Strong Research Performances by Australian Universities Depend Increasingly on Unsustainable Internal Discretionary Funding

Professor Emeritus Frank Larkins
Honorary Professorial Fellow
Melbourne Centre for the Study of Higher Education
And
School of Chemistry
The University of Melbourne

Summary: *The latest authoritative information released by the Australian Bureau of Statistics on the research and experimental development performance of the Australian higher education sector, known as HERD, provides a valuable baseline from which to assess the impact of the COVID-19 pandemic in coming years.*

The sector's research performance has strengthened over the past decade with HERD funding reaching a new expenditure high of $12.2 billion in 2018. This level of performance was possible because of the increased proportion of HERD expenditure provided from discretionary income as an outcome of exceptional growth in annual university operating revenues. In 2008 for every $100 of external funds obtained universities were providing internal R&D support of $70. By 2018 universities were supporting research to the level of $103 for every $100 externally sourced.

A new research funding profile landmark was achieved in 2018 with universities collectively using more discretionary income to fund research and research training programs than the total funds obtained from external competitive sources. This result was achieved even though the percentage of total annual operating expenditure devoted to R&D steadily decline from 41% in 2012 to 37% in 2018.The present research funding strategy is unsustainable for the future given the financial consequences of the pandemic.

Since 2008 there has been a significant shift in the type of research reportedly undertaken by universities from basic and strategic basic research to applied research and experimental development, partly because of the 30% decline in business R&D as a percent of GDP. In 2018 only 41% of all university research was classified at the basic end, down from 50% in 2008. There are serious consequences for knowledge creation and Australia's national innovation effort if this decline is not reversed.

Biomedical and Clinical Health Sciences have consistently been the dominant fields of research and the major contributor to the main socio-economic objective category. The proportion of university R&D undertaken in New South Wales and Victoria has increased over the past decade to be 59% of all activities in 2018.

Postgraduate students are the main contributors to the research workforce at around 56% of all the human resources deployed. A future with limited availability of overseas postgraduate students and the lack of ready access to research laboratories will be detrimental to the national research effort in the immediate future.

1. Introduction

The authoritative statements about the level of research and development (R&D) activities and the related longitudinal trends for the Australian higher education sector are the compilations prepared biennially since 1992 by the Australian Bureau of Statistics (ABS). The *Research and Experimental Development Performance of Australian Higher Education Organisations* reports are commonly known as HERD (1). The latest compilation released on 20 May 2020 relates to the R&D performance for 2018. The data provides a baseline from which to monitor changes due to the COVID-19 pandemic.

Over the years this author has published a series of articles examining these R&D trends. In an article published in 2011 using the 2008 HERD data clear evidence of the cross-subsidy for research from university discretionary income was presented (2). In a 2015 article (3) it was concluded from examination of 2012 HERD data that universities were then using an increasing proportion of their discretionary income to support research activities at a faster rate than overall university income growth. Research was being accorded a higher priority than teaching and learning for increased financial investment in a number of universities while the expenditure per student was in decline. In a further study in 2017 (4) the results of the 2014 HERD analysis provided more evidence that discretionary expenditure on research was growing at a faster rate than externally sourced research funding. The latest HERD data from 2018 provides the primary input for this updated study along with other relevant research performance data.

The analyses reported here provide evidence for the continuing strong R&D performance by universities, principally because of a major commitment of discretionary funding to underpin growth. This situation is less likely to continue for the foreseeable future because of the financial impact of the COVID-19 pandemic.

2. Data Sources for this Study

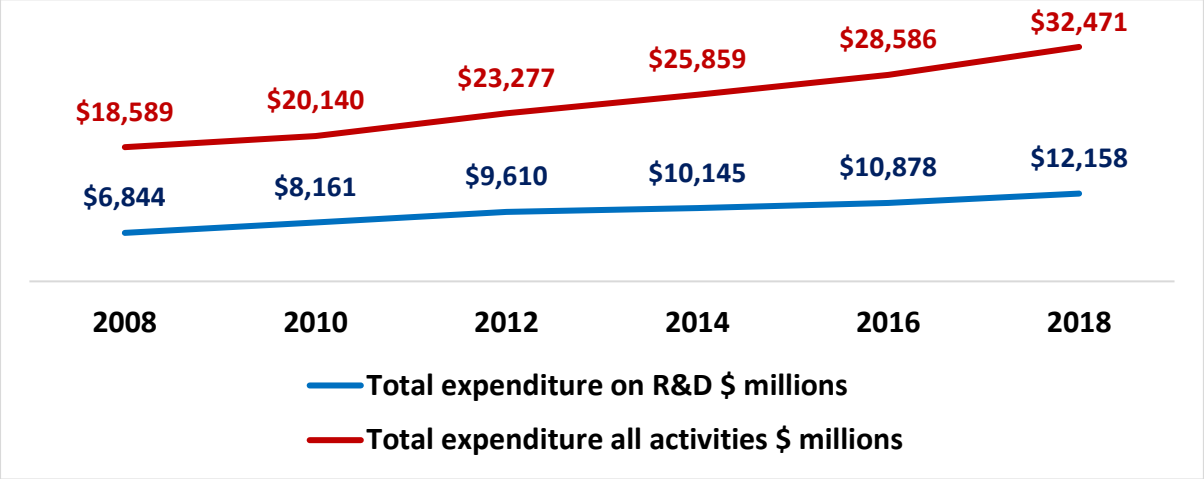
The biennial ABS HERD data from 2008 to 2018 (1) are presented in Appendix 1. Information is provided by **Type of Expenditure** – Capital and Current, **Sources of Funding** – Australian Competitive Grant and General University Funds, **Type of Activity**, **State Location of Expenditure**, **Human Resources deployed** in R&D in person years (PYE). Additional data from the Department of Education, Skills and Employment, relating to Research Block Grant data (5). Research Income Data (6) and University Finance (7) was sourced for the same period. These data are presented in Appendix 2. The ABS R&D expenditure by **Field of Research** (FOR) is given in Appendix 3 and the R&D activity by **Socio Economic Objective** (SEO) is in Appendix 4.

3. Higher Education Sector Expenditures 2008 to 2018

3.1 Total Operating and R&D Expenditures

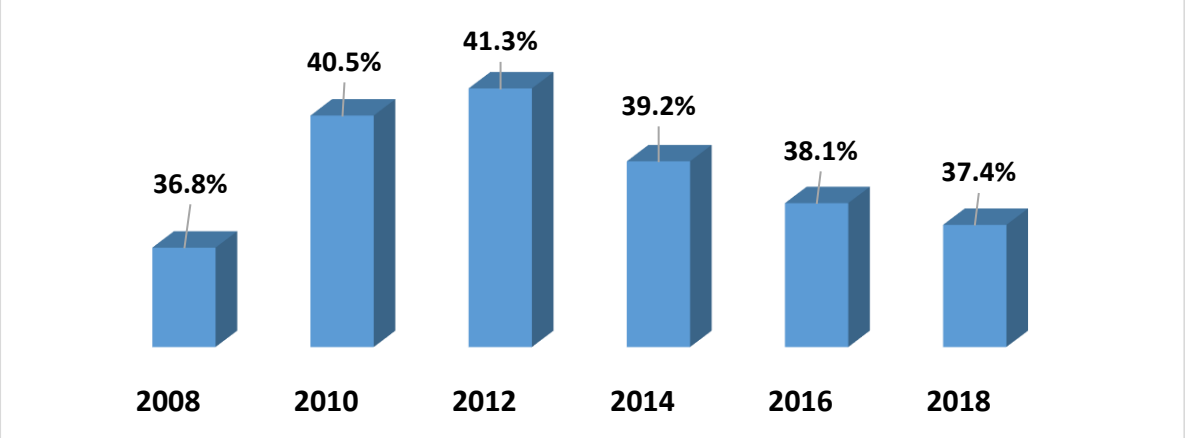
The total annual operating expenditure by universities and the R&D component (HERD) for the period 2008 to 2018 are shown in rows 2 and 8 of appendix 2 and in figure 1.

Figure 1 Total Annual Operating Expenditure and R&D Expenditure for Australian Universities 2008 to 2018 in $ million



Over this time period total operating expenditure has increase from $18.6 billion to $32.5 billion – a 75% increase. Over the same period R&D expenditure increased from $6.7 billion to $12.2 billion – a 78% increase. The proportion of research expenditure classified as capital development in 2018 is small at 8% (appendix 1, rows 4 to 6). It has declined by round 2% over the period 2008 to 2018. In aggregate over the period there has been similar growth in total expenditure and R&D expenditure, but with significant trend changes. After 2012 the R&D trend line has flattened, while the slope of the total expenditure line has increased. This change is well illustrated by plotting the R&D expenditure as a percentage of total operating expenditure, as shown in figure 2, using the data in row 11 of appendix 2.

Figure 2. R&D Expenditure as a Percentage of Total Operating Expenditure 2008 to 2018



The proportion of all university expenditure directed to R&D increased substantially from 36.8% in 2008 to 41.3% in 2012 at a growth rate of 9.0% pa. The increase in R&D funding followed from two influential higher education reviews in 2008 by Denise Bradley (8), known as the *Bradley Review*, and by Terry Cutler, known as the *Cutler Review* (9). Both reviews addressed shortcomings in the national research and innovation agenda. Of particular concern at that time was the lack of adequate funding for the indirect costs of government-sponsored university research. Bradley recommended that the contribution to the indirect costs be increased from 22 cents to 50 cents for each dollar of direct funding. The Gillard and Rudd governments both responded with some additional indirect funding along with innovation initiatives. The governments that followed did not demonstrate the same commitment to growth, especially by not maintaining the higher level of indirect funding allocations. University representatives have campaigned actively without success on this issue for many years. Another Bradley-type review would be timely.

Since 2012 the proportion of total university expenditure directed to research has declined from the 2012 level of 41.3%. For 2018 expenditure was down to 37.4%, a very similar level to 2008 at 36.8%. The R&D expenditure growth rate from 2012 to 2018 decreased to 4% pa from 9% pa for the previous period. If R&D expenditure had been maintained at the 2012 level, i.e. 41.3%, then an extra $1.25 billion would have been expended on R&D activities in 2018. Increased expenditure on teaching and learning as a result of the growth in demand-driven domestic student enrolments and fee-paying international student recruitment and significant capital works developments were contributing factors to the proportional decline in R&D activities.

3.2 Three Broad Sources of HERD Funding

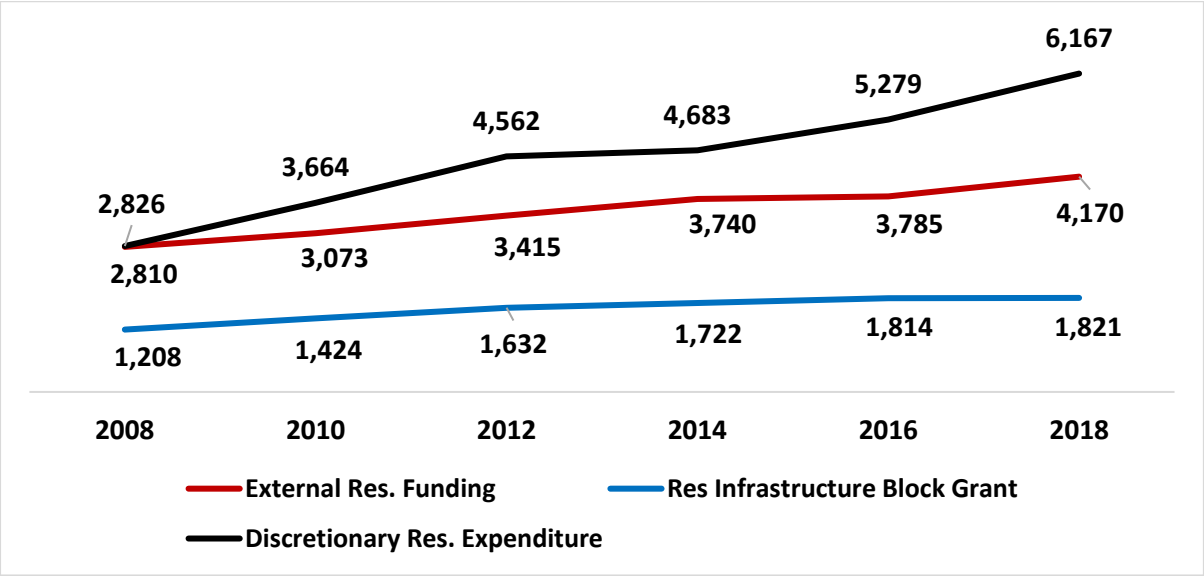
The HERD funding can be conveniently partitioned into three sources.

- The External Research Funding (ERF) for universities is compiled every year by the Department of Education as a major input into determining the performance-based annual Research Infrastructure Block Grants (RIBG) allocations to universities. The income is reported in four categories: Category 1. Australian Competitive Grant Funding; Category 2. Other Public Sector Research Funding; Category 3. Industry and Other Funding for Research; Category 4. Cooperative Research Centre Funding (6). The ERF data are presented in Appendix 2, row 3. For 2018 these funds amounted to $4.17 billion.
- The annual RIBG funding consists of two components: The Research Support Program and the Research Training Program (5). The total performance-based funding obtained by universities is shown in Appendix 2, row 4. The RIBG funding for 2018 was $1.82 billion, equivalent to 44% of the ERF funding.
- The difference between these two funding sources and the total R&D expenditure represents the additional funds universities provide from their discretionary income. The alternative use for at least some of these funds could have been additional support for teaching and learning initiatives and for non-R&D capital developments. The Discretionary Research Expenditure (DRE) may be expressed as DRE = HERD – ERF – RIBG. These data are shown in row 6 of appendix 2. For 2018 DRE funds amounted

to $6.17 billion – more than the combined sum of $5.99 billion for ERF and RIBG funding. The changes in these three components from 2008 to 2018 are shown in figure 3.

The total operating revenues for universities in 2018 were $33.7 billion (7). The non-government component of this income was $15.4 billion (46%). The sources of this income were student fees and charges, investments, royalties, contracts and miscellaneous. It is from these earnings that universities use their discretion and choose to invest in their research activities. It is reasonable to expect that this income would have increased for 2019, but 2020 is more problematic because the dominant component of the non-government income is student fees at 69%. This revenue stream is most seriously impacted by the COVID-19 pandemic.

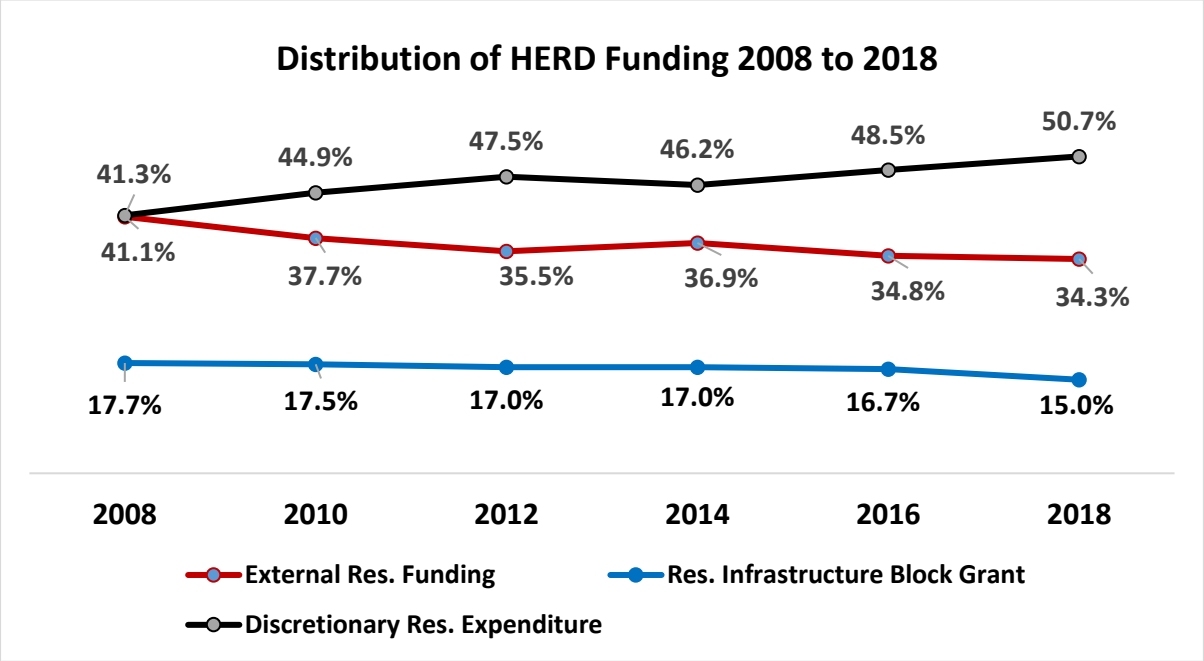
Figure 3. Sources of HERD Funding 2008 to 2018



In 2008 the ERF and the DRE outlays were very similar at $2.8 billion. By 2018 the discretionary outlays had increased to $6.2 billion – a 118% increase. The external funding had increased to $4.2 billion - a 48% increase and the RIBG funding to $1.8 billion – a 51% increase. The data provides clear confirmation of the increasing extent of cross-subsidisation of university R&D from discretionary income sources. The growth rates for the period 2008 to 2012 and for 2012 to 2018 are shown in appendix 2, columns 8 and 9 respectively. The growth rates were substantially less for the years 2012 to 2018 compared with the earlier years 2008 to 2012. The flattening of the curves in figure 3 well illustrates the trends.

The proportional change in the three components contributing to HERD is presented in figure 4.

Figure 4. Proportional Changes in the Three Contributions to HERD Expenditure 2008 to 2018.



The most notable feature of the R&D expenditure trend is the ever-increasing importance of the discretionary funding contribution from 41.3% in 2008 to 50.7% in 2018. Proportionally, both the external research funding and the RIBG funding have declined. In 2008 for every $100 of external funds obtained universities were providing internal R&D support of $70. By 2012 this figure had increased to $90 and by 2018 universities were supporting research to the level of $103 for every $100 externally sourced.

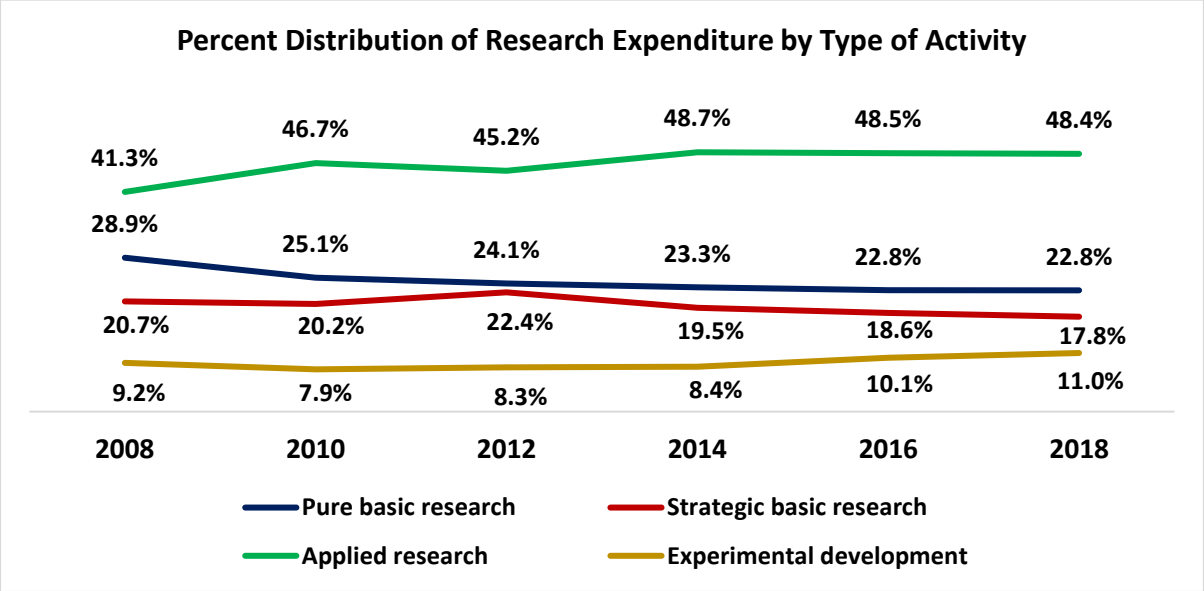
Hence, 2018 was a landmark year because universities collectively for the first time expended more discretionary income supporting research and research training programs than they obtained from externally competitive sources.

It is most probable that this trend of increased internal support for research will have continued for 2019, but 2020 and beyond is likely to be very different. While total research expenditure has declined as a proportion of total university expenditure (figure 2), the growth in discretionary expenditure since 2012 (5.2%) does reasonably reflect the growth in total university expenditure at 5.7% (appendix 2, column 9). With the expected decline in revenues for 2020 and in subsequent years, because of the impact of the COVID-19 pandemic, universities will have less discretionary funds available to commit to supporting research and research training. The momentum established over the past decade will not be sustained without increased government support for research.

4. Type of Research Activity

R&D activities are classified broadly by the ABS in accordance with the OECD Frascati Manual definitions (10) of **Basic Research, Applied Research and Experimental Development.** However, in Australia the basic research classification is separated into two parts, **Basic Research and Strategic Basic Research.** The annual expenditures for each of these four activities as reported by universities are presented in appendix 1, rows 27 to 30. The percentage distribution of these activities from 2008 to 2018 is shown in figure 5. The classifications do require value judgements to be made by university staff to classify their research. There will be variations in interpreting the definitions within and between universities as well as between biennial collections. Nevertheless, ABS does provide the most robust data set currently available.

Figure 5 Percentage Expenditure Distribution by Types of Research Activity, 2008 to 2018



It is very evident that there has been a significant shift in the nature of the research undertaken over the years from basic and strategic basic research to applied research and experimental development. This reflects changes in the source of funding from discovery-type grants to more mission-oriented targeted contract-type research. In 2008 basic-type research represented 49.6% of total R&D activity. By 2018 it was down to 40.6%. The trend to more applied research and experimental development by universities is consistent with the lower levels of business R&D in Australia. Business Expenditure on R&D (BERD) has declined by more than 30% between 2008 and 2018. (11)

The trend away from basic research should be of concern because it is from university investigations that most of the fundamental discoveries are made to underpin innovation and international competitiveness. It seems that universities are increasingly having to do more mission-oriented research because of the applied nature of directed funding and the lack of industry commitment. It would be in the national interest for sufficient research funding to be

available to universities to have near 50 percent of their R&D activities at the basic and strategic basic end of the research spectrum, as was the case a decade ago. The Group of Eight universities have commented on the importance of basic research (12 and there has been much international discussion about basic research as a core driver of knowledge creation and economic growth (13,14)

5. R&D Expenditure by Field of Research

A convenient way to gain insight into the breadth of research activity is to use Field of Research (FOR) groupings based upon the Australian and New Zealand Standard Research Classification (15). This approach has been used by the Australian Research Council for the Excellence in Research for Australia (ERA) exercises as well as by the ABS. The R&D expenditure data for 2008 and 2018 relating to the 22 FORs are presented in Appendix 3. The percentage increase over the time period for each FOR is also shown. Increases range from 39% for biological sciences to 263% for Built Environment and Design. For 2018 there were three dominant fields of research, Medical and Health Sciences $3.72 billion (an 80% increase), Engineering $1.25 billion (a 116% increase) and Biological Sciences $0.96 billion (a 39% increase).

A more convenient way to analyse the data is to group the 22 FORs into seven cluster following analyses conducted by the ARC as part of the ERA exercises. The groupings are shown in appendix 3, column 1. The consolidated data are shown in Table 1.

Table 1. R&D Expenditure by Cluster for 2018 and 2008.

Field of Research	2018	% Distribution	2008	% Distribution	Increase
Clusters	$'000s	2018	$'000s	2008	2008 to 2018
MIC: Mathematical, Information & Computing Sciences	698,033	6%	350,584	5%	99%
PCE: Physical, Chemical & Earth Sciences	1,051,966	9%	671,690	10%	57%
HCA: Humanities and Creative Arts	950,365	8%	502,450	7%	89%
EE: Engineering, and Environmental Sciences	2,192,562	18%	1,007,457	15%	118%
SBE: Social, Behavioural and Economic Sciences	2,095,050	17%	1,152,879	17%	82%
BB Biological Sciences and Biotechnology	1,447,940	12%	967,703	14%	50%
BCH: Biomedical and Clinical Health Sciences	3,721,910	31%	2,064,348	31%	80%
Total	12,157,826	100%	6,717,111	100%	81%

The 2018 percentage distribution is shown in column 3 and the 2008 distribution in column 5 of table 1. The proportional variations over the time period are minor. Most notable is that activity in the Engineering and Environmental Sciences cluster has increased at the expense of the fundamental sciences – Physical, Chemical, Earth and Biological Sciences. This expenditure outcome is consistent with an activity shift from basic to more applied research as discussed in the previous section. Consistently from 2008 to 2018 almost one-third of all

university R&D has been classified as biomedical and clinical health sciences research. Humanities and Social Sciences (clusters HCA and SBE) represent 25% of university research activities.

6. R&D Expenditure by Socio-Economic Objective

Another research activity grouping that is used by the ABS is the socio-economic objective (SEO) classification which is also part of the Australian and New Zealand Research Classification (15) scheme. The primary expenditure data for 2008 and 2018 are presented in appendix 4. Data for the major SEO categories are shown in table 2.

Table 2. R&D Expenditure by Socio-Economic Objective 2008 and 2018.

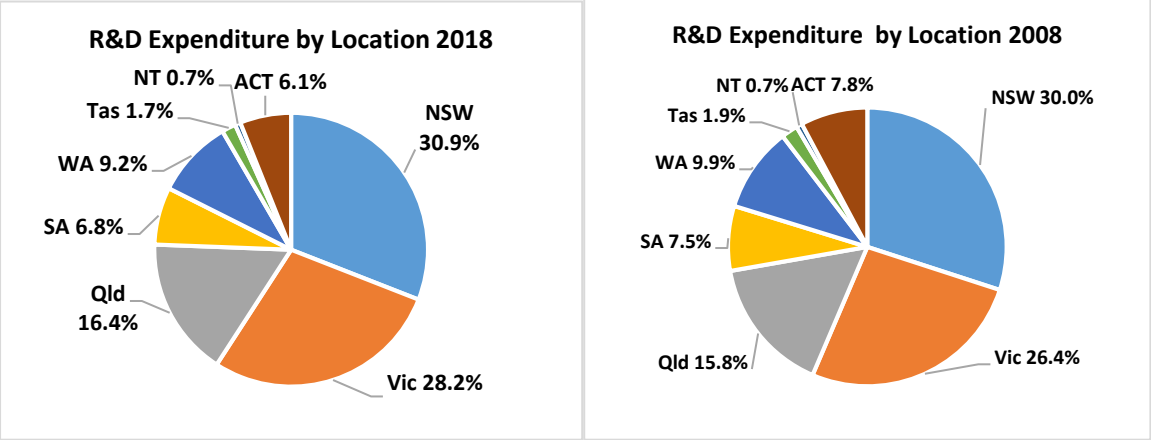
Socio-economic Objective	Expenditure 2018 $'000s	% Distribution 2018	Expenditure 2008 $'000s	% Distribution 2008	% Increase 2008 to 2018
Defence	153,572	1.3%	55,402	0.8%	177.2%
Economic Development	*3,051,921*	25.1%	*1,597,455*	23.8%	91.0%
Society	*5,843,409*	48.1%	*3,338,681*	49.7%	75.0%
Environment	1,103,148	9.1%	523,023	7.8%	110.9%
Expanding Knowledge	2,005,775	16.5%	1,202,552	17.9%	66.8%
Total	**12,157,826**	100.0%	**6,717,113**	100.0%	81.0%

Almost half the R&D undertaken is classified as Society. This is a broad SEO category including health, education, law and culture. The level of R&D activities related to Economic Development (25%) and Environment (9%) have proportionally increased slightly over time with fundamental studies in the Expanding Knowledge category in decline by 1.4%. Overall, changes in the distribution of activities since 2008 between SEO classifications are relatively minor.

7. Location for Higher Education Research Activities

As would be expected New South Wales and Victorian institutions undertake the majority of the R&D activities (see figure 6 and appendix 1, rows 32 to 39). The distribution profile has had minor changes between 2008 and 2018. In 2008 56.4% ($3.79 billion) of the R&D expenditure was in these two States. By 2018 the proportion had increased to 59.2% (7.19 billion). It is noteworthy that the remaining States and Territories, other than Queensland (16.4% to 15.8%), were undertaking a lower proportion of the national higher education R&D activities in 2018 (24.4%) compared with 2008 (27.8%).

Figure 6. R&D Expenditure by Location for 2018 and 2008



8. Human Resources Devoted to R&D

The ABS report details of the research workforce distribution in terms of person year equivalents (PYE) for academic staff, other staff and postgraduate students. The data are in appendix 1, rows 41 to 44. Overall, the human resources devoted to research have grown since 2008 by 33%, while the total R&D expenditure has grown by 78%. Academic staff increased by 31% over this period, other staff by 42% and postgraduate students by 33%. As a consequence, the human resource workforce distribution has changed very little as shown by the data in table 3. It is of concern that in the present pandemic context 56% of the R&D workforce are research students. Furthermore, 35% of research students are from overseas with three-quarters of these enrolments in science-related research degrees (16). The inability of staff and research students to access on-campus research resources is severely impacting on the breadth and level of research activities.

Table 3. Proportional Distribution of Research Workforce Profile from 2008 to 2018.

Human resources devoted to R&D %	2008	2010	2012	2014	2016	2018
Academic staff	31%	31%	31%	30%	30%	30%
Other staff	13%	12%	12%	12%	12%	14%
Postgraduate students	56%	57%	57%	57%	57%	56%

9. Conclusion

Australian universities have maintained a high level of R&D expenditure over the past decade because of their willingness to commit discretionary funds to supplement externally sourced funding. They have been driven to enhance their research performance inter alia to increase their international standing and rankings. Positioning is an important factor for being competitive in attracting international fee-paying students and winning external research funding. The 2018 situation where universities have in aggregate provided more internal funds than external funds to underpin their research activities is unsustainable for 2020 and beyond because of the financial stresses induced by the COVID-19 pandemic.

The Australian Government has in recent years enjoyed the luxury of universities self-funding up to 50 percent of their R&D activities, principally from entrepreneurial fee-paying initiatives. This level of support from universities cannot be expected to continue in the immediate future. Given the very important role universities now have in undertaking both applied research and experimental development it is clearly in the national interest for governments to increase their commitments to university research, including to basic research. It is through basic research that new knowledge is discovered leading to translational research and wealth creation for the nation.

The $900 million National Priorities and Linkage Fund (17) announced by the Minister for Education fostering industry engagement, including some research support, is a welcome initiative, but it will only partially address the issue. The Job-ready Graduates Reform Package will have limited, if any, benefits for university research (18). An important role for the Research Sustainability Working Group (19), established by the Minister, will be to convince government to provide substantial funding to offset a shortfall of several billion dollars in university earned revenue that would have been directed to research over the next five years.

Frank Larkins is currently an Emeritus Professor and Honorary Professorial Fellow at the University of Melbourne. He is a former Deputy Vice Chancellor from that university with portfolio responsibilities for research and global engagement. Many of his writings on higher education policy can be sourced from the CSHE website or from https:// franklarkins.wordpress.com

10. References

1. Australian Bureau of Statistics, *Research and Experimental Development Performance of Australian Higher Education Organisations*, Australian 2018 Published 20 May 2020 https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8111.02018
2. Larkins, F. P., *Universities Cross-Subsidised Research Activities by up to $2.7 billion in 2008*. 27th July 2011. http://www.lhmartininstitute.edu.au/insights-blog/2011/07/52-universities-cross-subsidised-research-activities-by-up-to-27-billion-in-2008 or at https://franklarkins.files.wordpress.com/2018/11/a3-higher-education-research-policy-analysis_frank-larkins_july-20111.pdf
3. Larkins F. P., *Australian Universities Increase Their Discretionary Research Investment To Enhance Reputational Competitiveness.* Published 16 March 2015 http://www.lhmartininstitute.edu.au/insights-blog/2015/03/205-universities-increased-research-investment-to-enhance-reputation. or at https://franklarkins.files.wordpress.com/2018/11/a18-flarkins_higher_education_research_18-herd_march15-2015.pdf
4. Larkins, F. P., *University Discretionary Research Expenditure Achieves Record Levels,* http://www.lhmartininstitute.edu.au/insights-blog/2017/10/262-university-discretionary-research-expenditure-achieves-record-levels or at https://franklarkins.files.wordpress.com/2018/11/university-discretionary-research-expenditure-achieves-record-levels.pdf 23rd October 2017

5. Australian Government, Department of Education, Skills and Employment, 22 December 2017, *Research Block Grants*, https://www.education.gov.au/news/2018-research-block-grant-allocations-released
6. Australian Government, Department of Education, Skills and Employment, 22 December 2017, *Research Income Data (1994-2018)*, https://docs.education.gov.au/node/47851
7. Australian Government Department of Education, Skills and Employment, *Financial Publication.* https://www.education.gov.au/finance-publication Australian Government, Department of Education, Skills and Employment, Finance Publication, 2018 https://app.powerbi.com/view?r=eyJrIjoiNThhMjNiZGEtMzlkNy00OWM5LWFmMmEtODFhN2ViNzE4ZGY1IiwidCI6ImRkMGNmZDE1LTQ1NTgtNGIxMi04YmFkLWVhMjY5ODRmYzQxNyJ9
8. Bradley, D., 2008, *Review of Australian Higher Education*, Department of Education, Employment and Workplace Relations, Canberra
9. Cutler, T., 2008, *Venturous Australia – Building Strength in Innovation*, Canberra.
10. OECD Frascati Manual, 8 October 2015, https://www.oecd.org/sti/frascati-manual-2015-9789264239012-en.htm
11. Australian Business Investment in Innovation, January 2020, page 10, https://www.industry.gov.au/sites/default/files/2020-02/australian-business-investment-in-innovation-levels-trends-and-drivers.pdf
12. Group of Eight, *The Importance of Basic Research*, 2014, https://go8.edu.au/oldcontent/sites/default/files/docs/publications/the_importance_of_basic_research-_final.pdf
13. Gersbach, H., and Schneider M. T., *On the global Supply of basic research*, Journal of Monetary Economics 75, 123, 2015.
14. Ramakrishnan, V., *Pro-science budget is not enough for a Brexit world*, Nature 551: 543, 2017
15. Australian and New Zealand Standard Research Classification, 9 May 2019, https://www.arc.gov.au/grants/grant-application/classification-codes-rfcd-seo-and-anzsic-codes
16. Larkins, F. P., *Research Students Seriously Impacted by Campus Closures*, 8 April 2020, https://campusmorningmail.com.au/news/frank-larkins-warns-research-students-seriously-impacted-by-campus-closures/ or at https://franklarkins.files.wordpress.com/2020/06/cmm3-2020-research-students-in-a-virtual-campus-environment.docx
17. National Priorities and Industry Linkage Working Group, Ministerial Media release, 1 July 2020, https://ministers.dese.gov.au/tehan/national-priorities-and-industry-linkage-fund-working-group
18. Job - ready Graduates. Department of Education, Skills and Employment, 19 June 2020, https://www.dese.gov.au/document/job-ready-graduates-discussion-paper
19. Research Sustainability Working Group, Ministerial Media release, 1 July 2020, https://ministers.dese.gov.au/tehan/national-priorities-and-industry-linkage-fund-working-group

Appendix 1 HERD Data 2008 to 2018

Expenditure on R&D $'000s	2008	2010	2012	2014	2016	2018
Type of expenditure						
Capital expenditure						
Land, buildings & other structures	407,305	549,459	732,234	549,299	487,325	715,549
Other capital expenditure	258,553	258,401	298,971	282,910	261,011	276,922
Total	665,858	807,861	1,031,205	832,209	748,336	992,471
Current expenditure $ '000s						
Labour costs	2,678,028	3,315,456	3,890,194	4,309,514	4,775,274	5,273,845
Scholarships	442,892	524,287	608,919	737,463	798,113	907,748
Other current expenditure	2,930,336	3,513,267	4,079,419	4,265,937	4,555,795	4,983,763
Total	6,051,256	7,353,010	8,578,531	9,312,914	10,129,181	11,165,355
Grand Total	6,717,114	8,160,871	9,609,736	10,145,123	10,877,517	12,157,826
Source of funds $ '000s						
Australian competitive grants						
Commonwealth schemes	1,119,782	1,290,897	1,567,964	1,745,725	1,592,006	1,700,454
Other schemes	61,442	64,662	56,733	86,332	80,835	73,656
Total	1,181,224	1,355,559	1,624,697	1,832,057	1,672,841	1,774,110
General university funds	3,522,914	4,476,912	5,340,032	5,464,897	6,075,061	6,822,562
Other commonwealth government	1,005,178	1,233,607	1,448,418	1,614,570	1,610,147	1,891,230
State & local government	400,636	419,680	419,891	374,288	420,107	457,013
Business	332,484	336,317	398,153	426,040	475,982	521,889
Donations, bequests & foundations	95,791	140,115	123,997	192,798	250,761	300,531
Other Australian	40,529	19,027	23,821	111	314	96
Overseas	138,357	179,653	230,728	240,361	372,305	390,396
Total	5,535,889	6,805,311	7,985,040	8,313,065	9,204,677	10,383,717
Type of activity $ '000s						
Pure basic research	1,941,298	2,051,418	2,312,221	2,366,560	2,477,718	2,769,006
Strategic basic research	1,389,047	1,651,849	2,153,155	1,980,751	2,019,183	2,166,901
Applied research	2,771,506	3,809,491	4,344,484	4,941,150	5,279,941	5,883,779
Experimental development	615,263	648,112	799,876	856,659	1,100,675	1,338,141
Location $ '000s						
New South Wales	2,015,432	2,389,104	2,908,529	3,160,847	3,225,973	3,761,626
Victoria	1,774,909	2,214,374	2,782,401	2,820,004	3,141,886	3,430,170
Queensland	1,061,473	1,480,154	1,557,039	1,667,540	1,918,429	1,999,861
South Australia	505,080	544,932	639,915	724,239	707,171	826,619
Western Australia	662,123	670,308	844,764	928,611	983,987	1,122,675
Tasmania	128,652	130,234	162,362	173,339	193,501	201,788
Northern Territory	46,073	49,745	65,679	68,954	73,233	79,037
Australian Capital Territory	523,370	682,021	649,048	601,589	633,338	736,049
Human resources PYE						
Academic staff	18,981	21,300	23,305	23,710	24,075	24,794
Other staff	7,970	8,530	8,897	9,510	9,720	11,276
Postgraduate students	34,359	39,561	42,467	44,819	45,212	45,647
Total human resources R&D	61,310	69,392	74,669	78,038	79,008	81,717

Appendix 2. Australian Universities Research Expenditure (HERD), External Research Funding (ERF), Research Infrastructure Block Grant Funding (RIBG), Discretionary Research Expenditure (DRE) and Total Operating Expenditure (TOE) 2008 to 2018

	2008	2010	2012	2014	2016	2018	Growth Rate 2008-2012 pa	Growth Rate 2012-2018 pa
HERD $m	6,844	8,160	9,610	10,145	10,878	12,158	9.0%	4.0%
ERF	2,810	3,073	3,415	3,740	3,785	4,170	5.0%	3.4%
RIBG	1,208	1,424	1,632	1,722	1,814	1,821	7.9%	1.9%
ERF+RIBG $m	4,018	4,497	5,047	5,462	5,599	5,991	5.9%	2.9%
HERD-ERF-RIBG= DRE. $m	2,826	3,664	4,562	4,683	5,279	6,167	12.7%	5.2%
DRE/HERD	41.3%	44.9%	47.5%	46.2%	48.5%	50.7%		
TOE $m	18,589	20,140	23,277	25,859	28,586	32,471	5.8%	5.7%
DRE/TOE	15.2%	18.2%	19.6%	18.1%	18.5%	19.0%		
HERD/TOE	36.8%	40.5%	41.3%	39.2%	38.1%	37.4%		

HERD: Higher Education Expenditure on R&D

ERF: External Research Funding

RIBG: Research Infrastructure Block Grant Funding

DRE: Discretionary Research Expenditure is equal to HERD-ERF-RIBG

TOE: Total Higher Education Sector Annual Operating Expenditure

Appendix 3 Expenditure on R&D by Field of Research and Cluster 2018 and 2008

		2018	2008	% Increase
Fields of Research	Clusters	$'000	$'000	2008 to 2018
Mathematical Sciences	MIC	225,598	132,378	70.4%
Physical Sciences	PCE	392,525	224,415	74.9%
Chemical Sciences	PCE	358,627	252,727	41.9%
Earth Sciences	PCE	300,814	194,548	54.6%
Environmental Sciences	EE	422,734	191,111	121.2%
Biological Sciences	BB	960,109	688,892	39.4%
Agricultural and Veterinary Sciences	BB	487,831	278,811	75.0%
Information and Computing Sciences	MIC	472,435	218,206	116.5%
Engineering	EE	1,245,145	577,160	115.7%
Technology	EE	274,558	170,261	61.3%
Medical and Health Sciences	BCH	3,721,910	2,064,348	80.3%
Built Environment and Design	EE	250,125	68,925	262.9%
Education	SBE	392,586	210,112	86.8%
Economics	SBE	295,711	162,719	81.7%
Commerce, Management, Tourism and Services	SBE	482,390	253,793	90.1%
Studies in Human Society	SBE	558,373	326,775	70.9%
Psychology and Cognitive Sciences	SBE	365,990	199,480	83.5%
Law and Legal Studies	HCA	231,759	85,502	171.1%
Studies in Creative Arts and Writing	HCA	156,801	82,681	89.6%
Language, Communication and Culture	HCA	295,976	161,510	83.3%
History and Archaeology	HCA	178,335	118,763	50.2%
Philosophy and Religious Studies	HCA	87,494	53,994	62.0%
Total		**12,157,826**	**6,717,113**	81.0%

MIC: Mathematical, Information and Computing Sciences
PCE: Physical, Chemical and Earth Sciences
BB: Biological Sciences and Biotechnology
EE: Engineering and Environmental Sciences
BCH: Biomedical and Clinical Health Sciences
SBE: Social, Behavioural and Economic Sciences
HCA: Humanities and Creative Arts

Appendix 4 R&D Expenditure By Socio Economic Objective 2018 and 2008

Socio-economic Objective	2018	2008
Defence $'000s	153,572	55,402
Economic Development $ '000s		
Plant Production and Plant Primary Products	439,048	192,082
Animal Production and Animal Primary Products	237,737	109,762
Mineral Resources (Excl. Energy Resources)	144,793	88,081
Energy	378,336	133,317
Manufacturing	551,310	330,524
Construction	164,637	118,169
Transport	165,236	66,805
Information and Communication Services	395,248	220,263
Commercial Services and Tourism	215,389	101,839
Economic Framework	360,187	236,614
Economic Development Total $ '000s	*3,051,921*	*1,597,455*
Society $ '000s		
Health	4,131,176	2,347,372
Education and Training	539,713	281,481
Law, Politics and Community Services	618,543	337,912
Cultural Understanding	553,977	371,916
Society Total $ '000s	*5,843,409*	*3,338,681*
Environment $ '000s	1,103,148	523,023
Expanding Knowledge $ '000s	2,005,775	1,202,552
Total $ '000s	**12,157,826**	**6,717,113**