbour	94
	Bundaberg	53	UNE	Armidale	481
	Emerald	0	USQ	Toowoomba	1215
	Townsville	9		Springfield/Ipswich	100
	Cairns	1	USC	Sippy Downs	608
	Noosa	25		Gympie	5
FED	Ballarat	680		Fraser Coast	23
	Churchill	64			
	Horsham	8			

Source: Graduate Outcome Survey from 2013-2016

Of course, the actual number of RUN-member graduates working in each region could be larger than the figure reported in Table 5, since we do not account for students who graduated before 2013. And the number may be smaller since 2013 graduates who were working in a RUN-member campus region may have moved to a different region. Ideally we would adjust the data in Table 5 to account for the probability of relocation, and use a longer time series to include students who graduated before 2013. Since these data are not available, we use the data in Table 5 on graduates working in each region and regard these data as conservative.

(vi) Research productivity

We measure the contribution of university research activity as the sum of the value of research income and the value of the time spent undertaking research activity by academics. Research income by RUN-member University is available from Higher Education Research Data

Collection (HERDC).[9] [HERDC data used is the HERDC timeseries maintained by Universities Australia, "HERDC time-series data dating back to 1992 (XLSX)", see: www.universitiesaustralia.edu.au/australias-universities/key-facts-and-data/Research-Intensity---Output, which is an accessible summary of the Higher Education Research Data Collection, see: https://www.education.gov.au/higher-education-research-data-collection] To get an estimate of the value of time spent undertaking research activity, we follow the process outlined in Madden (2017:17). ABS (2014) biennial data for research income by state include the category "General university funds", which is an estimate of time spent at research activity by academics. If the share of "General university funds" out of total research income reported by the ABS is $x \in (0,1)$, then the remainder (1-x) must be external research income as reported in HERDC. If we assume that the share of the value of research time for each RUN-member University is the same as the state average x, then the total value of research activity (i.e., the sum of research income plus the value of academics' time at research) will be given by 1/(1-x) times the value of RUN-member University external research income as reported in HERDC. Table 5 reports total HERDC research income (in $'000) as well as the share of the value of research time x for each RUN-member University, for each two-year period since 1992 (data in ABS (2014) are biennial).[10] These data are used to determine the total value of research activity for each RUN-member university. For example, in 2016, the total value of research activity for UNE would be $31,268.1·[1/(1-0.509)] = $63,682.5 thousand.

The next step is to determine each RUN-member University's contribution to the total stock of research knowledge. This will be given by the summation of the value of research activity over the entire period 1992-2016, presuming that the stock of research knowledge depreciates. Following Madden (2017), we suppose that the stock of research knowledge depreciates at a rate of 10 per cent per year. Finally, we use the most conservative estimate of the rate of return on the stock of research knowledge reported in Madden (2017), and adopt a value for this rate of return of 25 per cent. For more detail, see the discussion in Section 3.2.2 of Madden (2017:16-19).

[9] See https://www.education.gov.au/search/site/data.

[10] Note how the general decrease in the shares made up by "General university funds" in Table 2.5 reflect the trend that Universities are now relying more on external research funds.

TABLE 5

Total HERDC research income ($'000) and ABS share of General University Funds

	1992-93	1994-95	1996-97	1998-99	2000-01	2002-03	2004-05	2006-07	2008-09	2010-11	2012-13	2014-15	2016
CQUniversity	$1,996	$3,104	$4,639	$5,107	$6,573	$8,966	$10,412	$12,071	$12,223	$13,135	$17,072	$16,247	$7,604
	0.668	0.668	0.627	0.631	0.635	0.645	0.65	0.566	0.51	0.548	0.543	0.542	0.542
FederationUn	$777	$1,022	$1,933	$2,606	$4,630	$7,340	$10,173	$10,124	$10,587	$7,026	$7,159	$10,639	$4,847
	0.574	0.574	0.608	0.586	0.583	0.592	0.591	0.503	0.495	0.567	0.593	0.561	0.561
SouthCrossU	$844	$1,530	$6,131	$7,552	$9,218	$11,633	$17,480	$19,758	$18,209	$23,802	$26,555	$23,514	$11,508
	0.667	0.667	0.67	0.625	0.648	0.637	0.629	0.504	0.566	0.524	0.533	0.509	0.509
UNewEngland	$17,676	$19,281	$18,172	$17,802	$20,126	$26,875	$31,471	$34,648	$33,491	$38,791	$58,202	$63,499	$31,268
	0.667	0.667	0.67	0.625	0.648	0.637	0.629	0.504	0.566	0.524	0.533	0.509	0.509
USouthernQld	$1,527	$2,696	$3,407	$4,728	$6,392	$11,085	$8,077	$9,513	$11,161	$15,040	$17,455	$26,106	$14,754
	0.668	0.668	0.627	0.631	0.635	0.645	0.65	0.566	0.51	0.548	0.543	0.542	0.542
USunshCoast	$0	$0	$0	$283	$735	$1,277	$1,489	$3,073	$5,440	$6,879	$14,052	$23,420	$14,683
	0.668	0.668	0.627	0.631	0.635	0.645	0.65	0.566	0.51	0.548	0.543	0.542	0.542

Source: Calculated using HERDC timeseries maintained by Universities Australia, "HERDC time-series data dating back to 1992"

As in Section 2.4.1 for the labour productivity shocks, the data in Table 5 reflect the return on each RUN-member University's stock of research knowledge. These data need to be disaggregated across RUN-member regional campuses. To do so, we disburse each RUN-member University's return to its stock of research knowledge across regional campuses using each campus' share of Master's and PhD students. Ideally, we would use data on the share of research-active academic staff by campus, but these data are not available. Nonetheless, Master's and PhD students shares are likely to be quite similar to those on research-active staff by campus, since more staff engaged in research will work at larger campuses with larger enrolments of postgraduate students. We assume that none of the returns to the stock of research knowledge accrue specifically to the region in which the RUN-member University campus is located. Rather, the returns to the stock of research knowledge are shared equally across all regions in Australia. This implies that we have not considered the possible gains that may arise from synergies between a local university and local businesses or essential services. This was due to a lack of data.

III Simulation assumptions and results

In order to assess the economic contribution of each RUN-member University's regional campus, we need to devise a simulation that projects what each regional economy as well as the economies of the other Australian regions would look like if the RUN-member regional campuses did not operate in their respective SA3 regions (i.e. the hypothetical or counterfactual scenario). When each campus is removed we assume that a share of university activities are re-located elsewhere in Australia. We conduct a counterfactual simulation that provides the long-run effects of such a hypothetical removal and partial relocation.

The implied assumption underlying this simulation is that it incorporates full adjustment to this hypothetical removal and partial relocation, thus mimicking the counterfactual of each RUN-member University having had no regional campuses for many years.[11] Hence, we assume that the aggregate level of Australian employment is unaffected by the presence of any RUN-member University's regional campus. Instead, the aggregate level of Australian employment is dependent in the long run on demographic and industrial relations factors. At the national level the real wage adjusts to accommodate this. At the regional level, labour is imperfectly mobile. This means that as a region's labour market weakens relative to other regions, regional adjustment occurs through a combination of migration to other regions, higher regional unemployment and lower real wages than other regions in the long run.

[11] Recall that the research productivity effect was calculated using discounted research income back to 1992, a sufficient period to justify the counterfactual of each RUN-member University having had no regional campus for many years.

The rate of return on capital for each regional industry is assumed not to be affected by the location of RUN-member University regional campuses in the long run. Rather, rates of return are modelled as being dependent on the world interest rate level. Investment in individual regional industries is assumed to move approximately in line with changes in their long-run capital stocks.

To simulate the removal of RUN-member regional campuses, we introduce shocks to the model that reflect the effects that a campus' presence has on regional demand and supply as described in Section 2, as well as the effects on the Rest of Australia when a portion of university activities are relocated. We reduce demand in each region by the aggregate of expenditures by all domestic and overseas students studying via internal and external mode, by introducing the shocks to VU-TERM detailed in Table 6. For example, to simulate removal of CQU's Rockhampton campus, we reduce demand for processed food products by 1.08 per cent, the share of total spending in Rockhampton on processed food products accounted for by domestic students. Shocks to reflect the absence of overseas students are reflected in the final "ExpEdu" column. Notice how the shocks in Table 6 reflect the characteristics of enrolments in Table 2: Shocks are larger in the region's dominant campus (ie: Rockhampton for CQU or Sippy Downs for USC) and much smaller for the regional campuses with small enrolments. While Sippy Downs at USC and Rockhampton at CQU have a comparable number of intra- and inter-state students, a larger share at Sippy Downs study via internal mode while most at Rockhampton study via external mode. As a result, the negative demand shocks are larger at Sippy Downs than Rockhampton. Finally, we assume that when a RUN-member regional campus is removed, ¼ of the students study elsewhere in Australia, and introduce shocks that increase demand in the Rest of Australia by ¼ of the aggregate of expenditures by all domestic and overseas students at the campus that closes.

TABLE 6:

Demand shocks due to RUN-member campus removal

		Primary	FoodProds	AlcoSmokes	HholdGoods	ClothingFtwr	CarCosts	Transport	AirTransport	OwnerDwellng	OthEducation	TertiaryEdu	Health	ChildComCare	RecreatEnttn	ExpEdu
CQU	Rockhampton	0.00	-1.08	-0.86	-0.02	-0.35	-0.20	-0.11	-0.40	-0.25	-0.53	-0.27	-0.19	0.00	-0.18	-35.41
	Mackay	0.00	-0.04	-0.05	0.00	-0.02	-0.01	-0.01	-0.02	-0.02	-0.04	-0.02	-0.02	0.00	-0.02	-13.51
	Gladstone	0.00	-0.01	-0.01	0.00	-0.01	0.00	0.00	-0.01	0.00	-0.01	-0.01	-0.01	0.00	0.00	0.00
	Bundaberg	0.00	-0.10	-0.10	0.00	-0.05	-0.02	-0.02	-0.05	-0.04	-0.10	-0.05	-0.03	0.00	-0.03	-52.28
	Emerald	0.00	-0.02	-0.02	0.00	-0.01	0.00	0.00	-0.01	-0.02	-0.02	-0.01	-0.01	0.00	-0.01	0.00
	Townsville	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cairns	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00
	Noosa	0.00	-0.12	-0.08	0.00	-0.02	-0.03	-0.03	-0.03	-0.11	-0.18	-0.08	-0.06	0.00	-0.06	-7.08
FED	Ballarat	0.00	-2.65	-1.79	-0.08	-1.00	-0.46	-0.52	-1.01	-1.57	-1.29	-0.62	-0.39	0.00	-1.72	-32.90
	Churchill	0.00	-1.17	-0.73	-0.02	-0.43	-0.19	-0.16	-0.41	-0.62	-0.39	-0.20	-0.11	0.00	-0.65	-8.89
	Horsham	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCU	Lismore	0.00	-1.96	-1.80	-0.07	-0.79	-0.35	-0.76	-0.78	-1.03	-1.65	-0.88	-0.67	0.00	-1.17	-26.17
	Gold Coast	0.00	-2.46	-1.69	-0.05	-0.74	-0.54	-0.43	-0.70	-1.91	-2.32	-0.88	-0.86	0.00	-1.44	-32.69
	Coffs Harbour	0.00	-0.41	-0.23	-0.01	-0.08	-0.05	-0.10	-0.09	-0.20	-0.21	-0.13	-0.08	0.00	-0.18	-19.06
UNE	Armidale	0.00	-9.31	-5.30	-0.23	-2.18	-1.26	-2.76	-2.10	-2.61	-5.30	-1.74	-2.44	0.00	-2.92	-35.99
USQ	Toowoomba	0.00	-1.36	-1.14	-0.03	-0.61	-0.26	-0.18	-0.54	-0.41	-0.59	-0.23	-0.22	0.00	-0.32	-19.45
	Springfield/Ipswich	0.00	-0.33	-0.28	-0.01	-0.16	-0.06	-0.04	-0.13	-0.23	-0.22	-0.11	-0.08	0.00	-0.21	-22.17
USC	Sippy Downs	0.00	-9.15	-6.90	-0.20	-3.20	-1.92	-1.76	-3.24	-6.85	-8.65	-2.58	-3.31	0.00	-6.14	-31.79
	Gympie	0.00	-0.07	-0.06	0.00	-0.03	-0.01	-0.01	-0.03	-0.02	-0.07	-0.03	-0.02	0.00	-0.02	0.00
	Fraser Coast	0.00	-0.30	-0.21	-0.01	-0.09	-0.06	-0.05	-0.11	-0.17	-0.29	-0.14	-0.10	0.00	-0.14	-10.94

Source: Author calculations

To simulate the changes in labour productivity due to a removal of the RUN-member regional campuses, we construct negative productivity shocks by dividing the estimates of graduates working in each region in Table 4 by regional employment. As with the demand shocks, we assume that ¼ of RUN-member graduates represented in Table 4 would work in the Rest of Australia upon closure of the RUN-member regional campus, and apply a positive labour productivity shock to the Rest of Australia region.

TABLE 7

Supply shocks due to RUN-member campus removal (%)

		Labour product	Research product			Labour product	Research product
CQU	Rockhampton	3.33	0.0018	SCU	Lismore	2.07	0.0025
	Mackay	0.11	0.0018		Gold Coast	0.94	0.0025
	Gladstone	0.04	0.0018		Coffs Harbour	0.29	0.0025
	Bundaberg	0.18	0.0018	UNE	Armidale	3.28	0.0056
	Emerald	0.00	0.0018	USQ	Toowoomba	1.96	0.0021
	Townsville	0.01	0.0018		Springfield/Ipswich	0.13	0.0021
	Cairns	0.00	0.0018	USC	Sippy Downs	2.62	0.0015
	Noosa	0.16	0.0018		Gympie	0.03	0.0015
FED	Ballarat	1.57	0.0011		Fraser Coast	0.13	0.0015
	Churchill	0.23	0.0011				
	Horsham	0.03	0.0011				

Source: Author calculations

Finally, the counterfactual assumes that when the RUN-member University campus is relocated, only ¼ of the returns to the stock of research knowledge are retained. Since we assume that the returns to the stock of research knowledge are shared equally across all regions in Australia, removal of any of the RUN-member universities implies the same negative shock to research productivity in all regions in Australia.

Simulation results

The values of the economic effects that the presence of the regional campuses of RUN-member Universities have on their region are detailed in this Section. All tables report results where only ¼ of the labour and research productivity effects is retained in some other region(s) in the counterfactual simulation.[12] Table 8a reports results for the simulation of removing the

[12] As a less conservative counterfactual simulation, we also run simulations in which ¾ of the students in RUN campuses would study elsewhere in Australia. Consequently, ¾ of the labour productivity effects accrue to other regions in Australia, and ¾ of the returns to the stock of research knowledge are retained. For directly affected campus regions, the two assumptions generate almost identical impacts. This is so because we effectively assume that of the ¼ or ¾ of the residents who study elsewhere, none return to their region of origin. That is, when CQU's Rockhampton campus closes, ¼ of those who studied there go on to study elsewhere in Australia, but none return to Rockhampton after completing their studies. This is likely to be not too far from observed

Central Queensland University's campus. Tables 8b and 8c report results for the other five RUN-member University campuses. All variables are reported in percentage changes, except real GDP results are also reported in $ million and employment in full-time equivalent workers.

The employment loss in the long run in Rockhampton relative to retaining the campus is similar to direct campus job losses. 2016 ABS census data indicate that 2% of Rockhampton's workforce is employed in the tertiary education sector. Input-output analysis, which assumes quantity adjustments without price or wage adjustments, would result in local employment multipliers and hence larger local job losses. But in VU-TERM, the long run adjustment to regional labour market weakening due to campus removal entails a combination of migration out of the region and a decline in regional real wages relative to national real wages. That is, we do not assume that the regional labour market adjustment is perfectly elastic, in which case real wages would adjust by the same percentage across all regions. The lower real wage in Rockhampton (-1.9%, Table 8a) relative to the national wage (-0.1%, not shown) in the long run alleviates to some extent regional job losses.

TABLE 8A

Effects of CQU campus removal on regional macroeconomic variables
(% change from base)

Central Queensland University	Rockhampton	Mackay	Gladstone	Bundaberg	Emerald	Townsville	Cairns	Noosa
Real private consumption	-3.8	-0.4	-0.3	-0.9	-0.1	-0.1	-0.1	-0.5
Real private investment	-3.2	-0.2	-0.1	-0.6	0.0	-0.1	-0.1	-0.5
Average real wage	-1.9	-0.2	-0.2	-0.5	-0.1	0.0	-0.1	-0.3
Aggregate employment	-1.9	-0.2	-0.2	-0.5	0.0	0.0	-0.1	-0.2
Agg. employment (units)	-870	-97	-38	-133	-5	-29	-22	-39
Capital stocks	-2.9	-0.2	-0.1	-0.4	-0.1	-0.1	-0.1	-0.3
Real GDP	-4.1	-0.2	-0.2	-0.5	0.0	-0.1	-0.1	-0.4
Real GDP ($million)	-328	-22	-9	-22	-1	-7	-4	-8
GDP price index	0.5	-0.1	-0.1	-0.4	0.0	0.0	-0.1	-0.2

patterns of youth migration. For example, Hillman and Rothman (2007) note that over the period 1997-2004, "… just under three-quarters (74 per cent) of non-metropolitan young people in 1997 were still in non-metropolitan areas". If we accounted for the small share of the 26 per cent of those who were not in non-metropolitan areas and returned to Rockhampton (for example), this would slightly mitigate the losses reported for CQU-Rockhampton in Table 8A, more so if the share of graduates who studied elsewhere was assumed to be ¾. In the rest of Australia, the two assumptions provide proportionally different impacts but they are both small in percentage terms.

GNE price index	0.2	-0.1	0.0	-0.2	0.0	0.0	0.0	-0.1
Real disposable income	-3.8	-0.3	-0.2	-0.7	-0.1	-0.1	-0.1	-0.4

Source: Model simulations

We can explain regional real GDP using a back of the envelope equation: GDP =*f*(K,L,1/A) where K is capital stocks, L aggregate regional employment and 1/A productivity. In Rockhampton, L accounts for 53% of GDP on the income side and K 28%. The remaining 19% of income side GDP arises from land (unchanged) and indirect taxes (which change with economic activity). The contribution of primary factor losses to the overall GDP loss is only 1.8% [=0.53 · -1.9% + 0.28 · -2.9%] out of a total real GDP loss of 4.1%. In addition, there is a labour productivity decline in the region of 3.3%, which contributes an additional loss of 1.7% [=0.53 · -3.3%]. Most of the remaining loss arises from falling productivity associated specifically with the campus. Our assumption is that there is sharp fall in productivity of tertiary-education-specific labour and residual capital following campus removals. In Rockhampton, these industry-specific productivity losses account for most of the residual GDP losses (0.5%).

We also observe adjustment in the local housing market in the long run due to campus removals. These adjustments occur through a combination of falling prices and falling investment which in turn leads to a reduction in the housing stock. House prices in Rockhampton fall by 3.4% while the housing stock falls in quantity by 4.8% relative to base.

TABLE 8B

Effects of campus removal on regional macro variables: FED and SCU

	Federation U.			Southern Cross U.		
	Ballarat	Churchill	Horsham	Lismore	Gold Coast	Coffs Harbour
Real private consumption	-4.0	-1.2	0.0	-4.9	-2.4	-0.7
Real private investment	-4.5	-0.6	0.0	-5.3	-3.3	-0.8
Average real wage	-2.0	-0.6	0.0	-2.5	-1.2	-0.3
Agg. Employment	-2.0	-0.6	0.0	-2.5	-1.2	-0.3
Agg. employment (units)	-875	-172	-3	-639	-271	-108
Capital stocks	-3.2	-0.5	0.0	-3.4	-2.1	-0.5
Real GDP	-3.5	-0.7	0.0	-4.2	-2.1	-0.6
Real GDP ($million)	-198	-32	-1	-137	-65	-25
GDP price index	-1.3	-0.5	0.0	-1.3	-1.1	-0.2
GNE price index	-0.8	-0.3	0.0	-0.8	-0.7	-0.1
Real disposable income	-4.1	-0.9	0.0	-4.7	-2.5	-0.7

TABLE 8C

Effects of campus closures on regional macro variables: UNE, USQ, USC

	U. New England	U. Southern Queensland		U. Sunshine Coast		
	Armidale	Toowoomba	Springfield	Sippy Downs	Gympie	Fraser Coast
Real private consumption	-18.4	-4.0	-0.4	-5.5	-0.2	-0.4
Real private investment	-17.7	-3.9	-0.4	-7.7	-0.1	-0.4
Average real wage	-9.6	-2.0	-0.2	-2.8	-0.1	-0.2
Agg. employment	-9.6	-2.0	-0.2	-2.8	-0.1	-0.2
Agg. employment (units)	-1412	-1243	-133	-646	-15	-38
Capital stocks	-11.2	-3.1	-0.3	-5.7	-0.1	-0.3
Real GDP	-12.9	-3.7	-0.3	-5.4	-0.1	-0.3
Real GDP ($million)	-244	-352	-36	-170	-3	-7
GDP price index	-7.7	-1.0	-0.2	-2.3	-0.1	-0.2
GNE price index	-4.7	-0.6	-0.1	-1.6	0.0	-0.1
Real disposable income	-15.9	-4.0	-0.4	-6.1	-0.1	-0.4

Source: Model simulations

Results from Tables 8B and 8C show a similar pattern for other RUN-member campuses. For each RUN-member university's dominant campus, real GDP falls by 3.5-5.4 per cent, and aggregate employment falls by 2.0-2.8 per cent. For the smaller satellite campuses, real GDP and employment changes are typically much smaller than 1.0 per cent. As expected, the University of New England's campus at Armidale is an outlier, contributing almost 13.0 per cent to Armidale's regional GDP and 9.6 per cent to regional employment.

IV Conclusion

While the majority of Australia's 40 universities have their major campuses located in large cities, typically state capitals, university campuses can be found now in many smaller Australian cities in what is often referred to as "regional" Australia. Six universities, which have their major campus outside the state capitals, and which generally have a number of other campuses located in cities and towns in rural areas, established the Regional Universities

Network in 2011. RUN considers its member universities as important contributors to the economy of the region in which they are located. In this paper we have undertaken CGE simulations to estimate the degree to which this is so.

Our approach to estimating a university's contribution to a regional economy is to simulate the situation where the university had not been established in the region. The difference between this counterfactual and the actual regional economy is taken as the university's regional economic contribution.

The shocks required to undertake the counterfactual cover the effects of the university on both the demand-side and the supply-side of the regional economy. The demand-side shocks relate to the demands generated by the university's operation, expenditure by out-of-region and retained students and other associated demands. The demand-side effects are thus similar to other industries which involve induced tourism. Demand-side effects essentially act to pull resources into a region from other areas of the nation. Thus, while they may be important to the economy of the region itself, they have little impact at the national level.

The other set of shocks relates to the supply-side of the economy and relate to the effects of university study on human capital and in turn on labour productivity, and to university research on all-factor productivity. To the degree that regional universities add to national skill acquisition and the stock of research knowledge, these supply-side effects do affect the economy at the national level. At the regional level, they affect both the university's own region and the regions to which these "knowledge" effects spill out, via interstate migration of graduates and the typically public-good nature of research knowledge.

Simulations are conducted with the VU-TERM model, which for the current study is decomposed into 24 regions, of which 20 correspond to the SA3 regions in which RUN campuses are located. In estimating the shocks, we use data related to the RUN universities' cost structures, student numbers by home region and student living-expenses information, numbers graduating and their post-graduation destinations, wage premia after allowing for returns to signalling, and HERDC and ABS information on externally-funded research by RUN campuses and total (including general academic research) research expenditure, respectively.

The simulations show that RUN universities make a substantial contribution to those regions in which each university's major campus is located. Typical contributions are around 3 to 4 per cent of these regions' value added and about 2 to 3 per cent of regional employment. Satellite campuses tend to be smaller relative to the regional economies in which they are located. The effects of these campuses on the gross regional output of their local economies varies between 0.1 and 2.4 per cent, and is typically around half a per cent or less.

The one clear exception to these results is for Armidale, a university-town in which the University of New England (UNE) forms a major component of the city's total economic activity. UNE is shown to contribute almost 13 per cent to gross regional output and almost 10 per cent to regional employment.

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Appendix

Table A1: Aggregated industries/commodities in VU-TERM

Name	Description of major activity
1 Primary	Primary products: agriculture, mining, forestry, fishing
2 FoodProds	Processed food products
3 AlcoSmokes	Alcohol and tobacco
4 HholdGoods	Manufactured goods
5 ClothingFtwr	Clothing and footwear
6 CarCosts	Motor vehicles, petrol, car repairs
7 Utilities	Electricity, gas water
8 OthService	Other services
9 Transport	Transport services other than air transport services
10 AirTransport	Air transportation services
11 OwnerDwellng	Ownership of dwellings
12 OthEducation	Education other than tertiary education
13 TertiaryEdu	Tertiary education
14 Health	Health care services
15 ChildComCare	Child, aged and disabled care services
16 RecreatEnttn	Libraries, museums, art, sports, gambling
17 ExpEdu	Exports of education

Table A2: RUN-member University campuses, SA3 region and postcodes (local postcode in bold)

University	Campus	SA3	Intra-region postcodes
CQU	Rockhampton	30803	4699; 4700; 4701; **4702**; 4703; 4704; 4706; 4710; 4711; 4714
	Mackay	31202	4737; 4738; **4740; 4741**; 4750; 4751; 4753; 4754; 4756; 4757; 4798; 4799
	Gladstone	30802	4420; 4674; 4676; 4677; 4678; **4680**; 4694; 4695; 4697; 4715; 4716; 4718; 4719
	Bundaberg	31901	4660; **4670**; 4673
	Emerald	30801	4709; 4712; 4713; 4717; **4720**; 4722; 4723
	Townsville	31802	**4810**; 4811; 4812; 4813; 4814; 4815; 4816; 4817; 4818; 4819
	Cairns	30602	4865; 4868; 4869; **4870**
	Noosaville/Noosa	31605	4565; **4566**; 4567
Federation Uni	Ballarat	20101	**3350**; 3351; 3352; 3355; 3356; 3357
	Churchill	20504	3825; 3840; **3842**; 3844; 3854; 3856; 3869; 3870
	Horsham	21501	3317; 3318; 3319; 3374; 3375; 3377; 3378; 3379; 3380; 3381; 3384; 3385; 3387; 3388; 3390; 3391; 3392; 3393; 3395; 3396; 3400; 3401; 3409; 3412; 3413; 3414; 3415; 3418; 3419; 3420; 3423; 3424; 3477; 3478; 3485; 3487; 3488; 3489; 3491
Southern Cross	Lismore	11202	2469; 2470; 2471; 2474; 2476; **2480**
	Gold Coast	30902	4221; 4223; 4224; **4225**
	Coffs Harbour	10402	**2450**; 2452; 2453; 2454; 2455; 2456
U New England	Armidale	11001	2350; **2351**; 2354; 2358; 2365
U Sth. Queensland	Toowoomba	31701	4343; 4344; 4345; 4347; **4350**; 4352; 4358; 4400
	Springfield/Ipswich	31003; 31004	**4300**; 4301; 4303; 4304; 4305; 4306
U Sunshine Coast	Sippy Downs	31601	**4556**; 4557
	Gympie/Amamoor	31903	**4570**; 4580; 4581; 4600; 4601
	Fraser Coast/Wide Bay	31904	**4655**